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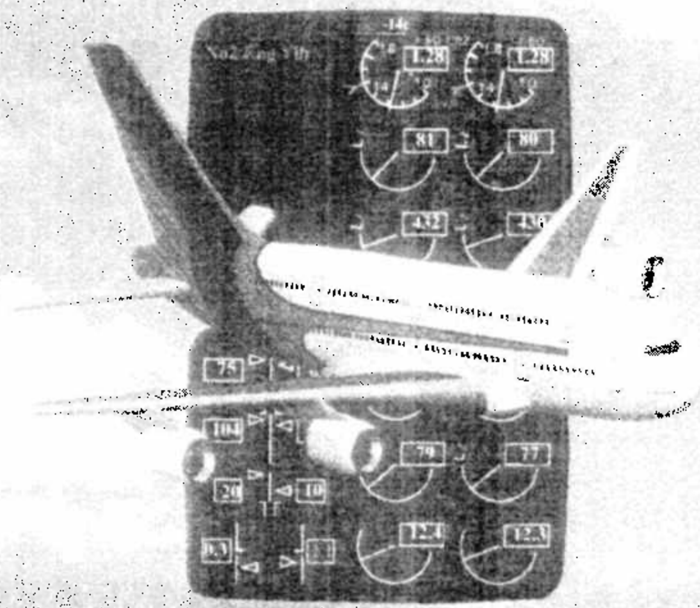

JAR ATPL(A) AND CPL(A)

INSTRUMENTS

KEITH WILLIAMS

1000 Questions

ANSWERS AND EXPLANATIONS FOR JAR ATPL(A) AND CPL(A)

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CONTENTS

SECTION 1

KEY FACTS AND COMMONLY USED EQUATIONS

INTERNATIONAL STANDARD ATMOSPHERE (ISA)	**MEAN SEA LEVEL (msl) CONDITIONS** **Static pressure:** 1013.25 hPa (or mb). 14.5 PSI, 29.92 inches of Mercury "Hg. Decreases by approximately 28 mb per 1000 ft altitude increase in the lower atmosphere. **Temperature:** 14.7° C. 287.7°K. To convert from C to k add 273. Decreases by 1.980C per 1000 ft altitude Increase up to the tropopause at approximately 36000 ft. Temperature above the Tropopause is approximately constant at –56.5°C up to approximately 65000 ft.
Calculating ISA Temperature & ISA Deviation.	To calculate the ISA temperature in the troposphere (below the tropopause) use the formula: ISA temperature = 15°C – (pressure altitude / 500) Or ISA temperature = 15°C – 2 degrees per 1000 ft above msl. For example at 10000 ft amsl: ISA temperature = 15°C – (2 x 10) = -5°C. The ISA Temperature Deviation is the difference between the actual temperature at any point in the atmosphere and the temperature that would occur at that point in the ISA. ISA Deviation = Actual Temperature – ISA Temperature For example if temperature is +10°C at 10000 ft amsl: ISA deviation = +10°C – (-5°C) = +15°C.

TOTAL AIR TEMPERATURE (TAT) AND STATIC AIR TEMPERATURE (SAT)

The movement of any object through the atmosphere tends to increase the air temperature in the immediate vicinity of the object.

Static Air Temperature or SAT is the temperature of the still air in the atmosphere before it is affected by the motion of an aircraft or any other object passing through it.

The Total air Temperature or TAT is the temperature of the air after it has been increased by the movement of an object passing through the atmosphere.

The increase in temperature caused by the movement of an object is called the RAM Rise.

TAT = SAT + RAM Rise.

Conversions between TAT and SAT can be carried out using the standard equation:

$$TAT = SAT \times (1 + (0.2 \times k \times M^2)$$

Where: k is the ram recovery factor which is a measure of the accuracy of the temperature probe. For a ROSEMOUNT Probe k is assumed to be 1.

M is the Mach number of the airflow relative to the object.

PRESSURE ALTITUDE

Pressure Altitude is the altitude indicated on a barometric altimeter when the sub-scale is set to 1013.25 mb.

The pressure altitude at any point in the atmosphere can be calculated using the standard equations:

Pressure altitude = Elevation + (30 x (1013 – QNH))

Pressure Altitude = (30 x (1013 – QFE))

EFFECTS OF VARIABLES
As pressure altitude increases the local static pressure decreases. This means that increasing static pressure decreases pressure altitude.

The static pressure in still air at any point in the atmosphere is determined by the mass of air above that point. Increasing air temperature causes the air to expand. This expansion is mainly in an upward direction, so that a greater proportion of the atmosphere is above any given point above the surface.

This increases the static pressure at any given point. So increasing air temperature decreases the pressure altitude at any given point above the surface.

This means that barometric altimeters under-read when air temperature is greater than ISA and over-read when temperature is lower than ISA.

This over-reading is potentially dangerous in that it can cause aircraft to hit high ground or obstacles.

This danger is reflected in the phrase " going from high temperatures to, low look out below".

DENSITY ALTITUDE

Whenever the actual temperature differs from ISA, the air density at any point in the atmosphere will also differ from ISA. The term Density Altitude means the altitude at which the prevailing air density would occur in the ISA.

Density altitude can be calculated using the standard equation:

Density Alt = Pressure alt + (118.6 x Temp Deviation)

Where Temp deviation = Actual Temp – ISA Temp

Always use the above formulae to calculate Density Altitude in JAR examinations because it is more accurate than any analogue navigation calculator.

EFFECTS OF VARIABLES
Increasing static pressure decreases density altitude.

Increasing air temperature increases density altitude.

CLIMBING

Climb gradient in still air = 100% x ROC/TAS.

Headwinds increases climb gradients and tailwinds decrease climb gradients.

Wind effective gradient = 100% x ROC / Ground speed

All of the speeds in the above equation, ROC, TAS and Ground speed must be in the same units. This can be done using the standard equations:

$$\text{Still air \% gradient} = \frac{\text{ROC in ft/min} \times 6000}{\text{TAS in Kts} \times 6080}$$

	And Wind effective % gradient = $\frac{\text{ROC in ft/min} \times 6000}{\text{Ground speed in Kts} \times 6080}$
RADIUS OF TURN	Radius of turn in metres can be calculated using the standard equation: Radius of turn in metres = $\frac{(\text{V in Kts} \times 0.515)^2}{\text{g TAN Angle Of Bank}}$ Where: g = gravitational acceleration (9.81 m/s^2) V = True airspeed or TAS in Kts. TAN AOB = the tangent of the angle of bank. 0.515 is the conversion factor used to convert the TAS in Kts into m/s.
RATE OF TURN	The rate of turn in radians per second can be calculated using the standard equation: ROT in radians per second = $\frac{\text{g TAN AOB}}{(\text{V in Kts} \times 0.515)}$ Where: g = gravitational acceleration (9.81 m/s^2) V = True airspeed or TAS in Kts. TAN AOB = the tangent of the angle of bank. 0.515 is the conversion factor used to convert the TAS in Kts into m/s. ROT in radians per second can be converted into degrees per second by multiplying by the conversion factor 1 radian = 57.3°. So ROT in degrees/second = $\frac{\text{57.3gTAN AOB}}{(\text{V in Kts} \times 0.515)}$ RATE ONE TURN A rate one turn is one in which the turning rate is 3 degrees per second. This means that a rate one turn requires 2 minutes to execute a full circle of 360°. An approximate value for the angle of bank required to execute a rate one turn can be calculated using the standard equation: Required AOB (in degrees) = (TAS in Kts / 10) + 7 Note: The above equation is valid only for rate one turns and speeds up to about 500 Kts.

PITOT STATIC SYSTEMS	The Pitot probe senses pitot or total pressure which is $P_{Total} = P_{Dynamic} + P_{Static}$ Static pressure is sensed by slots in the side of the probe or vents on the surface of the aircraft. Position errors are caused by the position of the sensors affecting the pressures sensed. Position errors are greatest at high angles of attack. Large aircraft use a static vent on each side to balance out errors when side slipping. **BLOCKED PITOT SOURCE** Altimeters and VSIs are unaffected because they use only static pressure. The ASI and Mach meter over indicate in climb. The ASI and Mach meter under indicate in descent. **BLOCKED STATIC VENT** The ASI, Mach meter, VSI and altimeter are all affected. The altimeter freezes on altitude at which blockage occurred. The VSI falls to zero. The ASI and Mach meter over indicate in climb. The ASI and Mach meter under indicate in descent. **PARTIAL BLOCKAGES** Delays sensing of pressure changes but instruments are accurate in any constant altitude (for static source) or constant CAS (for pitot source) condition. The VSI under reads when climbing or descending. Debris or icing adjacent to, but not blocking the pressure sources, can cause fluctuating and inaccurate indications due to turbulent boundary layer.

BAROMETRIC ALTIMETERS	Static pressure decreases as altitude increases. This Static pressure acting on the outside of an aneroid capsule causes the capsule to expand and contract with changes in altitude. EFFECT OF VARIABLES Increasing the sub-scale setting increases indicated altitude. Pressure altitude is indicated with 1013.25 mb set on sub scale. Altimeters under indicate if temperature increases. Altimeters over indicate if temperature decreases. Altimeters freeze if static source becomes blocked. Altimeters are sluggish if the static source is partly blocked. Altimeters under indicate when side slipping towards a blocked static port (when the port on the other side remains open). Altimeters over indicate when side slipping away from a blocked static port (when the port on the other side remains open). A leaking static pipe within a pressurised cabin allows increased pressure to enter the static lines. This causes the altimeter to indicate cabin altitude. The static pressure inside a non-pressurised aircraft is slightly less than local atmospheric static pressure. So a leaking static pipe within a non-pressurised cabin allows this lower pressure to enter the static lines. This causes the altimeter to over indicate slightly. In non-pressurised aircraft breaking the altimeter glass in an emergency allows cabin static pressure into altimeter case, therby giving an approximate indication of altitude when the static source is blocked.
RADIO ALTIMETERS	The Radio altimeter transmits a frequency modulated (FM) radio wave towards the ground below the aircraft. The phase difference between the modulation of the transmitted wave and the reflected wave gives an indication of the time of travel of the signal This is then used to calculate the height of the aircraft above the ground.

	Radio altimeters indicate the height of the aircraft above the terrain immediately below it. Radio altimeters use the Super High Frequency (SHF) waveband between 4200 and 4400 MHz. Radio altimeters in commercial aircraft are effective between 2500 ft and zero ft agl. Failure of the system is indicated by the appearance of a warning flag and the needle moving behind a mask.
VERTICAL SPEED INDICATORS (VSI)	Static pressure is applied to both the inside and the outside of a differential capsule. Changes in altitude cause the static pressure to change. The rate of change of static pressure is determined by the rate of change of altitude. The supply of static pressure to one side of the capsule is through a small diameter hole or choke. This restricts the rate of change of static pressure on that side of the capsule. The supply of static pressure to the other side of the capsule is unrestricted so this varies only with vertical speed. Whenever the aircraft is climbing or descending the choke causes the pressures on the two side of the capsule to differ slightly. This pressure difference gives an indication of vertical speed. EFFECTS OF VARIABLES A blocked static source will cause the vertical speed indication to fall to zero. A partly blocked static source will cause the VSI to under read the vertical speed.
LOCAL SPEED OF SOUND (LSS).	The Local Speed Of Sound is the speed at which pressure waves move through the air. It is determined by the absolute temperature of the air and can be calculated using the formula: LSS (in kts) = 38.94 $\sqrt{\text{AbsoluteTemperature}}$. Where the absolute temperature = temperature in degrees Centigrade + 273. At mean sea level in the ISA for example where the outside air temperature is approximately 15°C, the LSS is:

LSS at ISA msl = $38.94\sqrt{(15 + 273)}$ = 660.8 kts

As altitude increases up to the tropopause in the ISA, the temperature and LSS gradually decrease. Above the tropopause up to 85000 ft pressure altitude, both temperature and LSS remain constant.

MACH NUMBER.

Mach number is the TAS of an aircraft expressed as a fraction of the local speed of sound. So Mach 1 means that the TAS is equal to the Local Speed of Sound.

True Mach number = TAS / LSS

Indicated Mach Number is the indication given by a Mach Meter.

Indicated Mach number is equal to the ratio of dynamic pressure (P_{dyn}) and static pressure (P_{stat}).

So indicated mach number = $(P_{dyn}) / (P_{stat})$.

Changes in air temperature cause changes in air density. But changes in air density affect P_{dyn} and P_{stat} to the same degree. This means that Mach Meters are not affected by changes in air temperature.

So when flying at constant mach number increasing temperature does not affect CAS but increases TAS.

DEFINITIONS OF COMMONLY USED AIRSPEEDS

INDICATED AIRSPEED (IAS)
IAS is the speed shown on the Airspeed Indicator (ASI). It includes instrument errors.

CALIBRATED AIRSPEED (CAS)
CAS is the IAS corrected for position (pressure sensing errors) errors which are caused by the location of the pitot static probes and changes in the aircraft attitude.

EQUIVALENT AIRSPEED (EAS)
As airspeed increases, the increasing dynamic pressure compresses the air in the pitot probe. This increases the air density, thereby causing the ASI to over read at high speeds. EAS is the CAS corrected for this compressibility error.

TRUE AIRSPEED (TAS)
TAS is the true speed of the aircraft relative to the air around it. TAS is CAS corrected for density errors. ASIs are calibrated such that IAS is equal to TAS at mean sea level in the ISA. As altitude increases, the decreasing air density causes the TAS at any given IAS to increase.

MACH NUMBER

Mach Number is the TAS expressed as a fraction of the local speed of sound.

Mach Number = TAS / Local speed of Sound.

RELATIONSHIPS BETWEEN VARIATIONS IN ALTITUDE AND AIRSPEEDS

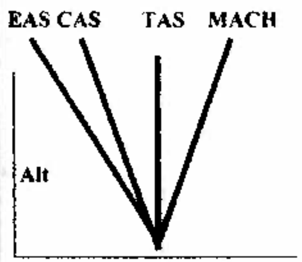
The airspeed indicator produces an Indicated Airspeed output (IAS) that is proportional to $\frac{1}{2}\rho V^2$. Where ρ is air density and V is TAS.

Any given value of $\frac{1}{2}\rho V^2$ will always produce the same IAS, regardless of altitude. Climbing at constant IAS therefore means climbing at constant $\frac{1}{2}\rho V^2$. But ρ decreases with increasing altitude, so The TAS equating to any given IAS must increase, such that the rate of decrease in ρ is equal to the rate of increase in $(TAS)^2$. At 40000 feet in the standard atmosphere, ρ is approximately ¼ of its sea level value, so TAS is approximately twice IAS.

As altitude increases up to the tropopause at 36000 feet, air temperature and the local speed of sound decrease. Above 36000 feet air temperature and the local speed of sound remain constant. Climbing at constant mach number therefore means IAS and TAS decrease up to 36000 feet.

Above 36000 feet IAS continues to decrease but TAS remains constant. The relationship between EAS, CAS TAS and Mach number in various atmospheric conditions can be determined using the diagrams below:

EFFECTS OF CLIMBING IN THE ISA TROPOSPHERE



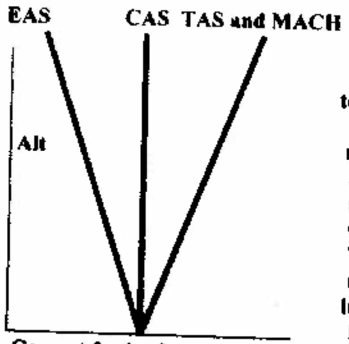
Correct for ISA to 36000 ft.

For altitudes below 36000 feet the speed lines all move further apart as altitude increases.
Draw the chart such that the constant parameter is vertical. The effect on the other three is then indicated by the lines.
The chart at the left indicates a constant TAS climb with EAS and CAS decreasing, while Mach increases.

For descents follow the lines down the chart.

For altitudes below sea level the lines may be extended below their crossover point.

EFFECTS OF CLIMBING IN AN ISOTHERMAL LAYER

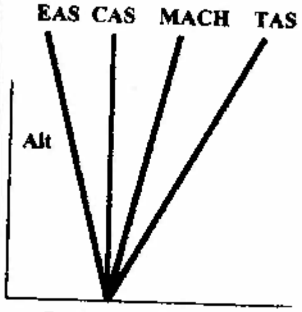


Correct for isothermal layers and above the tropopause

In isothermal layers and above 36000 feet the temperature is constant and so the TAS: MACH ratio is constant. So both are represented by a single line. The EAS, CAS and the combined TAS and MACH lines move apart with increasing altitude indicating that the EAS and CAS equating to any given TAS or Mach number decreases with increasing altitude.

The chart above indicates that in a constant CAS climb above 36000 feet, TAS and Mach number increase, while EAS decreases.

EFFECTS OF CLIMBING IN A TEMPERATURE INVERSION



Correct for Inversions.

In an inversion the normal temperature lapse rate is reversed causing the temperature to increase as altitude increases. But the TAS at any given MACH number is determined by temperature. So as the altitude increases in an in an inversion, the MACH at any given TAS decreases. The overall effect of this is a reversal of the order of the TAS and MACH lines in the graph above. This indicates that in a constant CAS climb in an inversion, the EAS decreases, while the MACH and TAS both increase.

AIRSPEED INDICATORS

Pitot pressure is fed into a differential capsule, and static pressure is fed to the outside. The differential capsule subtracts static pressure from pitot pressure to leave dynamic pressure. The capsule expands and contracts in response to changes in dynamic pressure.

EFFECT OF VARIABLES

Any given dynamic pressure will give the same indicated airspeed (IAS), regardless of altitude or other variables.

This means that climbing at constant IAS requires constant dynamic pressure.

TAS at any given IAS increases with increasing altitude.

TAS at any given IAS increases with increasing temperature.

<u>ASI COLOUR CODES</u>

WHITE ARC	V_{SO} to V_{FE}.
GREEN ARC	V_{S1g} to V_{MO}/V_{NO} or V_{RA}.
YELLOW ARC	V_{MO}/V_{NO} or V_{RA} to V_{NE}.
RED RADIAL LINE	V_{NE}.
BLUE RADIAL LINE	V_{YSE} Best single engine climb speed in a twin engine aircraft.
RED AND WHITE STRIPED POINTER (BARBERS' POLE)	Indicates CAS value of VMO at low altitude and MMO at high altitude.

GYROSCOPES

Employ a spinning mass to create properties of rigidity and precession.

RIGIDITY The tendency of the spin axis to remain aligned with one point in space.

PRECESSION An external force tending to change the alignment of the spin axis, acts not at its point of application but at a point 90 degrees later in the direction of rotation.

Degrees of freedom do not include spin, and are equal to the number of gimbals.

SPACE GYRO Has two gimbals, two degrees of freedom. Remains aligned with one point in space.

TIED GYRO Has two gimbals and two degrees of freedom, but its spin axis is tied to some specific orientation by some external force. An example is a DGI where the spin axis is tied to the yawing plane of the aircraft by a spring.

EARTH GYRO A tied gyro, where the spin axis is tied to the earth vertical direction. Used in an artificial horizon.

RATE GYRO Has only one gimbal and one degree of freedom. Senses rate of change of orientation of its spin axis, rather than the degree of change. Used in a turn and slip indicator.

	RATE INTEGRATING GYRO A special form of rate gyro used in IRS systems and in some autopilots, but not in INS systems. Integrates accelerations once to calculate velocities and a second time to calculate displacements. **DRIFT** Is when the spin axis shifts in the horizontal plane. **TOPPLE** Is when the spin axis shifts in the vertical plane. **WANDER** Is any change vertical or horizontal in the direction of the spin axis. Wander is the vector sum of drift and topple. **REAL WANDER** When the spin axis shifts relative to space. It is caused by mechanical imperfections, including imbalances and friction. **APPARENT WANDER** When the spin axis appears to shift relative to any given point on the earth but does not shift relative to space. Made up of earth rate drift and transport wander. **EARTH RATE DRIFT** It is caused by rotation of the earth. Earth rate drift in degrees per hour = 15° x the sine of the latitude. **EARTH RATE TOPPLE** It is caused by rotation of the earth. Earth rate topple in degrees per hour = 15° x the cosine of the latitude. **DRIFT DUE TO DGI TRANSPORT WANDER** TW drift rate in degrees per hour = (East West component of groundspeed (in Kts) x Tan of latitude) / 60 Where westerly ground speeds are negative. **LATITUDE NUT** is fitted to DGIs to compensate for earth rate drift.
RING LASER GYROSCOPES	Ring Laser Gyros have replaced conventional spinning rotor gyros in modern Inertial Reference Systems (IRS). They sense angular accelerations and velocities by measuring changes in the resonant frequency of two beams of laser light.

	They have no rotating parts, so they do not require any spin-up time and have longer service lives than conventional gyros. They suffer from laser lock, which reduces their ability to sense small movements. Laser lock is prevented or overcome by a dither motor, which vibrates the entire gyro unit. Laser gyros are used in modern strapped down IRS platforms.
INS, IRS & FMS	Inertial Reference Systems (IRS) use three accelerometers set at 90 degrees to each other to form a tribedron to sense vertical lateral and longitudinal accelerations. Inertial Navigation Systems (INS) use two accelerometers aligned North/South and East/West. Three gyros arranged in a similar manner detect angular accelerations. FMS systems coupled to autopilots fly great circle routes. INS systems use conventional gyros and stabilised platforms, which must be physically aligned with true north and earth horizontal before flight. IRS systems use ring laser gyros and strapped down platforms, which are not physically aligned with true north or earth horizontal before flight. Alignment is carried out mathematically instead of physically aligning the platform The IRS alignment process involves the computer calculation the orientation of the tribedron or platform relative to true north and earth horizontal. IRS and INS cannot be realigned in the air following a shut down or power loss. But IRS can still give attitude information for the remainder of the flight. IRS and INS suffer Schuler errors due to their pendulum effect, and corriolis effects because of earth rotation. The schuler period is 84.4 minutes and the greatest errors occur at 21.1 and 63.3 minutes. The errors are zero at 42.2 and 84.4 minutes.

ATTITUDE INDICATORS

CLASSICAL OR AIR DRIVEN TYPE

They employ an erection chamber and pendulous vanes to erect the gyro and keep it earth vertical.

They spin anti-clockwise viewed from above.

The nertia of erection chamber and pendulous vanes causes indication errors when accelerating or turning.

ACCELERATION ERROR

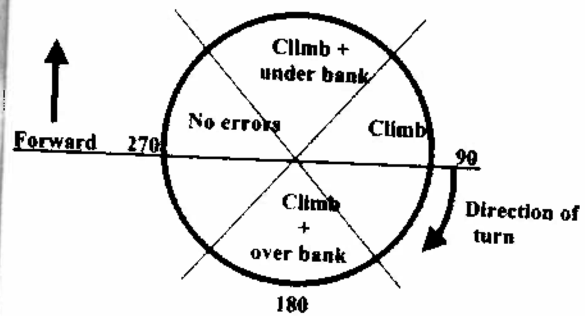
A right turn due to inertia of the erection chamber, plus a pitch up indication due to inertia of the pendulous vanes.

DECELERATION ERRORS

A left turn due to inertia of the erection chamber, plus a pitch down due to the inertia of the pendulous vanes.

TURNING ERRORS

A turn constitutes a deceleration in the longitudinal direction and an acceleration in the lateral direction. The combined effects of these accelerations depends upon the direction and magnitude of the turn. The errors for a right turn are illustrated below.



The Earth's Magnetic Field.

Is produced by the magnetic materials in the Earth's core.

The North pole of the Earth is the equivalent of the South (Blue) Pole of a magnet.

Lines of magnetic force or flux flow out of the Magnetic south pole of the Earth and into the Magnetic North Pole.

The magnetic and geographic poles are slightly out of alignment, such that the magnetic north pole is slightly to the west of the geographic north pole.

The difference between magnetic north and geographic north is called the Magnetic Variation and changes gradually with the passing of time.

VARIATION is the angle between True North and Magnetic North.

Variation East means that Magnetic North is to the east of True North.

Variation West means that Magnetic North is to the west of True North.

To convert from magnetic to true use the reminders below:

VARIATION WEST MAGNETIC IS BEST This means that if the variation is west then the magnetic heading is greater than the true heading.

VARIATION EAST MAGNETIC IS LEAST This means that if the variation is east then the magnetic heading is less than the true heading.

ISOGONAL LINES are lines of constant variation on charts and are marked as pecked (or dashed) lines.

AGONIC LINES are lines on charts joining points of zero variation.

The positions of the Magnetic North and South Poles varies gradually with the passing of time.

The lines of magnetic force are horizontal at the magnetic equator and dip downwards as they approach the poles.

This dipping of the lines of magnetic force is called dip and is 90° at the Magnetic Poles and zero at the Magnetic Equator.

ISOCLINALS are lines on charts joining points of equal magnetic dip.

ACLINIC LINES are lines on charts joining points of zero dip.

The dipping of the lines of magnetic force reduces the accuracy of magnetic compasses. So such compasses are most accurate at the Magnetic equator and least accurate at the magnetic Poles.

MAGNETIC COMPASSES	
	Use a magnetic needle, which aligns itself with the lines of force of the Earth's magnetic field. The horizontal (H) component of the field gives an indication of true north. As latitude increases towards the north and south poles, the lines of force assume an increasing vertical component as they dip towards the centre of the earth. This dipping of the lines of force reduces the accuracy of magnetic compasses. Are most accurate at the equator where the lines of force are horizontal and least accurate at the magnetic poles where the lines of force dip vertically into the Earth. The dipping of the lines of force make magnetic compasses virtually unusable at latitudes greater than 70 degrees north and south. DEVIATION is the angle between the local magnetic meridian and the direction in which the compass magnets are aligned. Deviation is East or + when the red end of the compass magnet points to the East of magnetic north. Deviation is West or - when the red end of the compass magnet points to the West of magnetic north. When applying deviation use the following reminders: DEVIATION WEST COMPASS IS BEST This means that if the deviation is west then the compass heading is greater than the magnetic heading. DEVIATION EAST COMPASS IS LEAST This means that if the deviation is east then the compass heading is less than the magnetic heading. Damping wires and short magnets are used to damp out oscillations making the compass aperiodic or dead-beat. Pendulous suspension systems are used to minimise the effect of the dipping of the lines of magnetic force. Suffer from errors when accelerating on East-West headings, except at the magnetic equator. Suffer from turning errors when turning through North-South headings.

Direct reading compasses employ a pendulous suspension system to reduce the effects of dip, but this causes errors when accelerating or decelerating as summarised below.

MANOEUVRE	HEADING	ACCELERATION ERRORS
ACCELERATING IN THE NORTHERN HEMISPHERE	NORTH SOUTH EAST WEST	NIL NIL COMPASS UNDER READS COMPASS OVER READS
DECELERATING IN THE NORTHERN HEMISPHERE	NORTH SOUTH EAST WEST	NIL NIL COMPASS OVER READS COMPASS UNDER READS
ACCELERATING IN THE SOUTHERN HEMISPHERE	NORTH SOUTH EAST WEST	NIL NIL COMPASS OVER READS COMPASS UNDER READS
DECELERATING IN THE SOUTHERN HEMISPHERE	NORTH SOUTH EAST WEST	NIL NIL COMPASS UNDER READS COMPASS OVER READS

A summary of magnetic compass turning errors is provided below.

Hemisphere	Turning	Aircraft Turns	Magnets turn	Reading at end of turn	Turn must be stopped	Effect of liquid swirl	Compass condition
North	45 to 315	Anti-clockwise	Anti-clockwise	More than 315	Early	Increases error	Sluggish
North	315 to 45	Clockwise	Clockwise	Less than 045	Early	Increases error	Sluggish
North	135 to 225	Clockwise	Anti-clockwise	More than 225	Late	Decreases error	Lively
North	225 to 135	Anti-clockwise	Clockwise	Less than 135	Late	Decreases error	Lively
South	45 to 315	Anti-clockwise	Clockwise	Less than 135	Late	Decreases error	Lively
South	315 to 45	Clockwise	Anti-clockwise	More than 045	Late	Decreases error	Lively
South	135 to 225	Clockwise	Clockwise	Less than 225	Early	Increases error	Sluggish
South	225 to 135	Anti-clockwise	Anti-clockwise	More than 135	Early	Increases error	Sluggish

SLUGGISH means that the compass heading is lagging behind the aircraft heading.

LIVELY means that the compass heading is leading the aircraft heading.

GYRO STABILISED COMPASSES	The magnetic compass provides a long term reference using the Earth's magnetic field. The gyro provides a short term reference to prevent errors when the aircraft is accelerating or turning. The Flux Valve senses the Earth's magnetic field and sends signals to the Error Detector. Error signals are amplified and sent to the Precession Coils to precess the gyro to keep it aligned with north. Initial erection is achieved by a torque motor, which precesses the gyro into its north alignment. The annunciator indicates when the compass is correctly aligned. The power supplies to precession motors are cut off whenever the aircraft is turning or accelerating to prevent errors.
TURN & SLIP INDICATORS	The turn indicator uses a rate gyro with one gimbal, one degree of freedom and its spin axis tied to the yawing plane of the aircraft. The slip or balance indicator is a ball in a curved tube. The ball is positioned by the vector sum of the acceleration forces acting upon it. In balanced flight the ball is central. In side slipping flight the ball move to the side towards which the aircraft is side slipping.
ECAM	ECAM is an AIRBUS system BASIC ECAM Uses a left and right display and does not provide any engine data. The left display shows written messages, while the right display shows diagrams. If a single display fails, material (words or diagram) from that display are lost.

	ADVANCED ECAM Uses upper and lower displays. The top part of upper display shows engine primary data. Bottom part of upper display shows warnings and cautions together with corrective actions to be taken by the pilot. The lower display shows engine secondary data or system data depending on the mode selected. ECAM MODES Both basic and advanced ECAM uses the following modes: NORMAL — The upper display shows engine primary data while the lower display is blank. In basic ECAM both screens are blank. ADVISORY — Indicates any non-emergency change in the status of the aircraft or its systems. FAILURE — The left or upper display provides a written statement of the nature of the problem, plus a list of actions to be taken. The lower or right display shows the relevant diagrams. MANUAL — The pilot selects systems from a menu and the ECAM lower display shows the status of the selected system.
EICAS	EICAS is a BOEING SYSTEM The upper display shows engine primary data, while the lower display is either blank or showing relevant secondary engine or system data. If a single display fails on basic EICAS, the other will go into compacted display mode to show as much as possible. If both displays in the basic EICAS fail engine primary data is shown on an emergency LED. If both EICAS displays fail in an EFIS fitted aircraft, the EICAS data can be transferred to one of the EFIS displays.

	OPERATIONAL MODE The upper display shows engine primary data while the lower is blank. Warnings cautions and advisory messages are shown on the left side of the upper display. The lower screen then shows relevant secondary data. **STATUS MODE** The pilot selects systems from a menu and the lower display shows their status. **MAINTENANCE MODE** Is available only on the ground to provide equipment usage information and servicing records.

MODES	BASIC GPWS		ADVANCED GPWS	
	Alerts	Warnings	Alerts	Warnings
1. Excess ROD	NIL	Whoop Whoop pull up	Sink rate	Whoop Whoop pull up
2. Excessive terrain closure rate	NIL	Whoop Whoop pull up	Terrain Terrain	Whoop Whoop pull up
3. Attitude loss after take-off or go-around	NIL	Whoop Whoop pull up	Don't sink	NIL
4A. Unsafe terrain clearance with gear not locked down	NIL	Whoop Whoop pull up	Too low gear	Whoop Whoop pull up
4B. Unsafe terrain clearance with flaps not in landing configuration	NIL	Whoop Whoop pull up	Too low flaps	Too low terrain
5. Descent below ILS Glideslope	Glideslope	NIL	Glideslope	NIL
6. Descent below minimums	NIL	NIL	Minimums	NIL

ALTITUDE ALERTING SYSTEM	Required for JAR certification of: a. All turbine powered aircraft with take-off mass over 5700 Kg or 9 or more passenger seats. b. All aircraft of take-off mass over 5700 Kg after 1 Apr 1995. Must provide at least an aural signal to indicate when the aircraft is approaching , or deviating above or below a pre-selected altitude. In Boeing 737 aircraft: a. A steady amber light illuminates and a 2 second C tone sounds when approaching within 900 ft above or below the selected altitude. b. The light extinguishes when within 300 ft. c. The light flashes and 2 second C tone sounds when deviation from selected altitude reaches 300 ft. d. Lght extinguishes when deviation reaches 900 ft.
TCAS	TCAS uses airborne transponders to provide warning of potential conflicts between traffic. **TERMINOLOGY** TRAFFIC ADVISORY (TA) indicates approximate positions relative to own aircraft, of other aircraft which may become a threat. RESOLUTION ADVISORY (RA) is an aural and visual recommendation of manoeuvres to be made or avoided in the vertical plane in order to conflicts with aircraft transponding in SSR mode C. CORRECTIVE ADVISORY is a resolution advisory advising the pilot to deviate from the current rate of climb or descent in order to resolve a conflict. PREVENTIVE ADVISORY is a resolution advisor advising the pilot of the rates of climb or descent that are to be avoided to avoid conflict. INTRUDER is an aircraft transponding in SSR mode A, C or S that is predicted to enter the TCAS collision area.

PROXIMATE TRAFFIC Transponding aircraft within 6 nm radius and plus or minus 1200 ft.

OTHER TRAFFIC Transponding aircraft not classified as proximate but within plus or minus 2700 ft and within the selected TCAS display range of 16, 8 or 4 nm.

TCAS I provides only TA.

TCAS II provides both TA and RA in the vertical plane.

TCAS III (when introduced) will also provide RA in azimuth.

TCAS is displayed on:

a. Dedicated TCAS display units.
b. Combined TCAS EVSI displays.
c. EFIS
d. Weather radar (in some aircraft types)
e. Other instruments in some types of small aircraft.

<u>TCAS SYMBOLOGY</u>

SOLID RED SQUARE	RA indicating intruder (immediate threat) traffic.
HOLLOW AMBER CIRCLE	TA indicating other traffic.
HOLLOW CYAN DIAMOND	TA indicating proximate traffic.

<u>TCAS PREVENTATIVE RA MESSAGES</u>
"Monitor Vertical Speed" This means that the VSI should be checked and the vertical speeds indicated by red arcs should be avoided.

<u>TCAS CORRECTIVE RA MESSAGES</u>
"Climb, Climb, Climb" This means that the aircraft should climb at a rate equal to or greater than that indicated on the VSI.

"Descend, Descend, Descend" This means that the aircraft should descend at a rate equal to or greater than that indicated on the VSI.

"Reduce Climb, Reduce Climb" This means that the ROC must be reduced to that indicated on the VSI.

"Reduce descent, Reduce descent" This means that the ROD

	must be reduced to that indicated on the VSI. <u>RESPONSE TO TCAS MESSAGES</u> Avoiding action is not required for TA messages, so ATC approval must be obtained prior to changing flight path. Appropriate avoiding action must be immediately taken in response to RA messages. Changes from ATC authorised flight path must be conducted smoothly and by the minimum amount necessary to avoid or resolve conflict. ATC must then be informed of the situation.
COCKPIT VOICE RECORDS (CVR) AND FLIGHT DATA RECORDS (FDR) MINIMUM DURATION OF RECORDING TIMES	Registration date After 1 Apr 1998 — CVR: 2 hours if over 5700 Kg; 30 minutes if 5700 Kg or less — FDR: 25 hours if over 5700 Kg; 10 hours if 5700 kg or less Both CVR and FDR must start recording before the aircraft is capable of moving under its own power and stop recording only after it becomes no longer capable of doing so.
EFIS EHSI DISPLAY MODES	A static map with active route oriented to true north.

No wind speed or direction information is available.

Active route from the FMC is shown in magenta.

Changes to the route may be selected though FMC.

Weather radar information is inhibited in this mode.

PLAN MODE

The weather radar data can also be displayed.

DME distance

Current heading

The wind direction and speed are shown at the bottom left corner

A white triangle at the bottom of the display represents the aircraft.

The active route from the FMC is shown in magenta.

In this mode the EHSI displays flight plan data from the FMC against a moving map.

The display covers 45° on either side of instantaneous track.

The display is oriented to magnetic north when between 73°N and 65°S.

The display is oriented to true north when above 73°N and below 65°S.

MAP MODE

Magenta bug indicates selected heading

DME distance

Current heading

Selected course is indicated by a magenta needle, currently 150°

Wind direction and speed

VOR source

White from/to pointer

Selected VOR frequency

Magenta course deviation bar

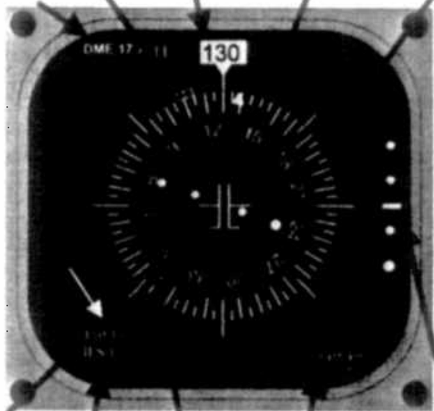
From/to indication

Weather radar data is not avaialble in this mode.

FULL VOR MODE

Weather radar data can also be displayed.

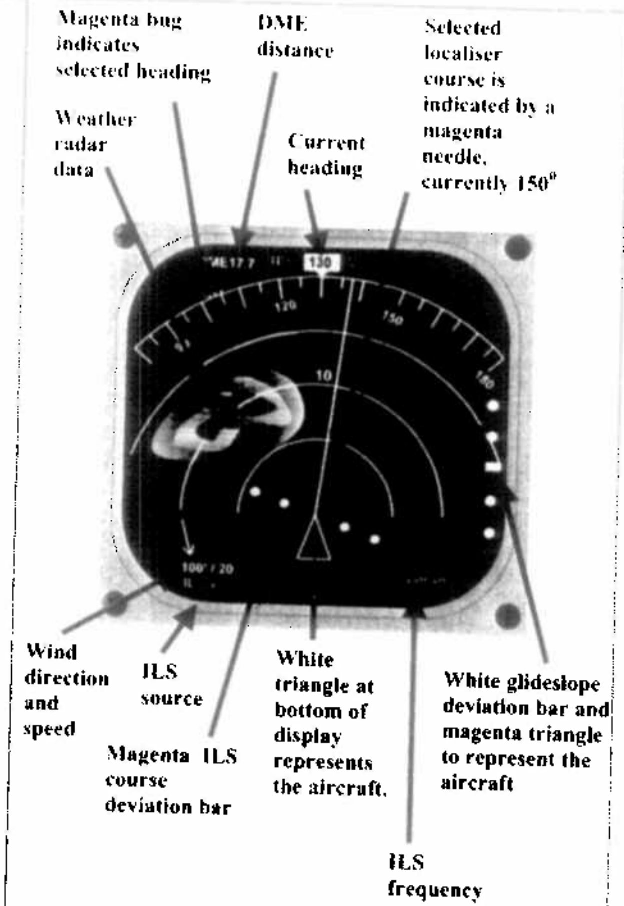
EXPANDED VOR



Displayed when an ILS frequency is selected.

Weather radar data cannot be displayed in this mode.

FULL ILS MODE



With an ILS frequency selected this mode display about 90° of the compass rose.

The range of the display in nm can be selected. The outer range arc of the compass rose is the furthest range selected.

EXPANDED ILS MODE

International Standard Atmosphere (ISA)

ALTITUDE Pieds	TEMPERATURE °C	TEMPERATURE °F	PRESSION hPa	PRESSION P.S.I.	PRESSION in Hg	PRESSION mm Hg	RAPPORT de PRESSION δ = P/Po	DENSITE RELATIVE σ = ρ/ρo	√DENSITE	VITESSE du SON (a) kt	ALTITUDE Mètres
45.000	-56,5	-69,7	147	2,14	4,36	110,7	0,1415	0,1936	0,440	574	13.716
44.000	-56,5	-69,7	155	2,24	4,57	116,0	0,1527	0,2031	0,451	574	13.411
43.000	-56,5	-69,7	162	2,35	4,79	121,7	0,1602	0,2131	0,462	574	13.106
42.000	-56,5	-69,7	170	2,47	5,03	127,8	0,1681	0,2236	0,473	574	12.802
41.000	-56,5	-69,7	179	2,59	5,28	134,1	0,1764	0,2346	0,484	574	12.497
40.000	-56,5	-69,7	188	2,72	5,54	140,7	0,1851	0,2467	0,496	574	12.192
39.000	-56,5	-69,7	197	2,86	5,81	147,6	0,1942	0,2583	0,508	574	11.887
38.000	-56,5	-69,7	206	2,99	6,10	154,9	0,2018	0,2710	0,521	574	11.582
37.000	-56,5	-69,7	217	3,14	6,40	162,6	0,2138	0,2843	0,533	574	11.278
36.000	-56,3	-69,4	227	3,30	6,71	170,4	0,2243	0,2981	0,546	574	10.973
35.000	-54,3	-65,8	238	3,46	7,04	178,9	0,2353	0,3089	0,557	576	10.668
34.000	-52,4	-62,3	250	3,63	7,38	187,5	0,2467	0,3220	0,567	579	10.363
33.000	-50,4	-58,7	262	3,80	7,74	196,6	0,2588	0,3345	0,578	582	10.058
32.000	-48,4	-55,1	274	3,98	8,11	206,0	0,2709	0,3473	0,589	584	9.754
31.000	-46,4	-51,6	287	4,17	8,49	215,6	0,2837	0,3605	0,600	587	9.449
30.000	-44,4	-48,0	301	4,36	8,89	225,8	0,2970	0,3741	0,611	589	9.144
29.000	-42,5	-44,4	315	4,57	9,30	236,2	0,3107	0,3881	0,623	591	8.839
28.000	-40,5	-40,9	329	4,78	9,73	247,1	0,3250	0,4025	0,634	594	8.534
27.000	-38,5	-37,3	344	4,99	10,17	258,3	0,3398	0,4173	0,646	597	8.230
26.000	-36,5	-33,7	360	5,22	10,63	270,0	0,3552	0,4325	0,658	599	7.925
25.000	-34,5	-30,2	376	5,45	11,10	281,9	0,3711	0,4481	0,669	602	7.620
24.000	-32,5	-26,6	393	5,70	11,60	294,6	0,3876	0,4642	0,681	604	7.315
23.000	-30,6	-23,0	410	5,95	12,11	307,6	0,4047	0,4806	0,693	607	7.010
22.000	-28,6	-19,5	428	6,21	12,64	321,1	0,4223	0,4976	0,705	609	6.706
21.000	-26,6	-15,9	446	6,47	13,18	334,8	0,4406	0,5150	0,718	612	6.401
20.000	-24,6	-12,3	466	6,75	13,75	349,3	0,4598	0,5328	0,730	614	6.096
19.000	-22,6	-8,8	485	7,04	14,34	364,2	0,4791	0,5511	0,742	617	5.791
18.000	-20,7	-5,2	506	7,34	14,94	379,5	0,4994	0,5699	0,755	619	5.486
17.000	-18,7	-1,6	527	7,65	15,57	395,5	0,5203	0,5892	0,768	622	5.182
16.000	-16,7	+1,9	549	7,97	16,22	412,0	0,5420	0,6089	0,780	624	4.877
15.000	-14,7	+5,5	572	8,29	16,89	429,0	0,5644	0,6292	0,793	626	4.572
14.000	-12,7	+9,1	595	8,63	17,58	446,1	0,5875	0,6500	0,806	629	4.267
13.000	-10,7	+12,6	619	8,99	18,29	464,6	0,6113	0,6713	0,819	631	3.962
12.000	-8,8	+16,2	644	9,35	19,03	483,4	0,6360	0,6932	0,833	634	3.658
11.000	-6,8	+19,8	670	9,72	19,79	502,7	0,6614	0,7155	0,846	636	3.353
10.000	-4,8	+23,3	697	10,11	20,58	522,7	0,6877	0,7385	0,859	638	3.048
9.000	-2,8	+26,9	724	10,50	21,39	543,3	0,7148	0,7619	0,873	641	2.743
8.000	-0,8	+30,5	753	10,92	22,23	564,6	0,7428	0,7860	0,887	643	2.438
7.000	+1,1	+34,0	782	11,34	23,09	586,5	0,7716	0,8106	0,900	645	2.134
6.000	+3,1	+37,6	812	11,78	23,98	609,1	0,8014	0,8358	0,914	648	1.829
5.000	+5,1	+41,2	843	12,23	24,90	632,5	0,8321	0,8616	0,928	650	1.524
4.000	+7,1	+44,7	875	12,69	25,84	656,3	0,8637	0,8881	0,942	652	1.219
3.000	+9,1	+48,3	908	13,17	26,82	681,2	0,8962	0,9151	0,957	655	914
2.000	+11,0	+51,9	942	13,66	27,82	706,6	0,9298	0,9427	0,971	657	610
1.000	+13,0	+55,4	977	14,17	28,86	733,0	0,9644	0,9710	0,985	659	305
0	+15,0	+59,0	1013	14,70	29,92	760,0	1,0000	1,0000	1,000	661	0
1.000	+17,0	+62,5	1050	15,23	31,02	787,9	1,0366	1,0295	1,015	664	-305

SECTION 2

QUESTIONS

PITOT STATICS 1.

In case of accidental closing of an aircraft's left static pressure port (rain, birds), the altimeter?

a. Over reads the altitude in case of a side-slip to the right and displays the correct information during symmetric flight.
b. Keeps on providing reliable reading in all situations.
c. Under reads the altitude.
d. Over reads the altitude in case of a sideslip to the left and displays the correct information during symmetric flight.

PITOT STATICS 2.

If an aircraft is equipped with one altimeter which is compensated for position error and another altimeter which is not, and all other factors being equal?

a. At high speed the non-compensated altimeter will indicate a lower altitude.
b. There will be no difference between them if the air data computer (ADC) is functioning normally.
c. ATC will get an erroneous altitude report SSR.
d. At high speed, the non-compensated altimeter will indicate a higher altitude

PITOT STATICS 3.

An Air Data Computer (ADC)?

a. Measures position error in the static system and transmits this information to ATC to provide correct altitude reporting.
b. Transforms air data measurements into electric impulses driving servo motors in instruments.
c. Is an auxiliary system that provides altitude information in the event that the static source is blocked.
d. Converts air data measurements given by ATC from the ground in order to provide correct altitude and speed information.

PITOT STATICS 4.

In An Air Data Computer (ADC), aeroplane altitude is calculated from?

a. The difference between absolute and dynamic pressure at the fuselage.
b. Measurement of outside air temperature (OAT).
c. Measurement of elapsed time for a radio signal transmitted to the ground surface and back.
d. Measurement of absolute barometric pressure from a static source on the fuselage.

PITOT STATICS 5.
In a non-pressurized aircraft, if one or several static pressure ports are damaged, there is an ultimate emergency means for restoring a practically correct static pressure intake?

a. Breaking the rate-of climb indicator glass window.
b. Slightly opening a window to restore the ambient pressure in the cabin.
c. Descending as much as possible in order to fly at a pressure as close to 1013.25 hPa as possible.
d. Calculating the ambient static pressure, allowing for the altitude and QNH and adjusting the instruments.

PITOT STATICS 6.
The altimeter consists of one or several aneroid capsules located in a sealed casing. The pressures in the aneroid capsule (i) and casing (ii) are respectively?

a. (i) Static pressure (ii) Total pressure.
b. (i) Vacuum (or very low pressure) (ii) Static pressure.
c. (i) Static pressure at time t (ii) Static pressure at time t – t.
d. (i) Total pressure (ii) Static pressure.

PITOT STATICS 7.
From the ISA table at page 35, the atmospheric pressure at FL 70 in a "standard + 10" atmosphere is?

a. 781.85 hPa.
b. 942.13 hPa.
c. 1 013.25 hPa.
d. 644.41 hPa.

PITOT STATICS 8.
The QNH is by definition the value of the?

a. Altimeter setting so that the needles indicate zero when the aircraft is on ground at the location for which it is provided.
b. Atmospheric pressure at the level of the ground over flown by the aircraft.
c. Altimeter setting so that the needles of the altimeter indicate the altitude of the location for which it is given.
d. Atmospheric pressure at the sea level of the location for which it is given.

PITOT STATICS 9.
During a climb after take-off from a contaminated runway, if the total pressure probe of the airspeed indicator is blocked, the pilot finds that indicated airspeed?

a. Decreases abruptly towards zero.
b. Increases steadily.
c. Increases abruptly towards VNE.
d. Decreases steadily.

PITOT STATICS 10.
With a pitot probe blocked due to ice build up, the aircraft airspeed indicator will indicate in descent a?

a. Increasing speed.
b. Fluctuating speed.
c. Decreasing speed.
d. Constant speed.

PITOT STATICS 11.
After an aircraft has passed through a volcanic cloud which has blocked the total pressure probe inlet of the airspeed indicator, the pilot begins a stabilized descent and finds that the indicated airspeed?

a. Increases steadily.
b. Decreases abruptly towards zero.
c. Decreases steadily.
d. Increases abruptly towards VNE.

PITOT STATICS 12.
The static pressure error of the static vent on which the altimeter is connected varies substantially with the?

a. Static temperature.
b. Mach number of the aircraft.
c. Deformation of the aneroid capsule.
d. Aircraft altitude.

PITOT STATICS 13.
The pressure altitude is the altitude corresponding?

a. In standard atmosphere, to the reference pressure Ps.
b. In ambient atmosphere, to the pressure Ps prevailing at this point.
c. In standard atmosphere, to the pressure Ps prevailing at this point.
d. In ambient atmosphere, to the reference pressure Ps.

PITOT STATICS 14.
The response time of a vertical speed detector may be increased by adding a?

a. Correction based on an accelerometer sensor.
b. Bi-metallic strip.
c. Return spring.
d. Second calibrated port.

PITOT STATICS 15.
The density altitude is?

a. The altitude of the standard atmosphere on which the density is equal to the actual density of the atmosphere.
b. The temperature altitude corrected for the difference between the real temperature and the standard temperature.
c. The pressure altitude corrected for the relative density prevailing at this point.
d. The pressure altitude corrected for the density of air at this point.

PITOT STATICS 16.
On board an aircraft the altitude is measured from the?

a. Standard altitude.
b. Pressure altitude.
c. Density altitude.
d. Temperature altitude.

PITOT STATICS 17.
The advantages provided by an air data computer to indicate the altitude are?

1. Position/pressure error correction.
2. Hysteresis error correction.
3. Remote data transmission capability.
4. Capability to feed data to a large number of instruments simultaneously.

The combination of correct statements is?

a. 1, 2, 3, 4.
b. 2, 3, 4.
c. 1, 2, 3.
d. 1, 3, 4.

PITOT STATICS 18.
If the static source to an airspeed indicator (ASI) becomes blocked during a descent the instrument will?

a. Read zero.
b. Continue to indicate the speed applicable to that at the time of the blockage.
c. Under-read.
d. Over-read.

PITOT STATICS 19.
If the static source to an altimeter becomes blocked during a climb, the instrument will?

a. Continue to indicate the reading at which the blockage occurred.
b. Under-read by an amount equivalent to the reading at the time that the instrument became blocked.
c. Over-read.
d. Gradually return to zero.

PITOT STATICS 20.
If the static source of an altimeter becomes blocked during a descent the instrument will?

a. Gradually indicate zero.
b. Under-read.
c. Indicate a height equivalent to the setting on the millibar subscale.
d. Continue to display the reading at which the blockage occurred.

PITOT STATICS 21.
A leak in the pitot total pressure line of a non-pressurized aircraft to an airspeed indicator would cause it to?

a. Under-read.
b. Over-read.
c. Over-read in a climb and under-read in a descent.
d. Under-read in a climb and over-read in a descent.

PITOT STATICS 22.
The pressure measured at the forward facing orifice of a pitot tube is the?

a. Total pressure plus static pressure.
b. Dynamic pressure.
c. Total pressure.
d. Static pressure.

PITOT STATICS 23.
The airspeed indicator circuit consists of pressure sensors. The pitot tube directly supplies?

a. The total pressure.
b. The static pressure.
c. The total pressure and the static pressure.
d. The dynamic pressure.

PITOT STATICS 24.
The error in altimeter readings caused by the variation of the static pressure near the source is known as?

a. Position pressure error.
b. Barometric error.
c. Instrument error.
d. Hysteresis effect.

PITOT STATICS 25.
A pitot blockage of both the ram air input and the drain hole with the static port open causes the airspeed indicator to?

a. Read a little high.
b. Read a little low.
c. Freeze at zero.
d. React like an altimeter.

PITOT STATICS 26.
A pitot tube covered by ice which blocks the ram air inlet will affect the following instrument(s)?

a. Airspeed indicator, altimeter and vertical speed indicator.
b. Airspeed indicator only.
c. Altimeter only.
d. Vertical speed indicator only.

PITOT STATICS 27.
Given: Ts is the static temperature (SAT).
Tt is the total temperature (TAT).
Kr is the recovery coefficient.
M is the Mach number.

The total temperature can be expressed approximately by the formula?

a. $Tt = Ts(1-0.2\ M^2)$.
b. $Tt = Ts(1+0.2\ Kr.M^2)$.
c. $Tt = Ts/(1+0.2\ Kr.M^2)$.
d. $Tt = Ts(1+0.2\ M^2)$.

PITOT STATICS 28.
The altimeter is fed by?

a. Differential pressure.
b. Static pressure.
c. Dynamic pressure.
d. Total pressure.

PITOT STATICS 29.
The vertical speed indicator (VSI) is fed by?

a. Differential pressure.
b. Static pressure.
c. Dynamic pressure.
d. Total pressure.

PITOT STATICS 30.
The operating principle of the vertical speed indicator (VSI) is based on the measurement of the rate of change of?

a. Kinetic pressure.
b. Static pressure.
c. Dynamic pressure.
d. Total pressure.

PITOT STATICS 31.
What advantages are provided by an ADC, compared to traditional pitot static systems?

(1) Instrument lag is reduced or eliminated.
(2) Position error is automatically correct for.
(3) Compressibility error is automatically corrected for.
(4) A large number of instruments can be fed from one ADC.
(5) It provides emergency altimeter following main system failure.

a. (1), (3), (4), (5).
b. (1), (2), (3), (4).
c. (2), (3), (4), (5).
d. (1), (2), (4), (5).

PITOT STATICS 32.
If the static vents in an un-pressurised aircraft become blocked?

a. Breaking or opening the windows will enable the altimeter to function.
b. Breaking or opening the windows will enable the ASI to function.
c. Breaking the front glass will enable the altimeter to function.
d. Only instruments fed from an ADC will function.

PITOT STATICS 33.
From where does the ADC obtain its altitude data?

a. Barometric information from the static pressure ports.
b. Barometric pressure from the pitot probe.
c. The difference between pitot and static pressures.
d. The time take for a radio signal to rebound from the earth.

PITOT STATICS 34.
What inputs are fed to the ADC?

(1) AOA.
(2) TAT.
(3) OAT.
(4) Dynamic pressure.
(5) Static pressure.
(6) Total pressure.
(7) AC electrical power.
(8) Autopilot commands.

a. (1), (2), (4), (5), (7).
b. (1), (2), (4), (5), (7).
c. (1), (2), (5), (6), (7).
d. (2), (4), (5), (7), (8).

PITOT STATICS 35.
Which of the following is correct?

a. $P_{Tot} = P_{Stat} + P_{Dyn}$.
b. $P_{Stat} = P_{Dyn} - P_{Stat}$.
c. $P_{Dyn} = P_{Tot} - P_{Stat}$.
d. $P_{Stat} = P_{Tot} + P_{Dyn}$.

PITOT STATICS 36.
Entering ground effect is likely to?

a. Decrease static pressure but increase pitot pressure.
b. Decrease pitot pressure but increase static pressure.
c. Increase position errors.
d. Decrease position errors.

PITOT STATICS 37.
If the pitot tube leaks and the pitot drains are blocked in an unpressurised aircraft?

a. The ASI will over indicate.
b. The ASI will under indicate.
c. The altimeter will under indicate.
d. The altimeter will over indicate.

PITOT STATICS 38.
If the static tube and drains become blocked?

a. The ASI will under indicate.
b. The ASI will over indicate.
c. The ASI will under or over indicate depending on altitude.
d. The ASI will indicate zero.

PITOT STATICS 39.
If the static tube and drains become blocked?

a. The altimeter will under indicate.
b. The altimeter will indicate zero.
c. The altimeter will over indicate.
d. The altimeter will under or over indicate depending on altitude.

PITOT STATICS 40.
If the static slots of a pitot probe become blocked but the pitot tapping remains clear?

a. ASI acts as an altimeter.
b. ASI acts in the opposite sense to an altimeter.
c. ASI indication freezes.
d. ASI indication falls to zero.

PITOT STATICS 41.
If the pitot tapping becomes blocked it will affect the operation of?

1. ASI.
2. Altimeter.
3. Radalt.
4. Mach meter.
5. VSI.

a. 1, 2, 3, 4.
b. 1, 2, 4, 5.
c. 1, 4.
d. 1, 5.

PITOT STATICS 42.
What will happen to the altimeter indications in an aircraft in level flight if the right static vent becomes blocked and the left remains clear?

a. Over indicate when side slipping right.
b. Over indicate when side slipping left.
c. Under indicate in all conditions.
d. Over indicate in all conditions.

PITOT STATICS 43.
What will happen to the ASI and mach meter indications in an aircraft in level flight if the right static vent becomes blocked and the left remains clear?

a. They will not be affected.
b. They will both over indicate.
c. Both will under indicate when side slipping right.
d. Both will under indicate when side slipping left.

PITOT STATICS 44.
If the static source becomes blocked in a descent the ASI will .... indicate, the VSI will .... indicate and the altimeter will ..... indicate?

a.	Under	under	under.
b.	Under	over	over.
c.	Over	under	under
d.	Over	under	over.

PITOT STATICS 45.
A blocked pitot probe will affect?

a. ASI.
b. VSI.
c. Altimeter.
d. All of the above.

PITOT STATICS 46.
A blocked static vent will affect?

a. ASI.
b. VSI.
c. Altimeter.
d. All of the above.

PITOT STATICS 47.
Debris on the sides of a pitot probe not blocking the air tappings might cause?

a. Total loss of IAS indications.
b. Total loss of Altitude indications.
c. Erratic or inaccurate IAS and altitude readings.
d. Total loss of VSI indications.

PITOT STATICS 48.
If the static vents in an unpressurised aircraft become blocked?

a. Breaking or opening the windows will enable the altimeter to function.
b. Breaking or opening the windows will enable the ASI to function.
c. Breaking the front glass will cause the altimeter to under indicate.
d. Only instruments fed from an ADC will function.

PITOT STATICS 49.
What inputs are fed to the ADC?

(1) AOA.
(2) TAT.
(3) OAT.
(4) Dynamic pressure.
(5) Static pressure.
(6) Pitot pressure.
(7) IAS.
(8) Mach number.

a. (1), (2), (5), (7).
b. (1), (2), (4), (5).
c. (1), (2), (5), (6).
d. (2), (5), (7), (8).

PITOT STATICS 50.
A blocked pitot probe will affect?

a. Mach meter.
b. VSI.
c. Altimeter.
d. All of the above.

ALT 1.
The hysteresis error of an altimeter varies substantially with the?

a. Time passed at a given altitude.
b. Mach number of the aircraft.
c. Aircraft altitude.
d. Static temperature.

ALT 2.
When flying from a sector of warm air into one of colder air, the altimeter will?

a. Under read.
b. Be just as correct as before.
c. Show the actual height above ground.
d. Over read.

ALT 3.
At sea level, on a typical servo altimeter, the tolerance in feet from indicated must not exceed?

a. +/-60 feet.
b. +/-75 feet.
c. +/-30 feet.
d. +/-70 feet.

ALT 4.
The altitude indicated on board an aircraft flying in an atmosphere where all the atmosphere layers below the aircraft are cold is?

a. Equal to the standard altitude.
b. Lower than the real altitude.
c. The same as the real altitude.
d. Higher than the real altitude.

ALT 5.
The purpose of the vibrating device of an altimeter is to?

a. Allow damping of the measurement in the unit.
b. Reduce the hysteresis effect.
c. Reduce the effect of friction in the linkages.
d. Inform the crew of a failure of the instrument

ALT 6.
The vertical speed indicator of an aircraft flying at a true airspeed of 100 kt, in a descent with a slope of 3 degrees, indicates?

a. -300 ft/min.
b. -150 ft/min.
c. -250 ft/min.
d. -500 ft/min.

ALT 7.
The altitude indicated on board an aircraft flying in an atmosphere where all atmosphere layers below the aircraft are warm is?

a. Equal to the standard altitude.
b. Higher than the real altitude.
c. The same as the real altitude.
d. Lower than the real altitude.

ALT 8.
The primary factor which makes the servo-assisted altimeter more accurate than the simple pressure altimeter is the use of?

a. A sub-scale logarithmic function.
b. An induction pick-off device.
c. More effective temperature compensating leaf springs.
d. Combination of counters/pointers.

ALT 9.
What will happen to the altimeter reading in a right sideslip, if an aircraft has a static vent at each side of the fuselage, but the left one is blocked?

a. Over read.
b. Under read.
c. No change.
d. Depends on altitude.

ALT 10.
From what is true altitude derived?

a. Pressure altitude.
b. Density altitude.
c. Temperature altitude.
d. Difference between total pressure and static pressure.

ALT 11.
What is QNH?

a. Ambient pressure at the airfield.
b. Sea level pressure based on ambient pressure at the airfield.
c. Sea level pressure.
d. Sea level pressure in the ISA.

ALT 12.
What is QNH?

a. Ambient pressure at msl.
b. The pressure to be set on the altimeter subscale to obtain an indication of zero on the runway.
c. The pressure to be set on the altimeter subscale to obtain a reading of the pressure altitude of the runway.
d. The pressure to be set on the altimeter subscale to obtain density altitude when on the runway.

ALT 13.
What is the true altitude of an aircraft if its altimeter indicated 16000 ft when the ambient temperature was -30° C?

a. 15200 ft.
b. 15400 ft.
c. 16200 ft.
d. 16400 ft.

ALT 14.
What will happen to the indicated altitude if an aircraft in level flight passes into a warmer air mass?

a. Over indicate.
b. Under indicate.
c. Not change.
d. Remain constant only if above the tropopause.

ALT 15.
What is density altitude?

a. Pressure altitude corrected for ambient temperature.
b. True altitude.
c. Pressure altitude corrected for density changes.
d. True altitude corrected for density changes.

ALT 16.
What will happen if an aircraft has two altimeters, one of which is compensated for position error, whilst the other is not?

a. One will over read at high airspeeds.
b. One will under read at high airspeeds.
c. One will under read close to the ground.
d. The ADC will compensate automatically, so both with read correctly.

ALT 17.
Why are vibrators sometimes fitted in altimeters?

a. Overcome friction.
b. Overcome inertia.
c. Overcome hysteresis.
d. Reduce lag.

ALT 18.
What will happen to altimeter indication if an aircraft in level flight enters a cold front?

a. Over indication.
b. Under indication.
c. No change.
d. No change above the tropopause.

ALT 19.
A barometric altimeter comprises of?

a. An aneroid capsule sensing static pressure.
b. An aneroid capsule sensing pitot pressure.
c. A differential capsule sensing pitot and static pressures.
d. A bellows sensing temperature and static pressure.

ALT 20.
If pressure altitude is 30000 ft, indicated TAT is –10, mach number is 0.82, what is the density altitude?

a. 31000 ft.
b. 30472 ft.
c. 30573 ft.
d. 30674 ft.

ALT 21.
If QNH is 999 hPa, what is the pressure altitude at an elevation of 25000 ft?

a. 25100 ft.
b. 25200 ft.
c. 25300 ft.
d. 25400 ft.

ALT 22.
If pressure altitude is 22800 ft, at an elevation of 22000 ft, what is QNH?

a. 985 hPa.
b. 976 hPa.
c. 1034 hPa.
d. 1026 hPa.

ALT 23.
If field elevation is 4000 ft amsl and QNH is 900 mb, what is the pressure altitude?

a. 7390.
b. 6390.
c. 610.
d. 5540.

ALT 24.
If field elevation is 3500 ft amsl and QFE is 1020 mb, what is the pressure altitude?

a. 210.
b. –210.
c. 3710.
d. 3290.

ALT 25.
If pressure altitude is 3700 ft amsl and QNH is 1000 mb, what is field elevation?

a. 3310.
b. 3210.
c. 390.
d. 490.

ALT 26.
Density altitude is?

a. The altitude at which the existing density would occur in the ISA.
b. The density at which the existing temperature would occur in the ISA.
c. The elevation at which the existing density would occur in the ISA.
d. The pressure altitude corrected for density deviation.

ALT 27.
The pressure altitude of the field can be found by?

a. Setting QNH on the altimeter subscale.
b. Setting QFE on the altimeter subscale.
c. Setting 1013 mb on the altimeter subscale.
d. From an ADC only.

ALT 28.
If field pressure altitude is 5000 ft amsl and OAT is 25°C, what is the density altitude?

a. 5000 + 118(25 - (15 - (5 x 1.98))) = 7348.2 ft.
b. 5000 - 118(25 - (15 + (5 x 1.98))) = 4988.2 ft.
c. 5000 + 118(25 + (15 – (5 x 1.98))) = 8551.8 ft.
d. 5000 - 118(25 + (15 + (5 x 1.98))) = 10888.2 ft.

ALT 29.
If QFE is 1022 hPa what is the pressure altitude of the field?

a. 270 ft amsl.
b. –270 ft amsl.
c. 30660 ft amsl.
d. 500 ft amsl.

ALT 30.
If QNH is 1000 hPa and field elevation is 4500 ft amsl, what is QFE?

a. 850 hPa.
b. 163 hPa.
c. -850 hPa.
d. 900 hPa.

ALT 31.
Pressure altitude is?

a. The altitude above sea level.
b. The altimeter indication when QFE is set on the sub-scale.
c. The altimeter indication when QNH is set on the subscale.
d. The altimeter indication when 1013.25 hPa is set on the sub-scale.

ALT 32.
Which of the following cause air density to decrease?

a. Increasing humidity, increasing altitude, increasing temperature.
b. Increasing humidity, increasing altitude, decreasing temperature.
c. Increasing humidity, decreasing altitude, increasing temperature.
d. Decreasing humidity, increasing altitude, decreasing temperature.

ALT 33.
If QNH changes from 1013 hPa to 1022 hPa this will?

a. Increase field elevation.
b. Decrease field elevation.
c. Not affect field elevation.
d. Decrease QFE.

ALT 34.
If QFE changes from 1013 hPa to 1022 hPa will?

a. Increase field elevation.
b. Not affect QNH.
c. Increase QNH.
d. Decrease QNH.

ALT 35.
As pressure altitude increases?

a. Temperature decreases.
b. Temperature increases.
c. Temperature increases then remains constant.
d. Temperature decreases then remains constant.

ALT 36.
At a fixed pressure altitude an increase in temperature will?

a. Decrease density but increase density altitude.
b. Decrease density altitude.
c. Not affect density altitude.
d. Increase density but decrease density altitude.

ALT 37.
What will happen to the altimeter reading in a right sideslip, if an aircraft has a static vent at each side of the fuselage, but the right one is blocked?

a. Over read.
b. Under read.
c. No change.
d. Depends on altitude.

ALT 38.
What will a cabin altimeter read with QFE set.

a. The same as with QNH set.
b. Height AGL.
c. Height above sea level.
d. Field elevation when on the runway.

ALT 39.
The altimeter of an aircraft with a static pressure source on each side of the fuselage will .... if one becomes blocked ?

a. Over read when side slipping.
b. Over read when side slipping towards the blocked source.
c. Over read when side slipping towards the clear source.
d. Under read when side slipping.

ALT 40.
A servo altimeter is .... it employs an electrical pick-off?

a. More accurate because........
b. Less accurate because..........
c. Less reliable because..........
d. More reliable because..........

ALT 41.
What will happen to the altimeter reading if an aircraft flying at a fixed heading meets a colder air mass?

a. Read less than true altitude.
b. Read more than true altitude.
c. Read zero.
d. Readings will not be affected.

ALT 42.
What is the true altitude of an aircraft flying at 16000 ft indicated altitude with an OAT of –16 degrees C?

a. 13200 ft.
b. 14200 ft.
c. 16050 ft.
d. 16200 ft.

ALT 43.
From where does the ADC obtain altitude data?

a. Radio Altimeter.
b. OAT sources.
c. Barometric altitude source.
d. Dynamic minus total pressure.

ALT 44.
True altitude is obtained from ...... on board an aircraft?

a. Density altitude.
b. Temperature altitude.
c. Pressure altitude.
d. International standard altitude.

ALT 45.
What is density altitude?

a. Pressure altitude corrected for density.
b. Temperature altitude corrected for density.
c. Temperature altitude corrected for pressure.
d. Pressure altitude corrected for temperature.

ALT 46.
How will altimeter readings be affected if the layers of air below an aircraft are colder than the standard temperature?

a. Read true altitude, only the air above matters.
b. Read zero.
c. Read higher than true.
d. Read lower than true.

ALT 47.
How will altimeter reading be affected if the static vent pipe becomes blocked?

a. Read true altitude, only the air above matters.
b. Readings will freeze.
c. Read higher than true.
d. Read lower than true.

ALT 48.
One definition of pressure altitude is?

a. Altitude indication with QFE set.
b. Pressure at that height in the standard atmosphere.
c. Altitude indication with 1013.25 hPa set.
d. Altitude indication with QNH set.

ALT 49.
If icing or debris cause pressure disturbances at the static source, the effect will be?

a. Increased compressibility error.
b. Increased instrument error.
c. Decreased altitude indication.
d. Increased position error.

ALT 50.
If an aircraft flying at constant height over a level surface meets a hotter air mass, the altimeter will?

a. Indicate higher than true.
b. Indicate lower than true.
c. Indicate randomly varying altitude.
d. Indicate zero.

ALT 51.
Servo altimeters are more accurate because?

a. They employ a logarithmic scale.
b. They sense pressure changes more accurately.
c. They employ a vibrator to minimise friction errors.
d. They employ electromagnetic pick-offs.

ALT 52.
The ADC obtains its altitude data from?

a. A barometric altimeter.
b. A radio altimeter.
c. The TAT and OAT probes.
d. A barometric static pressure sensor similar to a servo altimeter.

ALT 53.
A servo altimeter is .... than a conventional one, because ....?

a.	More accurate	electrical servos.
b.	More accurate	electrical pick-off coils.
c.	Less accurate	electric servos.
d.	Less accurate	Electrical pick-off coils.

ALT 54.
In a barometric altimeter .... is fed into the capsule and .... is fed into the case?

a.	Static pressure	dynamic pressure.
b.	Vacuum	static pressure.
c.	Dynamic pressure	vacuum.
d.	Total pressure	static pressure.

ALT 55.
If the static pressure source in an un-pressurised aircraft became blocked the altimeter would.......... but might be rectified by ....?

a.	Read zero	break the altimeter glass.
b.	Read zero	open the windows.
c.	Freeze	break the altimeter glass.
d.	Freeze	open the windows.

ALT 56.
If the pitot source becomes blocked the barometric altimeter will?

a. Freeze.
b. Read zero.
c. Read altitude at which it blocked.
d. Be unaffected.

ALT 57.
If the static vent becomes partly blocked in a descent the indications will?

a. Be too high when descending but correct when at constant altitude.
b. Be too high when descending but correct when at constant height.
c. Be too low when descending but correct when at constant altitude.
d. Be too low when descending but correct when at constant height.

ALT 58.
A vibrator is sometimes fitted in an altimeter to?

a. Overcome gauge parallax error.
b. Reduce instrument errors.
c. Reduce sensing errors.
d. To act as an aural warning.

ALT 59.
In a banked turn a barometric altimeter using a single static source?

a. Will over indicate.
b. Will under indicate.
c. Might over or under indicate, depending on the position of the static source.
d. Will read zero.

ALT 60.
True altitude is shown from .... on board an aircraft?

a. Density altitude.
b. Pressure altitude.
c. Radio altitude.
d. Temperature altitude.

ALT 61.
Density altitude is?

a. Temperature altitude corrected for density.
b. Temperature altitude corrected for pressure.
c. Pressure altitude corrected for temperature.
d. Pressure altitude corrected for density.

ALT 62.
If an aircraft has two altimeters, only one of which is corrected for position error?

a. ATC transponder replies will be inaccurate.
b. At high altitude and high speed the non-corrected altimeter will over indicate.
c. At high altitude and high speed the non-corrected altimeter will under indicate.
d. At low altitude and low speed the corrected altimeter will over indicate.

ALT 63.
Some altimeters employ vibrators in order to?

a. Minimise hysteresis.
b. Minimise inaccuracies due to internal friction.
c. Provide audible warning of low altitudes.
d. Eliminate instrument error.

ALT 64.
If an aircraft with two static ports, sideslips towards the blocked port, the altitude indication will?

a. Increase.
b. Decrease.
c. Remain unchanged.
d. Increase or decrease depending on sideslip angle.

ALT 65.
If an aircraft with two static ports, sideslips towards the unblocked port, the altitude indication will?

a. Increase.
b. Decrease.
c. Remain unchanged.
d. Increase or decrease depending on sideslip angle.

ALT 66.
Barometric altimeter readings can become erratic during landing because?

a. Static ports can become blocked by debris.
b. Static pressure is changed by ground effect.
c. The air is warmer close to the ground so dynamic pressure changes.
d. Static ports become shielded by other parts of the aircraft at high angles of attack.

ALT 67.
What type of pressure sensor is employed in a barometric altimeter?

a. Aneroid capsule.
b. Differential capsule.
c. Bellows.
d. Bourden tube.

ALT 68.
If the glass of a barometric altimeter in a pressurised aircraft becomes cracked and the static ports become blocked, the altimeter will?

a. Over read.
b. Under read.
c. Read zero continuously.
d. Read cabin altitude.

ALT 69.
If the pressure feed line to a barometric altimeter becomes detached from the back of the instrument in flight the instrument will?

a. Read zero continuously.
b. Read cabin altitude.
c. Over read.
d. Under read.

RADIO ALTIMETERS 1.
During the approach, a crew reads on the radio altimeter the value of 650 ft. This is an indication of the true?

a. Height of the lowest wheels with regard to the ground at any time.
b. Height of the aircraft with regard to the ground at any time.
c. Height of the aircraft with regard to the runway.
d. Altitude of the aircraft.

RADIO ALTIMETERS 2.
For most radio altimeters, when a system error occurs during approach the?

a. Height indication is removed.
b. DH lamp flashes red and the audio signal sounds.
c. DH lamp flashes red.
d. Audio warning signal sounds.

RADIO ALTIMETERS 3.
A radio altimeter can be defined as a?

a. Ground radio aid used to measure the true height of the aircraft.
b. Ground radio aid used to measure the true altitude of the aircraft.
c. Self-contained on-board aid used to measure the true height of the aircraft.
d. Self-contained on-board aid used to measure the true altitude of the aircraft.

RADIO ALTIMETERS 4.
The data supplied by a radio altimeter?

a. Indicates the distance between the ground and the aircraft.
b. Concerns only the decision height.
c. Is used only by the radio altimeter indicator.
d. Is used by the automatic pilot in the altitude hold mode.

RADIO ALTIMETERS 5.
The low-altitude radio altimeters used in precision approaches:

1. Operate in the 1540-1660 MHz range.
2. Are of the pulsed type.
3. Are of the frequency modulation type.
4. Have an operating range of 0 to 5000 ft.
5. Have a precision of +/- 2 feet between 0 and 500 ft.

The combination of the correct statements is?

a. 3, 5.
b. 3, 4.
c. 2, 3, 4.
d. 1, 2, 5.

RADIO ALTIMETERS 6.
In low altitude radio altimeters, the reading is zero when main landing gear wheels are on the ground. For this, it is necessary to?

a. Change the display scale in short final, in order to have a precise readout.
b. Compensate residual altitude due to antennas height above the ground and coaxial cables length.
c. Account for signal processing time in the unit and apply a correction factor to the reading.
d. Place the antennas on the bottom of the aeroplane.

RADIO ALTIMETERS 7.
The operating frequency range of a low altitude radio altimeter is?

a. 2700 MHz to 2900 MHz.
b. 5 GHz.
c. 4200 MHz to 4400 MHz.
d. 5400 MHz or 9400 MHz.

RADIO ALTIMETERS 8.
Modern low altitude radio altimeters emit waves in the following frequency band?

a. HF (High Frequency).
b. UHF (Ultra High Frequency).
c. SHF (Super High Frequency).
d. VLF (Very Low Frequency).

RADIO ALTIMETERS 9.
The operation of the radio altimeter of a modern aircraft is based on?

a. Pulse modulation of the carrier wave.
b. A combination of frequency modulation and pulse modulation.
c. Frequency modulation of the carrier wave.
d. Amplitude modulation of the carrier wave.

RADIO ALTIMETERS 10.
In low altitude radio altimeters height measurement (above ground) is based upon?

a. A triangular amplitude modulation wave, for which modulation phase shift between transmitted and received waves after ground reflection is measured.
b. A frequency modulation wave, for which the frequency variation between the transmitted wave and the received wave after ground reflection is measured.
c. A pulse transmission, for which time between transmission and reception is measured on a circular scanning screen.
d. A wave transmission, for which the frequency shift by DOPPLER effect after ground reflection is measured.

RADIO ALTIMETERS 11.
The aircraft radio equipment which emits on a frequency of 4400 MHz is the?

a. Weather radar.
b. Primary radar.
c. Radio altimeter.
d. High altitude radio altimeter.

RADIO ALTIMETERS 12.
A radio altimeter is?

a. Aircraft based and indicates true altitude.
b. Aircraft based and indicates pressure altitude.
c. Aircraft based and indicates true height.
d. Ground based and employ microwaves.

RADIO ALTIMETERS 13.
Radio altimeters are based on the principle of?

a. Frequency modulated carrier wave.
b. Pulse modulated carrier wave.
c. Amplitude modulated carrier wave.
d. Continuous wave.

RADIO ALTIMETERS 14.
For the landing configuration a radio altimeter indicates?

a. Height of the aircraft above the ground.
b. Height of the flight deck above the ground.
c. Height of the main wheel above the ground.
d. Altitude.

RADIO ALTIMETERS 15.
Low altitude radio altimeters operate on the .... wavelength?

a. Metric.
b. Decimetric.
c. Centimetric.
d. Millimetric.

RADIO ALTIMETERS 16.
Low altitude altimeters use the .... waveband?

a. HF.
b. VHF.
c. UHF.
d. SHF.

RADIO ALTIMETERS 17.
If there is a fault in the system the radalt display will?

a. Needle will disappear and an alarm flag will appear, possibly accompanied by an audio warning.
b. Freeze.
c. Turn red and activate an aural warning.
d. Turn red and activate visual and aural warnings.

RADIO ALTIMETERS 18.
A radio altimeter measures?

a. True Altitude.
b. Pressure altitude.
c. Height above sea level.
d. Height above the ground or water over which the aircraft is flying.

RADIO ALTIMETERS 19.
A radalt is?

a. Ground based and measures true altitude.
b. Ground based and measures true height.
c. Aircraft based and measures true altitude.
d. Aircraft based and measures true height.

RADIO ALTIMETERS 20.
A RADALT provides?

a. Radio altitude.
b. Pressure altitude.
c. Density altitude.
d. Height above terrain.

RADIO ALTIMETERS 21.
The failure of the radio altimeter would cause?

a. Loss of pressure altitude data.
b. Loss of density altitude data.
c. Loss of altitude data.
d. Loss of height data.

RADIO ALTIMETERS 22.
A radio altimeter has a maximum effective height because?

a. At greater heights the signal will be too weak.
b. At greater heights the signal will be undetectable.
c. At greater heights the signal will be absorbed by moisture in the air.
d. At greater heights signal from different modulation cycles will overlap.

RADIO ALTIMETERS 23.
Radio altimeters work on the principal of?

a. Frequency modulation.
b. Amplitude modulation.
c. Pulse modulation.
d. Pulse and amplitude modulation.

RADIO ALTIMETERS 24.
A RADALT employs .... waveband?

a. HF.
b. VHF.
c. UHF.
d. SHF.

RADIO ALTIMETERS 25.
Radio altimeters employ?

a. FM.
b. AM.
c. Pulsed FM.
d. Pulse modulation.

RADIO ALTIMETERS 26.
A radio altimeter will indicate zero when the aircraft is on the ground because of?

1. Frequency modulation of the transmitted signal.
2. Allowance for the signal path through the aircraft.
3. Allowance for the height of the aerials above the main wheels.
4. Beam width compensation.
5. Reduction in gain rate very close to the surface.

a. 1, 2.
b. 2, 3.
c. 3, 4.
d. 4, 5.

RADIO ALTIMETERS 27.
Radio altimeters are accurate only within the height range?

a. Zero to 50 ft.
b. Zero to 500 ft.
c. 50 ft to 2700 ft.
d. Zero ft to 2500 ft.

RADIO ALTIMETERS 28.
The frequency range used by a low altitude radio altimeter is ?

a. 5 GHz.
b. 115 GHz to 750 GHz.
c. 1200 MHz to 1500 MHz.
d. 4200 MHz to 4400 MHz.

RADIO ALTIMETERS 29.
A RADALT system is?

a. Ground based and measures true altitude.
b. Ground based and measures true height.
c. Aircraft based and measures true altitude.
d. Aircraft based and measures true height.

VSI 1.
If the pitot pipe becomes partly blocked?

a. The VSI indication will be too low when climbing.
b. The VSI will be too low when descending.
c. The VSI will not be affected.
d. The VSI will be too low when descending and too high when climbing.

VSI 2.
If the static pipe becomes partly blocked?

a. The VSI indication will be too high when descending.
b. The VSI indication will be too high when accelerating.
c. The VSI indication will be too low when climbing or descending.
d. The VSI indication will be unaffected.

VSI 3.
VSI lag is reduced by?

a. Two dashpots responding to acceleration.
b. Two return springs.
c. Bi-metallic strips.
d. Electronic systems.

VSI 4.
If the choke in the VSI becomes partly blocked?

a. The VSI indication will be too high when climbing.
b. The VSI indication will be too low when descending.
c. The VSI indication will be too high at all times.
d. The VSI indication will be too high when climbing or descending.

VSI 5.
The correct action to be taken when the static vent blocks on an unpressurised aircraft is to?

a. Break the VSI glass.
b. Use the standby static source.
c. Calculate ROC using mathematically.
d. Open a window to equalise pressures.

VSI 6.
If the casing of a VSI in a pressurised aircraft develops a leak?

a. VSI indications will be too low when climbing or descending.
b. VSI indications will be too high when climbing or descending.
c. VSI indications will be too low when climbing and too high when descending.
d. VSI indications will be too high when climbing and too low when descending.

VSI 7.
A VSI?

a. Produces an output proportional to ambient pressure.
b. Measures the difference between total pressure and static pressure.
c. Measures the difference between the pressure inside and outside a capsule.
d. Measures only dynamic pressure.

VSI 8.
A VSI indicates increasing ROD by?

a. VSI needle moving downwards.
b. VSI needle moving upwards.
c. VSI needle stationary.
d. The VSI indicates only vertical speeds, not accelerations.

VSI 9.
As an aircraft moves close to the ground during a landing the VSI might?

a. Become inaccurate due to ground effect.
b. Become inaccurate due to turbulence.
c. Stick due to loss of pitot source.
d. Become inaccurate due to aircraft attitude changes.

VSI 10.
What should the VSI indicate when an aircraft on a 3 degree glideslope is flying at 100 Kts TAS?

a. 224 fpm descent.
b. 324 fpm descent.
c. 424 fpm descent.
d. 524 fpm descent.

VSI 11.
If the static pipe becomes partly blocked?

a. The VSI indication will be too high when descending.
b. The VSI indication will be too high when accelerating at constant altitude.
c. The VSI indication will be too low at all times.
d. The VSI indication will be too low when descending.

VSI 12.
If the pitot pipe becomes partly blocked?

a. The VSI will over read when climbing or descending.
b. The VSI will be unaffected.
c. The VSI will over under read at all times.
d. The VSI will read zero at all times.

VSI 13.
The response rate of a VSI can be improved by fitting a?

a. Accelerometer system.
b. Choke system.
c. Bi-metallic compensator.
d. Return spring.

VSI 14.
If the port static vent of a large aircraft is blocked, what will happen to the VSI indications when it is side slipping to the left in a descent?

a. Over indicate.
b. Under indicate.
c. Be unaffected.
d. Fluctuate.

ASI 1.
What does the "barber's pole" used on some ASI's indicate?

a. M_{MO}.
b. V_{NE}.
c. TAS.
d. Temperature and V_{MO}.

ASI 2.
What speed is V_{NO}?

a. That which may only be exceeded with caution and in still air.
b. That which may never be exceeded.
c. That which may be exceeded only in emergencies.
d. The maximum at which fully control deflection is possible without overstressing the aircraft structure.

ASI 3.
From what is V_{MO} calculated?

a. TAS.
b. EAS.
c. CAS
d. RAS.

ASI 4.
What will be the effect if the drain hole and pitot tapping in a pitot probe are blocked, whilst the static source remains open?

a. The ASI will respond to changes in pressure altitude only.
b. The ASI will not respond.
c. The ASI will under read at all speeds.
d. The ASI will over read when accelerating, decelerating, climbing or descending.

ASI 5.
What do the upper and lower limits of the yellow arc on an ASI represent?

a. V_{NE} and V_{NO}.
b. V_{NO} and V_{NE}.
c. V_{MO} and V_{NE}.
d. V_{NO} and V_{MO}.

ASI 6.
If the pitot source and drain become blocked by ice when in cruise flight, how will the ASI respond when descending?

a. It will under read.
b. It will over read.
c. It will read zero in all conditions.
d. It will remain fixed at the reading at which it became blocked.

ASI 7.
At msl in the ISA?

a. CAS = TAS.
b. IAS = TAS.
c. IAS = EAS.
d. CAS < TAS.

ASI 8.
In an ASI system, what does the pitot probe measure?

a. Total pressure.
b. Dynamic pressure.
c. Static pressure.
d. Ambient pressure.

ASI 9.
What does the blue line on a twin engine piston aircraft ASI indicate?

a. V_{XSE}.
b. V_{NO}.
c. V_{NE}.
d. V_{YSE}.

ASI 10.
What are indicated by the lower and upper ends of the white arc on an ASI?

a. V_{S1} and V_{FE}.
b. V_{S0} and V_{FE}.
c. V_{FE} and V_{FO}.
d. V_{SE} and V_{NE}.

ASI 11.
V_{FE} is the?

a. Maximum speed at which the aircraft is permitted to fly with its flaps extended.
b. Maximum speed at which the flaps can be extended or retracted.
c. The minimum speed for flaps up flight.
d. The maximum speed for flaps up flight.

ASI 12.
What will be the effect on the ASI if the pitot tube of an unpressurised aircraft is fractured and the pitot drain is blocked?

a. It will over read.
b. It will under read.
c. It will give a constant reading.
d. It will read zero at all speeds.

ASI 13.
At any given weight or altitude, an aircraft will always lift-off at the same?

a. CAS.
b. TAS.
c. Ground speed.
d. EAS.

ASI 14.
CAS is?

a. EAS corrected for position error and compressibility error.
b. IAS corrected for position error and instrument error.
c. TAS corrected for instrument error and ram effect.
d. IAS corrected for density error and position error.

ASI 15.
When descending from FL400 and attempting to maintain maximum groundspeed, airspeed will be limited by?

a. V_{NE} then V_{MO}.
b. V_{NO} then V_{NE}.
c. M_{MO} then V_{MO}.
d. V_{MO} then M_{MO}.

ASI 16.
What will happen to TAS when descending through an isothermal layer at constant CAS?

a. Decrease.
b. Increase.
c. Remain constant.
d. Decrease then increase.

ASI 17.
When descending through an inversion at constant TAS?

a. Mach number increases.
b. Mach number decreases.
c. Mach number remains constant.
d. CAS decreases.

ASI 18.
When climbing through an inversion at constant TAS?

a. Mach number increases.
b. Mach number decreases.
c. Mach number remains constant.
d. CAS increases.

ASI 19.
When descending through an inversion at constant CAS?

a. TAS increases.
b. Mach number increases.
c. Mach number remains constant.
d. TAS remains constant.

ASI 20.
When climbing through an inversion at constant CAS?

a. TAS increases.
b. Mach number decreases.
c. Mach number remains constant.
d. TAS decreases.

ASI 21.
When climbing through an inversion at constant mach number?

a. CAS increases.
b. TAS decreases.
c. TAS remains constant.
d. TAS increases.

ASI 22.
When descending through an inversion at constant mach number?

a. TAS increases.
b. TAS decreases.
c. TAS remains constant.
d. CAS decreases.

ASI 23.
When climbing through an inversion at constant mach number?

a. CAS increases.
b. LSS decreases.
c. TAS remains constant.
d. TAS increases.

ASI 24.
When descending through an inversion at constant mach number?

a. CAS decreases.
b. LSS increases.
c. LSS remains constant.
d. TAS decreases.

ASI 25.
When climbing through an inversion at constant CAS?

a. TAS increases.
b. TAS decreases.
c. TAS remains constant.
d. Mach number decreases.

ASI 26.
When descending through an inversion at constant CAS?

a. TAS increases.
b. TAS decreases.
c. TAS remains constant.
d. Mach number increases.

ASI 27.
When descending through an isothermal layer at constant TAS?

a. Mach number increases.
b. Mach number decreases.
c. Mach number remains constant.
d. CAS decreases.

ASI 28.
When climbing through an isothermal layer at constant TAS?

a. Mach number increases.
b. Mach number decreases.
c. Mach number remains constant.
d. CAS decreases.

ASI 29.
When descending through an isothermal layer at constant CAS?

a. Mach number increases.
b. Mach number decreases.
c. Mach number remains constant.
d. TAS increases.

ASI 30.
When climbing through an isothermal layer at constant CAS?

a. Mach number increases.
b. Mach number decreases.
c. Mach number remains constant.
d. TAS decreases.

ASI 31.
When climbing through an isothermal layer at constant mach number?

a. TAS increases.
b. TAS decreases.
c. TAS remains constant.
d. CAS increases.

ASI 32.
When descending through an isothermal layer at constant mach number?

a. TAS increases.
b. TAS decreases.
c. TAS remains constant.
d. CAS decreases.

ASI 33.
When climbing through an isothermal layer at constant mach number?

a. CAS increases.
b. CAS decreases.
c. CAS remains constant.
d. TAS decreases.

ASI 34.
When descending through an isothermal layer at constant CAS?

a. LSS increases.
b. LSS decreases.
c. LSS remains constant.
d. TAS increases.

ASI 35.
When climbing through an isothermal layer at constant CAS?

a. TAS increases.
b. TAS decreases.
c. TAS remains constant.
d. Mach number decreases.

ASI 36.
When descending through an isothermal layer at constant CAS?

a. TAS increases.
b. TAS decreases.
c. TAS remains constant.
d. Mach number increases.

ASI 37.
If pressure remains constant as temperature increases?

a. Density will increase, causing the CAS : TAS ratio to increase.
b. Density will increase, causing the CAS : TAS ratio to decrease.
c. Density will decrease, causing the CAS : TAS ratio to increase.
d. Density will decrease, causing the CAS : TAS ratio to decrease.

ASI 38.
If the pitot pipe becomes partly blocked?

a. The IAS reading will be too low when climbing.
b. The IAS reading will be too low when descending.
c. The IAS reading will be too low at all times.
d. The IAS reading will be too low when descending and too high when climbing.

ASI 39.
If the pitot pipe becomes partly blocked?

a. The IAS will be too high when descending.
b. The IAS will be too high when accelerating.
c. The IAS will be too low at all times.
d. The IAS will be too low when accelerating.

ASI 40.
If the static pipe becomes partly blocked?

a. The IAS and ROC will be too low when climbing.
b. The IAS and ROC will be too low when descending.
c. The IAS and ROC will be too low at all times.
d. The IAS will be too low when descending and too high when climbing.

ASI 41.
If the static pipe becomes partly blocked?

a. The IAS will be too high when descending at constant IAS.
b. The IAS will be too high when accelerating at constant altitude.
c. The IAS will be too low at all times.
d. The IAS will be too low when accelerating at constant altitude.

ASI 42.
If the pitot pipe becomes partly blocked?

a. The ASI will over read and the error will be greater when climbing at constant CAS than when climbing at constant TAS.
b. The ASI will over read and the error will be greater when climbing at constant TAS than when climbing at constant CAS.
c. The ASI will under read and the error will be greater when climbing at constant CAS than when climbing at constant TAS.
d. The ASI will under read and the error will be greater when climbing at constant TAS then when climbing at constant CAS.

ASI 43.
CAS is IAS corrected for?

a. Position error.
b. Instrument error.
c. Compressibility error.
d. Temperature error.

ASI 44.
What does the white arc on an ASI indicate?

a. V_{S0} at the lower end and V_{FE} at the upper end.
b. V_{S0} at the lower end and V_{FO} at the upper end.
c. V_{S1} at the lower end and V_{FE} at the upper end.
d. V_{S1} at the lower end and V_{FO} at the upper end.

ASI 45.
If the pitot source becomes blocked while the static source remains open, an ASI will?

a. Under read at all speeds.
b. Over read at all speeds.
c. Read zero at all speeds.
d. Give an indication proportional to altitude.

ASI 46.
The pitot source in an ASI system provides?

a. Dynamic pressure.
b. Static pressure.
c. Kinetic pressure.
d. Total pressure.

ASI 47.
The barber's pole on an ASI indicates?

a. V_{NE}.
b. V_{MO}.
c. V_{MO} and temperature.
d. V_{NO}.

ASI 48.
If an aircraft is climbed with a constant mach meter indication in the ISA, how should the ASI indication respond?

a. Increase.
b. Decrease.
c. Increase then remain constant.
d. Decrease then remain constant.

ASI 49.
The blue line on the ASI of a twin prop aircraft indicates?

a. V_{FE}.
b. V_{NE}.
c. V_{YSE}.
d. V_{XSE}.

ASI 50.
The yellow arc on an ASI indicates?

a. V_{NO} at lower end and V_{NE} at upper end.
b. V_{NE} at lower end and V_{MO} at upper end.
c. V_{LO} at lower end and V_{FE} at upper end.
d. V_{FO} at lower end and V_{FE} at upper end.

ASI 51.
V_{NE} is?

a. The speed that must never be exceeded.
b. The maximum speed for normal operations.
c. The best climb speed.
d. The best descent speed.

ASI 52.
What is V_{FE}?

a. The maximum speed for extending or retracting the flaps.
b. The maximum speed for flight with the flaps extended.
c. The maximum speed for the flight envelope.
d. The minimum speed for extending or retracting the flaps.

ASI 53.
What is V_{LO}?

a. The maximum speed with landing gear out.
b. The maximum speed for retracting or extending the landing gear.
c. The minimum speed for flight with landing gear out.
d. The minimum speed for flight when operating the landing gear.

ASI 54.
What does the green arc on an ASI indicate?

a. V_{LE} at the lower end and V_{LO} at the upper end.
b. V_{FE} at the lower end and V_{FO} at the upper end.
c. V_{S1} at the lower end and M_{MO} at the upper end.
d. V_{S1} at the lower end and V_{NO} at the upper end.

ASI 55.
What is V_{NO}?

a. Maximum operating speed.
b. Maximum emergency speed.
c. Maximum cruise speed.
d. Maximum dive speed.

ASI 66.
V_{NE} is .... and is indicated by the .... on an ASI?

a.	Minimum night envelope speed	upper end of white arc.
b.	Maximum night envelope speed	lower end of green arc.
c.	Never exceed speed	red radial line at the upper end of the yellow arc.
d.	Normal endurance speed	green radial at the upper end of the green arc.

AIRSPEEDS 1.
Considering the maximum operational Mach number (MMO) and the maximum operational speed (VMO), the captain of a pressurized aircraft begins his descent from a high flight level. In order to meet his scheduled time of arrival, he decides to use the maximum ground speed at any time of the descent. He will be limited?

a. By the MMO.
b. By the VMO in still air.
c. Initially by the MMO, then by the VMO below a certain flight level.
d. Initially by the VMO, then by the MMO below a certain flight level.

AIRSPEEDS 2.
In a standard atmosphere and at the sea level, the calibrated airspeed (CAS) is?

a. Lower than the true airspeed (TAS).
b. Equal to the true airspeed (TAS).
c. Independent of the true airspeed (TAS).
d. Higher than the true airspeed (TAS).

AIRSPEEDS 3.
With a constant weight, irrespective of the airfield altitude, an aircraft always takes off at the same?

a. Calibrated airspeed.
b. Ground speed.
c. True airspeed.
d. Equivalent airspeed.

AIRSPEEDS 4.
The calibrated airspeed (CAS) is obtained by applying to the indicated airspeed (IAS)?

a. A compressibility and density correction.
b. An instrument and position/pressure error correction.
c. An antenna and compressibility correction.
d. An instrument and density correction.

AIRSPEEDS 5.
The velocity maximum operating (VMO) is a speed expressed in?

a. True airspeed (TAS).
b. Computed airspeed (COAS).
c. Calibrated airspeed (CAS).
d. Equivalent airspeed (EAS).

AIRSPEEDS 6.
The limits of the white scale of an airspeed indicator are?

a. VSI for the lower limit and VFE for the upper limit.
b. VSO for the lower limit and VLE for the upper limit.
c. VSI for the lower limit and VLE for the upper limit.
d. VSO for the lower limit and VFE for the upper limit.

AIRSPEEDS 7.
The limits of the green scale of an airspeed indicator are?

a. VS1 for the lower limit and VNE for the upper limit.
b. VS1 for the lower limit and VLO for the upper limit.
c. VS1 for the lower limit and VNO for the upper limit.
d. VS0 for the lower limit and VNO for the upper limit.

AIRSPEEDS 8.
The limits of the yellow scale of an airspeed indicator are?

a. VLO for the lower limit and VNE for the upper limit.
b. VLE for the lower limit and VNE for the upper limit.
c. VFE for the lower limit and VNE for the upper limit.
d. VNO for the lower limit and VNE for the upper limit.

AIRSPEEDS 9.
During a straight and uniform climb, the pilot maintains a constant calibrated airspeed (CAS)?

a. The Mach number increases and the true airspeed (TAS) increases.
b. The Mach number increases and the true airspeed (TAS) is constant.
c. The Mach number is constant and the true airspeed (TAS) is constant.
d. The Mach number is constant and the true airspeed (TAS) decreases.

AIRSPEEDS 10.
VLE is the maximum?

a. Speed authorized in flight.
b. Flight speed with landing gear down.
c. Speed at which the landing gear can be operated with full safety.
d. Speed with flaps extended in a given position.

AIRSPEEDS 11.
VLO is the maximum?

a. Speed at which the landing gear can be operated with full safety.
b. Flight speed with landing gear down.
c. Speed with flaps extended in a given position.
d. Cruising speed not to be exceeded except in still air with caution.

AIRSPEEDS 12.
VNE is the maximum speed?

a. At which the flight controls can be fully deflected.
b. With flaps extended in landing position.
c. Which must never be exceeded.
d. Not to be exceeded except in still air and with caution.

AIRSPEEDS 13.
VNO is the maximum speed?

a. Which must never be exceeded.
b. At which the flight controls can be fully deflected.
c. With flaps extended in landing position.
d. Not to be exceeded except in still air and with caution.

AIRSPEEDS 14.
For a constant Calibrated Airspeed (CAS) and a level flight, a fall in ambient temperature will result in a?

a. Lower True Airspeed (TAS) due to a decrease in air density.
b. Lower True Airspeed (TAS) due to an increase in air density.
c. Higher True Airspeed (TAS) due to a decrease in air density.
d. Higher True Airspeed (TAS) due to an increase in air density.

AIRSPEEDS 15.
When climbing at a constant Mach number below the tropopause, in ISA conditions, the Calibrated Airspeed (CAS) will?

a. Decrease.
b. Increase at a linear rate.
c. Remain constant.
d. Increase at an exponential rate.

AIRSPEEDS 16.
If the outside temperature at 35 000 feet is -40° C, the local speed of sound is?

a. 686 kt.
b. 596 kt.
c. 247 kt.
d. 307 kt.

AIRSPEEDS 17.
When descending through an isothermal layer at a constant Calibrated Airspeed (CAS), the True Airspeed (TAS) will?

a. Decrease.
b. Increase at a linear rate.
c. Remain constant.
d. Increase at an exponential rate.

AIRSPEEDS 18.
In a steady climb with the auto-throttle maintains a constant calibrated airspeed. If the total temperature remains constant, the Mach number?

a. Decreases.
b. Remains constant.
c. Decreases if the static temperature is lower than the standard temperature.
d. Increases.

AIRSPEEDS 19.
The airspeed indicator of a twin-engined aircraft comprises different sectors and color marks. The blue line corresponds to the?

a. Maximum speed in operations, or VMO.
b. Optimum climbing speed with one engine inoperative, or Vy.
c. Speed not to be exceeded, or VNE.
d. Minimum control speed, or VMC.

AIRSPEEDS 20.
The airspeed indicator of an aircraft is provided with a moving red and white hatched pointer. This pointer indicates the?

a. Speed indicated on the auto-throttle control box, versus temperature.
b. Speed indicated on the auto-throttle control box versus altitude.
c. Maximum speed in VMO operation versus altitude.
d. Maximum speed in VMO operation, versus temperature.

AIRSPEEDS 21.
VFE is the maximum speed?

a. At which the flaps can be operated.
b. With the flaps extended in take-off position.
c. With the flaps extended in a given position.
d. With the flaps extended in landing position.

AIRSPEEEDS 22.
An airplane is in steady descent. The auto-throttle maintains a constant Mach number. If the total temperature remains constant, the calibrated airspeed?

a. Remains constant.
b. Decreases if the static temperature is lower than the standard temperature, increases if above.
c. Increases.
d. Decreases.

AIRSPEEDS 23.
An aeroplane is in steady descent below the tropopause in the ISA. The auto-throttle maintains a constant calibrated airspeed. If the total temperature remains constant, the Mach number?

a. Increases if the static temperature is lower than the standard temperature, decreases if higher.
b. Decreases.
c. Increases.
d. Remains constant.

AIRSPEEDS 24.
An aeroplane is in a steady climb. The auto-throttle maintains a constant Mach number. If the total temperature remains constant, the calibrated airspeed?

a. Decreases if the static temperature is lower than the standard temperature, increases if higher.
b. Decreases.
c. Increases.
d. Remains constant.

MACH 1.
How will mach meter indication respond if an aircraft is flying at constant CAS at FL270 when it experiences a reduction in OAT?

a. No change.
b. Increase.
c. Decrease.
d. Increase or decrease depending on TAT.

MACH 2.
What is the LSS at 30000 ft if ambient temperature is -40^0 C?

a. 579 Kts.
b. 660 Kts.
c. 584 Kts.
d. 594 Kts.

MACH 3.
Which of the following best defines Mach number?

a. The ratio of TAS:LSS.
b. The ratio of LSS:TAS.
c. The ratio of CAS:LSS.
d. The ratio of ambient density to that at msl in the ISA.

MACH 4.
A mach meter comprises of?

a. A combination of ASI and altimeter.
b. A combination of VSI and altimeter.
c. An ASI with its scale marked in mach numbers.
d. An altimeter with its scale marked in mach numbers.

MACH 5.
What is the LSS at 40000 ft in the ISA?

a. 542 Kts.
b. 660 Kts.
c. 573 Kts.
d. 550 Kts.

MACH 6.
How will mach meter indication vary in a constant CAS climb?

a. Increase.
b. Decrease.
c. Increase then remain constant.
d. remain constant.

MACH 7.
What is the LSS at msl ISA?

a. 600 Kts
b. 550 Kts.
c. 750 Kts.
d. 661 Kts.

MACH 8.
Mach meter indications?

a. Vary with airspeed and temperature.
b. Vary only with airspeed.
c. Vary only with temperature.
d. Vary with density and altitude.

MACH 9.
How will mach meter indication respond if an aircraft passes through a cold front when flying at constant CAS and altitude?

a. Increase.
b. Decrease.
c. Remain constant.
d. Increase or decrease depending on altitude.

MACH 10.
How will the mach meter respond in a constant CAS climb if the static source becomes blocked?

a. Increase.
b. Decrease.
c. Remain constant.
d. Increase or decrease depending on airspeed.

MACH 11.
How will the mach meter respond in a constant TAS climb if the static source becomes blocked?

a. Increase.
b. Decrease.
c. Remain constant.
d. Increase or decrease depending on airspeed.

MACH 12.
How will the mach meter respond in a constant mach number climb if the static source becomes blocked?

a. Increase.
b. Decrease.
c. Remain constant.
d. Increase or decrease depending on airspeed.

MACH 13.
The indications on a mach meter are independent of?

a. Dynamic pressure.
b. Ambient temperature.
c. Static pressure.
d. Total pressure.

MACH 14.
What happens to mach meter indication in a constant RAS climb?

a. Increases.
b. Decreases.
c. Increases then remains constant.
d. Increases unless in an inversion or isothermal layer.

MACH 15.
What would happen if the static pipe became detached from the back of a mach meter in a pressurised aircraft at high altitude?

a. Under read.
b. Over read.
c. No effect.
d. Under read or over read depending on temperature.

MACH 16.
If an aircraft climbs at constant TAS from FL 200 to FL 400 the mach meter indication will?

a. Increase.
b. Decrease.
c. Increase then remain constant.
d. Decrease then remain constant.

MACH 17.
A mach meter is made up of?

a. An altimeter with a density capsule.
b. An ASI with an altitude capsule.
c. A VSI with a modified scale.
d. An ASI with a modified scale.

MACH 18.
V_{MO} is calculated based on?

a. TAS.
b. RAS.
c. CAS.
d. EAS.

MACH 19.
Mach number is the ratio of?

a. IAS:TAS.
b. CAS:LSS.
c. TAS:LSS.
d. RAS:TAS.

MACH 20.
If the static source becomes blocked the mach meter will .... as an aircraft climbs?

a. Over indicate.
b. Under indicate.
c. Not indicate.
d. Freeze.

MACH 21.
If temperature decreases when flying at constant CAS at FL 200, the mach meter indication will .... and the true mach number will .....?

a. Increase increase.
b. Decrease decrease.
c. Not change not change.
d. Not change increase.

MACH 22.
Mach meter indications?

a. Are temperature related.
b. Increase with temperature.
c. Decrease with temperature.
d. Are independent of temperature.

MACH 23.
The speed of sound at ISA msl is?

a. 550 Kts.
b. 560 Kts.
c. 660 Kts.
d. 670 kts.

MACH 24.
If ambient temperature is -10^0 C, what is the mach number when TAS is 594 Kts?

a. 0.5M.
b. 0.75M.
c. 0.94M.
d. 1.5M.

MACH 25.
The speed of sound at 25000 ft ISA is?

a. 600 Kts.
b. 602 Kts.
c. 604 kts.
d. 606 Kts.

MACH 26.
What is true mach number at 25000 ft ISA if the TAS is 500 Kts?

a. 0.75M
b. 0.83M.
c. 0.90M.
d. 0.93M.

MACH 27.
A mach meter indicates mach number based on the ratio of?

a. Static pressure to pitot pressure.
b. Pitot pressure to static pressure.
c. Dynamic pressure to static pressure.
d. Static pressure to dynamic pressure.

MACH 28.
How will CAS respond if temperature increases by 5 degrees C when flying at a constant indicated mach number at FL290?

a. Increases.
b. Decreases.
c. Remains approximately constant.
d. Depends on conditions relative to ISA.

MACH 29.
What happens to TAT when an aircraft descends at constant indicated mach number?

a. Increases.
b. Decreases.
c. Remain constant.
d. Remains constant then increases.

MACH 30.
What is actually measured by a mach meter?

a. Pitot pressure.
b. The ratio of (pitot pressure – static pressure) : static pressure.
c. The ratio of static pressure to dynamic pressure.
d. The ratio of (static pressure + pitot pressure) : pitot pressure.

MACH 31.
When descending at constant CAS, the TAT and mach meter indications should?

a.	Increase	increase.
b.	Increase	decrease.
c.	Increase then remain constant	decrease.
d.	Remain constant	remain constant.

MACH 32.
Mach meter indications are derived from?

a. $(P_T - P_S)/P_T$.
b. $(P_S - P_T)/P_S$.
c. $(P_T - P_S)/P_S$.
d. $(P_S - P_T)/P_T$.

MACH 33.
If temperature increases by 5 degrees C during a constant mach number descent, what will happen to CAS?

a. Increase by 5 Kts.
b. Increase by 10 Kts.
c. Remain constant.
d. Increase or decrease depending on whether conditions are above or below ISA.

MACH 34.
A mach meter compares?

a. $(P_T - P_S)$ to P_T.
b. $(P_S - P_T)$to P_S.
c. $(P_T - P_S)$ to P_S.
d. $(P_S - P_T)$ to P_T.

MACH 35.
What does mach number represent?

a. The CAS of an aircraft as a fraction of the local speed of sound.
b. The local speed of sound as a fraction of the CAS of an aircraft.
c. The TAS of an aircraft as a fraction of the local speed of sound.
d. The local speed of sound as a fraction of the CAS of an aircraft.

MACH 36.
What is the local speed of sound at sea level if the ambient temperature is 20^0 C?

a. 661 Kts.
b. 666 Kts.
c. 677 Kts.
d. 680 Kts.

MACH 37.
If ambient temperature increases by 10 degrees, for an aircraft flying at constant TAS, the indicated mach number will .... and the true mach number will ....?

a.	Increase	increase
b.	Decrease	decrease.
c.	Not change	increase.
d.	Not change	decrease.

MACH 38.
When climbing at constant mach number below the torpopause in the ISA, the CAS will?

a. Increase.
b. Decrease.
c. Remain constant.
d. Decrease then remain constant.

MACH 39.
When descending at constant CAS, if temperature remains constant the indicated mach number will?

a. Remain constant.
b. Increase.
c. Decrease .
d. Increase exponentially.

MACH 40.
What should the mach meter indicate when flying at 500 kts TAS at FL250, if the ambient temperature is -30^0 C?

a. 0.52M.
b. 0.62M.
c. 0.72M.
d. 0.82M.

GYRO 1.
The building principle of a gyroscope, the best efficiency is obtained through the concentration of the mass?

a. Close to the axis and with a low rotation speed.
b. On the periphery and with a high rotation speed.
c. Close to the axis and with a high rotation speed.
d. On the periphery and with a low rotation speed.

GYRO 2.
A Standby horizon or emergency attitude indicator?

a. Only works of there is a complete electrical failure.
b. Contains its own separate gyro.
c. Is automatically connected to the primary vertical gyro if the alternator fails.
d. Is fully independent of external energy resources in an emergency situation.

GYRO 3.
The basis properties of a gyroscope are?

1. The gyro's weight.
2. The rigidity in space.
3. The inertia.
4. The high RPM.
5. The precession

The combination of correct statements is?

a. 3, 4.
b. 2, 5.
c. 2, 3, 5.
d. 1, 3, 5.

GYRO 4.
The indications of the directional gyro when used as an on-board instrument are valid only for a short period of time. The causes of this inaccuracy are?

1. The earth's rotation.
2. The longitudinal acceleration.
3. The aircraft's motion over the surface of the earth.
4. The mechanical defects of the gyro.
5. The gyro's weight.
6. The gimbal mount of the gyro rings.

The combination of correct statements is?

a. 1, 3, 4.
b. 1, 2, 3, 4, 5, 6.
c. 2, 5, 6.
d. 1, 3, 4, 6.

GYRO 5.
The characteristics of the directional gyro (DG) used in a gyro stabilised compass system are?

a. One degree of freedom, whose vertical axis, aligned with the real vertical to the location is maintained in this direction by an automatic erecting system.
b. Two degrees of freedom, whose horizontal axis corresponding to the reference direction is maintained in the horizontal plane by an automatic erecting system.
c. Two degrees of freedom, whose axis aligned with the vertical to the location is maintained in this direction by an erecting system.
d. One degree of freedom, whose horizontal axis is maintained in the horizontal plane by an automatic erecting system.

GYRO 6.
A gravity type erector is used in a vertical gyro device to correct errors on?

a. An artificial horizon
b. A directional gyro unit.
c. A turn indicator.
d. A gyro-magnetic indicator.

GYRO 7.
When an aircraft has turned 360 degrees with a constant attitude and bank, the pilot observes the following on a classic artificial horizon?

a. Too much nose-up and bank correct.
b. Too much nose-up and bank too high.
c. Attitude and bank correct.
d. Too much nose-up and bank too low.

GYRO 8.
When an aircraft has turned 270 degrees with a constant attitude and bank, the pilot observes the following on a classic artificial horizon?

a. Too much nose-up and bank too high.
b. Too much nose-up and bank too low.
c. Attitude and bank correct.
d. Too much nose-up and bank correct.

GYRO 9.
Note: in this question, the degrees of freedom of a gyro are determined by the number of gimbal rings it comprises. Among the flight control instruments, the artificial horizon plays an essential part. It uses a gyroscope with?

a. Two degrees of freedom, whose axis is oriented and continuously maintained to local vertical by an automatic erecting system.
b. Two degrees of freedom, whose horizontal axis corresponding to a reference direction is maintained in a horizontal plane by an automatic erecting system.
c. One degree of freedom, whose horizontal axis is maintained in a horizontal plane by an automatic erecting system.
d. One degree of freedom, whose vertical axis oriented in the direction of the real vertical to the location is maintained in this direction by an automatic erecting system.

GYRO 10.
A slaved directional gyro derives it's directional signal from?

a. A direct reading magnetic compass.
b. The flight director.
c. The flux valve.
d. The air-data-computer.

GYRO 11.
A turn indicator is built around a gyroscope with?

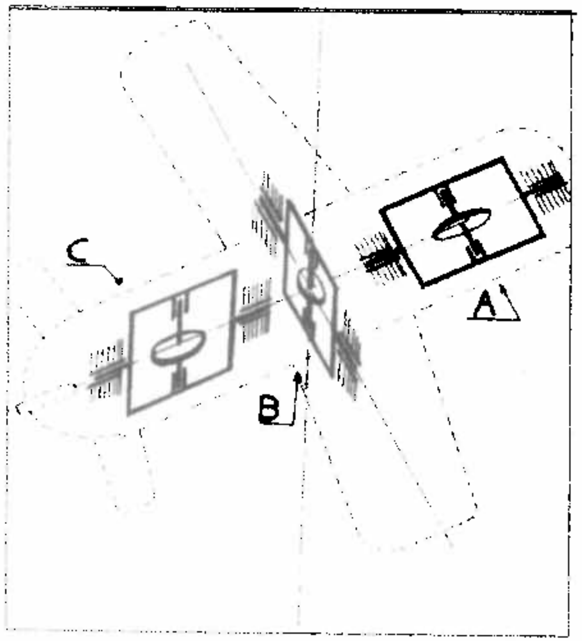
a. 1 degree of freedom.
b. 3 degrees of freedom.
c. 2 degrees of freedom.
d. 0 degree of freedom.

GYRO 12.
The diagram below shows three gyro assemblies: A, B and C. Among these gyros,

One is a roll gyro (noted 1).
One is a pitch gyro (noted 2).
One is a yaw gyro (noted 3)

The correct matching of gyros and assemblies is?

a. 1C, 2A, 3B.
b. 1B, 2A, 3C.
c. 1A, 2B, 3C.
d. 1B, 2C, 3A.



GYRO 13.
The indications on a directional gyroscope or gyrocompass are subject to errors, due to:

1. Rotation of Earth.
2. Aeroplane motion on Earth.
3. Lateral and transversal aeroplane bank angles.
4. North change.
5. Mechanical defects.

Chose the combination with true statements only?

a. 2, 3, 5.
b. 1, 2, 3, 5.
c. 3, 4, 5.
d. 1, 2, 4, 5.

GYRO 14.
At a low bank angle, the measurement of rate-of-turn actually consists in measuring the?

a. Angular velocity of the aircraft.
b. Yaw rate of the aircraft.
c. Pitch rate of the aircraft.
d. Roll rate of the aircraft.

GYRO 15.
An airborne instrument, equipped with a gyro with 2 degrees of freedom and a horizontal spin axis is?

a. An artificial horizon.
b. A turn indicator.
c. A fluxgate compass.
d. A directional gyro.

GYRO 16.
When, in flight, the needle of a needle and ball indicator is on the left and the ball on the right, the aircraft is?

a. Turning left with too much bank.
b. Turning right with not enough bank.
c. Turning right with too much bank.
d. Turning left with not enough bank.

GYRO 17.
When, in flight, the needle of a needle and ball indicator is on the right and the ball on the left, the aircraft is?

a. Turning left with too much bank.
b. Turning right with not enough bank.
c. Turning right with too much bank.
d. Turning left with not enough bank.

GYRO 18.
When, in flight, the needle and ball of a needle and ball indicator are on the right, the aircraft is?

a. Turning left with too much bank.
b. Turning left with not enough bank.
c. Turning right with too much bank.
d. Turning right with not enough bank.

GYRO 19.
When, in flight, the needle and ball of a needle-and-ball indicator are on the left, the aircraft is?

a. Turning right with too much bank.
b. Turning right with not enough bank.
c. Turning left with too much bank.
d. Turning left with not enough bank.

GYRO 20.
On the ground, during a left turn, the turn indicator indicates?

a. Needle to the left, ball to the left.
b. Needle in the middle, ball to the right.
c. Needle in the middle, ball to the left.
d. Needle to the left, ball to the right.

GYRO 21.
The rate-of-turn is the?

a. Pitch rate in a turn.
b. Change-of-heading rate of the aircraft.
c. Yaw rate in a turn aircraft.
d. Speed in a turn.

GYRO 22.
In a Turn-indicator, the measurement of rate of turn consists for?

a. High bank angles, in measuring the yaw rate.
b. High bank angles, in measuring the roll rate.
c. Low bank angles, in measuring the yaw rate.
d. Low bank angles, in measuring the roll rate.

GYRO 23.
In a turn at constant rate, the turn indicator reading is?

a. Proportional to the aircraft true airspeed.
b. Independent to the aircraft true airspeed.
c. Proportional to the aircraft weight.
d. Inversely proportional to the aircraft true airspeed.

GYRO 24.
An airborne instrument, equipped with a gyro with 2 degrees of freedom and a horizontal spin axis is?

a. A directional gyro.
b. An artificial horizon.
c. A turn indicator.
d. A flux gate compass.

GYRO 25.
An airborne instrument, equipped with a gyro with 1 degree of freedom and a horizontal spin axis is a?

a. Fluxgate compass.
b. Directional gyro.
c. Turn indicator.
d. Gyro-magnetic compass.

GYRO 26.
The vertical reference unit of a three-axis data generator is equipped with a gyro with?

a. 1 degree of freedom and horizontal spin axis.
b. 1 degree of freedom and vertical spin axis.
c. 2 degrees of freedom and vertical spin axis.
d. 2 degrees of freedom and horizontal spin axis.

GYRO 27.
When an aircraft has turned 90 degrees with a constant attitude and bank, the pilot observes the following on a classic artificial horizon?

a. Too much nose-up and bank correct.
b. Too much nose-up and bank too high.
c. Too much nose-up and bank too low.
d. Attitude and bank correct.

GYRO 28.
On the ground, during a right turn, the turn indicator indicates?

a. Needle in the middle, ball to left.
b. Needle to the right, ball to left.
c. Needle to the right, ball to right.
d. Needle in the middle, ball to right.

GYRO 29.
The heading reference unit of a three-axis data generator is equipped with a gyro with?

a. 2 degrees of freedom and horizontal spin axis.
b. 2 degrees of freedom and vertical spin axis.
c. 1 degree of freedom and horizontal spin axis.
d. 1 degree of freedom and vertical spin axis.

GYRO 30.
Following 180° stabilized turn with a constant attitude and bank, the artificial horizon indicates?

a. Too high pitch-up and too low banking.
b. Too high pitch-up and correct banking.
c. Attitude and banking correct.
d. Too high pitch up and too high banking.

GYRO 31.
The gyro-magnetic compass torque motor?

a. Causes the directional gyro unit to precess.
b. Causes the heading indicator to precess.
c. Feeds the error detector system.
d. Is fed by the flux valve.

GYRO 32.
The heading information originating from the gyro-magnetic compass flux valve is sent to the?

a. Error detector.
b. Erector system.
c. Heading indicator.
d. Amplifier.

GYRO 33.
The input signal of the amplifier of the gyro-magnetic compass resetting device originates from the?

a. Directional gyro erection device.
b. Error detector.
c. Flux valve.
d. Directional gyro unit.

GYRO 34.
A rate integrating gyro is a detecting element used in?

1. An inertial attitude unit.
2. An automatic pilot.
3. A stabilizing servo system.
4. An inertial navigation system.
5. A rate-of-turn indicator.

The combination of correct statements is?

a. 1, 4.
b. 1, 2, 3, 4, 5.
c. 2, 3, 5.
d. 2, 3, 4.

GYRO 35.
Under normal operating conditions, when an aircraft is in a banked turn, the rate-of-turn indicator is a valuable gyroscopic flight control instrument ; when it is associated with an attitude indicator it indicates?

1. The angular velocity of the aircraft about the yaw axis.
2. The bank of the aircraft.
3. The direction of the aircraft turn.
4. The angular velocity of the aircraft about the real vertical.

The combination of correct statements is?

a. 3, 4.
b. 2, 4.
c. 1, 3.
d. 1, 2.

GYRO 36.
The gimbal error of the directional gyro is due to the effect of?

a. A bank or pitch attitude of the aircraft.
b. An apparent weight and an apparent vertical.
c. Too slow precession on the horizontal gimbal ring.
d. The aircraft's track over the earth

GYRO 37.
The pendulum type detector system of the directional gyro feeds?

a. A torque motor on the sensitive axis.
b. 2 torque motors arranged horizontally.
c. A leveling erection torque motor.
d. A nozzle integral with the outer gimbal ring.

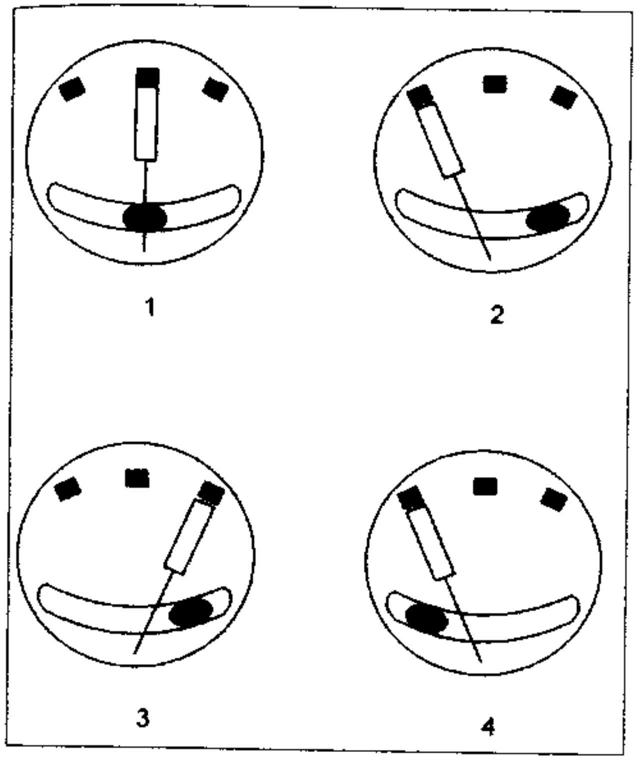
GYRO 38.
The directional gyro axis spins about the local vertical by 15°/hour?

a. In the latitude 30°.
b. In the latitude 45°.
c. On the equator.
d. On the North pole.

GYRO 39.
Compared with a conventional gyro, a laser gyro?

a. Consumes a lot of power.
b. Has a longer life cycle.
c. Is influenced by temperature.
d. Has a fairly long starting cycle.

GYRO 40.
The diagram representing a left turn with insufficient rudder is?



a. 2.
b. 3.
c. 4.
d. 1.

GYRO 41.
A turn indicator is an instrument which indicates rate of turn. Rate of turn depends upon:

1. Bank angle.
2. Aeroplane speed.
3. Aeroplane weight.

The combination regrouping the correct statements is?

a. 1, 2, and 3.
b. 1 and 2.
c. 1 and 3.
d. 2 and 3.

GYRO 42.
During an acceleration phase at constant attitude, the resetting principle of the artificial horizon results in the horizon bar indicating a?

a. Nose-down attitude.
b. Constant attitude.
c. Nose-down followed by a nose-up attitude.
d. Nose-up attitude.

GYRO 43.
Heading information given by a gyro platform, is given by a gyro at?

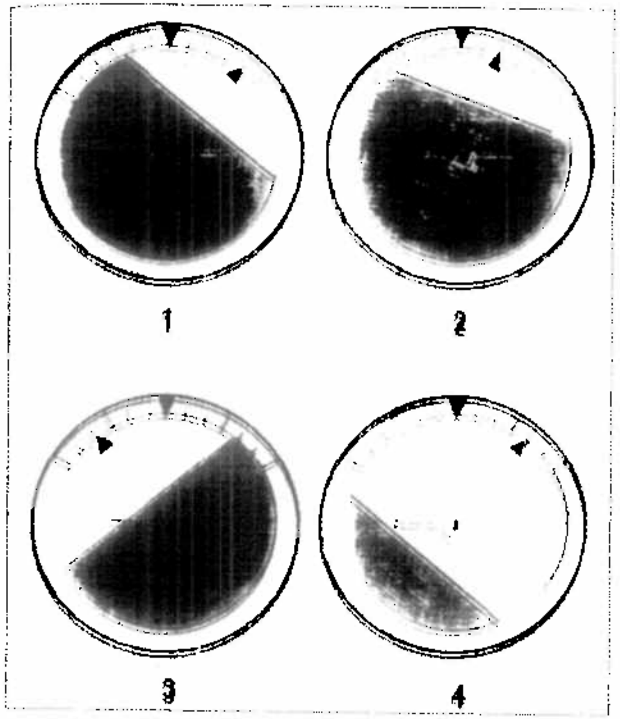
a. 2 degrees-of-freedom in the vertical axis.
b. 1 degree-of-freedom in the horizontal axis.
c. 1 degree-of-freedom in the vertical axis.
d. 2 degrees-of-freedom in the horizontal axis.

GYRO 44.
Among the systematic errors of the "directional gyro", the error due to the earth rotation make the north reference turn in the horizontal plane. At a mean latitude of 45° N, this reference turns by?

a. 15°/hour to the right.
b. 7.5°/hour to the right.
c. 7.5°/hour to the left.
d. 10.5°/hour to the right.

GYRO 45.
The diagram which shows a 40° left bank and 15° nose down attitude is?

a. 1.
b. 2.
c. 3.
d. 4.



GYRO 46.
The heading read on the dial of a directional gyro is subject to errors, one of which is due to the movement of the aircraft. This error?

a. Is at its greatest value when the aircraft follows a meridional track.
b. Shows itself by an apparent rotation of the horizontal axis of the gyroscope which seems to turn at 15° per hour to the right in the northern hemisphere.
c. Is dependent on the ground speed of the aircraft, its true track and the average latitude of the flight.
d. Is, in spite of this, insignificant and may be neglected.

GYRO 47.
A gravity erector system is used to correct the errors on?

a. Artificial horizon.
b. A directional gyro.
c. A turn indicator.
d. A gyro-magnetic compass.

GYRO 48.
The maximum directional gyro error due to the earth rotation is?

a. 180°/hour.
b. 5°/hour.
c. 15°/hour.
d. 90° /hour.

GYRO 49.
A directional gyro is:

1. A gyroscope free around two axis.
2. A gyroscope free around one axis.
3. Capable of self-orientation around an earth-tied direction.
4. Incapable of self-orientation around an earth-tied direction.

The combination which regroups all of the correct statements is?
a. 1, 4.
b. 2, 4.
c. 2, 3.
d. 1, 3.

GYRO 50.
For an aircraft flying a true track of 360° between the 005° S and 005° N parallels, the precession error of the directional gyro due to apparent drift is equal to?

a. Depends only on the aircraft's ground speed.
b. 0°/hour.
c. +5°/hour.
d. -5°/hour.

GYRO 51.
What is the maximum gyro drift rate that can be caused by earth rotation?

a. 5^0 per hour.
b. 15^0 per hour.
c. 20^0 per hour.
d. 90^0 per hour.

GYRO 52.
A DGI has .... degrees of freedom and a ...... spin axis?

a. 1 vertical.
b. 2 horizontal.
c. 3 horizontal.
d. 2 vertical.

GYRO 53.
Which instrument uses a vertical gyroscope fitted with a gravity erection device?

a. Artificial horizon.
b. DGI.
c. Turn indicator.
d. Rate gyro.

GYRO 54.
Integrating gyroscopes are used?

1. Attitude indicators.
2. Inertial attitude units.
3. Rate of turn indicators.
4. Inertial navigation platforms.
5. Autopilots.

a. 3 and 4.
b. 4 and 5.
c. 2, 3, and 5.
d. 2 and 4.

GYRO 55.
How many degrees of freedom and what spin axis will a two axis gyro measuring vertical changes use?

a. 2 Vertical.
b. 2 Lateral.
c. 2 Longitudinal.
d. 1 Vertical.

GYRO 56.
The properties that are peculiar to a gyroscope are?

1. Inertia.
2. Precession.
3. Rigidity.
4. Angular momentum.

a. 1 and 2.
b. 2 and 4.
c. 2, 3, and 4
d. 2 and 3.

GYRO 57.
Rigidity increases with?

a. Increasing RPM, and concentrating mass close to the centre.
b. Increasing RPM and concentrating mass at the periphery.
c. Decreasing RPM and radius.
d. Increasing RPM and spin axis length.

GYRO 58.
A gravity erection device would be used on?

a. VSI.
b. DGI.
c. Artificial horizon.
d. Turn and slip indicator.

GYRO 59.
The yaw damper system, uses a …… gyro and produces rudder inputs proportional to ………..?

a.	Horizontal rate	yaw rate.
b.	Vertical rate	yaw and roll.
c.	Horizontal displacement	yaw rate.
d.	Vertical displacement	roll rate.

GYRO 60.
To obtain heading information a gyro-stabilised platform requires?

a. A horizontal axis and one degree of freedom.
b. A vertical axis and two degrees of freedom.
c. A lateral axis and two degrees of freedom.
d. A vertical axis and one degree of freedom.

GYRO 61.
What will be the apparent wander on gyroscope when flying on a northerly track from 05° S to 05° N.

a. 10° per hour.
b. 15° per hour.
c. Zero.
d. 120° per hour.

GYRO 62.
The number of degrees of freedom of a gyro is?

a. One more than the number of gimbals.
b. The same as the number of gimbals.
c. One less than the number of gimbals.
d. Not related to the number of gimbals.

GYRO 63.
A directional gyro requires?

a. One gimbal, one degree of freedom and a horizontal spin axis.
b. Two gimbals, two degrees of freedom and a horizontal spin axis.
c. Three gimbals, three degrees of freedom and a lateral spin axis.
d. One gimbal, one degree of freedom and a vertical spin axis.

GYRO 64.
What type of gyro has a horizontal spin axis and one degree of freedom?

a. Rate gyro.
b. Displacement gyro.
c. Rate integrating gyro.
d. Space gyro.

GYRO 65.
The properties of a gyro are?

1. Mass.
2. Rigidity in space.
3. Inertia.
4. Precession.
5. Rigidity with reference to the earth.

a. 1, 2, 3, 4.
b. 1, 3, 4, 5.
c. 1, 2, 3, 5.
d. 2, 3, 4, 5.

GYRO 66.
Gyro rigidity improves with?

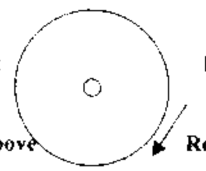
a. Increasing RPM, mass and radial displacement of mass.
b. Increasing RPM and mass but decreasing radial displacement of mass.
c. Decreasing RPM but increasing mass and radial displacement of mass.
d. Decreasing RPM and mass but increasing radial displacement of mass.

GYRO 67.
The dither motor in a ring laser gyroscope?

a. Stabilises the frequency or the laser source.
b. Prevents laser lock.
c. Prevents or minimises transport wander.
d. Increases accuracy at all rotation rates.

GYRO 68.
When viewed from above a gyro is seen to rotate on a vertical spin axis, as illustrated in the diagram. If a force tends to push the right side downwards?

a. It will tilt upwards at the front.
b. It will tilt upwards at the left.
c. It will tilt upwards at the right.
d. It will tilt upwards at the back.



GYRO 69.
A 2 axis gyro measuring vertical changes will have?

1. One degree of freedom.
2. Two degrees of freedom.
3. Vertical axis.
4. Horizontal axis.

a. 1, 3.
b. 1, 4.
c. 2, 3.
d. 2, 4.

GYRO 70.
The properties unique to a gyro include?

1. Mass.
2. Inertia.
3. Rigidity.
4. Precession.
5. Rotational velocity.

a. 1, 2.
b. 2, 3.
c. 3, 4.
d. All of the above.

GYRO 71.
The gyro in a DGI has.

1. One degree of freedom.
2. Two degrees of freedom.
3. Vertical axis.
4. Horizontal axis.

a. 1, 3.
b. 1, 4.
c. 2, 3.
d. 2, 4.

GYRO 72.
The gyro in a vertical reference data generator has?

1. One degree of freedom.
2. Two degrees of freedom.
3. Vertical axis.
4. Horizontal axis.

a. 1, 3.
b. 1, 4.
c. 2, 3.
d. 2, 4.

GYRO 73.
The purpose of the torque motor in a gyro stabilised magnetic compass is to?

a. Move the selsyn stator to calibrate the compass.
b. Remove flux valve errors.
c. Precess the directional gyro.
d. Align the heading pointer with true heading prior to flight.

GYRO 74.
Where would a rate integrating gyro be used?

1. Rate of turn indicator.
2. Autopilot.
3. Inertial navigation unit.
4. Inertial attitude reference unit.

5. As a stabiliser for an instrument or inertial platform.

a. 1, 2.
b. 2, 3.
c. 3, 4.
d. 4, 5.

GYRO 75.
DGI errors are caused by?

1. Mechanical imperfections.
2. Earth rate.
3. Transport wander.
4. Banking when pitching.
5. Annual migration of the poles.

a. All of the above.
b. 1, 2, 3, 4.
c. 2, 3, 4, 5.
d. 3, 4, 5.

GYRO 76.
To indicate true heading, the gyros in a gyro stabilised platform require?

1. One degree of freedom.
2. Two degrees of freedom.
3. Vertical axis.
4. Horizontal axis.

a. 1, 3.
b. 1, 4.
c. 2, 3.
d. 2, 4.

GYRO 77.
A gravity erector system is used to correct errors in?

a. A ROT indicator.
b. A DGI.
c. An artificial horizon.
d. An inertial platform.

GYRO 78.
What error is caused by movement of the gyro relative to the earth in a DGI?

a. Transport wander.
b. Earth rate.
c. Real wander.
d. Longitude latitude error.

GYRO 79.
The gyro in an artificial horizon requires.

1. One degree of freedom.
2. Two degrees of freedom.
3. Vertical axis.
4. Horizontal axis.

a. 1, 3.
b. 1, 4.
c. 2, 3.
d. 2, 4.

GYRO 80.
Gyroscope rigidity is increased by .... RPM and concentrating the mass at the .... of the rotor?

a. Increasing hub.
b. Increasing rim.
c. Decreasing hub.
d. Decreasing rim.

GYRO 81.
Which instrument employs a gravity erecting device on its gyro?

a. ASI.
b. Directional gyro unit.
c. Turn indicator.
d. Artificial horizon.

GYRO 82.
A gyro with one degree of freedom is used in a?

a. Slaved gyro compass.
b. Directional gyro unit.
c. Turn indicator.
d. Artificial horizon.

GYRO 83.
Transport wander when flying east at 400 Kts at 45 degrees north is?

a. 5.67° per hour.
b. 6.67° per hour.
c. 7.67° per hour.
d. 8.67° per hour.

GYRO 84.
Transport wander when flying east at 300 Kts at 40 degrees south is?

a. -4.2° per hour.
b. -5.2° per hour.
c. 6.2° per hour.
d. 7.2° per hour.

GYRO 85.
Transport wander when flying west at 300 Kts at 25 degrees south is?

a. -2.33° per hour.
b. -3.34° per hour.
c. 2.33° per hour.
d. 3.34° per hour.

GYRO 86.
Transport wander when flying west at 300 Kts at 25 degrees north is?

a. 2.33° per hour.
b. 3.34° per hour.
c. -2.33° per hour.
d. -3.34° per hour.

GYRO 87.
Earth rate at 25 degrees south is?

a. 13.59° per hour.
b. 6.34° per hour.
c. -13.59° per hour.
d. -6.34° per hour.

GYRO 88.
Earth rate at 45 degrees north is?

a. -13.59° per hour.
b. -10.61° per hour.
c. 13.59° per hour.
d. 10.61° per hour.

GYRO 89.
Earth rate at the equator is?

a. Zero.
b. 15° per hour.
c. -15° per hour
d. 6.34° per hour.

ATTITUDE 1.
How many degrees of freedom and what is the spin axis of an attitude indicator?

a.	Local earth vertical	two degrees of freedom.
b.	Aircraft lateral axis	two degrees of freedom.
c.	Aircraft horizontal axis	one degree of freedom.
d.	aircraft longitudinal axis	three degrees of freedom.

ATTITUDE 2.
What would be the indication on an attitude indicator in a right turn?

a. Climb due to pendulous vanes.
b. No climb.
c. Descent due to pendulous vanes.
d. Correct pitch and bank at all times.

ATTITUDE 3.
What will a classic artificial horizon indicate when turning through 90 degrees at constant attitude and bank angle?

a. Correct bank angle and attitude.
b. Too much bank and too much nose up attitude.
c. Too little bank and too little nose up attitude.
d. Too little bank and too much nose up attitude.

ATTITUDE 4.
An AI has?

a. One degree of freedom and a lateral spin axis.
b. Two degrees of freedom and a vertical spin axis.
c. Two degrees of freedom and a horizontal spin axis.
d. One degree of freedom and a vertical spin axis.

ATTITUDE 5.
How will a basic AI respond if an aircraft performs a 270 degree turn at constant bank angle and ROT?

a. Nose up and bank.
b. Nose down and bank.
c. Nose level and bank.
d. Correct bank and pitch.

ATTITUDE 6.
Aircraft attitude is indicated on?

a. EICAS/ECAM primary display.
b. EFIS ND.
c. EFIS PFD.
d. All of the above.

ATTITUDE 7.
When turning through 90° at constant AOB and pitch attitude, what will a classic artificial horizon indicate?

a. Too much nose up and too little bank angle.
b. Too much nose up and too much bank angle.
c. Too little nose up and too little bank angle.
d. Too little nose up and too much bank angle.

ATTITUDE 8.
When turning through 270° at constant AOB and pitch attitude, what will a classic artificial horizon indicate?

a. Too much nose up and too little bank angle.
b. Too much nose up and too much bank angle.
c. Too little nose up and too little bank angle.
d. Too little nose up and too much bank angle.

ATTITUDE 9.
An artificial horizon has?

a. Two degrees of freedom and a vertical spin axis.
b. Two degrees of freedom and a longitudinal spin axis.
c. Two degrees of freedom and a lateral spin axis.
d. No degrees of freedom because it is earth tied.

ATTITUDE 10.
The latitude nut .... an artificial horizon?

a. Compensates for transport error.
b. Is not fitted to.
c. Compensates for latitude error.
d. Compensates for earth rate errors.

ATTITUDE 11.
The gravity sensing unit in an artificial horizon is used to?

a. Prevent tilting of the gyro.
b. Prevent precession of the gyro.
c. Erect the gyro.
d. Provide signals to the autopilot.

ATTITUDE 12.
Classic artificial horizon indications turning through 180° at constant AOB?

a. Nose up and AOB too low.
b. Nose up and AOB too high.
c. Nose up and correct AOB.
d. Pitch attitude and AOB correct.

ATTITUDE 13.
An artificial horizon has..... degrees of freedom in the .... axis?

a. Two vertical.
b. Two horizontal.
c. One vertical.
d. One horizontal.

ATTITUDE 14.
Which or the following properties are possessed by a standby artificial horizon?

1. Independent power supply.
2. Integral gyro.
3. Remote (external) gyro.
4. Used only in emergencies.
5. At least one per pilot in JAR 25 aircraft.

a. 1, 2.
b. 2, 3.
c. 3, 4.
d. 4, 5.

ATTITUDE 15.
If an aircraft turns through 270° at a constant rate of turn and AOB, the indications on its classic artificial horizon will be?

a. Bank left nose up.
b. Bank right nose up.
c. Wings level nose up.
d. AOB and pitch attitude correct.

TURN/SLIP 1.
The ball in a serviceable slip indicator is .... by .... and .... Indicate/s the state of slip?

a.	Held central	Gravity	Does not always.
b.	Positioned	Acceleration	Does not always.
c.	Held central	Gravity	Always.
d.	Positioned	Acceleration	Always.

TURN/SLIP 2.
The turn indicator is affected by?

1. AOB.
2. Airspeed.
3. Weight.
4. Altitude.

a. 1, 2.
b. 2, 3.
c. 3, 4.
d. 4, 5.

TURN/SLIP 3.
A turn indicator used in conjunction with an attitude indicator will show?

1. Turn direction.
2. Rate of turn.
3. Angular velocity about the true vertical axis.
4. Angular velocity about the aircraft vertical axis.
5. Angular velocity about the longitudinal axis.

a. 1, 2.
b. 1, 3.
c. 1, 2, 4.
d. 2, 3, 5.

TURN/SLIP 4.
ROT indications are?

a. Proportional to TAS.
b. Proportional to CAS.
c. Proportional to mass.
d. Proportional to EAS.

TURN/SLIP 5.
A turn indicator has?

1. A horizontal spin axis.
2. A vertical spin axis.
3. One degree of freedom.
4. Two degrees of freedom.
5. A spin axis tied to the yawing plane of the aircraft.
6. A gravity erecting unit.

a. 1, 3.
b. 1, 5.
c. 3, 5.
d. 4, 6.

TURN/SLIP 6.
When both the needle and ball of a turn and slip indicator are displaced to the right the aircraft is?

a. Turning right with insufficient bank.
b. Turning right with too much bank.
c. Turning left with too much bank.
d. Turning left with insufficient bank.

TURN/SLIP 7.
When both the needle and ball of a turn and slip indicator are displaced to the right the aircraft is?

a. Turning right with too much TAS.
b. Turning right with insufficient TAS.
c. Turning left with too much TAS.
d. Turning left with insufficient TAS.

TURN/SLIP 8.
When the needle is displaced right and the ball displaced left, in a turn and slip indicator, the aircraft is?

a. Turning right with insufficient bank.
b. Turning left with too much bank.
c. Turning left with insufficient TAS.
d. Turning right with too much bank.

TURN/SLIP 9.
The turn needle indicates ...... in a slightly banked turn?

a. Angular velocity about the vertical axis.
b. Angular acceleration about the vertical axis.
c. Angular velocity about the lateral axis.
d. Yaw displacement.

TURN/SLIP 10.
A rate 1 turn at 120 kts requires?

a. 10^{0} AOB.
b. 20^{0} AOB.
c. 30^{0} AOB.
d. 40^{0} AOB.

TURN/SLIP 11.
The correct turn and slip indications when turning right on the ground are?

a. Needle and ball right.
b. Needle and ball left.
c. Needle right and ball left.
d. Needle left and ball right.

TURN/SLIP 12.
ROT indications depend on?

1. Airspeed.
2. Mass.
3. AOB.

a. 1, 2.
b. 2, 3.
c. 1, 3.
d. 1, 2, 3.

TURN/SLIP 13.
For a rate one turn at 150 Kts the AOB must be?

a. 22^{0}.
b. 33^{0}.
c. 44^{0}.
d. 55^{0}.

TURN/SLIP 14.
Following a left engine failure the pilot of a multi-engine aircraft uses rudder to arrest the yaw, whilst side slipping down track with the wings held level by the ailerons. What will the turn and slip indicator show in this condition.

a. Both needle and ball central.
b. Both needle and ball right.
c. Both needle and ball left.
d. Needle left and ball right.

TURN/SLIP 15.
Following a left engine failure the pilot of a multi-engine aircraft uses rudder to oppose yaw and keep the aircraft on heading, whilst using bank to prevent side slip. What will the turn and slip indicator show?

a. Both needle and ball central.
b. Both needle and ball right.
c. Both needle and ball left.
d. Needle central and ball right.

TURN/SLIP 16.
What will be the immediate turn and slip indications when a left engine fails in climbing flight.

a. Needle and ball left.
b. Needle and ball right.
c. Needle left and ball right.
d. Needle right and ball left.

TURN/SLIP 17.
What does it indicate if both the needle and ball in a turn and slip indicator move out to the right?

a. Turning right with too much bank.
b. Turning right with too little bank.
c. Turning left with too much bank.
d. Turning left with too little bank.

TURN/SLIP 18.
When turning at constant bank angle the rate of turn is?

a. Determined by weight and TAS.
b. Determined by weight.
c. Determined by TAS.
d. Determined only by AofA.

TURN/SLIP 19.
A turn indicator used in conjunction with an attitude indicator can show?

1. TAS in a turn.
2. Direction of turn.
3. Angular velocity about the vertical axis of the aircraft.
4. Angular velocity about the true vertical axis.

a. 1, 2.
b. 1, 3.
c. 2, 3.
d. 3, 4.

TURN/SLIP 20.
What factors affect the turn indicator?

1. AofA.
2. AOB.
3. TAS.
4. Weight.

a. 1, 2.
b. 1, 3.
c. 2, 3.
d. 3, 4.

TURN/SLIP 21.
What are the essential properties of a turn indicator?

1. Two degrees of freedom.
2. One degree of freedom.
3. Horizontal spin axis.
4. Vertical spin axis.
5. Longitudinal spin axis.

a. 1, 2.
b. 2, 3.
c. 3, 4.
d. 2, 5.

TURN/SLIP 22.
What angle of bank would give a rate 1 turn at 120 Kts?

a. 10 degrees.
b. 14 degrees.
c. 18 degrees.
d. 22 degrees.

TURN/SLIP 23.
What does it indicate when the turn needle is out to the left and the ball out to the right?

a. Right turn with too much bank.
b. Right turn with too little bank.
c. Left turn with too much bank.
d. Left turn with too little bank.

TURN/SLIP 24.
What should a turn and slip indicator show in a right turn on the ground?

a. Needle left and ball left.
b. Needle left and ball right.
c. Needle right and ball left.
d. Needle right and ball right.

TURN/SLIP 25.
What will the turn needle indicate in a slightly banked turn?

a. Yaw rate.
b. Roll rate.
c. Pitch rate.
d. Angular velocity about the vertical axis.

TURN/SLIP 26.
What corrective action is required if the ball is out to the right in a left turn?

a. More right ruder.
b. More left rudder.
c. More right bank.
d. More left bank.

TURN/SLIP 27.
If both the ball and needle are out to the left in a turn, the ball can be centralised by?

a. Pushing the right rudder bar forward.
b. Increasing left bank.
c. Decreasing TAS.
d. Increasing TAS.

TURN/SLIP 28.
How should the turn and slip indicator respond in a right turn when taxiing?

a. Needle left and ball left.
b. Needle left and ball right.
c. Needle right and ball right.
d. Needle right and ball left.

TURN/SLIP 29.
For a coordinated rate 1 right turn at 250 Kts TAS, the correct AOB is approximately?

a. 32 degrees.
b. 23 degrees.
c. 16 degrees.
d. 25 degrees.

TURN/SLIP 30.
For a coordinated 300 Kts TAS rate 1 right turn the AOB should be?

a. 17 degrees.
b. 27 degrees.
c. 37 degrees.
d. 47 degrees.

TURN/SLIP 31.
For a coordinated rate 1 left turn at an AOB of 27 degrees, the TAS should be?

a. 200 Kts.
b. 250 kts.
c. 270 Kts.
d. 300 Kts.

TURN/SLIP 32.
The gyro in a turn indicator must have …… gimbal and ……. degrees of freedom?

a. One one.
b. Two one.
c. Two two.
d. Three two.

TURN/SLIP 33.
If the turn indicator needle is out to the right and the ball is out to the left, it indicates?

a. A left turn with too much bank.
b. A left turn with too little bank.
c. A right turn with too much bank.
d. A right turn with too little bank.

TURN/SLIP 34.
What angle of bank is required to conduct a balanced rate 1 turn in an aircraft at 125 kts TAS at a mass of 55000 Kg?

a. 15.5 degrees.
b. 17.5 degrees.
c. 19.5 degrees.
d. 21.5 degrees.

TURN/SLIP 35.
If the mass of the aircraft in question 34 above, was decreased to 45000 Kg?

a. It would increase the required AOB.
b. It would decrease the required AOB.
c. It would not affect the required AOB, but less power would be required.
d. It would not affect the required AOB but more power would be required.

TURN/SLIP 36.
The correct indications when taxiing to the left are?

a. Needle right, ball right.
b. Needle right, ball centre.
c. Needle left , ball left
d. Needle left, ball right.

TURN/SLIP 37.
If the turn and slip indicator shows needle left and ball left in a banked turn, the aircraft is .... and the required corrective action is ....?

a.	Skidding	push left pedal forward.
b.	Skidding	push right pedal forward.
c.	Slipping	push left pedal forward.
d.	Slipping	push right pedal forward.

TURN/SLIP 38.
If the turn and slip indicator shows needle left and ball right in a banked turn, the aircraft is .... and the required corrective action is ....?

a.	Skidding	push left pedal forward.
b.	Skidding	push right pedal forward.
c.	Slipping	push left pedal forward.
d.	Slipping	push right pedal forward.

TURN/SLIP 39.
If the turn and slip indicator shows needle right and ball right in a banked turn, the aircraft is .... and the required corrective action is ....?

a.	Skidding	push left pedal forward.
b.	Skidding	push right pedal forward.
c.	Slipping	push left pedal forward.
d.	Slipping	push right pedal forward.

TURN/SLIP 40.
If the turn and slip indicator shows needle right and ball left in a banked turn, the aircraft is .... and the required corrective action is ....?

a.	Skidding	push left pedal forward.
b.	Skidding	push right pedal forward.
c.	Slipping	push left pedal forward.
d.	Slipping	push right pedal forward.

INS/IRS/FMS 1.
What is the Schuler period?

a. 48 minutes.
b. 84 seconds.
c. 48 seconds.
d. 84 minutes.

INS/IRS/FMS 2.
To obtain heading information from a gyro-stabilised platform, the gyros should be?

a. 1 degree of freedom and a horizontal axis.
b. 1 degrees of freedom and a vertical axis.
c. 2 degree of freedom and a horizontal axis.
d. 2 degree of freedom and a vertical axis.

INS/IRS/FMS 3.
While inertial platform system is operating on board an aircraft, it is necessary to use a device with the following characteristics, in order to keep the vertical line with the pendulous system?

a. With damping and a period of about 84 minutes.
b. With damping and a period of about 84 seconds.
c. Without damping and a period of about 84 minutes.
d. Without damping and a period of about 84 seconds.

INS/IRS/FMS 4.
Heading information given by a gyro platform is given by a gyro with?

a. 3 degrees of freedom in the vertical axis.
b. 3 degrees of freedom in the horizontal axis.
c. 2 degrees of freedom in the vertical axis.
d. 1 degrees of freedom in the horizontal axis.

INS/IRS/FMS 5.
The amber ALERT light on an INS control and display unit?

a. Illuminates steadily for 2 minutes before reaching the next waypoint.
b. Flashes for 2 minutes before reaching the next waypoint.
c. Illuminates if power from the aircraft bus bar has been lost and the system is operating on standby battery.
d. Illuminates steadily after passing a waypoint in manual mode, until the next leg is programmed in.

INS/IRS/FMS 6.
At the second state of integration E/W speed is converted into E/W distance gone. To convert this departure into change of longitude it has to?

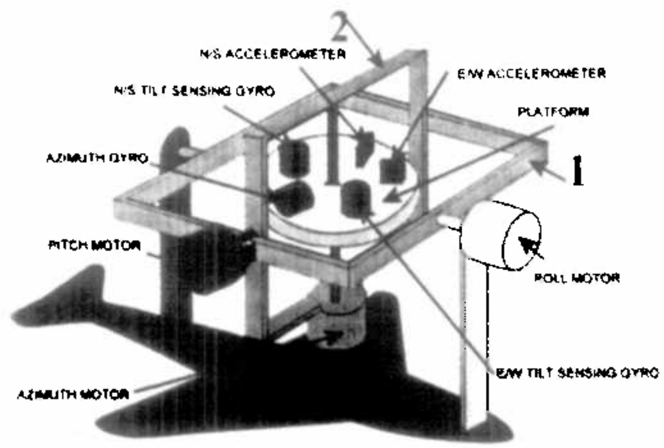
a. Be divided by the secant of latitude.
b. Be multiplied by the secant of latitude.
c. Be divided by the tangent of latitude.
d. Be multiplied by the Cosine of latitude.

INS/IRS/FMS 7.
An INS with the accelerometers aligned N/S and E/W is limited to use at latitudes below about 82°. This is because?

a. It loses horizontal reference as dip becomes large.
b. At high speed on East or West tracks the rate of convergency is faster than the azimuth motor can correct.
c. The functions of secant latitude and tangent latitude used in certain corrections in the computer start to approach infinity and the computer cannot handle the rapid changes involved.
d. The correction for the coriolis effect of the earth rotation approaches infinity above 82° latitude.

INS/IRS/FMS 8.
The diagram below shows a gyro-stabilised platform. 1 is a .... gyro gimbal and 2 is a ...... gimbal?

a. Roll Pitch.
b. Pitch Roll.
c. Roll Yaw.
d. Pitch Roll.



INS/IRS/FMS 9.
The vertical reference unit of a three axis data generator is equipped with a gyro with?

a. 1 degree of freedom and a horizontal spin axis.
b. 1 degree of freedom and a vertical spin axis.
c. 2 degrees of freedom and a horizontal spin axis.
d. 2 degrees of freedom and a vertical spin axis.

INS/IRS/FMS 10.
With reference to Inertial Navigation Systems, the functions of the integrator are?

1. At the second stage integration to suppress unbounded errors (when in nav mode).
2. At the first stage of integration to convert accelerations with respect to time, into speed, (when in nav mode).
3. At the second stage of integration to convert speed with respect to time, into distance gone, (when in nav mode).
4. To align the platform (when in level and align modes).

a. All of the above statements are correct.
b. Only statements 2, 3 and 4 are correct.
c. Only statements 1, 2 and 3, are correct.
d. Only statements 2 and 3 are correct.

INS/IRS/FMS 11.
Ring laser gyros use dither motors to?

a. Reduce random wander.
b. Prevent unbounded errors.
c. Level and align the gyros.
d. Prevent lock in of the laser beams.

INS/IRS/FMS 12.
The product of the first integration of the E/W acceleration sensed by an INS system is?

a. Departure.
b. Speed along the local parallel.
c. Speed along the local horizontal.
d. Distance.

INS/IRS/FMS 13.
Why is an INS platform virtually unusable at very high latitudes?

a. The value of the earth rate affecting the E/W accelerometer is a component dependent on the sine lat. At high latitudes this component is nearly zero and makes alignment to true north virtually impossible.
b. The value of the earth rate affecting the E/W accelerometer is a component dependent on the sine lat. At high latitudes this component is nearly zero and makes alignment to true magnetic virtually impossible.
c. The value of the earth rate affecting the E/W accelerometer is a component dependent on the cosine lat. At high latitudes this component is nearly zero and makes alignment to magnetic north virtually impossible.
d. The value of the earth rate affecting the E/W accelerometer is a component dependent on the cosine lat. At high latitudes this component is nearly zero and makes alignment to true north virtually impossible.

INS/IRS/FMS 14.
A longitude error in an INS will cause:

a. A failure to align.
b. Poor alignment and degraded accuracy.
c. Will be corrected for once the E/W accelerometer has aligned to true north.
d. Will cause no problems at all.

INS/IRS/FMS 15.
When using an INS platform coriolis affects?

a. The N/S accelerometer.
b. The E/W accelerometer.
c. Both a, and b.
d. Neither a, nor b.

INS/IRS/FMS 16.
The errors of an INS fall into three categories?

a. Bounded, unbounded and velocity.
b. Coriolis, unbounded and inherent.
c. Bounded, unbounded and inherent.
d. Bounded, unbounded and accelerometer.

INS/IRS/FMS 17.
The fundamental difference between INS and IRS is that?

a. The INS is a strap down system with 2 accelerometers mounted at 90° to each other.
b. The IRS is a strap down system with 2 accelerometers mounted at 90° to each other.
c. The INS is a strap down system with 3 accelerometers mounted at 90° to each other.
d. The IRS is a strap down system with 3 accelerometers mounted at 90° to each other.

INS/IRS/FMS 18.
The position accuracy of an RLG INS is?

a. 1 nm/hr.
b. 2 nm/hr.
c. 5 nm/hr.
d. 10 nm/hr.

INS/IRS/FMS 19.
The control and display unit of an inertial navigation system indicates a position of 4810.9°N 00812.2°W on a ramp position 4807.5°N 00005.1°E. What is the radial error rate of the system if it has been in NAV mode for 8 hours 20 minutes?

a. 1.37 Km/hr.
b. 1.37 Nm/hr.
c. 11.42 Nm/hr.
d. 14.3 Nm/hr.

INS/IRS/FMS 20.
In an INS a TAS input is?

a. Not required.
b. Required for polar navigation.
c. Required for great circle navigation.
d. Required in order to provide a wind velocity read out.

INS/IRS/FMS 21.
In an INS which is Schuler tuned, the largest unbounded errors are?

a. Due to the output of the first stage integrators.
b. Due to the real wander of the platform gyroscopes.
c. Due to accelerometer errors.
d. Track errors due to initial platform misalignment.

INS/IRS/FMS 22.
During initialisation of an INS the aircraft must not be moved until?

a. The ramp position has been inserted and checked.
b. The platform is levelled.
c. The gyros and the accelerometers are all in the NULL position.
d. The green READY NAV light is illuminated and the mode selector switch has been set to the NAV position.

INS/IRS/FMS 23.
An INS in the ALIGN mode will?

a. Not accept an error on 10° latitude and 10° longitude of the inserted initial position.
b. Accept an error of 10° latitude and 10° of longitude of the inserted position.
c. Accept an error of 10° latitude but not an error of 10° longitude of the inserted initial position.
d. Accept an error of 10° longitude but not one of 10° of latitude in the inserted initial position.

INS/IRS/FMS 24.
An IRS with laser gyros should (i)……. be Schuler tuned, and (ii)….. be strapped down?

a. (i) always (ii) always.
b. (i) always (ii) never.
c. (i) never (ii) always.
d. (i) never (ii) never.

INS/IRS/FMS 25.
Laser gyros are used in an IRS. Why must accurate latitude and longitude be inserted?

a. To determine magnetic north.
b. To check the function of the laser gyros.
c. To determine the computed trihedron.
d. To compensate for aircraft movement.

INS/IRS/FMS 26.
The triangular cavity in a RLG is filled with which combination of gasses?

a. Helium and argon.
b. Hydrogen and neon.
c. Helium and neon.
d. Hydrogen and argon.

INS/IRS/FMS 27.
Alignment of a RLG INS takes?

a. Less than 10 minutes.
b. 10 to 15 minutes.
c. 15 to 20 minutes.
d. 84.4 minutes.

INS/IRS/FMS 28.
In an INS the gyros should ….. be strap down. In an IRS the gyros should …. be strapped down?

a. always never.
b. always always.
c. never always.
d. never never.

INS/IRS/FMS 29.
In order to align a strap-down inertial unit, it is required to insert the local geographical coordinates. This is necessary to?

a. Position the computing trihedron with reference to the earth.
b. Check operation of the laser gyros.
c. Determine magnetic or true heading.
d. Re-erect laser gyros.

INS/IRS/FMS 30.
When initial position is put into an INS system?

a. It rejects initial latitude or longitude errors.
b. It rejects initial longitude errors, but will accept latitude errors.
c. It rejects initial latitude errors, but accepts initial longitude errors.
d. It accepts both longitude and latitude errors.

INS/IRS/FMS 31.
IRS is different from INS in that it?

a. Its strapped down accelerometers are not rotated with the aircraft and hence do not suffer schuler errors.
b. It requires no corrections for central accelerations or coriolis effects.
c. It suffers laser lock but spins up faster.
d. It is not affected by vertical accelerations due to gravity, but it requires a longer spin-up time.

INS/IRS/FMS 32.
An FMS database is valid for?

a. 7 days.
b. 28 days.
c. 56 days.
d. It depends upon operational area.

INS/IRS/FMS 33.
In an IRS system?

a. Both the platform and accelerometers are strapped down.
b. Both the platform and accelerometers are gyro-stabilised.
c. The platform is strapped down but the accelerometers are gyro-stabilised.
d. The platform is gyro-stabilised but the accelerometers are strapped down.

INS/IRS/FMS 34.
The JAR 25 standard colour for an FMS active planned route is?

a. Cyan.
b. Magenta.
c. Red.
d. White.

INS/IRS/FMS 35.
The sequences for switching on INS is?

a. Off, Standby, Align, Nav.
b. Off, Align, Standby, Nav.
c. Off, On, Align, Standby.
d. Off, Align, On, Standby.

INS/IRS/FMS 36.
The correct latitude must be put into INS?

a. Because it cannot detect initial latitude.
b. Because it cannot detect latitude changes.
c. Because small latitude errors will not be detected but will cause unbounded errors during the subsequent flight.
d. Large latitude errors will be undetected but cause large errors during the subsequent flight.

INS/IRS/FMS 37.
During initial alignment the IRS must be given coordinates to?

a. Establish true magnetic north.
b. Test the accuracy and serviceability of the laser ring gyros.
c. Establish the trihedron with reference to the earth.
d. Input initial heading information.

INS/IRS/FMS 38.
The schuler period is?

a. 12 minutes.
b. 20 minutes.
c. 84 minutes.
d. 98 minutes.

INS/IRS/FMS 39.
The inputs to the FMS include?

1. Air data computer information.
2. Route data.
3. Radio aids information.
4. Power pland data.
5. Operating data.

a. 1, 2, 3, 4, 5.
b. 1, 3, 4, 5.
c. 2, 3, 4, 5.
d. 1, 2, 3, 4.

INS/IRS/FMS 40.
The selection on an IRS mode panel are used in the following order?

a.	OFF	STBY	ALIGN	ATT	NAV.
b.	OFF	ALIGN	STBY	NAV	ATT.
c.	OFF	ALIGN	STBY	ATT	NAV
d.	OFF	STBY	ALIGN	NAV	ATT.

INS/IRS/FMS 41.
What is the first page on an FMS CDU?

a. INDEX.
b. IDENT.
c. TAKE-OFF.
d. PRE-START.

INS/IRS/FMS 42.
Setting zero cost index on an FMS gives?

a. Best range.
b. Best time.
c. Best endurance.
d. Lowest total costs.

INS/IRS/FMS 43.
Valid FMS CDU waypoint entries include?

1. Runway number.
2. Navaid limitations.
3. Airport ICAO identifier.
4. Navaid identifier.
5. Waypoint name.
6. Country code.

a. 1, 2, 3, 4.
b. 1, 3, 4, 5.
c. 1, 4, 5, 6.
d. 2, 3, 4, 6.

INS/IRS/FMS 44.
Where would a rate integrating gyro be used?

1. Turn and slip indicators.
2. Servo stabiliser mechanisms.
3. Autopilots.
4. Inertial attitude units.
5. Inertial navigation units.

a. 1, 2, 3, 4.
b. 2, 4, 5.
c. 3, 4, 5.
d. 4, 5.

INS/IRS/FMS 45.
Integration of a yaw rate signal?

a. Gives heading.
b. Gives yaw displacement.
c. Gives yaw acceleration rate.
d. Gives track.

INS/IRS/FMS 46.
The schuler period is?

a. 1 oscillation in azimuth.
b. 22 minutes.
c. 66 minutes.
d. 84 minutes.

INS/IRS/FMS 47.
Why is the inertial strapdown unit in an IRS programmed with coordinates during alignment?

a. To compensate for earth rotation errors.
b. To establish the trihedron with reference to the earth.
c. To functionally test the ring laser gyroscopes.
d. To establish magnetic north and true north.

INS/IRS/FMS 48.
Obtaining heading information from a gyro stabilised platform requires a gyro with?

a. Two degrees of freedom and a vertical spin axis.
b. Two degrees of freedom and a horizontal spin axis.
c. One degree of freedom and a vertical spin axis.
d. One degree of freedom and a horizontal spin axis.

INS/IRS/FMS 49.
When an IRS is first switched on it must be aligned in order to?

a. Establish true and magnetic north.
b. Establish latitude.
c. Calculate the computed triehedron.
d. Warm up the gyroscopes.

INS/IRS/FMS 50.
The inputs to an FMS include?

1. Operating data.
2. Terminal data.
3. Air data.
4. Route data.
5. Engine data.
6. Radio aids data.

a. 1, 2, 3, 4.
b. 2, 3, 4, 5.
c. 3, 4, 5, 6.
d. All of the above.

INS/IRS/FMS 51.
Which of the following is closest to the schuler period?

a. 48 seconds.
b. 84 seconds.
c. 48 minutes.
d. 84 minutes.

INS/IRS/FMS 52.
Modern systems employ ring laser gyros because they offer?

a. More rapid run up.
b. More rapid alignment.
c. Longer life.
d. Lower electrical power requirements.

INS/IRS/FMS 53.
A rate integrating gyro is used in?

a. Artificial horizon.
b. Flight Director.
c. Inertial navigation system.
d. Turn and slip indicator.

INS/IRS/FMS 54.
With reference to an FMS, what does the term managed guidance mean?

a. The INS gives commands to the autopilot.
b. The FMC gives commands to the autopilot.
c. The autopilot gives commands to the FMC.
d. The term managed guidance is not related to FMS.

INS/IRS/FMS 55.
What would be the FMC displayed position in an aircraft equipped with a twin inertial system and DME?

a. Identical to the primary inertial system position.
b. The mean of the radio fix position and the primary inertial position.
c. The mean between the radio fix and the mean of the two inertial positions.
d. The mean of the two inertial positions.

INS/IRS/FMS 56.
What happens if an FMC that autotunes to DME stations for fixing purposes, does not receive a satisfactory decode?

a. The beacon frequency will be displayed instead of its identifier.
b. The MCDU will display a warning message.
c. The identifier codes are retrieved from memory and displayed in red.
d. Alternative DME's are selected and employed.

INS/IRS/FMS 57.
A cost index is?

a. An FMS output code.
b. An FMS input code telling the FMS the required balance between optimising fuel costs and sector time.
c. A fixed code giving the best fuel efficiency for each aircraft type.
d. A fixed code giving best fuel efficiency for each route.

INS/IRS/FMS 58.
What happens if an FMC operating in VNAV and LNAV modes reaches a waypoint beyond which no route has been input?

a. The aircraft circles the waypoint until commanded to do otherwise.
b. The aircraft returns to the previous waypoint.
c. The system reverts to heading mode.
d. The autopilot will disconnect and a warning will be sounded and illuminated on EICAS/ECAM.

INS/IRS/FMS 59.
The flight control unit in an FMS?

a. Control vertical flight paths.
b. Controls lateral flight paths.
c. Control all flight paths.
d. Controls only heading.

INS/IRS/FMS 60.
When an INS is turned on it is aligned in order to?

a. Establish magnetic north.
b. Establish magnetic and true north.
c. Establish its position relative to magnetic and true north.
d. Align the trihedron with True North.

EFIS 1.
Cautionary information on an EHSI is displayed in?

a. Cyan.
b. Red orMagenta.
c. Yellow or Amber.
d. White.

[illegible]
The Primary Flight Display (PFD) displays inforamtion dedicated to?

a. Weather.
b. Piloting.
c. Engines and alarms.
d. Systems.

EFIS 3.
Decision height is?

a. Calculated by the Flight management Computer.
b. Displayed on the EADI, and set by the pilot using the EFIS control panel.
c. Displayed on the EADI using the FMC inputs.
d. Pre-set automatically by the autopilt system.

EFIS 4.
The symbol below when shown on an EHSI display represents?

a. The selected track and track reference.
b. The selected heading and heading reference.
c. The heading orientation, current heading, heading reference and heading pointer.
d. The track orientation, current track, track reference and track pointer.

EFIS 5.
In addition to altitude and auto-flight modes, what information is also typically displayed on an EADI?

a. Engine indications and systems information.
b. Altitude, speed and sometimes heading information.
c. Speed, altitude, ILS Localiser and Glide Slope information, and sometimes heading information.
d. Altitude, groundspeed, heading and wind speed and direction.

EFIS 6.
Regarding the Electronic Flight Instruments System (EFIS).

1. The Navigation Display (ND) displays Flight Director Bars.
2. The altimeter setting is displayed on the Primary Flight Display (PFD).
3. The Primary Flight Display (PFD) is the main flying instrument.
4. The Flight Mode Annunciator (FMA) is part of the Navigation Display (ND).

The combination regrouping all of the correct statements is?

a. 1, 2.
b. 3, 4.
c. 1, 4.
d. 2, 3.

EFIS 7.
Below which altitude does the radio altitude indication on an EADI appear within the circular scale as a digital readout?

a. Above 2500 ft.
b. Below 1000 ft.
c. Below 2500 ft.
d. Above 1000 ft.

EFIS 8.
Which of the following statements is true?

a. The Weather Radar display data is available on all modes of the EFSI.
b. In PLAN mode, the Weather Radar data is inhibited on the EHSI.
c. The weather radar data is inhibited on the full and expanded NAV modes of the EHSI.
d. The Weather Radar data is only available on the PLAN mode of the EHSI.

EFIS 9.
Radio altitude is shown on the EADI and changes from a digital display to a circular scale?

a. At 2500 ft.
b. At 1000 ft and below AGL.
c. Below 1000 ft AGL.
d. At DH.

EFIS 10.
Weather Radar returns show as areas of precipitation in the following colours?

a. Green Magenta, Yellow and Red.
b. Green, Orange, Yellow and Red.
c. Green, Yellow, Red and Magenta.
d. Green, Yellow, Magenta and Red.

EFIS 11.
In the diagram below the next waypoint to be overflown is... and the estimated .....is.....?

a. TIC, time of departure, 01:44.
b. TIC, time of arrival, 15:08.
c. VLM, time of departure, 01:44.
d. VLM, time of arrival, 15:08.

EFIS 12.
The symbol shown appears in white on the EHSI display. It represents?

a. An off-route waypoint.
b. The aeroplane.
c. An inactive waypoint.
d. A VOR/DME.

EFIS 13.
On an EHSI display, wind velocity can be displayed in which of the following modes?

a. Plan, Full ILS, Expanded VOR and Full VOR.
b. Map, Expanded ILS, Full ILS and Full VOR.
c. Map, Plan, Full ILS and Full VOR.
d. Expanded ILS, Expanded VOR, Plan and Full ILS.

EFIS 14.
Command information is displayed in ...... on the EHSI?

a. White.
b. Green.
c. Red.
d. Magenta.

EFIS 15.
In which of the following EHSI modes are the Weather Radar returns visible?

a. Any full mode.
b. Plan mode.
c. Map mode and in any expanded mode.
d. Any expanded mode.

EFIS 16.
Decision height is displayed on the?

a. EADI, and below 2500 ft the display changes to a circular scale with magenta coloured marker.
b. EADI, and below 1000 ft is shown as a circular scale which is erased anti-clockwise as the aircraft descends.
c. EHSI, in Map mode, and below 1000 ft is shown as a circular display, which is erased, anti-clockwise as the aircraft descends.
d. EADI, and below 800 ft changes to a circular scale which is white with a magenta DH marker.

EFIS 17.
The heading reference used on the EHSI is?

a. True.
b. True or Magnetic.
c. Magnetic.
d. Compass.

EFIS 18.
On the FMA, engaged flight automatic flight modes are displayed in?

a. Blue.
b. Green.
c. Red.
d. Magenta.

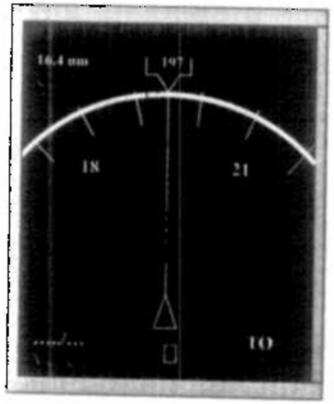
EFIS 19.
The EFIS control panel allows selection of?

a. EADI, operating modes.
b. EHSI fail-operational fall back mode.
c. Autopilot operating modes.
d. Decision height.

EFIS 20.
Which colours are typically used on an EHSI?

a. Red and blue.
b. Black, blue, purple, red, green and white.
c. Magenta, brown, black and green.
d. White, green, magenta, cyan, yellow and red.

EFIS 21.
Which mode is selected on the Navigation Display in the diagram below?



a. Expanded VOR mode.
b. Full VOR mode.
c. Plan mode.
d. Expanded ADF mode.

EFIS 22.
In PLAN mode?

a. The active flight path appears as a red line joining successive waypoints.
b. The Weather Radar display data is inhibited.
c. The display may be oriented to Grid North.
d. The wind arrow is oriented to True North.

EFIS 23.
At what height does the DH, on the EADI display, start flashing yellow?

a. At DH plus 100 ft.
b. On reaching DH.
c. On touchdown.
d. At 1000 ft AGL.

EFIS 24.
In the displayed weather modes, the intensities of the returns in ascending order of intensity are?

a. Yellow, green, blue and red.
b. Yellow, green, red and magenta.
c. Green, yellow, red and magenta.
d. Blue, green, yellow and red.

EFIS 25.
The green symbol of a circle with T/D on the EHSI display below represents?

a. The actual top-of-descent.
b. The FMC calculated top-of-climb.
c. An en-route waypoint.
d. The FMC calculated top-of-descent

EFIS 26.
The EHSI mode in which the whole compass rose is not visible and upon which the relative bearing to the active waypoint is shown although the waypoints themselves are not, is the?

a. Full rose, VOR mode.
b. Centre MAP mode.
c. Expanded VOR mode.
d. Expanded NAV mode.

EFIS 27.
The Weather Radar display can be shown on the?

a. Only one EHSI at a time.
b. The First Officer's EHSI only.
c. The Captain's EHSI only.
d. The Captain's and the First Officer's EHSI simultaneously.

EFIS 28.
Aircraft electronic display systems normally incorporate?

a. One symbol generator for each CRT.
b. LED alphanumeric displays.
c. Automatic CRT brightness control.
d. A single CRT for each pilot.

EFIS 29.
The speed tape on an EADI is located?

a. On the left side of the EADI.
b. On the left side of the EHSI.
c. At the top of the ADI.
d. On the right side of the EADI.

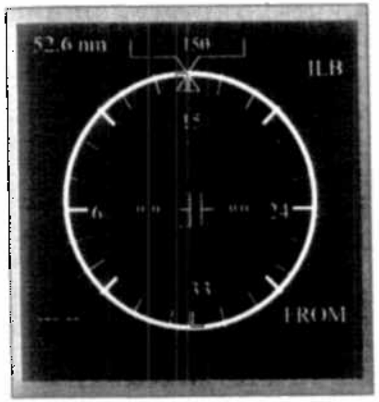
EFIS 30.
An EFIS installation in a Boeing 737 consists of?

a. Two screens, one control panel and two symbol generators.
b. Two screens and one symbol generator.
c. Four screens and two symbol generators.
d. Four screens and three symbol generators.

EFIS 31.
Which of the following displays are part of the Electronic Flight Instrumentation System (for Boeing Aircraft)?

a. ND and Electronic Attitude Director Indicator.
b. EHSI and PFD.
c. Navigation Display and Primary Flight Display.
d. Electronic Attitude Director Indicator and Electronic Horizontal Situation Indicator.

EFIS 32.
Which mode is selected on the EHSI illustrated below?



a. Expanded VOR mode.
b. Expanded ILS mode.
c. Full VOR mode.
d. Map Mode.

EFIS 33.
The decision Height (DH) warning light illuminates when the aircraft?

a. Passes over the outer marker.
b. Descends below a pre-set radio altitude.
c. Descends below a pre-set barometric altitude.
d. Passes the ILS inner marker.

EFIS 34.
The wind direction symbol displayed in all EHSI modes except PLAN is oriented?

a. With respect to aircraft heading.
b. To Grid North when flying at high altitude.
c. To True North.
d. To Magnetic North.

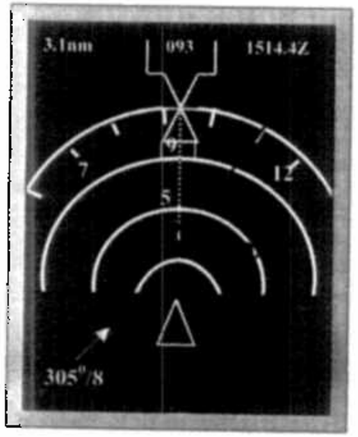
EFIS 35.
The Head Up Display (HUD) is a device allowing the pilot while still looking outside, to have?

a. A monitoring only during CAT II precision approaches.
b. A flying and flight path control aid.
c. A synthetic view of the instrument procedure.
d. A monitoring of engine data.

EFIS 36.
In order to know which mode of the auto-throttle is engaged the crew must check the?

a. ND (Navigation Display).
b. TCC (Thrust Control Computer).
c. Throttle position.
d. PFD (Primary Flight Display).

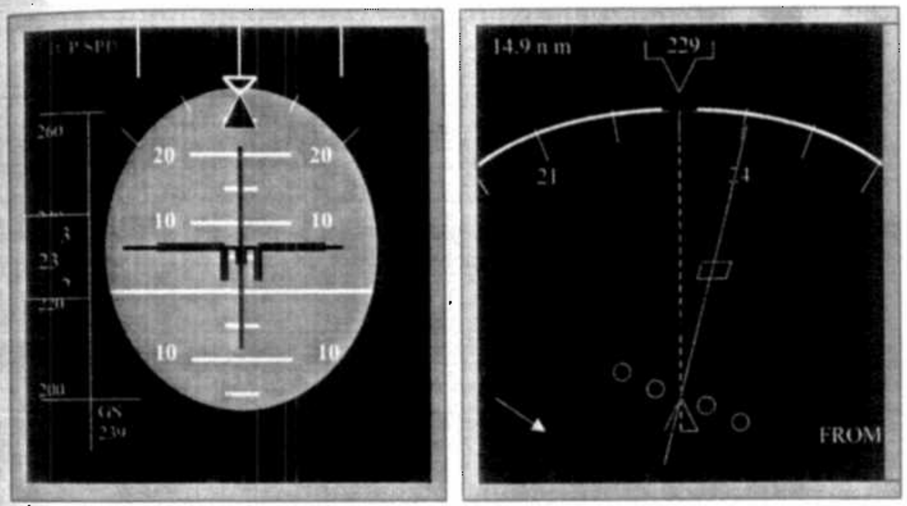
EFIS 37.
The white arrow in the lower left corner in the diagram below indicates?



a. After passing BODAL waypoint in 8 minute the next heading will be 305°.
b. The current wind of 305°/8 kts is being experienced.
c. The active waypoint (BODAL) is located on radial 305° and 8 nm from VOR tuned in the active NAV receiver.
d. The active waypoint (T/D) is located on radial 305° and 8 nm from a VOR tuned in the active NAV receiver.

EFIS 38.
An aircraft is under guidance mode following a VOR radial. From the ADI and HSI represented in the diagram below, it is possible to deduce that the aircraft is?

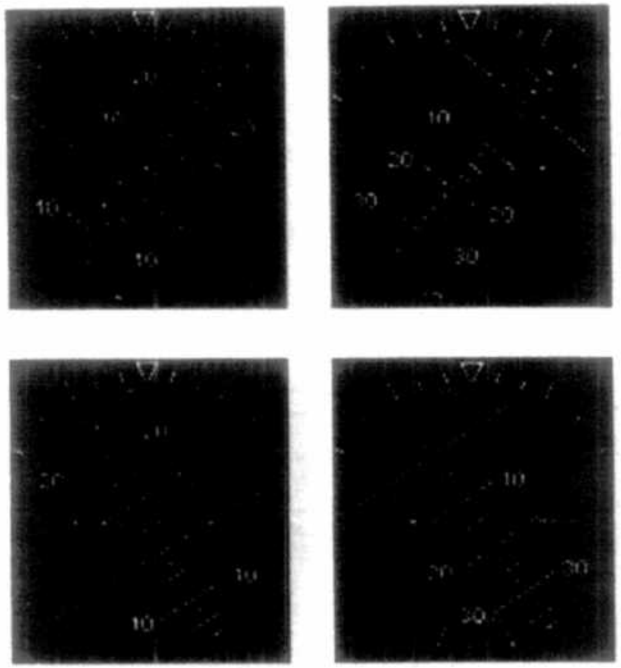
a. Located to the left side of the selected radial.
b. Located to the right side of the selected radial.
c. Experiencing left side crosswind.
d. Experiencing right side crosswind.



EFIS 39.
Which of the diagrams below illustrates a 30° right bank and 15° nose down attitude?

a. 1.
b. 2.
c. 3.
d. 4.

1 2 3 4

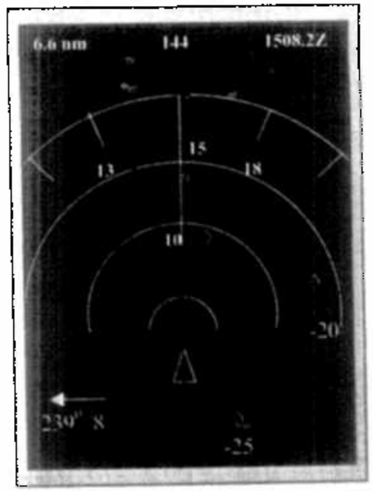


EFIS 40.
With reference to the diagram is question EFIS 38, it is possible to deduce that the aircraft is?

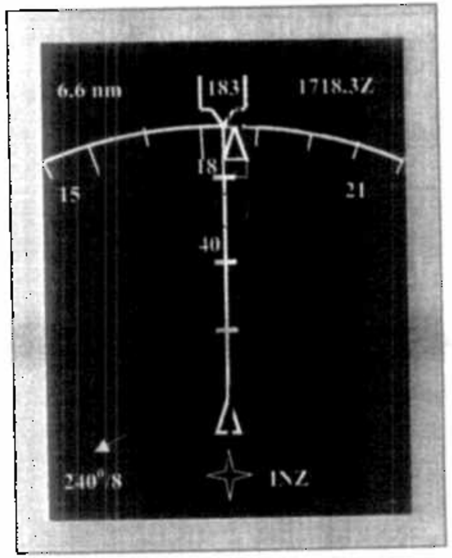
a. Following a radial 240° from OKL VOR.
b. Following a radial 229° from OKL.
c. Flying towards OKL VOR.
d. Flying below the selected command speed, which is 220 Kts.

EFIS 41.
In the diagram below the T/C is a .... and it will be reached at approximately.......?

a.	FMC calcualted top of climb:	5 nm from present position.
b.	Actual top of climb speed:	15.08Z.
c.	FMC waypoint:	15.08Z.
d.	TCAS traffic:	10 nm from present position.



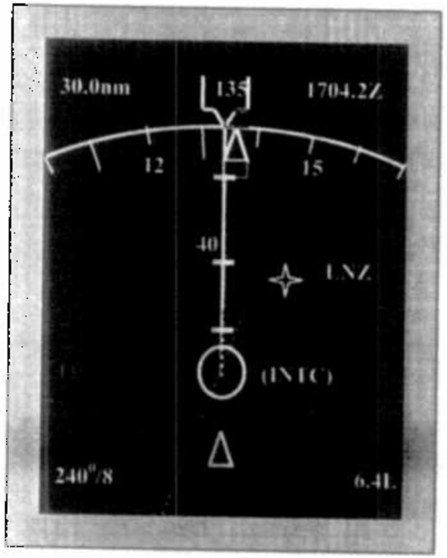
EFIS 42.
What is the current active waypoint in the diagram below is?



a. ILB.
b. VIW.
c. TIC.
d. TRA.

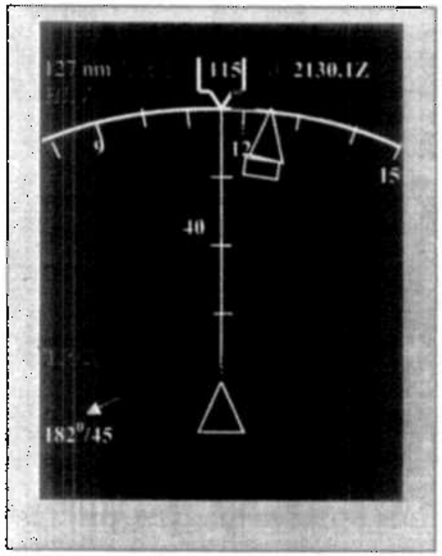
EFIS 43.
In the diagram below, what is the meaning of the white circle with (INTC) next to it?

a. It denotesd an active waypoint on the flight plan.
b. It indicates a location where you will intercept radial 330° from FRE VOR and track inbound.
c. TCAS indication – you are being inercepted by military aircraft.
d. It indictaes a location of an intersecting airway – a mandatory reporting point.



EFIS 44.
What heading is the aircraft currently flying in diagram below?

a. 109°.
b. 115°.
c. 120°.
d. 125°.



EFIS 45.
What value is selected by the heading selector (heading bug) in the diagram in question EFIS 44 above?

a. 109°.
b. 115°.
c. 120°.
d. 125°.

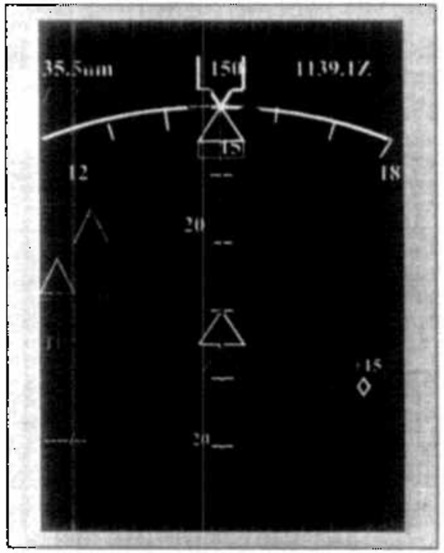
EFIS 46.
On what track is the aircraft currently flying in the diagram in quiestion EFIS 44 on the previous page?

a. 109°.
b. 115°.
c. 120°.
d. 125°.

EFIS 47.

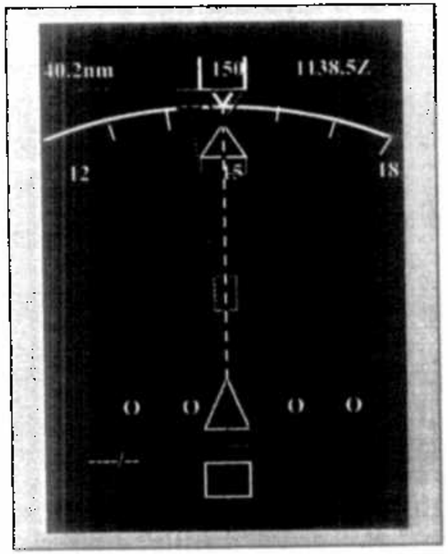
Which mode is selected on the Navigation Display (EHSI) in diagram below?

a. **Map mode.**
b. **Centre Map mode.**
c. **Plan mode.**
d. **Centre plan mode.**



EFIS 48.

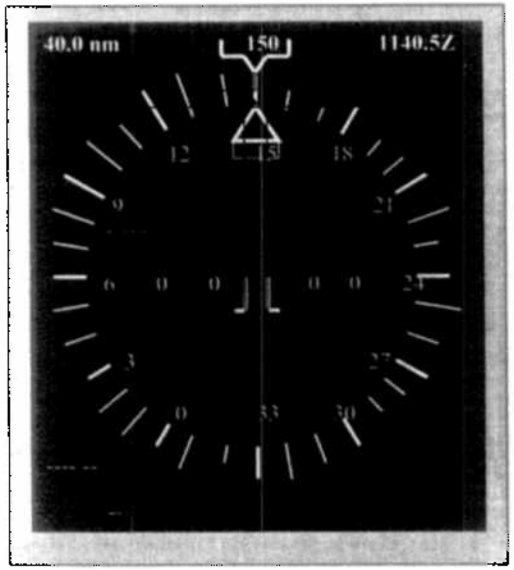
Which mode is selected on the Navigation Display (EHSI) in the diagram below?



a. **Full VOR mode.**
b. **Expanded VOR mode.**
c. **Full NAV mode.**
d. **Expanded NAV mode.**

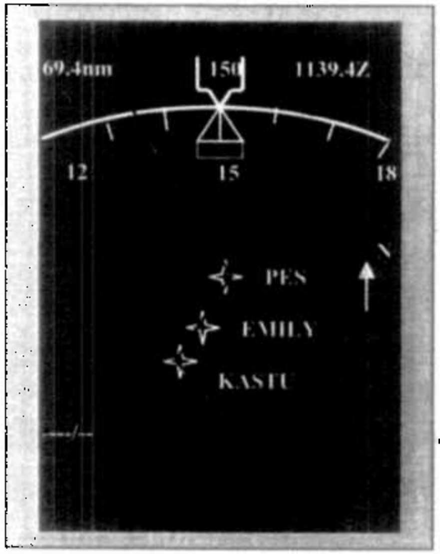
EFIS 49.
Which mode is selected in the Navigation Display (EHSI) in diagram below?

a. Full VOR mode.
b. Expanded VOR mode.
c. Full NAV mode.
d. Expanded NAV mode.



EFIS 50.
Which mode is selected on the Navigatiion Display (EHSI) in the diagram below?

a. Map mode.
b. Centre Map mode.
c. Plan mode.
d. Full NAV mode.

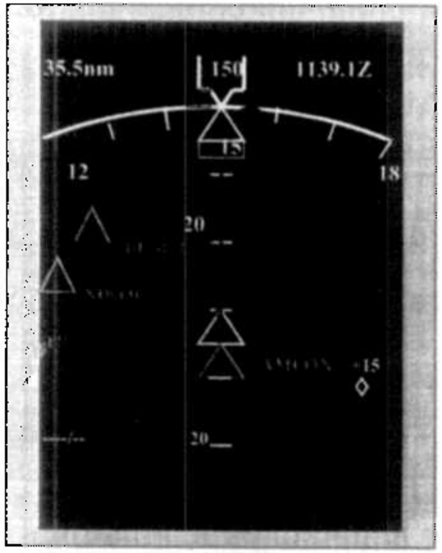


EFIS 51.
When using the EHSI, the weather radar may be displayed on the 3 following settings?

a. Map, VOR/ILS.
b. VOR/ILS, Map, Expalnded plan.
c. Expanded Map, VOR/ILS, Plan.
d. Map, Expanded VOR/ILS.

EFIS 52.
What is the current active waypoint in the diagram below?

a. AMLON.
b. ANC10.
c. ILB.
d. TRA.



EFIS 53.
Decision height is adjusted and set on the?

a. Flight Management Computer.
b. HSI section of the EFIS control panel.
c. ADI section of the EFIS control panel.
d. ADI or ESI.

EFIS 54.
The WXR display is controlled from?

a. The Captain's EHSI only.
b. The Co-pilot's EHSI only.
c. A special control panel.
d. Both the Capatain's and the Co-pilot's ESI control panels.

EFIS 55.
The WXR display is on?

a. The Captaion's CRT only.
b. The Co-pilot's CRT only.
c. A special screen.
d. On both the Captain's and the Co-pilot's CRTs.

EFIS 56.
Airspeed is shown on?

a. Only on the Captain's EHSI.
b. On both EADI's.
c. On both EHSI's.
d. Only on the flight management CRT.

EFIS 57.
In addition to a control panel, symbol generators and a remote light sensor, an EFIS also has?

a. EADIs and EHSIs.
b. EHSIs and altitude indicator.
c. EADIs and EICASs.
d. EADIs and WXR display tubes.

EFIS 58.
Modes available for (EFIS) HSI on some units are?

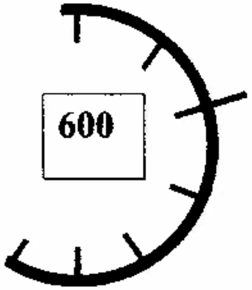
a. Airspeed and Mach.
b. Map and Plan.
c. VOR, ILS, Map and Auto Select.
d. Only from manometric sources.

EFIS 59.
With an EFIS Flight director using EFIS guidance, reference North can be?

a. Magnetic North only.
b. Magnetic North between 73°N and 65°S and True North above these latitudes.
c. Magnetic North between 65°N and 73°S and True North above these latitudes.
d. Magnetic North between 75°N and 75°S and True North above these latitudes.

EFIS 60.
In diagram below the data is is shown on (i)......which is displaying (ii)......?

a. (i) Primary Flight Display. (ii) 600 Kts TAS.
b. (i) Navigation Display. (ii) 600 ft RA.
c. (i) EADI. (ii) 600 ft RA.
d. (i) EHSI. (ii) 600 Kts GS.

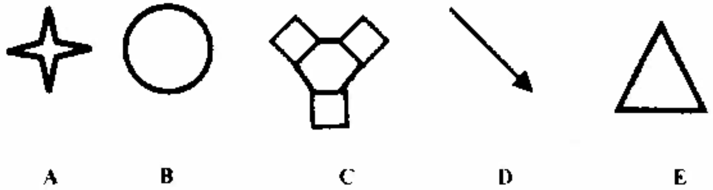


EFIS 61.
The symbol below appears in yellow in place of the normal radio altitude display when?

a. The selected radio altitude has been reached.
b. The radio altitude needs re-setting on the EHSI.
c. There is a failure of the radio altimeter.
d. The aircraft has descended below 1000 ft AGL.

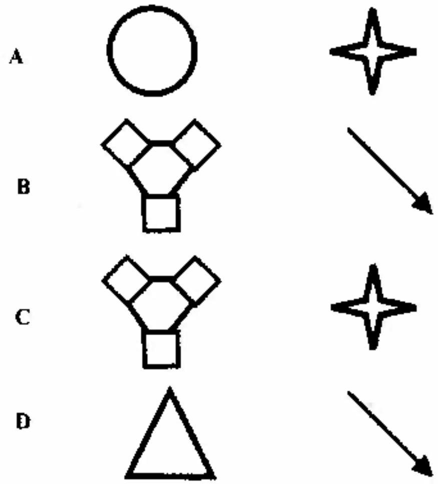
EFIS 62.
In the diagram below the symbols A, C and E respectively are best described as?

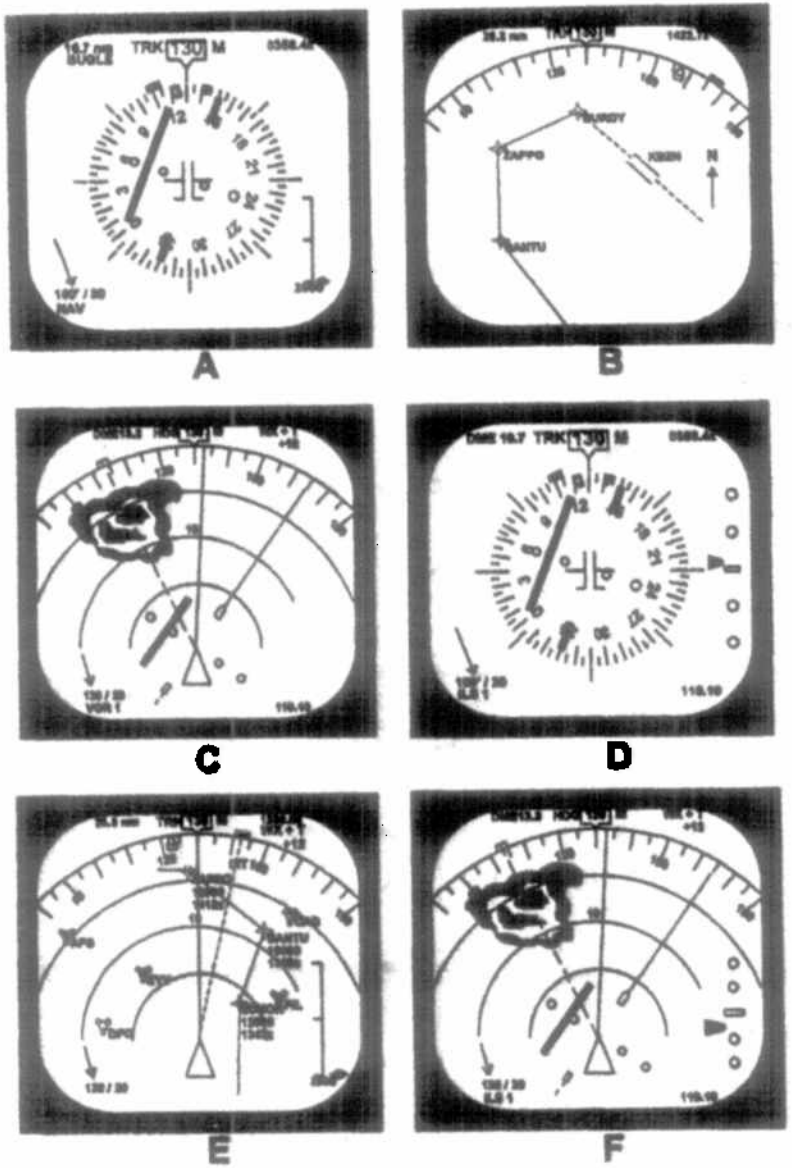
a. Off route waypoint, airport, novigation aid.
b. Next waypoint, navigation aid, airport.
c. Off route waypoint, navigation aid, a navigation point.
d. Active waypoint aircraft currently navigating to, navigation aid, off route waypoint.



EFIS 63.
In the diagrams below the symbols for a navaid and enroute wayoint are?

a. A.
b. B.
c. C.
d. D.





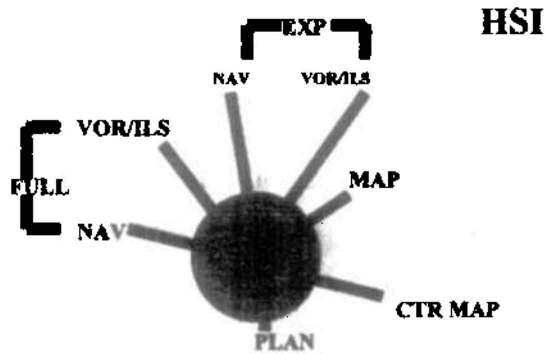
EFIS 64.
In diagrams on the previous page, the full VOR display is shown on diagram?

a. A.
b. B.
c. C.
d. D.

EFIS 65. d.
In the diagrams in question EFIS 64, on which of the displays can weather be displayed?

a. B, D and E.
b. A, C and F.
c. B and D.
d. C, E and F.

EFIS 66.
In the diagrams in question EFIS 64, what would be the display which would result from the selections as shown in the diagram below?

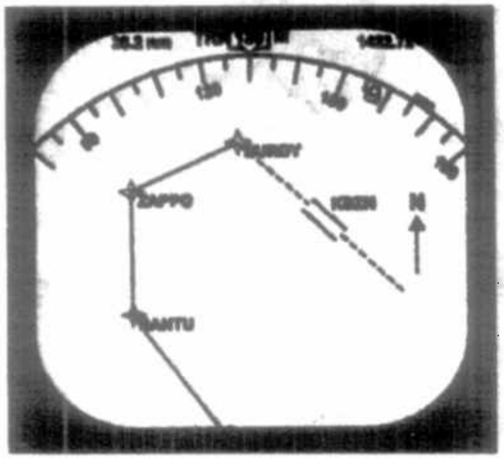


a. B.
b. E.
c. A.
d. D.

EFIS 67.
In the display below, what is the correct statement?

a. The aircraft is closing the localiser from the right, heading 130°M and is approaching the glide path from above.
b. When established on the localiser the inbound heading will be 165°M.
c. The localiser track is 165°M.
d. The localiser centre line is 133°M.

EFIS 68.
In the display below, the track from ZAPPO to BANTU is?



a. 310M.
b. 130M.
c. 360M.
d. 180M.

EFIS 69.
In the display below, the centre weather returns are?

a. 106° relative, 18 nm.
b. 332° relative, 13 nm.
c. 100° Magnetic, 130 nm.
d. 30 nm left of track, 15 nm ahead.

EFIS 70.
The groundspeed is indicated in which of the following colours?

a. Magenta.
b. White.
c. Green.
d. Yellow.

EFIS 71.
With APP selected on the MCP below 500 ft AGL, if more than one dot for one second in glideslope deviation or more than 1/5th dot for one second in localiser deviation occurs?

a. The respective localiser or glideslope scales change colour from white to magenta and the pointer flashes.
b. The respective localiser or glideslope scales change colour from white to red and the pointer flashes.
c. The respective localiser or glideslope scales change colour from steady white to flashing white.
d. The respective localiser or glideslope scales change colour from white to amber and the pointer flashes.

EFIS 72.
On a HSI map mode, distance to go is displayed in the?

a. Top left corner.
b. Bottom left corner.
c. Bottom right corner.
d. Top right corner.

EFIS 73.
Weather radar data can not be displayed on the EHSI in which of the following modes?

a. VOR.
b. ILS.
c. MAP.
d. PLAN.

AUTOFLIGHT 1.
The purpose of Auto Trim function in autopilot is to?

a. Tell the pilot when elevator trimming is required.
b. Help Auto Pilot to compensate for crosswind influence.
c. Trim throttles to obtain smooth engine power variation.
d. Control elevator trim tab in order to relieve elevator load

AUTOFLIGHT 2.
The purpose of Auto Throttle is?

a. Automatic shut down of one engine at too high temperature.
b. To deactivate manual throttles and transfer engine control to Auto Pilot.
c. To synchronize engines to avoid "yawing".
d. To maintain constant engine power or airplane speed.

AUTOFLIGHT 3.
In order to know in which mode the auto-throttles are engaged, the crew will check the?

a. ND (Navigation Display).
b. TCC (Thrust Control Computer).
c. Throttles position.
d. PFD (Primary Flight Display).

AUTOFLIGHT 4.
Mode "Localizer ARM" active on Flight Director means?

a. Localizer ALARM, making localizer approach not authorized.
b. Coupling has occurred and system provides control data to capture the centreline.
c. Localizer is armed and coupling will occur when flag warning disappears.
d. System is armed for localizer approach and coupling will occur upon capturing centre line.

AUTOFLIGHT 5.
The Altitude Select System?

a. Disengages autopilot Auto Trim at selected altitude.
b. Is annunciated by light and/or sound when airplane is approaching selected altitude.
c. Illuminates a light when selected altitude is attained.
d. Engages autopilot Auto Trim at selected altitude.

AUTOFLIGHT 6.
The correction of the control surface deflection made by the automatic pilot calculator in order to stabilize the longitudinal attitude will be all the more significant as the?

1. Difference between the reference attitude and the instantaneous attitude is high.
2. Rate of change of the difference between the reference attitude and the instantaneous attitude is high.

3. Temperature is low.
4. Pressure altitude is high.

The combination regrouping all the correct statements is?

a. 1, 2.
b. 1, 2, 3, 4.
c. 1, 2, 3.
d. 2, 3, 4.

AUTOFLIGHT 7.
The correction of the control surface deflection made by the auto-pilot calculator in order to keep a given altitude will be all the more significant when the?

1. Difference between the attitude necessary to keep the given or reference altitude and the instantaneous attitude is high.
2. Variation speed of the difference between the attitude necessary to maintain the altitude and the instantaneous attitude is high.
3. Difference between the altitude of reference and the instantaneous altitude is high.
4. Variation speed of the difference between the reference altitude and the instantaneous altitude is high.

The combination regrouping the correct statements is?

a. 1, 2, 3 and 4.
b. 1 and 2.
c. 3 and 4.
d. 1, 2 and 3.

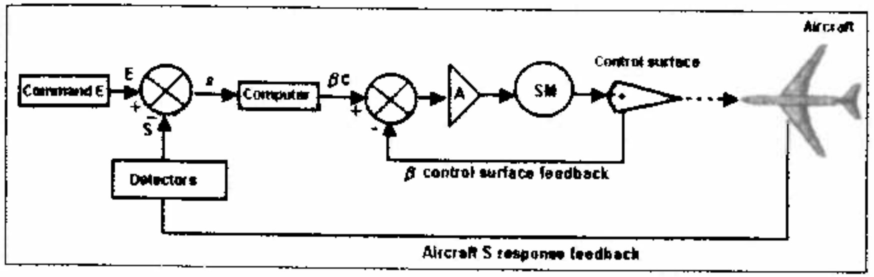
AUTOFLIGHT 8.
An automatic landing is carried out when the automatic pilot?

a. And the auto-throttle ensure a correct final approach, at least up to ground roll.
b. Ensures a correct final approach, at least up to ground roll while the human pilot controls the power.
c. And the auto-throttle ensure a correct final approach, at least up to flare-out.
d. And the auto-throttle ensure a correct final approach, at least up to flare-out while the human pilot controls the power.

AUTOFLIGHT 9.
A pilot has to carry out a single-pilot IFR flight on a light twin-engined aircraft for cargo transport. The purpose of the automatic pilot is at least to hold the?

a. Heading.
b. Altitude.
c. Heading, to hold the altitude and to have a radio axis tracking function.
d. Heading and to hold the altitude.

AUTOFLIGHT 10.
The block diagram of an autopilot is shown below.



For each control channel (pitch, roll and yaw) the piloting law is the relationship between the deflection of the control surface commanded by the computer (BETA c) and the?

a. Real deflection of the control surface (BETA control surface feedback).
b. Offset EPSILON at the computer input.
c. Pilot command E.
d. Aircraft response S.

AUTOFLIGHT 11.
In the automatic trim control system of an autopilot, automatic trimming is normally effected about the?

a. Pitch axis only.
b. Roll and yaw axes only.
c. Pitch roll and yaw axes.
d. Pitch and roll axes only.

AUTOFLIGHT 12.
A closed loop control system in which a small power input controls a much larger power output in a strictly proportionate manner is known as?

a. An amplifier.
b. A feedback control circuit.
c. An autopilot.
d. A servomechanism.

AUTOFLIGHT 13.
Mach Trim is a device to compensate for?

a. Weight reduction resulting from fuel consumption during the cruise.
b. Backing of the aerodynamic centre at high Mach numbers by moving the elevator to nose-up.
c. The effects of fuel transfer between the main tanks and the tank located in the horizontal tail.
d. The effects of temperature variation during a climb or descent at constant Mach.

AUTOFLIGHT 14.
Which one of the following statements is true with regard to the operation of a Mach trim system?

a. It only operates above a pre-determined Mach number.
b. It operates to counteract the larger than normal forward movements of the wing centre of pressure at high subsonic airspeeds.
c. It only operates when the autopilot is engaged.
d. It operates over the full aircraft speed range.

AUTOFLIGHT 15.
A landing will be considered to be performed in the SEMI-AUTOMATIC mode when?

1. The autopilot maintains the airplane on the ILS beam until the decision height is reached then is disengaged automatically.
2. The auto-throttle maintains a constant speed until the decision height is reached then is disengaged automatically.
3. The autopilot maintains the airplane on the ILS beam until the flare.
4. The auto-throttle decreases the thrust when the height is approximately 30 ft.
5. The flare and the ground roll are performed automatically.

The combination regrouping all the correct statements is?

a. 3, 4 and 5.
b. 1 and 4.
c. 2, 3 and 5.
d. 1 and 2.

AUTOFLIGHT 16.
When using the autopilot, the function of the pitch channel automatic trim is to?

1. Cancel the hinge moment of the elevator.
2. Ease as much as possible the load of the serve-actuators.
3. Restore to the pilot a correctly trimmed airplane during the autopilot disengagement.

The combination regrouping all the correct statements is?

a. 1 and 2.
b. 1, 2 and 3.
c. 3.
d. 1 and 3.

AUTOFLIGHT 17.
Among the following functions of an autopilot, those related to the airplane guidance are?

1. Pitch attitude holding.
2. Horizontal wing holding.
3. Indicated airspeed or Mach number holding.
4. Altitude holding.
5. VOR axis holding.
6. Yaw damping

The combination regrouping all the correct statements is?
a. 1, 3, 4 and 5.
b. 3, 4 and 5.
c. 1, 2, and 6.
d. 1, 2, 3 and 6.

AUTOFLIGHT 18.
Among the following functions of an autopilot, those related to the airplane stabilization are?

1. Pitch attitude holding.
2. Horizontal wing holding.
3. Displayed heading or inertial track holding.
4. Indicated airspeed or Mach number holding.
5. Yaw damping.
6. VOR axis holding.

The combination regrouping all the correct statements is?

a. 2, 4, and 5.
b. 1, 2 and 5.
c. 1, 2, 3 and 6.
d. 3, 4, 5 and 6.

AUTOFLIGHT 19.
The interception of a localizer beam by the autopilot takes place?

a. According to an interception versus radio deviation law.
b. According to an interception versus range and angular speed law.
c. At a constant heading.
d. At a constant magnetic course.

AUTOFLIGHT 20.
The yaw damper, which suppresses Dutch roll?

a. Controls the ailerons, with the angular rate about the vertical axis as the input signal.
b. Controls the rudder, with the angular rate about the vertical axis as the input signal.
c. Controls the ailerons, with Mach Number as the input signal.
d. Controls the rudder, with Mach Number as the input signal.

AUTOFLIGHT 21.
Landing shall be considered as having been carried out automatically when the autopilot and the auto-throttle of an aircraft are disengaged by flight crew?

a. At the outer marker.
b. During ground roll.
c. During the flare.
d. At the decision height.

AUTOFLIGHT 22.
The yaw damper indicator supplies the pilot with information regarding the?

a. Yaw damper action on the rudder.
b. Rudder displacement by the rudder pedals.
c. Yaw damper action only on the ground.
d. Rudder position.

AUTOFLIGHT 23.
An airplane is in steady cruise at flight level 290. The auto-throttle maintains a constant Mach number. If the total temperature increases, the calibrated airspeed?

a. Decreases.
b. Increases if the static temperature is higher than the standard temperature, decreases if lower.
c. Remains constant.
d. Increases.

AUTOFLIGHT 24.
The calibrated airspeed (CAS) or Mach holding mode is carried out by:

1. The autopilot pitch channel in the climb mode at a constant calibrated airspeed (CAS) or Mach number.
2. The auto-throttles in the climb mode at a constant calibrated airspeed (CAS) or Mach number.
3. The autopilot pitch channel in the altitude or glide path holding mode.
4. The auto-throttles in the altitude or glide path holding mode.

The combination regrouping all the correct statements is?

a. 2 and 4.
b. 1 and 3.
c. 2 and 3.
d. 1 and 4.

AUTOFLIGHT 25.
When an automatic landing is interrupted by a go-around:

1. The auto-throttle reacts immediately upon the pilot action on the TO/GA (Takeoff/Go-around) switch in order to recover the maximum thrust.
2. The autopilot monitors the climb and the rotation of the airplane.
3. The autopilot retracts the landing gear and reduces the flap deflection in order to reduce the drag.
4. The pilot performs the climb and the rotation of the airplane.
5. The pilot retracts the landing gear and reduces the flap deflection in order to reduce the drag.

The combination regrouping all the correct statements is?

a. 1, 3 and 4.
b. 1, 2 and 3.
c. 1, 2 and 5.
d. 1, 4 and 5.

AUTOFLIGHT 26.
A landing will be considered to be performed in the AUTOMATIC mode when:

1. The autopilot maintains the airplane on the ILS beam until the decision height is reached then is disengaged automatically.
2. The auto-throttle maintains a constant speed until the decision height is reached then is disengaged automatically.
3. The autopilot maintains the airplane on the ILS beam until the flare.
4. The auto-throttle decreases thrust when the height is approximately 30 ft.
5. The flare and the ground roll are performed automatically.

The combination regrouping all the correct statements is?

a. 1 and 2.
b. 2, 3 and 5.
c. 1 and 4.
d. 3, 4 and 5.

AUTOFLIGHT 27.
An autopilot capable of holding at least altitude and heading mode is compulsory?

a. For IFR or night flights with only one pilot.
b. On multi-pilot airplanes.
c. For VFR and IFR flights with only one pilot.
d. On airplanes over 5.7 t.

AUTOFLIGHT 28.
The automatic power control system (auto-throttle) of a transport airplane has the following mode(s):

1. Capture and holding of speeds.
2. Capture and holding of Mach number.
3. Capture and holding of flight angle of attack.
4. Capture and holding of N1 or EPR (Engine Power Ratio).
5. Capture and holding of flight paths.

The combination regrouping all the correct statements is?

a. 1, 2, 4.
b. 1, 2, 3, 5.
c. 2, 4.
d. 1, 4, 5.

AUTOFLIGHT 29.
From a flight mechanics point of view, the "guidance" functions of a transport airplane autopilot consist in?

a. Stabilizing and monitoring the movements around the aerodynamic centre.
b. Monitoring the movements of the centre of gravity in the three dimensions of space (path).
c. Stabilizing and monitoring the movements around the centre of gravity.
d. Monitoring the movements of the aerodynamic centre in the three dimensions of space (path).

AUTOFLIGHT 30.
The functions of an autopilot (basic modes) consist of?

a. Guiding the airplane path.
b. Stabilizing and monitoring the movement around the airplane aerodynamic centre.
c. Stabilizing and monitoring the movement around the airplane centre of gravity.
d. Monitoring the movement of the airplane centre of gravity.

AUTOFLIGHT 31.
A pilot engages the control wheel steering (CWS) of a conventional autopilot and carries out a manoeuvre in roll. When the control wheel is released, the autopilot will?

a. Restore the flight attitude and the rate of turn selected on the autopilot control display unit.
b. Maintain the flight attitude obtained at that moment.
c. Roll wings level and maintain the heading obtained at that moment.
d. Maintain the track and the flight attitude obtained at that moment.

AUTOFLIGHT 32.
During a Category II automatic approach, the height information is supplied by the?

a. Altimeter.
b. Radio altimeter.
c. GPS (Global Positioning System).
d. Encoding altimeter.

AUTOFLIGHT 33.
The purpose of an airplane automatic trim system is to trim out the hinge moment of the?

a. Rudder(s).
b. Elevator(s) and rudder(s).
c. Elevator(s), rudder(s) and ailerons.
d. Elevator(s).

AUTOFLIGHT 34.
An automatic pilot is a system which can ensure the functions of?

a. Piloting from take-off to landing without any action from the human pilot.
b. Piloting and guidance of an aircraft in both the horizontal and vertical planes.
c. Piloting only.
d. Navigation.

AUTOFLIGHT 35.
When being engaged, and without selecting a particular mode, an automatic pilot enables?

a. A constant speed on track, wings horizontal.
b. All aeroplane piloting and guidance functions except maintaining radio-navigation course lines.
c. Aeroplane stabilization with attitude hold or maintaining vertical speed and possibly automatic trim.
d. Aeroplane piloting and guidance functions.

AUTOFLIGHT 36.
On an autopilot coupled approach, GO AROUND mode is engaged?

a. By the pilot pushing a button located on the throttles.
b. By the pilot selecting G.A. mode on the thrust computer control panel.
c. Automatically in case of an autopilot or flight director alarm.
d. If the aircraft reaches the decision height selected on the radio altimeter at a higher speed than the one selected.

AUTOFLIGHT 37.
In a transport airplane, an autopilot comprises, in addition to the mode display devices, the following fundamental elements:

1. Airflow valve.
2. Sensors.
3. Comparators.
4. Computers.
5. Amplifiers.
6. Servo-actuators.

The combination regrouping all the correct statements is?

a. 1, 3, 4, 6.
b. 1, 2, 6.
c. 2, 3, 4, 5, 6.
d. 2, 3, 4, 5.

AUTOFLIGHT 38.
The engagement of an autopilot is not possible when:

1. There is a fault in the electrical power supply.
2. The controlled-turn knob is not set to centre-off.
3. There is a synchronization fault in the pitch channel.
4. There is a fault in the attitude reference unit.

The combination regrouping all the correct statements is?

a. 1, 2, 4.
b. 2, 3, 4.
c. 1, 3, 4.
d. 1, 2, 3, 4.

AUTOFLIGHT 39.
The purpose of the automatic trim is to:

1. Reduce to zero the hinge moment of the entire control surface in order to relieve the load on the servo-actuator.
2. Ensure the aeroplane is properly trimmed when the autopilot is disengaged.
3. Maintain the same stability/manoeuverability trade-off within the whole flight envelope.

The combination regrouping all the correct statements is?

a. 1, 3.
b. 2, 3.
c. 1, 2, 3.
d. 1, 2.

AUTOFLIGHT 40.
In automatic landing mode, in case of failure of one of the two autopilots, the system is considered?

a. "Fail soft" with minimized failure effect.
b. "Fail passive" or without failure effect but with disconnection.
c. "Fail survival" or without failure effect with function always ensured.
d. "Fail hard" or without failure effect and disconnection.

AUTOFLIGHT 41.
In automatic landing mode, when the 2 autopilots are used, the system is considered?

a. "Fail survival" or without failure effect with function always ensured.
b. "Fail soft" or with minimized failure effect.
c. "Fail passive" or without failure effect but with disconnection.
d. "Fail hard" or with failure effect and disconnection.

AUTOFLIGHT 42.
When only one autopilot is used for climbing, cruising and approach, the system is considered?

a. "Fail survival" or without failure effect with function always ensured.
b. "Fail safe" with failure effect without disconnection.
c. "Fail soft" with minimized failure effect but with disconnection.
d. "Fail passive" or without failure effect.

AUTOFLIGHT 43.
The autopilot basic modes include, among other things, the following functions?

1. Pitch attitude hold.
2. Pressure altitude hold.
3. Horizontal wing hold.
4. Heading hold.

The combination regrouping all the correct statements I?

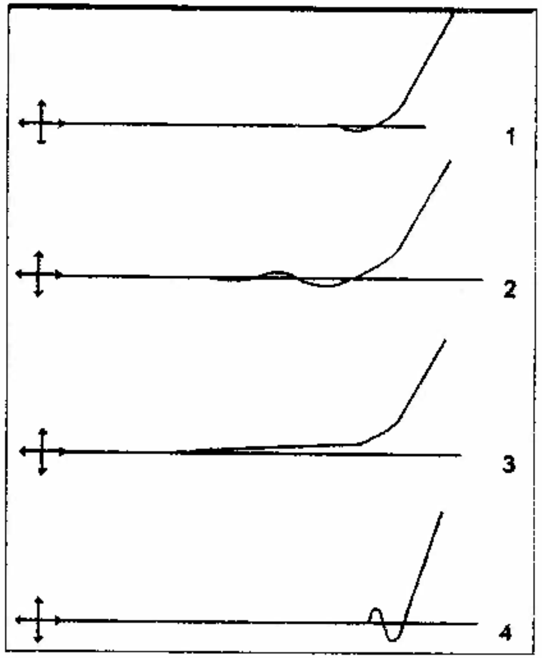
a. 1, 4.
b. 1, 3.
c. 1, 2, 3, 4.
d. 1, 2, 3.

AUTOFLIGHT 44.
The control law of a transport airplane autopilot control channel may be defined as the relationship between the?

a. Computer input deviation data and the signals received by the servo-actuators.
b. Input and output signals at the amplifier level respectively control deviation data and control deflection signals.
c. Crew inputs to the computer and the detector responses (returned to the airplane).
d. Computer input deviation data and the output control deflection signals.

AUTOFLIGHT 45.
Four scenarios of VOR axis interception are represented below. The one corresponding to the optimal interception path calculated by a flight director is number?

a. 3.
b. 2.
c. 1.
d. 4.



AUTOFLIGHT 46.
When an aircraft, operating in the VOR coupled mode, approaches the "cone of confusion" over a VOR station, the roll channel of the autopilot?

a. Remains always coupled to the selected VOR radial.
b. Is temporarily disconnected.
c. Maintains its existing heading.
d. Is damped by a trim input signal from the lateral trim system.

AUTOFLIGHT 47.
A landing is performed automatically when the autopilot and auto-throttle ensure good performance from the final approach?

a. Until the flare.
b. Until reaching decision height.
c. During the landing roll and sometimes until the aircraft comes to a complete stop.
d. Until reaching 100 ft, height at which point the autopilot is automatically disconnected.

AUTOFLIGHT 48.
A semi-automatic landing system disconnects itself automatically?

a. On ground.
b. When going around.
c. At approximately 100 ft.
d. At the decision height.

AUTOFLIGHT 49.
An automatic landing system necessitating that the landing be continued manually in the case of a system failure during an automatic approach is Called "FAIL...."?

a. "OPERATIONAL".
b. "SAFE".
c. "REDUNDANT".
d. "PASSIVE".

AUTOFLIGHT 50.
An automatic landing system which can keep on operating without deterioration of its performances following the failure of one of the autopilots is called "FAIL...:?

a. "REDUNDANT".
b. "OPERATIONAL".
c. "PASSIVE".
d. "SAFE".

AUTOFLIGHT 51.
During an automatic landing, from a height of about 50 ft the?

a. Autopilot maintains a vertical speed depending on the radio altimeter height.
b. Glideslope mode is disconnected and the airplane continues its descent until landing.
c. Autopilot maintains an angle of attack depending on the radio altimeter height.
d. Loc and Glideslope modes are disconnected and the airplane carries on its descent until landing.

AUTOFLIGHT 52.
Automatic trim is a component of the autopilot pitch channel. Its function is to?

a. Reset the attitude, after engaging (the autopilot).
b. Set the attitude to an instantaneous value before engaging the autopilot.
c. Automatically disengage the autopilot in the case of an excessive pitch up.
d. Transfer a stabilized aeroplane to the pilot during autopilot disengagement.

AUTOFLIGHT 53.
The auto-throttle:

1. Enable to catch and to maintain the N1 RPM.
2. Enable to catch and to maintain the N2 RPM.
3. Enable to catch and to maintain an airplane indicated airspeed (IAS).
4. Is always engaged automatically at the same time as the autopilot.

The combination regrouping all the correct statements is?

a. 1 and 3.
b. 2 and 3.
c. 1 and 4.
d. 1, 3 and 4.

AUTOFLIGHT 54.

When the altitude acquisition mode is engaged on a jet transport airplane equipped with autopilot (AP) and auto-throttle (ATS) systems the?

a. True airspeed (TAS) is maintained constant by the auto-throttle system.
b. Indicated airspeed (IAS) is maintained constant by the auto-throttle system.
c. Indicated airspeed (IAS) is maintained constant by the autopilot by means of elevator.
d. True airspeed (TAS) is maintained constant by the autopilot by means of elevator.

AUTOFLIGHT 55.

The synchronization of the autopilot control channel system:

1. Enables the prevention of jerks during disengagement.
2. Enables the cancellation of rudder control signals.
3. Enables the prevention of jerks during engagement.
4. Functions in the heading, navigation, approach modes.

The combination regrouping all the correct statements is?

a. 3, 4.
b. 2, 4.
c. 1, 4
d. 2, 4.

AUTOFLIGHT 56.

In a selected axis capture mode, the autopilot gives a bank attitude input?

a. Proportional to the deviation between the selected heading and the current heading but not exceeding a given value.
b. Of a fixed value equal to 27°.
c. Of a fixed value equal to 20°.
c. Proportional to the aircraft true airspeed but not exceeding a given value.

AUTOFLIGHT 57.

The computers of the electrical flight controls system comply with programs defined by attitude control laws such as:

1. On the longitudinal axis, the law may combine the load factor and the changes in the pitch rate as control data sources.
2. The trimming is automatic and ensures stability.
3. The protections apply to pitch and bank attitudes depending on the speed.
4. These laws do not apply to the whole flight envelope.

-bination regrouping all the correct statements is?

AUTOFLIGHT 61.
When the auto-pilot is engaged; the role of the automatic trim is to?

a. Relieve the pressure on the control column and return, the aircraft in trim at A.P. disconnect.
b. React to altitude changes in Altitude Hold mode.
c. Synchronize the longitudinal loop.
d. Relieve the A.P. servo motor and return the aircraft in-trim at A.P. disconnection.

AUTOFLIGHT 62
What happens to the glideslope signal at 50 ft agl in an autoland?

a. It causes the aircraft to execute a flare.
b. It is automatically disconnected.
c. It continues to be followed automatically.
d. It changes gradient to reduce landing impact.

AUTOFLIGHT 63.
When is the autoland considered to have been completed and the autopilot disconnected in an automatic landing?

a. At 100 ft agl.
b. At roll out.
c. At the flare.
d. At decision height.

AUTOFLIGHT 64.
Which of the following prevent engagement of the autopilot?

1. Attitude reference unit failure.
2. Synchronisation error.
3. Electrical supply failure.
4. Turn control knob not at centre off position.
5. Altimeter not set to correct QFE.

a. 1, 2, 3, 4, 5.
b. 1, 2, 4, 5.
c. 1, 3, 4, 5.
d. 1, 2, 3, 4.

AUTOFLIGHT 65.
What provides the required height information during a Cat 2 autoland?

a. Central ADC.
b. Radalt.
c. Baralt.
d. Glideslope signal.

AOTUFLIGHT 66.
What is the term used for an autopilot system that can still conduct an automatic landing safely following a single system failure?

a. Fail active.
b. Fail passive.
c. Fail safe.
d. Fail operational.

AUTOFLIGHT 67.
What is the term used for an autopilot system that cannot conduct an automatic landing safely but does not endanger the aircraft following a single system failure?

a. Fail active.
b. Fail passive.
c. Fail safe.
d. Fail operational.

AUTOFLIGHT 68.
For what type of operations is an autopilot with heading hold and altitude hold the minimum requirement?

a. Class A aircraft operations.
b. Commercial operations.
c. Flight in IFR or at night by a single pilot.
d. Flight in VMC or IMC by a single pilot.

AUTOFLIGHT 69.
What happens if an aircraft flies over the cone of confusion with its autopilot set to VOR hold?

a. Existing heading will be held until intelligible signals are regained.
b. The pilot must immediately deselect VOR hold or the flight path will become erratic.
c. The system will automatically disengage VOR hold.
d. The cone of confusion is not a phenomenon of VOR.

AUTOLFLIGHT 70.
The yaw damper indicator shows?

a. Rudder position.
b. Rudder movements caused by the damper.
c. Nothing until the system fails.
d. Nothing until the system becomes active.

AUTOFLIGHT 71.
Localiser beam interception by the autopilot?

a. Uses a radio deviation law.
b. Uses range computation algorithms.
c. Uses a constant heading.
d. Uses the inner and outer markers.

AUTOFLIGHT 72.
A yaw damper system?

a. Moves the ailerons in proportion to yaw rates.
b. Moves the ailerons in proportion to Dutch roll rates.
c. Moves the rudder in proportion to yaw rates.
d. Moves the rudder in proportion to Dutch roll rates.

AUTOFLIGHT 73.
When conducting an automatic landing the autopilot?

a. Controls attitude and the auto-throttle controls speed and altitude.
b. Controls attitude and altitude and the auto-throttle controls speed.
c. And the auto-throttle together control the aircraft until at least the roll out.
d. And the auto-throttle control the aircraft until decision height, when the auto-throttle becomes inactive.

AUTOFLIGHT 74.
The roll commands generated by an autopilot system?

a. Are zero when AOB is less than 25 degrees.
b. Are zero when heading error less than 5 degrees.
c. Are proportional to the difference between the selected heading and the actual heading.
d. Are proportional to TAS in order to avoid overshooting the desired heading.

AUTOFLIGHT 75.
The purpose of synchronisation in an autopilot system is to?

1. Prevent snatching on engagement.
2. Prevent snatching on disengagement.
3. Prevents the engagement of an unserviceable autopilot system.
4. Cancels pilot-induced rudder inputs.

a. 1, 2, 3, 4.
b. 1, 3.
c. 2, 3, 4.
d. 2, 3.

AUTOFLIGHT 76.
Fly by wire system employ control laws which?

a. Determines how pilot input demands are translated into control surface movement.
b. Determines how controls must move to maintain steady state conditions.
c. Analyses error signals between pick-offs on the ailerons and rudder.
d. Maintains constant aircraft attitude.

AUTOFLIGHT 77.
The device in a closed loop that converts a small input signal into a large output in a proportionate manner is?

a. An autostab module.
b. An amplifier.
c. A servomechanism.
d. A negative feedback loop.

AUTOFLIGHT 78.
Autotrim is employed in an autopilot system in order to?

1. Prevent snatching on engagement.
2. Prevent snatching on disengagement.
3. Prevent the autopilot engaging when unserviceable.
4. Provide manual control.
5. To reduce control hinge moments.
6. Maintain manual control authority.

a. 1, 6.
b. 2, 4.
c. 3, 5, and 6.
d. 2, 3, and 5.

AUTOFLIGHT 79.
During a semi-automatic landing the autopilot?

a. Controls speed down to 30 ft agl before automatically disengaging.
b. Controls the aircraft throughout the approach and until at least the decision height.
c. Controls the aircraft throughout the approach and until the end of the roll out.
d. Is not employed below 400 ft agl.

AUTOFLIGHT 80.
At 50 ft agl in an automatic landing?

a. Glideslope disconnects and the aircraft continues to descend.
b. Glideslope disconnects and the aircraft flares.
c. Radalt reduces ROD to produce a flare.
d. Radalt reduces ROD to zero.

AUTOFLIGHT 81.
An autoland procedure is complete when?

a. The aircraft reaches decision height.
b. The aircraft stops.
c. The aircraft starts its ground roll.
d. The flare is completed.

AUTOFLIGHT 82.
The mach trimmer system?

a. Prevents tuck under at low mach numbers.
b. Prevents tuck under at high mach numbers.
c. Prevents tuck under only at mach 1.
d. Prevents tuck under at high altitudes.

AUTOLFLIGHT 83.
The autopilot causes an aircraft to pitch, roll and yaw?

a. Only when it becomes unserviceable.
b. Its centre of pressure.
c. Its centre of gravity.
d. Its manoeuvre point.

AUTOFLIGHT 84.
What will an autopilot provide if it is engaged with no modes selected?

a. Autostab and autotrim.
b. Autostab and constant attitude.
c. VNAV and LNAV.
d. Height hold.

AUTOFLIGHT 85.
Which of the following best describes what happens when the TOGA switch is pressed during a missed approach?

1. The pilot takes over and flies manually.
2. Go around power is selected automatically.
3. Maximum power is selected automatically.
4. Flaps and gear are retracted automatically.
5. The autopilot controls the aircraft during the go around manoeuvre.

a. 1, 2.
b. 2, 4.
c. 2, 5.
d. 3, 5.

AUTOFLIGHT 86.
Under what conditions is a landing considered to be fully automatic?

1. Both flare and ground roll are conducted automatically.
2. The autopilot follows the ILS down to the flare.
3. The autopilot follows the ILS down to decision height, at which point it is disengaged.
4. Auto-throttle is disengaged at 50 ft.
5. Auto-throttle maintains speed down to decision height and is then disengaged.

a. 1, 2, 5.
b. 1, 2.
c. 2, 3.
d. 2, 3, 4.

AUTOFLIGHT 87.
A Category 3A autoland procedure is complete when?

a. At the flare.
b. At the end of the ground roll.
c. At the start of the ground roll.
d. At decision height.

AUTOFLIGHT 88.
When a go around is initiated from an automatic approach?

1. The pilot takes over and flies manually.
2. Go around power is selected automatically.
3. Maximum power is selected automatically.
4. Flaps and gear are retracted automatically.
5. The autopilot controls the aircraft during the go around manoeuvre.

a. 1, 2.
b. 2, 4.
c. 2, 5.
d. 3, 5.

AUTOFLIGHT 89.
In straight and level cruising flight, …….. holds speed and …….. holds height?

a. Autostab autopilot.
b. Auto-throttle autopilot.
c. Autopilot autopilot.
d. Autopilot auto-throttle.

AUTOFLIGHT 90.
What type of autopilot system prevents the contin…
continue after one autopilot fails?

a. Fail safe.
b. Fail passive.
c. Fail active.
d. Duplex.

AUTOFLIGHT 91.
What are the minimum

a. Heading
b. Hea…
c.
d.

AUTOFLIGHT 93.
Turning the barometric setting knob clockwise when ALT HOLD is engaged will?

a. Have no immediate effect.
b. Make the aircraft climb.
c. Make the aircraft descend.
d. Cause the autopilot to disengage.

AUTOFLIGHT 94.
The rate at which an autopilot system moves the control surfaces?

1. Varies greatly with altitude.
2. Varies greatly with the deviation from the selected condition.
3. Varies with rate of deviation from selected parameters.
4. Is constant.

a. 1, 2, 3.
b. 1, 2.
c. 2, 3.
d. 4.

AUTOFLIGHT 95.
A yaw damper?

a. Moves the rudder in proportion to yaw displacement.
b. Moves the rudder in proportion to yaw rate.
c. Moves the rudder to prevent spiral instability.
d. Moves the rudder in proportion to mach number.

AUTOFLIGHT 96.
If only one autopilot is employed to control climb, cruise and approach, it must be?

a. Fail safe and automatically disconnected in the event of its failure.
b. Fail soft and manually disconnected in the event of its failure.
c. Redundant and fail safe.
d. Fail operational.

AUTOFLIGHT 97.
The pilot can check which auto-throttle mode is engaged by looking at?

a. Thrust computation computer.
b. EPR indicator.
c. EFIS ND.
d. EFIS PFD.

AUTOFLIGHT 98.
When is the autoland flare initiated?

a. 1000 ft agl.
b. 400 ft agl.
c. 100 ft agl.
d. 50 ft agl.

AUTOFLIGHT 99.
A pilot can check auto-throttle mode on the?

a. EICAS or ECAM primary display.
b. EFIS PFD.
c. EFIS ND.
d. Overhead panel.

AUTOFLIGHT 100.
At what height will the autopilot be disengaged during a semi-automatic landing?

a. 400 ft.
b. 100 ft.
c. 50 ft.
d. Decision height.

AUTOFLIGHT 101.
What is the minimum acceptable autopilot facility for single pilot flight at night or in IFR conditions?

a. Two axis autopilot providing altitude hold, heading hold, and VOR tracking.
b. Two axis autopilot providing altitude hold and heading hold.
c. Single axis autopilot providing altitude hold.
d. Single axis autopilot providing heading hold.

AUTOFLIGHT 102.
An autopilot capable of providing heading hold and altitude hold is the minimum requirement for?

a. Automatic landings.
b. Single pilot IMC and VMC operations.
c. Single pilot night and IFR operations.
d. Class A aircraft.

AUTOFLIGHT 103.
What is the meaning of an illuminated "LOC ARMED" caption on the annunciator?

a. ILS captured.
b. Localiser is armed and awaiting capture.
c. Localiser has been captured.
d. Localiser beam has failed.

AUTOFLIGHT 104.
An automatic landing is one in which?

1. The flare is conducted automatically.
2. The auto-throttle is disengaged at 50 ft.
3. The autopilot follows the ILS down to the flare.
4. The auto-throttle controls airspeed down to decision height then disengages.

a. 1, 2.
b. 1, 3.
c. 2, 3.
d. 2, 4.

AUTOFLIGHT 105.
What is the purpose of automatic trim in an autopilot system?

a. To prevent snatching on engagement.
b. To prevent snatching on disengagement.
c. To prevent system runaway.
d. To prevent mach tuck under.

AUTOFLIGHT 106.
If an aircraft is provided with only a single autopilot to control climb, cruise and descent, the failure of this system will?

a. Cause no problems because it will be fail safe and disengage automatically upon failure.
b. Cause the system to run away unless immediately switched off by the pilot.
c. Be redundant and hence fail passively.
d. Will fail soft and hence not need switching off.

AUTOFLIGHT 107.
Which of the following can be held by the auto-throttle system?

1. Mach number.
2. IAS.
3. Altitude.
4. N1 and EPR.

5. VOR tracking.
6. Vertical speed.

a. 1, 2, 3.
b. 2, 3, 4.
c. 1, 2, 4.
d. 3, 4, 5, 6.

AUTOFLIGHT 108.
The purpose of the automatic trim facility is to?

a. To relieve the forces on the control column prior to hand over.
b. To reduce control hinge moments to zero.
c. To relieve forces on the autopilot servos prior to hand over.
d. To prevent sudden altitude changes in alt hold.

AUTOFLIGHT 109.
In the heading select mode the autopilot banks the aircraft by inputting control signal that are?

1. Proportional to the error between actual heading and selected heading.
2. Within specific limits.
3. Sufficient to achieve a maximum of 25 degrees of bank.
4. Sufficient to achieve a rate one turn.

a. 1, 2.
b. 1, 3.
c. 1, 4.
d. 2, 3.

AUTOFLIGHT 110.
The most basic autopilot function is to?

a. Level the wings.
b. Heading hold.
c. Altitude hold.
d. Pitch hold.

AUTOFLIGHT 111.
The effects of an automatic trim function in an autopilot system are to?

1. Cancel rudder control inputs to prevent runaway.
2. Prevent snatching on engagement.
3. Prevent snatching on disengagement.
4. to prevent system engagement if autotrim is not abvailable.

a. 1, 2.
b. 1, 3.
c. 2, 4.
d. 3, 4.

AUTOFLIGHT 112.
The TOGA facility is activated?

a. By pressing the TOGA button on or close to the throttle levers.
b. By pressing the pulling back on the control column during an autoland.
c. If the autopilot fails during an autoland.
d. When the glideslope is lost.

AUTOFLIGHT 113.
Initiating a go-around during an automatic approach?

1. The pilot controls the aircraft in the climb.
2. The autopilot controls the aircraft in the climb.
3. Auto-throttle selects maximum power.
4. Auto-throttle selects go-around power.
5. The pilot retracts flaps and gear.
6. The flaps and gear are retracted automatically.

a. 1, 3, 5.
b. 2, 4, 5.
c. 1, 4, 6.
d. 2, 3, 6.

AUTOFLIGHT 114.
A fully automatic landing is one in which?

a. The autopilot and auto-throttle control the aircraft until at least the roll out.
b. The autopilot and auto-throttle control the aircraft down to the flare.
c. The autopilot and auto-throttle control the aircraft until it stops.
d. The autopilot and auto-throttle control the aircraft down to decision height.

AUTOFLIGHT 115.
The term used to describe an autopilot system that is unable to continue an automatic landing after a single autopilot failure is?

a. Fail safe.
b. Fail passive.
c. Duplexed.
d. Fail operational.

AUTOFLIGHT 116.
What happens if the barometric altimeter pressure setting is adjusted when the autopilot is flying the aircraft altitude hold mode?

a. The changed pressure setting has no effect.
b. The aircraft climbs or descend, depending on which way the setting is changed.
c. The aircraft climbs.
d. The aircraft descends.

AUTOFLIGHT 117.
The autopilot rotates the aircraft around?

a. Its C of P.
b. Its C of G.
c. Its aerodynamic centre.
d. Only when defective.

AUTOFLIGHT 118.
A single pilot flying IFR must have an autopilot providing at least?

a. Horizontal hold.
b. Attitude hold.
c. Altitude and heading hold.
d. Attitude hold and altitude hold employing some form of radio navigation aid.

AUTOFLIGHT 119.
What is the name for a closed loop system in which a small input controls a much larger output in accordance with a set proportionality law?

a. Autopilot.
b. Amplifier.
c. Servo mechanism.
d. Positive feedback loop.

AUTOFLIGHT 120.
What is controlled by an auto flight system?

a. Elevators to control IAS.
b. Elevators to control heading.
c. Auto-throttle to control altitude.
d. Auto-throttle to control vertical speed.

AUTOFLIGHT 121.
At 50 ft agl?

a. The autopilot disengages.
b. The ILS and glideslope disengage.
c. The localiser and glideslope disengage.
d. The glideslope disengages.

AUTOFLIGHT 122.
How is the go around mode selected?

a. Automatically when the glideslope is lost.
b. By the pilot pressing the TOGA button on the throttle quadrant.
c. By the pilot pressing the TOGA button on the overhead panel.
d. By the pilot pushing the throttle levers fully forward.

AUTOFLIGHT 123.
At 50 ft agl during an auotland?

a. The horizontal stabiliser is trimmed nose up.
b. The glideslope and localiser disengage.
c. The flare mode becomes armed.
d. The autopilot flare mode takes over pitch control from the glideslope.

AUTOFLIGHT 124.
The yaw damper indicator?

a. Shows rudder angle.
b. Show rudder angle only when on the ground.
c. Shows rudder rate of movement.
d. Shows the degree to which the yaw damper has moved the rudder.

AUTOFLIGHT 125.
If the autopilot is engaged without selecting any modes it will provide?

a. Nothing.
b. Automatic stabilisation and in some cases automatic trim.
c. Wings level only.
d. Pitch attitude hold only.

AUTOFLIGH 126.
The "LOC ARMED" caption indicates that?

a. The localiser system has failed.
b. The localiser beam has been captured.
c. The localiser has been armed and is ready for capture.
d. The glideslope has been captured and the localiser is armed ready for capture.

AUTOFLIGHT 127.
When an aircraft has both autopilot and auto-throttle?

a. When climbing the auto-throttle holds IAS or mach number in the speed mode and the autopilot holds attitude in the climb mode.
b. When climbing the auto-throttle holds thrust or EPR while the autopilot holds IAS or mach number is the LVL CHG mode.
c. When cruising the auto-throttle holds altitude in the ALT hold mode and the autopilot holds IAS or mach number in the speed hold mode.
d. When descending, the auto-throttle holds vertical speed while the autopilot holds IAS or mach number.

AUTOFLIGHT 128.
What happens at 50 ft agl during an autoland?

a. The glideslope signal flares the aircraft.
b. The glideslope signal is automatically disengaged.
c. The glidslope signal continues to be used to fly the aircraft but its angle reduces.
d. The glideslope signal frequency increase to improve accuracy.

AUTOFLIGHT 129.
If an aircraft climbs with its auto-throttle system in mach hold?

a. IAS will increase.
b. CAS will decrease.
c. TAS will remain constant.
d. Throttle angle will remain constant.

FLIGHT DIRECTOR 1.
On a modern aircraft, the flight director modes are displayed on the?

a. Control panel of the flight director only.
b. Upper strip of the PFD (Primary Flight Display).
c. Upper strip of the ND (Navigation Display).
d. Upper strip of the ECAM (Electronic Centralized A/C Management).

FLIGHT DIRECTOR 2.
The essential components of a flight director are:

1. A computer.
2. An automatic pilot.
3. An autothrottle.
4. Command bars.

The combination of correct statements is?

a. 2, 4.
b. 2, 3.
c. 1, 4.
d. 1, 2.

FLIGHT DIRECTOR 3.
The aim of the flight director is to provide information to the pilot?

a. Allowing him to return to a desired path according to a 45° intercept angle.
b. Allowing him to return to a desired path according to a 30° intercept angle.
c. Allowing him to return to a desired path in an optimal way.
d. About his position with regard to a radio-electric axis.

FLIGHT DIRECTOR 4.
Flight Director Information supplied by an FD computer is presented in the form of command bars on the following instrument?

a. ADI Attitude Display Indicator.
b. BDHI Bearing Distance Heading Indicator.
c. RMI Radio Magnetic Indicator.
d. HSI Horizontal Situation Indicator.

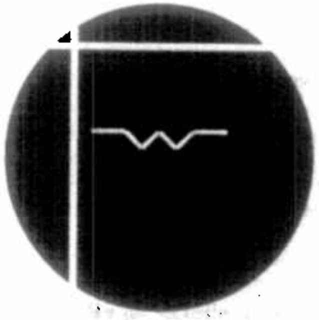
FLIGHT DIRECTOR 5.
The "heading hold" mode is selected on the flight director (FD) with a course to steer of 180°. Your aircraft holds a heading of 160°. The vertical bar of the FD?

a. Cannot be centreed.
b. Is centreed if the aircraft is on optimum path to join heading 180°.
c. Is centreed if the aircraft has a starboard drift of 20°.
d. Is centreed if the aircraft has a port drift of 20°.

FLIGHT DIRECTOR 6.
The Flight Director bars are?

a. Always visible in flight.
b. Always visible in automatic flight.
c. Sometimes visible in automatic flight.
d. Never visible in automatic flight.

FLIGHT DIRECTOR 7.
After having programmed your flight director, you see that the indications of your ADI (Attitude Director Indicator) are as represented in diagram below. On this instrument, the command bars indicate that you must bank your airplane to the left and?



a. Increase the flight attitude until the command bars recentre on the symbolic airplane.
b. Decrease the flight attitude until the command bars recentre on the symbolic airplane.
c. Increase the flight attitude until the command bars recentre on the horizon.
d. Decrease the flight attitude until the command bars recentre on the horizon.

FLIGHT DIRECTOR 8.
The command bars of a flight director are generally represented on an?

a. HSI (Horizontal Situation Indicator).
b. RMI (Radio Magnetic Indicator).
c. ILS (Instrument Landing System).
d. ADI (Attitude Director Indicator).

FLIGHT DIRECTOR 9.
An aeroplane is equipped with a Flight Director (with crosshair trend bars), heading 270° , in HDG mode (heading hold). A new heading, of 360° , is selected the vertical trend bar?

a. Deviates to its right stop as long as the aeroplane is more than 10° off the new selected heading.
b. Deviates to the right and will be centred as soon as you roll the aircraft to the bank angle calculated by the flight director.
c. Deviates to the right and remains in that position until the aircraft has reached heading 360°.
d. Disappears, the new heading selection has deactivated the HDG mode.

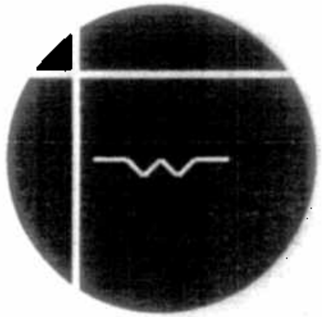
FLIGHT DIRECTOR 10.
The flight director indicates the?

a. Optimum path at the moment it is entered to reach a selected radial.
b. Path permitting reaching a selected radial in minimum time.
c. Path permitting reaching a selected radial over a minimum distance.
d. Optimum instantaneous path to reach selected radial.

FLIGHT DIRECTOR 11.
The position of a Flight Director command bars?

a. Indicates the manoeuvers to execute, to achieve or maintain a flight situation.
b. Repeats the ADI and HSI information.
c. Enables the measurement of deviation from a given position.
d. Only displays information relating to radio-electric deviation.

FLIGHT DIRECTOR 12.
After having programmed your flight director, you see that the indications of your ADI (Attitude Director Indicator) are as represented in diagram below. On this instrument, the command bars indicate that you must?



a. Increase the flight attitude and bank your airplane to the left until the command bars recentre on the symbolic aeroplane.
b. Increase the flight attitude and bank your aeroplane to the right until the command bars recentre on the symbolic aeroplane.
c. Decrease the flight attitude and bank your airplane to the left until the command bars recentre on the symbolic aeroplane.
d. Decrease the flight attitude and bank your airplane to the right until the command bars recentre on the symbolic aeroplane.

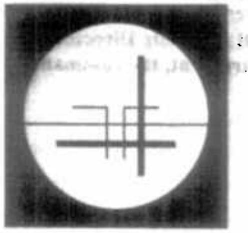
FLIGHT DIRECTOR 13.
What commands are being indicated by the flight director at the right?

a. Go down and right.
b. Go up and left.
c. Go down and left.
d. Go up and right.

FLIGHT DIRECTOR 14.
What commands are being indicated by the flight director at the right?

a. Go down and right.
b. Go up and left.
c. Go down and left.
d. Go up and right.

FLIGHT DIRECTOR 15.
What commands are being indicated by the flight director at the right?



a. Go down and right.
b. Go up and left.
c. Go down and left.
d. Go up and right.

FLIGHT DIRECTOR 16.
An aircraft is flying on a heading of 275° and the autopilot is in the heading select mode. What will the flight director command bars do if heading is changed to 350°?

a. The roll bar will move to the right until the AFDS angle of bank required to intercept is achieved. The bar will then centralise.
b. Roll bar moves hard right then gradually centralises as the difference between actual heading and selected heading reduces.
c. Roll bar moves left until the actual heading matches the selected heading.
d. The roll bar does not move, but the system automatically regains the selected heading.

FLIGHT DIRECTOR 17.
Flight director modes are displayed?

a. On the EFIS primary flight display.
b. On the EFIS nav display.
c. On EICAS or ECAM.
d. On the flight director control panel

FLIGHT DIRECTOR 18.
What command are being indicated by the FD at the right.

a. Go up and right.
b. Go up and left.
c. Go down and right.
d. Go down and left.

FLIGHT DIRECTOR 19.
On which instrument are the FD bars normally displayed?

a. EFIS ND.
b. EFIS PFD.
c. EICAS or ECAM.
d. PPI.

FLIGHT DIRECTOR 20.
When will the ADI vertical bar become centralised with 180 degrees is selected when flying on a heading of 160 degrees?

a. When at the correct attitude to intercept 180 degrees.
b. When on a heading of 180 degrees.
c. When on a heading of 160 degrees.
d. When within 20 degrees of 180 degrees.

FLIGHT DIRECTOR 21.
Having programmed the flight director, a pilot observes that the ADI indications are as illustrated in the diagram at the right. The command bars indicate that the aircraft should?

a. Bank left and increase nose up attitude until the bars centralise.
b. Bank left and decrease nose up attitude until the bars centralise.
c. Bank right and increase nose up attitude until the bars centralise.
d. Bank right and decrease nose up attitude until the bars centralise.

FLIGHT DIRECTOR 22.
If heading is set to 180 degrees when the aircraft is stable on 160 degrees, what will happen to the vertical bar on the flight director?

a. Move left.
b. Move right.
c. Move down.
d. Remain central.

FLIGHT DIRECTOR 23.
Where are the flight director modes displayed?

a. EFIS ND.
b. EFIS PFD.
c. EICAS/ECAM.
d. FD controller.

FLIGHT DIRECTOR 24.
How will the FD bars respond if a heading of 350 degrees is selected, when the aircraft with heading hold engaged is in steady flight on a heading of 270 degrees?

a. Move right until the turn command is executed, then centralise until a heading of about 340 degrees is reached, when it will move left to execute a roll out.
b. Move right until on 350 degrees then centralise.
c. Move right until on heading 260 degrees then move left to regain 350 degrees.
d. Move right temporarily then quickly centralise.

EICAS/ECAM 1.
In a basic ECAM system?

a. The left screen show information in checklist and memo form, whilst the right screen shows relevant diagrams.
b. The right screen shows information in checklist or memo form, whilst the left screen shows the relevant diagrams.
c. The left screen is normally blank with the right showing primary engine data.
d. The right screen is normally blank with the left showing primary engine data.

EICAS/ECAM 2.
The basic ECAM system has?

a. Three automatic modes and one manual mode.
b. Four automatic modes and one manual mode.
c. Three manual modes and one automatic mode.
d. No manual modes.

EICAS/ECAM 3.
A message enclosed within a box?

a. Is used in EICAS to show a system which is unserviceable.
b. Is used in ECAM to show a system which is unserviceable.
c. Is used in EICAS to show a system which although serviceable, is rendered non-operational due to the failure of a different system.
d. Is used in ECAM to show a system which although serviceable, is rendered non-operational due to the failure of a different system.

EICAS/ECAM 4.
ECAM provides?

a. Information in checklist or memo format on the left or upper display and a synoptic diagram on the right or lower display.
b. Information in checklist or memo format on the right or lower display and a synoptic diagram on the left or upper display.
c. No information about the engines.
d. Information about the engines only on the right or lower displays.

EICAS/ECAM 5.
If a screen fails in a basic (non-EFIS equipped) ECAM system?

a. The information that would normally appear on that screen is displayed in compacted format on the other screen.
b. The information that would normally be displayed on that screen is provided on conventional analogue displays.
c. The information that would normally be displayed on that screen is lost.
d. The engine primary data is displayed on the emergency engine data LED display.

EICAS/ECAM 6.
If a screen fails in an advanced (EFIS equipped) ECAM system?

a. The information that would normally appear on that screen is displayed in compacted format on the other screen.
b. The information that would normally be displayed on that screen is automatically transferred to one of the EFIS screens.
c. The information that would normally be displayed on that screen is lost.
d. The engine primary data is displayed on the emergency engine data LED display.

EICAS/ECAM 7.
If a screen fails in a basic (non EFIS equipped) EICAS system?

a. The information that would normally appear on that screen is displayed in compacted format on the other screen.
b. The information that would normally be displayed on that screen is automatically transferred to one of the EFIS screens.
c. The information that would normally be displayed on that screen is lost.
d. The engine primary data is displayed on the emergency engine data LED display.

EICAS/ECAM 8.
If a screen fails in an advanced (EFIS equipped) EICAS system?

a. The information that would normally appear on that screen is displayed in compacted format on the other screen.
b. The information that would normally be displayed on that screen is automatically transferred to one of the EFIS screens.
c. The information that would normally be displayed on that screen is lost.
d. The engine primary data is displayed on the emergency engine data LED display.

EICAS/ECAM 9.
If an emergency occurs in an aircraft employing advanced ECAM?

a. The nature of the problem is indicated in red at the bottom left of the upper display, together with corrective instructions in blue.
b. The nature of the problem is indicate in amber at the bottom left of the upper display, together with corrective instructions in white.
c. The nature of the problem is indicated in red at the top left of the upper display.
d. The nature of the problem is indicated in red on the lower display.

EICAS/ECAM 10.
If an emergency occurs in an aircraft employing advanced EICAS?

a. The nature of the problem is indicated in red at the bottom left of the upper display, together with corrective instructions in blue.
b. The nature of the problem is indicate in amber at the bottom left of the upper display, together with corrective instructions in white.
c. The nature of the problem is indicated in red at the top left of the upper display.
d. The nature of the problem is indicated in red on the lower display.

EICAS/ECAM 11.
In EICAS?

a. Engine primary data such as N1, EGT and EPR are displayed constantly on the lower screen, the upper screen remaining blank in normal flight.
b. Engine primary and secondary data plus flap, slat and flying control positions are displayed constantly on the upper screen, the lower screen remaining blank throughout normal flight.
c. Engine primary and secondary data plus flap, slat and flying control positions are displayed constantly on the lower screen, the upper screen remaining blank throughout normal flight.
d. Engine primary data such as N1, EGT and EPR are displayed constantly on the upper screen, the lower screen remaining blank in normal flight.

EICAS/ECAM 12.
The EICAS display modes are?

a. Operational, status and maintenance.
b. Normal, failure, status, manual.
c. Operational, status, manual, emergency.
d. Normal, manual, status.

EICAS.ECAM 13.
A red message on an upper EICAS display?

a. Is a warning of a situation for which immediate corrective action is required. It may or may not be accompanied by an aural warning, depending on the seriousness of the situation.
b. Is a warning of a situation for which immediate corrective action is required. It will be accompanied by an appropriate aural warning.
c. Advises the crew of a situation that does not require immediate corrective action, but might do so in the near future. It will always be accompanied by an aural warning.
d. Advises the crew of a situation that does not require immediate corrective action, but might do so in the near future. It may or may not be accompanied by an aural warning, depending upon the seriousness of the situation.

EICAS.ECAM 14.
An amber message on an upper EICAS display?

a. Is a warning of a situation for which immediate corrective action is required. It may or may not be accompanied by an aural warning, depending on the seriousness of the situation.
b. Is a warning of a situation for which immediate corrective action is required. It will be accompanied by an appropriate aural warning.
c. Advises the crew of a situation that does not require immediate corrective action, but might do so in the near future. It will always be accompanied by an aural warning.
d. Advises the crew of a situation that does not require immediate corrective action, but might do so in the near future. It may or may not be accompanied by an aural warning, depending upon the seriousness of the situation.

EICAS/ECAM 15.
A green bug on an EICAS EPR gauge indicates?

a. The current EPR value.
b. The fact that the current EPR value is the correct one for that stage of flight.
c. The target EPR value.
d. The maximum safe EPR value.

EICAS/ECAM 16.
The main advantages of EICAS and ECAM are?

a. More accurate indications.
b. Lighter and cheaper instruments.
c. Less cockpit clutter and better information management.
d. The ability to display parameters for multiple engines.

EICAS/ECAM 17.
How will a single EICAS failure be displayed.

1. If one screen of a basic EICAS system fails the other will go into compacted display mode.
2. If one computer of an EICAS system fails an amber caption will appear on the upper display but the system will continue to function.
3. If one screen of an advanced EICAS system fails the information from that screen will be automatically transferred to one of the EFIS navigation displays, and an amber caption will appear on the screen depicting EICAS primary data.

a. 1, 2.
b. 1, 3.
c. 2, 3.
d. All of the above.

EICAS/ECAM 18.
If both displays fail on a basic EICAS system?

a. Limited engine primary data (N1, N2, EGT) are displayed on an EFIS screen.
b. Limited engine primary data (N1, N2, EGT) are displayed on analogue gauges.
c. Limited engine primary data (N1, N2, EGT) are displayed on the standby engine LED indicator.
d. All data becomes unavailable.

EICAS/ECAM 19.
An EICAS advisory message?

a. Appears in amber on the upper display, indented one digit to the left.
b. Appears in amber on the upper display, indented one digit to the right.
c. Appears in green on the lower display, indented one digit to the right.
d. Appears in amber on the lower screen, indented one digit to the right.

EICAS/ECAM 20.
For what is the colour red used in EICAS and ECAM displays?

a. Warning and cautions.
b. Cautions and limits.
c. Warnings and limits.
d. Cautions and limits.

EICAS/ECAM 21.
How must a pilot react to an amber EICAS or ECAM indication?

a. Take immediate corrective action.
b. Take no action, it is for information only.
c. Take no immediate corrective action but be aware of it and consider its potential effects in the event of other failures.
d. Contact ATC immediately and divert to the nearest capable airfield.

EICAS/ECAM 22.
What indication is given for an ECAM system failure?

a. Light only.
b. Light and aural.
c. A button is illuminated to indicate how to switch off warning.
d. Amber message.

EICAS/ECAM 23.
What is the purpose of the cancel and recall buttons on an EICAS or ECAM system?

a. To delete unwanted messages and recover them if the situation suddenly deteriorates.
b. To scroll down and up the list of warnings, cautions and advisories, when they fill more than one page.
c. To delete warnings if they cannot be rectified, and to recover them if it is decided to make a further attempt.
d. To delete low priority messages to concentrate on the high priority ones. Then to recall the low priority messages when the more important ones have been dealt with.

EICAS/ECAM 24.
When an ECAM warning has been dealt with?

a. The blue corrective instructions will be replaced by a blue statement of the new configuration.
b. The red corrective instructions will be deleted.
c. The blue corrective instructions will be deleted.
d. The blue corrective instructions will be replaced by a green statement of the new configuration.

EICAS/ECAM 25.
When the ECAM T/O button is pushed?

a. The aircraft takes-off.
b. The system checks that the aircraft is in the take-off configuration.
c. The system puts the aircraft into the take-off configuration.
d. The system prepares the aircraft for take-off, then awaits the release of the brakes before spooling up the engines.

EICAS/ECAM 26.
When the Take-off button on an ECAM system is pushed?

a. The aircraft conducts an automatic take-off, to flap retraction height.
b. The aircraft conducts an automatic take-off and climb out to cruise height.
c. The ECAM confirms that the aircraft is in the take-off configuration.
d. The ECAM confirms that the aircraft is in the lift-off attitude.

EICS/ECAM 27.
The basic ECAM system displays?

a. Engine and aircraft systems primary data.
b. Engine and aircraft systems primary and secondary data.
c. Aircraft systems primary data.
d. Aircraft systems primary and secondary data.

EICS/ECAM 28.
Both ECAM and EICAS?

a. Display engine secondary data in analogue format only.
b. Display engine secondary and primary data in digital format only.
c. Display engine primary and secondary data in analogue and digital format.
d. Display engine primary data in analogue and digital format, and secondary only in analogue format

EICAS/ECAM 29.
ECAM displays warnings and cautions?

a. At the right side of the left or upper display.
b. At the left side of the right or lower display.
c. At the bottom of the left or upper display.
d. At the top of the left or upper display.

EICAS/ECAM 30.
The correct response to an EICAS red message is to?

a. Take immediate corrective action.
b. Press the status button to get more information about the failed system.
c. Press the cancel button to see if other faults exist.
d. Press the recall button to obtain a list of corrective actions.

EICAS/ECAM 31.
The correct response to an EICAS amber and aural message is?

a. Take the immediate corrective actions listed on the bottom of the upper display.
b. Take no immediate action but be aware of the situation.
c. Take immediate corrective actions listed on the lower display.
d. Press the recall button to obtain a list of corrective actions required.

EICAS/ECAM 32.
The correct response to an EICAS amber without aural message is?

a. Take the immediate corrective actions listed on the bottom of the upper display.
b. Take no immediate action but be aware of the situation.
c. Take immediate corrective actions listed on the lower display.
d. Press the recall button to obtain a list of corrective actions required.

EICAS/ECAM 33.
The correct response to an ECAM red message is?

a. To take immediate corrective action as listed on the bottom of the left or upper display.
b. To press the recall button to obtain details of corrective actions required.
c. Take no immediate actions but be aware of the situation.
d. Corrective action will be taken automatically by the system.

EICAS/ECAM 34.
Where are the flying control positions indicated on an advanced ECAM system?

a. The right side of the upper display.
b. The left side of the upper display.
c. The bottom of the lower display.
d. The left side of the lower display.

EICAS/ECAM 35.
Where are the flap and slat positions indicated on an advanced ECAM system?

a. The right side of the upper display.
b. The left side of the upper display.
c. The bottom of the lower display.
d. The left side of the lower display.

EICAS/ECAM 36.
When an aircraft system failure occurs on an aircraft with a basic ECAM system?

a. The left display will indicate the situation in red or amber, together with the required corrective actions in blue. The right display will show a diagram of the faulty system.
b. The left display will indicate the situation in red or amber, together with the required corrective actions in green. The right display will show a diagram of the faulty system.
c. The right display will indicate the situation in red or amber, together with the required corrective actions in blue. The left display will show a diagram of the faulty system.
d. The right display will indicate the situation in red or amber, together with the required corrective actions in green. The left display will show a diagram of the faulty system.

EICAS/ECAM 37.
When the required corrective actions have been taken to remedy an aircraft system fault, an ECAM system will?

a. The upper screen will continue to display the original fault statement together with the blue corrective action list, but the lower screen will go blank.
b. The upper screen will briefly continue to display the original fault statement, but the list of corrective actions will become green. Both screens will then revert to normal.
c. The fault indications will immediately disappear as the screens return to normal.
d. The original fault statement will remain but the corrective actions list will turn green. The lower display will return to normal.

EICAS/ECAM 38.
In normal flight conditions an EICAS system display is?

a. Both screens blank.
b. Upper screen blank and lower one indicating primary engine data.
c. Lower screen blank and upper screen indicating primary engine data.
d. Upper screen indicating engine primary data and lower screen indicating engine secondary data.

EICAS/ECAM 39.
An engine fire on an EICAS equipped aircraft would be indicated by?

a. Red caption on the upper display and engine secondary data on the lower display.
b. Red caption on the upper display, aural warning, engine secondary data on the lower display.
c. Amber caption on the upper display and engine secondary data on the lower display.
d. Amber caption on the upper display, aural warnings, engine secondary data on the lower display.

EICAS/ECAM 40.
In an EICAS system, excessive EGT is indicated by?

a. The position and figures on an analogue and digital display.
b. The EGT display will turn red.
c. The EGT display will turn amber.
d. The EGT display will flash alternately red and amber.

EICAS/ECAM 41.
If the lower EICAS display fails but the EICAS system does not detect the failure?

a. The lower display will remain blank, but the upper will show a series of ∨ Signs whenever data should be on the lower display.
b. Display failures are always detected by EICAS.
c. The lower display will remain blank, but the upper will show a series of ↓ Signs whenever data should be on the lower display.
d. The system will automatically go into compacted display mode.

EICAS/ECAM 42.
The message on an ECAM display | RADALT | **indicates?**

a. The RADALT is defective.
b. The RADALT is not itself defective but it has been rendered unavailable due to the failure of another systems which is not identified.
c. The RADALT is not itself defective but it has been rendered unavailable due to the failure of another systems which is also identified by another message.
d. The RADALT has been switched on.

EICAS/ECAM 43.
How is the lower screen in an EICAS system cleared when in status mode?

a. By pressing the CLR button.
b. By pressing the status button.
c. By repeatedly pressing the status button until all pages have been viewed.
d. By pressing the RCL button.

EICA/ECAM 44.
Modern commercial transport aircraft will employ?

a. ECAM, EICAS and EFIS.
b. ECAM and EICAS but not EFIS.
c. EFIS and either ECAM or EICAS
d. EFIS only.

EICAS/ECAM 45.
The advantages of EICAS and ECAM include?

1. Reduced cockpit clutter.
2. Reduced pilot workload.
3. Easier identification of faults.
4. Easier interpretation of information in difficult conditions.
5. Lighter indication systems.
6. Better integration of information.

a. 1, 2, 3, 4.
b. 2, 3, 4, 6.
c. 3, 4, 5, 6.
d. All of the above.

ENGINE 1.
The temperature measured by the CHT (Cylinder Head temperature) probe is The?

a. Temperature within the hottest cylinder, depending on its position in the engine block.
b. Average temperature within the whole set of cylinders.
c. Temperature of the exhaust gases.
d. Temperature of the carburetor to be monitored when the outside air temperature is between -5° C and 10° C.

ENGINES 2.
The signal supplied by a transmitter fitted with a 3-phase AC generator, connected to RPM indicator, is a DC voltage varying with the RPM?

a. The indicator is a plain voltmeter with a rev/min scale measuring an AC voltage, the frequency of which varies with the RPM.
b. The indicator converts the signal into square pulses which are then counted as an AC voltage varying with the RPM.
c. The indicator rectifies the signal via a diode bridge and is provided with a voltmeter a three-phase voltage, the frequency of which varies with the RPM.
d. The indicator is provided with a motor, which drives a magnetic tachometer.

ENGINES 3.
The signal supplied by a transmitter fitted with a magnetic sensor, connected to an RPM indicator is a three-phase voltage frequency varies with the RPM?

a. The indicator is provided with a motor which drives a magnetic tachometer a DC voltage varying with the RPM.
b. The indicator is a simple voltmeter with a rev/min scale measuring an AC voltage varying with the RPM?
c. The indicator rectifies the signal via a diode bridge and is provided with a voltmeter measuring an AC voltage, the frequency of which varies with the RPM.
d. The indicator converts the signal into square pulses which are then counted.

ENGINES 4.
A vibration indicator receives a signal from different sensors (accelerometers). It indicates the?

a. Vibration period expressed in seconds.
b. Vibration amplitude at a given frequency.
c. Acceleration measured by the sensors, expressed in g.
d. Vibration frequency expressed in Hz.

ENGINES 5.
The transmitter of RPM indicator may consist of:

1. A magnetic sensor supplying an induced AC voltage.
2. A DC generator supplying a DC voltage.
3. A single-phase AC generator supplying an AC voltage.
4. A three-phase AC generator supplying a three-phase voltage.

The combination of correct statements is?

a. 1, 2, 3.
b. 1, 2, 3, 4.
c. 2, 3, 4.
d. 1, 4.

ENGINES 6.
The Engine Pressure Ratio (EPR) is computed by?

a. Dividing turbine discharge pressure by compressor inlet pressure.
b. Dividing compressor discharge pressure by turbine discharge pressure.
c. Multiplying compressor inlet pressure by turbine discharge pressure.
d. Multiplying compressor discharge pressure by turbine inlet pressure.

ENGINES 7.
The principle of detection of a vibration monitoring system is based on the use of?

a. 2 accelerometers.
b. 2 high and low frequency amplifiers.
c. 2 high and low frequency filters.
d. A frequency converter.

ENGINES 8.
The green sector of the arc of a temperature gauge corresponds to?

a. An exceptional operating range.
b. A forbidden operating range.
c. A special operating range.
d. A normal operating range.

ENGINES 9.
A synchroscope is used on aircraft to?

a. Reduce the vibration of each engine.
b. Reduce the rpm of each engine.
c. Achieve optimum control of on-board voltages.
d. Set several engines to the same speed.

ENGINES 10.

A thermocouple type thermometer consists of?

a. A single-wire metal winding.
b. Two metal conductors of different type connected at one point.
c. Two metal conductors of the same type connected at two points.
d. A Wheatstone bridge connected to a voltage indicator.

ENGINES 11.

The yellow sector of the temperature gauge corresponds to?

a. A frequent operating range.
b. A forbidden operating range.
c. An exceptional operating range.
d. A normal operating range.

ENGINES 12.

In an engine vibration monitoring system for a turbojet any vibration produced by the engine is?

a. Directly proportional to engine speed.
b. Fed directly to the cockpit indicator without amplification or filtering.
c. Amplified and filtered before being fed to the cockpit indicator.
d. Inversely proportional to engine speed.

ENGINES 13.

Different pressure sensors are used according to the intensity of the pressure measured (low, medium or high). Classify the following sensors by order of increasing pressure for which they are suitable?

1. Bellows type.
2. Bourdon tube type.
3. Aneroid capsule type.

a. 2, 1, 3.
b. 3, 1, 2.
c. 1, 2, 3.
d. 3, 2, 1.

ENGINES 14.

The RPM indicator (or tachometer) of a piston engine can include a small red arc within the arc normally used (green arc). In the RPM range corresponding to this small red arc the?

a. Rating is the minimum usable in cruise propeller efficiency.
b. Is minimum at this rating.
c. Propeller generates vibration, continuous rating is forbidden.
d. Rating is the maximum possible in continuous mode.

ENGINES 15.

In order to measure temperature the cylinder head temperature (CHT) gauge utilises a?

a. Thermocouple consisting of two dissimilar metals.
b. Wheatstone bridge circuit.
c. Ratiometer circuit.
d. Bourdon tube.

ENGINES 16.

A manifold pressure gauge of a piston engine measures?

a. Fuel pressure leaving the carburettor.
b. Vacuum in the carburettor.
c. Absolute pressure in intake system near the inlet valve.
d. Absolute air pressure entering the carburettor.

ENGINES 17.

If a manifold pressure gauge consistently registers atmospheric pressure, the cause is probably?

a. Leak in pressure gauge line.
b. Too high float level.
c. Fuel of too low volatility.
d. Ice in induction system.

ENGINES 18.

A millivoltmeter measuring the electromotive force between the "hot junction" and the "cold junction" of a thermocouple can be directly graduated in temperature values provided that the temperature of the?

a. Cold junction is maintained constant.
b. Hot junction is maintained constant.
c. Cold junction is maintained at 15° C.
d. Hot junction is maintained at 15° C.

ENGINES 19.
The main advantage of a ratiometer-type temperature indicator is that it?

a. Is simple.
b. Can operate without an electrical power supply.
c. Is very accurate.
d. Carries out an independent measurement of the supply voltage.

ENGINES 20.
The probe used to measure the air intake pressure of a gas turbine engined powerplant is?

a. A differential capsule.
b. A Bourdon tube.
c. A bellows sensor.
d. An aneroid capsule.

ENGINES 21.
The pressure probe used to measure the pressure of a low pressure fuel pump is?

a. An aneroid capsule.
b. A bellows sensor.
c. A Bourdon tube.
d. A differential capsule.

ENGINES 22.
The disadvantages of a single-phase A.C. generator tachometer are:

1. The presence of spurious signals due to a D.C. generator commutator.
2. The importance of line resistance on the information value.
3. The influence of temperature on the tachometer information.

The combination regrouping all the correct statements is?

a. 2.
b. 1, 2, 3.
c. 1, 2.
d. 1, 3.

ENGINES 23.
The advantages of single-phase A.C. generator tachometer are:

1. The suppression of spurious signals due to a D.C. generator commutator.
2. The importance of line resistance on the information value.
3. The independence of the information in relation to the airborne electrical power supply.

4. The ease of transmission of the information.

The combination regrouping all the correct statements is?

a. 1, 3.
b. 1, 2, 3, 4.
c. 2, 3, 4.
d. 2, 4.

ENGINES 24.
The advantages of a D.C. generator tachometer are:

1. Easy transmission of the information.
2. Independence of the information relative to the airborne electrical power supply.
3. Freedom from any spurious current due to the commutator.

The combination regrouping all the correct statements is?

a. 2, 3.
b. 1, 3.
c. 1, 2.
d. 1, 2, 3.

ENGINES 25.
The electronic tachometer sensor is composed of?

a. The rotor of a single phase A.C. generator.
b. The rotor of a three phase A.C. generator.
c. A notched wheel rotating in front of an electro-magnet.
d. A circular magnet with four poles.

ENGINES 26.
The advantages of an electrical induction tachometer are:

1. The display is not sensitive to line resistance.
2. The measurement is independent of aircraft power supply.
3. The measurement is independent of temperature variations.
4. The option to use without restriction several indicators connected in parallel to a single transmitter.

The combination regrouping all the correct statements is?

a. 1, 3, 4.
b. 1, 2, 3, 4.
c. 2, 3, 4.
d. 1, 2, 4.

ENGINES 27.
The measurement of the turbine temperature or of the EGT (Exhaust Gas Temperature) is carried out at the?

a. Combustion chamber outlet.
b. Combustion chamber intake.
c. High pressure chamber intake.
d. High pressure turbine outlet.

ENGINES 28.
The sensors used to measure the exhaust gas temperature on an aircraft equipped with turbojets are?

a. Thermocouples.
b. Based on metallic parts whose expansion/contraction is measured.
c. Based on metallic conductors whose resistance increases linearly with temperature.
d. Capacitors whose capacity varies proportionally with temperature.

ENGINES 29.
The red pointer which is normally on the red line on the EGT (Exhaust Gas Temperature) indicators?

a. Allows the display of the parameter value to be adopted during take-off.
b. Shows the vibration level of the engine under consideration.
c. Moves when the corresponding value is exceeded and remains positioned at the maximum value that has been reached.
d. Shows the limit value not to be exceeded.

ENGINES 30.
A Full Authority Digital Engine Control (FADEC) has the following functions:

1. Flow regulation (fuel, decelerations and accelerations monitoring).
2. Automatic starting sequence.
3. Transmissions of engine data to the pilot's instruments.
4. Thrust management and protection of operation limits.
5. Monitoring of the thrust reversers.

The combination regrouping all the correct statements is?

a. 1, 3, 4, 5.
b. 1, 2, 3, 4, 5.
c. 2, 4, 5.
d. 1, 3, 5.

ENGINES 31.
The operating principle of the "induction" type of tachometer is to measure the?

a. Electromotive force (EMF) produced by a dynamo or an alternator.
b. Frequency of the electric impulse created by a notched wheel rotating in a magnetic field.
c. Magnetic field produced by a dynamo or an alternator.
d. Rotation speed of an asynchronous motor energized by an alternator.

ENGINES 32.
The operating principle of an "electronic" tachometer is to measure the?

a. Rotation speed of an asynchronous motor energized by an alternator.
b. Magnetic field produced by a dynamo or an alternator.
c. Frequency of the electric impulse created by a notched wheel rotating in a magnetic field.
d. Electromotive force (EMF) produced by a dynamo or an alternator.

ENGINES 33.
In a 3-phase synchronous motor type tachometer indicator:

1. The transmitter is a direct current generator.
2. The voltage is proportional to the transmitter drive speed.
3. The frequency is proportional to the transmitter drive speed.
4. The speed indicating element is a galvanometer.
5. The speed indicating element is a synchronous motor driving a magnetic tachometer.

The combination regrouping all the correct statements is?

a. 3, 5.
b. 1, 2.
c. 2, 5.
d. 1, 4.

ENGINES 34.
The two main sources of information used to calculate turbojet thrust are the?

a. Fan rotation speed (or N1) or the total pressure at the low pressure turbine outlet.
b. Fan rotation speed (or N1) or the EPR (Engine Pressure Ratio).
c. High pressure turbine rotation speed or the EPR (Engine Pressure Ratio).
d. Fan rotation speed (or N1) or the total pressure at the high pressure compressor outlet.

ENGINES 35.
To permit turbine exit temperatures to be measured, gas turbines are equipped with thermometers which work on the following principle?

a. Gas pressure.
b. Thermocouple.
c. Bi-metallic strip.
d. Liquid expansion.

ENGINES 36.
On an aeroplane equipped with a constant speed propeller, the RPM indicator enables?

a. Control of power.
b. Selection of engine RPM.
c. On a twin-engine aeroplane, automatic engine synchronisation.
d. Control of the propeller regulator and the display of propeller RPM.

ENGINES 37.
Torque can be determined by measuring the?

a. Oil pressure at the fixed crown of an epicycloidal reducer of the main engine gearbox.
b. Phase difference between 2 impulse tachometers attached to a transmission shaft.
c. Frequency of an impulse tachometer attached to a transmission shaft.
d. Quantity of light passing through a rack-wheel attached to a transmission shaft.

ENG 38.
What type of sensor is employed to measure compressor air inlet temperature in a typical turbojet engine fuel system?

a. Temperature probe.
b. Mercury thermometer.
c. Alcohol thermometer.
d. Optical pyrometer.

ENG 39.
A millimetric voltmeter measuring the PD across the hot and cold junctions of a thermocouple, can be calibrated to indicate temperature by?

a. The cold junction is kept at absolute zero.
b. The cold junction is kept a zero degree Celsius.
c. The cold junction temperature is known.
d. The cold junction is kept at a constant temperature.

ENG 40.
The electrical supply for a basic thermocouple system is?

a. Provided by a dedicated transformer.
b. Provided from the essential services busbar.
c. Self generated by the SEEBECK effect.
d. Self generated by the inductive reactance method.

ENG 41.
Cylinder head temperature on a piston engine is measured using a …….. on the ………?

a.	Thermocouple	coolest cylinder.
b.	Resistive element	hottest cylinder.
c.	Resistive element	exhaust manifold.
d.	Thermocouple	hottest cylinder.

ENG 42.
Temperature is measured in aircraft engines by means of?

1. Thermocouples.
2. Mercury.
3. Resistive elements.
4. Capacitive elements.

a. 1, 2.
b. 2, 3.
c. 3, 4.
d. 1, 3.

ENG 43.
If one of the probes in a typical gas turbine engine EGT system becomes defective, the indications would be?

a. Too high.
b. Too low.
c. Not significantly affected.
d. Lost.

ENG 44.
Cylinder head temperature measurement systems typically work on the ...... principle?

a. Thermocouple.
b. Resistive.
c. Capacitive.
d. Thermal expansion (bi-metal strip).

ENG 45.
Thermocouples are?

a. Two dissimilar metals connected at one point.
b. Two dissimilar metals connected at two points.
c. Two dissimilar metals separated by a dielectric material.
d. Two similar metals connect at two points.

ENG 46.
Jet engine exhaust gas temperature is measured using?

a. A thermocouple.
b. A number of thermocouples connected in series.
c. A number of thermocouples connected in parallel.
d. A thermistor.

ENG 47.
The pointer that aligns with the red line on a EGT gauge?

a. Indicates maximum temperature.
b. Is movable and indicates maximum temperature exceeding the red line.
c. Is adjustable to permit different limits to be set as required.
d. Is adjustable to permit higher limits to be set when taking-off at high mass in high ambient temperatures.

ENG 48.
A temperature gauging system employing thermocouples can be graduated to indicate temperature by?

a. By keeping the cold junction at 15 degrees Celsius.
b. By keeping the hot junction above 15 degrees Celsius.
c. By keeping the cold junction at a constant temperature.
d. By protecting the hot junction from high temperatures.

ENG 49.
Which of the following is used to measure temperature?

1. The seebeck effect.
2. the variation of electrical resistance with changes in temperature.
3. The variation of capacitance with changes in temperature.
4. Thermal expansion of liquids and solids.

a. 1, 2, 3.
b. 1, 3, 4.
c. 1, 3, 4.
d. 1, 2, 4.

ENG 50.
A cylinder head temperature gauge measures?

a. All of the cylinders and sums the result.
b. All of the cylinders and averages the result.
c. The coolest cylinder only to preserve the sensor.
d. The hottest cylinder only.

ENG 51.
Where is EGT measured?

a. At the HP turbine outlet.
b. At the LP turbine outlet.
c. At the LP turbine inlet.
d. At the HP turbine inlet.

ENG 52.
Where is EGT measured?

a. At the turbine outlet.
b. At the turbine inlet.
c. In the jet pipe.
d. In the combustion chamber.

ENG 53.
If a ratiometer is used in the indicator of temperature measuring system rather than an ameter?

a. It will be less affected by line resistance losses.
b. It will be more affected by line resistance losses.
c. It will be ineffective due to line resistance losses.
d. It will always give accurate readings, regardless of line resistance losses.

ENG 54.
What type of sensor is typically used to measure lubricating oil temperature in a turbojet engine?

a. Resistive probe.
b. Capacitive probe.
c. Thermocouple probe.
d. Bi-metal strip.

ENG 55.
What type of sensors are used in an EPR gauge?

a. Bourden tubes.
b. Bellows.
c. Aneroid capsules
d. Differential capsules.

ENG 56.
What type of sensors are typically used to measure carburettor inlet temperatures?

a. Thermocouples.
b. Resistive probes.
c. Reactive probes.
d. Capacitive probes.

ENG 57.
What type of sensors are typically used to measure engine oil temperature?

a. Thermocouples.
b. Resistive probes.
c. Reactive probes.
d. Capacitive probes.

ENG 58.
What type of sensor is normally used to measure inlet air temperature where the signal is to be employed for altitude compensation in a conventional (non FADEC) engine fuel system?

a. Liquid expansion.
b. Resistive.
c. Bi-metallic.
d. Capacitive.

ENG 59.
What does the amber arc on an EGT gauge indicate?

a. Maximum EGT for normal operations.
b. Time limited EGT.
c. Altitude limited EGT.
d. Mass limited EGT.

ENG 60.
If a remote sensing pressure measurement system uses a ratiometer rather than an ammeter as its indicator, it will be?

a. More sensitive to line resistance changes.
b. Less sensitive to line resistance changes.
c. Not affected by line resistance changes.
d. Rendered unserviceable by line resistance changes.

ENG 61.
What measures inlet pressure?

a. Bourden tube.
b. Bellows.
c. Differential capsule.
d. Aneroid capsule.

ENG 62.
Arrange the following sensors in increasing order of the pressures they would be used to sense?

1. Capsule.
2. Bellows.
3. Bourden tube.

a. 1, 2, 3.
b. 2, 3, 1.
c. 3, 1, 2.
d. 1, 3, 2.

ENG 63.
A capsule stack would be used to measure .... pressure when a ...... mechanical output for a given pressure change was required?

a.	High	large.
b.	High	small.
c.	Low	large.
d.	Low	small.

ENG 64.
What is a bellows used to measure?

a. Low pressures.
b. High pressures.
c. Low temperatures.
d. Density.

ENG 65.
Turbine outlet pressure is detected by?

a. Aneroid capsule.
b. Bellows.
c. Differential capsule.
d. Bourden tube.

ENG 66.
A remote sensing pressure gauging system measuring low pressures, typically employs a .... to move .... The variations in .... are then measured using a .... or ....?

a. Aneroid capsule, capacitor, capacitance, wheatstone bridge, ratiometer.
b. Bellows, variable resister, resistance, wheatstone bridge, ratiometer.
c. Bourden tube, variometer, capacitance, transistor, capacitor.
d. Differential capsule, ratiometer, current, capacitor, ammeter.

ENG 67.
EPR is calculated by?

a. Dividing compressor inlet pressure by HP turbine outlet pressure.
b. Diving HP turbine outlet pressure by air inlet pressure.
c. Dividing LP turbine outlet pressure by LP compressor inlet pressure.
d. Subtracting LP compressor inlet pressure from JP turbine outlet pressure.

ENG 68.
A turbocharged piston engine has a rated boost of 10 PSI and a critical altitude of 15000 ft amsl ISA. If the aircraft is at a pressure altitude of 10000 ft climbing at rated power, what will be its MAP?

a. 50 inches Hg.
b. 30 inches Hg.
c. 10 PSI.
d. Ambient static plus 10 PSI.

ENG 69.
Vibration meters measure?

a. Accelerations in g.
b. Frequency in Hz.
c. Amplitude at a given frequency.
d. Period in seconds.

ENG 70.
What does the vibration measuring system indicate to the pilot?

a. Relative frequency.
b. Relative amplitude.
c. Absolute frequency.
d. Absolute magnitude.

ENG 71.
Vibration is measured using?

1. Accelerometers.
2. Pieze crystals.
3. Inductive coils.
4. Capacitive elements.
5. Strain gauges.

a. 1, 2, 3, 4.
b. 1, 2, 3.
c. 2, 3, 4, 5.
d. 3, 4, 5.

ENG 72.
On what principle does a vibration meter work?

a. High frequency, low amplitude.
b. Accelerometers, frequency filters and amplifiers.
c. Accelerometers, amplitude filters, and comparators.
d. Dynamometers, frequency filters and amplifiers.

ENG 73.
A vibration meter indicates?

a. Frequency.
b. Pitch.
c. Period.
d. Relative amplitude.

ENG 74.
Vibration sensors on a turbofan engine are typically located?

a. Radially pointing on the fan and turbine casings.
b. Longitudinally pointing, on the fan and turbine casings.
c. On the gearboxes and output shafts.
d. On the HP spool and by-pass duct.

ENG 75.
A synchroscope is used to?

a. Coordinate fan RPMs in multi turbofan aircraft.
b. Coordinate the RPM of the high a low speed spools on turbofans.
c. To indicate RPM difference between engines in multi prop aircraft.
d. To ensure that AC generators are properly synchronised before coupling.

ENG 76.
A vibration monitoring system uses .... to measure ...., filters out unwanted ...., then indicates ...., to the pilot?

a. Thermisters, radial movement, frequencies, absolute amplitude.
b. Accelerometers, axial movement, noise, relative amplitude.
c. Radiometers, radial movement, frequencies, absolute frequency.
d. Accelerometers, radial movement, frequencies and noise, relative amplitude.

ENG 77.
Typical vibration sensors include?

1. Inductive coils.
2. Phonic wheels.
3. Magnetometers.
4. Piezo crystals.

a. 1, 2, 4.
b. 1, 4.
c. 1, 3, 4.
d. 2, 4.

ENG 78.
A tacho-generator RPM measuring system employs?

a. A single phase AC generator, the frequency of which varies with engine RPM , and is fed to a single phase synchronous motor driving a drag cup in the indicator.
b. A phonic wheel producing an AC signal, the frequency of which is fed to a synchronous motor in the indicator.
c. A DC motor, the frequency of which varies with engine RPM and is fed to a DC motor in the indicator.
d. A three phase AC generator, the frequency of which varies with engine RPM, and is fed to a synchronous motor driving a drag cup in the indicator.

ENG 79.
A system which measures both torque and engine RPM employs?

a. A phonic wheel at each end of the output shaft, coupled to a device which measures frequency and phase difference between the twp outputs.
b. A phonic wheel and a tacho-generator. The phonic wheel detects torque and the tacho-generator detects RPM.
c. A phonic wheel at each end of the output shaft, coupled to a device which measures frequency and voltage differences between the two outputs.
d. A tacho-generator at each end of the output shaft, coupled to a device which measures frequency and phase difference between the two output signals.

ENG 80.
The drag cup in a tacho-indicator?

a. Overcomes the effects of internal friction within the indicator.
b. Converts rotary motion into limited angular displacement proportional to the variable being measured.
c. Converts limited angular motion into rotation.
d. Converts AC input into rotary motion.

ENG 81.
The squirrel cage motor in a tacho-indicator?

a. Is driven directly by the engine.
b. Is driven by the output from a DC tacho-generator driven by the engine.
c. Is driven by three phase AC current from a tacho-generator driven by the engine.
d. Drives the indicator needle directly.

ENG 82.
The speed of rotation of the motor in a tacho-indicator is?

a. Constant.
b. Proportional to tacho-generator output voltage.
c. Proportional to tacho-generator output current.
d. Proportional to tacho-generator output frequency.

ENG 83.
What is EPR in a turbofan engine?

a. The ratio of compressor inlet pressure to turbine outlet pressure.
b. The ratio to HP turbine outlet pressure to Hp compressor inlet pressure.
c. The ratio of the integrated mean of LP turbine outlet pressure plus fan outlet pressure to the fan inlet pressure.
d. The ratio of combustion chamber pressure to compressor inlet pressure.

ENG 84.
If the EPR gauge compressor inlet air tapping becomes blocked?

a. The gauge will over read during the take-off run.
b. The gauge will over read in all conditions of flight.
c. The gauge will read zero.
d. The gauge will under read.

ENG 85.
If the EPR gauge over reads during the take-off run?

a. There is a danger that the aircraft will fail to take-off safely.
b. Climb performance will be improved.
c. The engine will exceed its limiting pressures and temperatures.
d. The engines will not start.

ENG 86.
Torque in a turbo-prop engine is indicated in?

1. Newton meters.
2. %.
3. PSI.
4. EPR.
5. Lbf ft.

a. 1, 2, 3, 4.
b. 1, 2, 3, 5.
c. 2, 3, 4, 5.
d. 1, 3, 4, 5.

ENG 87.
Turbo-prop engine torque is commonly measured using?

1. Rotary hydraulic systems.
2. Axial hydraulic systems.
3. Strain gauges.
4. Phase shifting phonic wheel systems.

a. 1, 2, 3.
b. 2, 3, 4.
c. 1, 3, 4.
d. All of the above.

ENG 88.
The squirrel cage tachometer employs?

a. External DC power supply modified by the speed sensor.
b. External AC power supply modified by the speed sensor.
c. A three phase AC generator producing a signal frequency proportional to RPM.
d. A three phase AC generator producing a voltage proportional to RPM.

ENG 89.
An engine vibration monitoring system employs?

a. Amplitude filters and thermistors.
b. Amplitude filters and amplifiers.
c. Frequency filters and amplifiers.
d. Frequency filters and capacitors.

ENG 90.
Which of the following is least affected by variations in power supply voltage?

a. Variometers.
b. Galvanometers.
c. Ratiometers.
d. Rheostats.

TEMP 1.
Total Air Temperature is .... Than .... by an amount which is proportional to ....?

a.	Higher	Static air temperature	CAS.
b.	Higher	Static air temperature	TAS.
c.	Lower	Dynamic air temperature	CAS.
d.	Higher	Static air temperature	LSS.

TEMP 2.
Total air temperature is ....?

a. SAT plus kinetic heating effect.
b. SAT plus the heating effect caused by shock waves at high mach numbers.
c. SAT plus skin friction heating effect.
d. Dynamic heating effect.

TEMP 3.
What is the ram recovery factor for a Rosemount temperature probe?

a. 0.5.
b. 1.0.
c. 1.5.
d. 2.0.

TEMP 4.
The formula for TAT is?

a. TAT = SAT(1 + (0.2 x K x M^2).
b. TAT = SAT/(1+ 0.2 x K x M^2).
c. TAT = SAT/(1 – 0.2 M^2).
d. TAT = SAT(1-KM^2).

TEMP. 5.
The pointer that aligns with the red line in an EGT gauge?

a. Is movable to indicate when temperatures have exceeded the red line limit.
b. Is painted on the glass.
c. Is moved only prior to flight.
d. Is moved to set lower limits when required by ambient conditions.

TEMP 6.
What types of thermometer are used in modern aircraft?

1. Resistive.
2. Mercury.
3. Capacitive.
4. Inductive.
5. Thermocouples.

a. 1, 2, 4.
b. 1, 3, 4.
c. 2, 4, 5.
d. 1, 2, 5.

TEMP 7.
TAT is?

a. SAT plus ram rise due to skin friction.
b. SAT plus ram rise due to adiabatic compression.
c. SAT plus ram rise due to shock wave formation.
d. Sat plus gauge error.

TEMP 8.
The advantages of a thermocouple temperature gauging system are?

1. Self powered.
2. No moving parts in sensors.
3. Low voltages.
4. Not susceptible to resistance losses.
5. Suitable for high temperatures.

a. 1, 2, 3, 4.
b. 1, 2, 3, 5.
c. 2, 3, 4, 5.
d. All of the above.

TEMP 9.
A thermocouple circuit can be graduated to read temperature if?

a. The hot junction is kept at a constant temperature.
b. The cold junction is kept at a constant temperature.
c. The cold junction is kept at ambient temperature.
d. The cold junction is kept at the same temperature as the hot junction.

TEMP 10.

What is used to sense temperature in a jet engine turbine and how are they connected?

a. Thermisters in series.
b. Thermocouples in parallel.
c. Thermocouples in series.
d. Rosemount probes in parallel.

TEMP 11.

An aircraft is flying at Mach 1 at 36000 ft in the ISA. What TAT will a Rosemount probe indicate?

a. -13° C.
b. 13° C.
c. -56° C.
d. 56° C.

TEMP 12.

The formula for total ait temperature is?

a. TAT = SAT+ 0.2 M^2).
b. TAT = SAT/(1+ 0.2 M^2).
c. TAT = SAT(1 – 0.2 KrM^2).
d. TAT = SAT/(1-KrM^2).

TEMP 13.

A TAT probe measures using the relationship?

a. TAT = SAT + heating to compressibility.
b. TAT – SAT + Kinetic heating.
c. TAT - = SAT + friction heating.
d. TAT = SAT + convection cooling.

TEMP 14.

A thermocouple system employs?

a. Two dissimilar metals joined at one end and a wheatstone bridge at the other.
b. Two dissimilar metal joined at one end and a ratio meter at the other.
c. Two dissimilar metals joined at both ends and a moving coil instrument.
d. Tow dissimilar metals separated by a dielectric substance at one end and a capacitive gauge at the other.

TEMP 15.

The resistive temperature sensing system is based on the fact that?

a. Electrical resistance of metals is constant.
b. Electrical resistance of metals increases with increasing temperature.
c. Electrical resistance of metals decreases with increasing temperature.
d. Electrical resistance causes temperature to change.

TEMP 16.

The bi-metallic temperature sensing system is employed?

a. Only in low temperature systems.
b. To measure jet pipe temperature.
c. In thermostatic switches.
d. In thermistors.

TEMP 17.

Methods employed in sensing temperature in aircraft include?

1. Resistive.
2. Inductive.
3. Capacitive.
4. Expansive.
5. Seebeck effect.

a. 1, 2, 4.
b. 2, 3, 5.
c. 3, 4, 5.
d. 1, 4, 5.

TEMP 18.

At mach 2 a TAT probe will indicate +45° K in an ambient temperature of? (assume K = 0.85).

a. 2.68° K.
b. 26.78° K.
c. 67.8° K.
d. 16.78° K.

TEMP 19.

Temperature sensing based on varying … are … than those using varying ………?

a.	Current	more accurate	voltage.
b.	Current	less accurate	voltage.
c.	Voltage	as accurate	current.
d.	Voltage	less accurate	resistance.

TEMP 20.

A Rosemount probe employs an electrical heater to?

a. Maintain constant temperature.
b. Prevent corrosion of the sensing elements.
c. Prevent icing.
d. Maintain constant electrical resistance.

FUEL 1.

The disadvantages of a float type fuel gauging system include inaccuracies due to?

1. Changes in aircraft attitude.
2. Acceleration.
3. Ambient pressure changes.
4. Ambient temperature changes.

a. 1, 2, 3.
b. 1, 2, 4.
c. 2, 3, 4.
d. 1, 3, 4.

FUEL 2.

A capacitive fuel gauging system measures?

a. Changes in capacitance of the fuel.
b. Changes in capacitance due to variations in the proportion of sensors immersed in fuel.
c. Changes in capacitance of fuel due to density changes.
d. Changes in dielectric constant of fuel.

FUEL 3.

What type of sensor if used to measure pressure output of a fuel booster pump?

a. Bourden tube.
b. Capacitor.
c. Aneroid capsule.
d. Bellows.

FUEL 4.

A capacitive fuel gauging system can calculate the mass of fuel by using the fact that?

a. Fuel dielectric constant is proportional to ρ and twice that of air.
b. Fuel dielectric constant is equal to $1/\rho$ and proportional to that of air.
c. Fuel dielectric constant is equal to ρ and proportional to that of air.
d. Fuel dielectric constant is proportional to $1/\rho$ and equal to that of air.

FUEL 5.

The fundamental principle of a capacitive fuel gauging system is?

a. Changes in capacitive reactance.
b. Changes in reactive capacitance.
c. Constant reactive capacitance.
d. Variations in dielectric constant of fuel.

FUEL 6.

A volumetric fuel flow meter differs from mass flow meter in that only the latter compensates for?

a. Changes in density.
b. Changes in fuel dielectric constant.
c. Changes in mass of fuel.
d. Changes in fuel pressure.

FUEL 7.

An aircraft with a compensated capacitive fuel gauging system is refuelled to a fuel load of 45000 Kg. If the temperature of the fuel then falls from 15° C to –40° C in flight, how will the indications vary? (ignore fuel usage in flight)

a. No change.
b. Increase.
c. Decrease.
d. Depends upon density and type of fuel.

FUEL 8.

A fuel flow meter measures?

a. The mass flow of fuel.
b. The volumetric flow of fuel.
c. The density of fuel.
d. The mass flow or volumetric flow of fuel depending on type of system.

FUEL 9.

The disadvantages of a float type fuel gauging system include?

1. Errors due to acceleration.
2. Errors due to changes in aircraft attitude.
3. It requires an AC power supply.
4. It requires a DC power supply.
5. Errors due to thermal expansion and contraction of fuel.
6. Errors due to refuelling with different fuel grades.

a. 1, 2, 3, 5, 6.
b. 1, 2, 5, 6.
c. 1, 2, 3, 4.
d. 1 ,2, 4, 5.

FUEL 10.
A mass flow meter is better than a volumetric flow meter because it is able to?

a. Compensate for density changes.
b. Compensate for pressure changes.
c. Compensate for changes in fuel calorific value.
d. Compensate for changes in fuel viscosity.

FUEL 11.
Fuel mass flow rate is more important than volumetric flow rate because?

a. Fuel costs are calculated by mass.
b. Calorific value is proportional to mass.
c. Calorific value is proportional to volume.
d. Fuel air ratio is based on mass.

FUEL 12.
Modern turbojet or turboprop aircraft are likely to employ?

a. Volumetric fuel flow gauges.
b. Mass fuel flow meters.
c. Spectrometric fuel flow meters.
d. Capacitive fuel flow meters.

FUEL 13.
Modern turbojet and turboprop aircraft are likely to employ?

a. Capacitive mass fuel flow meters.
b. Venturi type fuel flow meters.
c. Variable orifice fuel flow meters.
d. Turbine impeller type fuel flow meters.

FUEL 14.
If the tanks of an aircraft employing a capacitive fuel gauging system contain only water, the gauge will?

a. A mass equal to the same mass of water.
b. Read the exact mass of water contained in the tank.
c. A mass equal to zero.
d. A mass of water different from zero but inaccurate.

FUEL 15.
The advantages of a float type fuel gauging system include?

1. Automatically compensates for density changes.
2. It is simple and cheap.
3. Compensates for thermal expansion and contraction.
4. Compensates for attitude changes.

a. 1, 2, 3, 4.
b. 2.
c. 2, 3, 4.
d. 2, 4.

FUEL 16.
A float type fuel gauging system?

a. Is sensitive to variations in system voltage if it employs a galvanometer.
b. Is sensitive to variations in system voltage if it employs a ratiometer.
c. Depends upon changes in system voltage.
d. Is independent of variations in system voltage.

FUEL 17.
A paddle-wheel placed in the fuel circuit of a gas turbine engine initially measures?

a. Mass flow by tally of the impulses.
b. Volumetric flow by tally of the impulses.
c. Volumetric flow by measure of a voltage proportional to the rotational speed.
d. Mass flow by measure of a voltage proportional to the rotational speed.

COMPASS 1.
A direct reading magnetic compass will be affected by?

a. Soft iron.
b. Hard iron.
c. Aluminium.
d. Soft iron effect hard iron, and hard iron.

COMPASS 2.
The purpose of the torque motor in a gyro stabilised magnetic compass is to?

a. Precess the directional gyro.
b. Adjust the selsyn stator.
c. Calibrate the pointer.
d. Convert flux valve electrical output into pointer movement.

COMPASS 3.
When landing on a northerly heading a direct reading magnetic compass will indicate?

a. A westerly turn.
b. An easterly turn.
c. No turn.
d. Rapidly increasing oscillations.

COMPASS 4.
Magnetic heading can be calculated from true heading using?

a. A compass and a map indicating isogonal lines.
b. A compass and a calibration card.
c. A calculator and a deviation card.
d. A compass and a deviation card.

COMPASS 5.
A direct reading compass will not be affected by?

a. Ferrous metals.
b. Transformers.
c. Magnetic fields.
d. Non-ferrous metals.

COMPASS 6.
The purpose of a compass swing is to?

a. Align the lubber lines with true north.
b. Confirm the accuracy of the schuler tuning.
c. Align compass north with magnetic north.
d. Align compass north with true north.

COMPASS 7.
When landing in a southerly direction a direct reading magnetic compass will indicate?

a. Easterly turn.
b. Westerly turn.
c. No turn.
d. Rapidly increasing oscillations.

COMPASS 8.
Permanent magnetism in aircraft is caused by?

a. The hammering of rivets during construction.
b. Large changes in latitude.
c. Large changes in longitude.
d. Strong electrical fields and lightening strikes.

COMPASS 9.
A magnetic compass must be swung?

a. After long term changes in latitude.
b. After long term changes in longitude.
c. Short term changes in longitude.
d. Change of base airfield.

COMPASS 10.
The greatest cause of errors in a direct reading magnetic compass is?

a. Turning.
b. Latitude changes.
c. Parallax.
d. Changes in magnetic deviation.

COMPASS 11.
The sensitivity of a magnetic compass can be affected by?

a. The H component of the earth's magnetic field.
b. The Z component of the earth's magnetic field.
c. Both of the above.
d. None of the above.

COMPASS 12.
When cruising on a westerly heading a direct reading magnetic compass will indicate?

a. Northerly turn.
b. Southerly turn.
c. No turn.
d. Rapidly increasing oscillations.

COMPASS 13.
When taking-off on a calm day on heading of 45^0 in the northern hemisphere, the compass will indicate .... If the field is on an agonic line?

a. 45^0.
b. More than 45^0.
c. Less than 45^0.
d. 45^0 only if the wings are level.

COMPASS 14.
The flux gate of a gyro magnetic compass transmits data to?

a. The error detector.
b. The amplifier.
c. The erecting system.
d. The annunciator.

COMPASS 15.
Magnetic heading can be found from true heading using?

a. A compass and a map showing isoclinal lines.
b. A compass and a map showing isogonal lines.
c. A compass and compass calibration chart.
d. A compass and deviation card.

COMPASS 16.
In a remote indicating magnetic compass the flux valve?

a. Uses a DC power supply.
b. Uses an AC power supply.
c. Requires no power supply because it uses its own self-exciter unit..
d. Is manufactured from perm-alloy steel.

COMPASS 17.
The output of the flux valve is fed to the?

a. Feed back loop.
b. Compass card.
c. Amplifier.
d. Error detector.

COMPASS 18. a.
What is the strength of the H component of the earths magnetic field (in micro teslas) at the North pole?

a. 0.
b. 10.
c. 16.
d. 23.

COMPASS 19.
A direct reading magnetic compass will be affected by?

1. Adjacent electrical equipment.
2. Ferrous metals.
3. Non-ferrous metals.

a. 1, 2.
b. 1, 3.
c. 1, 4.
d. 3, 4.

COMPASS 20.
Upon landing on a northerly heading a DRMC will indicate?

a. A turn to the east.
b. A turn to the west.
c. No turn.
d. Oscillations about north.

COMPASS 21.
The principal cause of errors in a direct reading magnetic compass is?

a. Latitude.
b. Magnetic deviation.
c. Parallax.
d. Turning.

COMPASS 22.
The function of the torque motor in a gyro stabilised magnetic compass is to?

a. Move the selsyn stators.
b. Move the heading pointer.
c. Precess the directional gyro.
d. Receive the input from the flux valve.

COMPASS 23.
Errors in direct reading magnetic compasses can be caused by?

a. Turns through 90 degrees East and 270 degrees west.
b. Acceleration son east/west headings.
c. Crosswinds when on east/west headings.
d. Parallax.

COMPASS 24.
In an aircraft taking-off on a westerly heading in the northern hemisphere, what will its DRMC indicate?

a. Southerly turn.
b. Northerly turn.
c. Oscillations about west.
d. No turn.

COMPASS 25.
To what does the flux valve of a gyro magnetic compass transmit information?

a. Errecting system
b. Error detector.
c. Amplifier.
d. Heading indicator card.

COMPASS 26.
The purpose of a compass swing is to?

a. Align compass north with true north.
b. Align compass north with magnetic north.
c. Align true north with the lubber line.
d. Draw up a compass correction card.

COMPASS 27.
From what does the flux valve in a RIMC get its power supply?

a. DC busbar.
b. AC busbar.
c. Internal self-exciter system.
d. It does not require one because it is made of perm-alloy material.

COMPASS 28.
A runway in the northern hemisphere is on an agonic line and heading 045 degrees. If an aircraft with zero compass deviation takes off in still air, what will the northerly turning errors be?

a. The compass will remain on 045.
b. The compass will move to less than 045.
c. The compass will move to more than 045.
d. If the wings remain level the compass will remain on 045.

COMPASS 29.
In order to convert true heading into magnetic heading a compass card and ...... are required?

a. Deviation card.
b. Error card.
c. Map with isogonal lines.
d. Map with isoclinal lines.

COMPASS 30.
What will the DRMC indicate when an aircraft lands in a southerly direction in the southern hemisphere?

a. Westerly turn.
b. Easterly turn.
c. No turn.
d. Oscillations about north.

COMPASS 31.
To improve the horizontality of a compass, the magnet assembly is suspended from a point?

a. On the centre line of the magnet.
b. Below the centre of gravity.
c. Above the centre of gravity.
d. Varying with magnetic latitude.

COMPASS 32.
A DRMC can be affected by?

a. Hard iron.
b. Mild iron.
c. Soft iron.
d. Northerly accelerations.

COMPASS 33.
The maximum gyro drift rate due to earth rate is?

a. 5 degrees per hour.
b. 15 degrees per hour.
c. 90 degrees per hour.
d. 180 degrees per hour.

COMPASS 34.
At what DRMC heading is roll out required when conducting a turn from south-west to south-east at 45 degrees north?

a. 115 degrees.
b. 135 degrees.
c. 140 degrees.
d. 145 degrees.

COMPASS 35.
At what point on the earth would earth rate wander and transport wander be zero?

a. North pole.
b. Equator.
c. South pole.
d. 45 degrees north and south.

COMPASS 36.
From what does a gyro magnetic compass torque motor obtain its information?

a. Error detector.
b. Flux valve.
c. Amplifier
d. Rotor gimbal tilt unit.

COMPASS 37.
What is the maximum drift error that can be sensed by an uncompensated DGI?

a. 5 degrees per hour.
b. 10 degrees per hour.
c. 15 degrees per hour.
d. 20 degrees per hour.

COMPASS 38.
Magnetic dip angle at the south pole is?

a. Zero.
b. 45 degrees.
c. 60 degrees.
d. 90 degrees.

COMPASS 39.
Earth rotation at 45 degrees north will cause the spin axis of a directional gyro to move?

a. 7.6 degrees clockwise.
b. 6.7 degrees anti-clockwise.
c. 10.6 degrees clockwise.
d. 10.6 degrees anti-clockwise.

COMPASS 40.
The DRMC in an aircraft accelerating for take-off on a runway with QDM 45 degrees, in the northern hemisphere, will indicate?

a. 45 degrees.
b. More than 45 degrees.
c. Less than 45 degrees.
d. 45 degrees as long as the wings are level.

COMPASS 41.
When turning right through 90 degrees to north, in the northern hemisphere, roll out should be conducted on a heading of?

a. 10 degrees.
b. 20 degrees.
c. 330 degrees.
d. 350 degrees.

COMPASS 42.
A magnetic compass must be swung after?

a. A short term change in latitude.
b. Long term change in latitude.
c. Short term change in longitude.
d. Long term change in longitude.

COMPASS 43.
To what is the output of the flux valve in a remote indicating compass initially fed?

a. Amplifier.
b. Gyro precessing torque motor.
c. Error detector.
d. Indicator.

COMPASS 44.
When turning from SE to SW at 50 degrees north, the roll out should occur at?

a. 180 degrees.
b. 210 degrees.
c. 225 degrees.
d. 245 degrees.

COMPASS 45.
When turning from SW to SE at 45 degrees north, the roll out should occur at?

a. 115 degrees.
b. 135 degrees.
c. 140 degrees.
d. 150 degrees.

COMPASS 46.
What will the compass indicate as an aircraft lands and decelerates on a westerly heading on the magnetic equator?

a. Turn to south.
b. Turn to west.
c. Oscillations.
d. No turn.

COMPASS 47.
If the ADF pointer indicates 270 degrees when the RMI rose is stuck at 075 degrees, what is the relative bearing of the beacon?

a. 290 degrees.
b. 110 degrees.
c. 195 degrees.
d. It cannot be determined from this information.

COMPASS 48.
What are the errors in a DGI?

1. Transport wander.
2. Earth rate.
3. Heading errors when banking and pitching.
4. Mechanical imperfections.

a. 1, 2, 3.
b. 1, 2, 4.
c. 2, 3, 4.
d. All of the above.

COMPASS 49.
What is the function of the latitude nut on a DI?

a. To correct coriolis effect.
b. To compensate for earth rate error.
c. To compensate for latitude error.
d. To compensate for transport error.

COMPASS 50.
What error is introduced into a DGI due to movement of the gyro relative to the earth?

a. Transport wander.
b. Earth rate error.
c. Altitude error.
d. Latitude error.

COMPASS 51.
One of the factors causing error in a DRMC is?

a. Turning though east/west headings.
b. Crosswinds on west/east headings.
c. Parallax due to compass card oscillations.
d. Accelerations on east/west headings.

COMPASS 52.
The flux valve in a RIMC requires?

a. DC power supply.
b. AC power supply.
c. No external power supply.
d. AC and DC power supply.

COMPASS 53.
In the northern hemisphere, the direct reading compass card of an aircraft decelerating on an easterly heading will turn .... and will .... ?

a. Clockwise over read.
b. Clockwise under read.
c. Anti-clockwise over read.
d. Anti-clockwise under read.

COMPASS 54.
If an aircraft in the northern hemisphere accelerates on a westerly heading, the compass needle moves .... indicating a turn to the ....?

a. Clockwise north.
b. Clockwise south.
c. Anti-clockwise north.
d. Anti-clockwise south.

COMPASS 55.
A perfectly frictionless DI is corrected to give zero drift at 30 degrees north, and its DI is set to indicate 100 degrees. If it remains stationary on the ground for 1 hour what will the indication be?

a. 100 degrees.
b. 92.5 degrees.
c. 107.5 degrees.
d. 75 degrees.

COMPASS 56.
If the ADF pointer indicates 240 degrees when the RMI rose is stuck at 090 degrees, what is the relative bearing of the beacon?

a. Zero degrees.
b. 150 degrees.
c. 180 degrees.
d. It cannot be determined from this information.

COMPASS 57.
When an aircraft lands on a southerly heading in the southern hemisphere, the DRMC will indicate?

a. 180 degree turn to the west.
b. 180 degree turn to the east.
c. No apparent turn.
d. Oscillations.

COMPASS 58.
How can deviation be determined using a magnetic compass?

a. By referring to the compass card.
b. By reference to a map of isoclinal lines.
c. By reference to a map of isogonal lines.
d. By reference to a compass deviation card.

COMPASS 59.
What will a DRMC indicate when taking-off on a runway with QDM 045 in the southern hemisphere?

a. Turn north.
b. Turn south
c. No turn.
d. Oscillations.

COMPASS 60.
The roll out must be performed at .... when turning from SW to SE in the northern hemisphere?

a. 135 degrees.
b. 115 degrees.
c. 145 degrees.
d. 160 degrees.

COMPASS 61.
The roll out must be performed at .... when turning from NW to NE in the southern hemisphere?

a. 025 degrees.
b. 045 degrees.
c. 055 degrees.
d. 035 degrees.

COMPASS 62.
The roll out must be performed at .... when turning from NW to SE in the northern hemisphere?

a. 145 degrees.
b. 125 degrees.
c. 155 degrees.
d. 135 degrees.

COMPASS 63.
The roll out must be performed at …….. when turning from NW to SE in the southern hemisphere?

a. 115 degrees.
b. 125 degrees.
c. 135 degrees.
d. 145 degrees.

COMPASS 64.
If the ADF pointer indicates 200 degrees when the RMI rose is stuck at 090 degrees, what is the relative bearing of the beacon?

a. 290 degrees.
b. 110 degrees.
c. 180 degrees.
d. It cannot be determined from this information.

COMPASS 65.
If the ADF pointer indicates 270 degrees when the RMI rose is stuck at 090 degrees, what is the relative bearing of the beacon?

a. 290 degrees.
b. 110 degrees.
c. 180 degrees.
d. It cannot be determined from this information.

COMPASS 66.
If the ADF pointer indicates 120 degrees when the RMI rose is stuck at 080 degrees, what is the relative bearing of the beacon?

a. 200 degrees.
b. 80 degrees.
c. 40 degrees.
d. It cannot be determined from this information.

COMPASS 67.
What will the compass indicate as an aircraft lands and decelerates on a westerly heading in the northern hemisphere?

a. Turn to south.
b. Turn to west.
c. Oscillations.
d. No turn.

WARN/REC 1.
The FDR in a JAR certificated aircraft must be located in ?

a. The front.
b. The back
c. The undercarriage bay.
d. The outer wings.

WARN/REC 2.
In an aircraft certificated under JAR since 1 April 1998 the CVR must record for?

a. 30 minutes.
b. 2 hours.
c. 8 hours.
d. 72 hours.

WARN/REC 3.
A basic stall warning system monitors?

a. A of A.
b. CAS.
c. Mach number.
d. Slat and flap position.

WARN/REC 4.
In an aircraft of more than 5700 Kg mass certificated under JAR after April 1998, the FDR must record for?

a. 30 minutes.
b. 60 minutes.
c. 10 hours.
d. 25 hours.

WARN/REC 5.
Between what heights is GPWS active?

a. Zero and 500 ft.
b. Zero and 2500 ft.
c. 50 ft and 500 ft.
d. 50 ft and 2450 ft.

WARN/REC 6.
A CVR records?

a. Radio conversations.
b. Cabin crew conversations.
c. Crew conversations on intercom.
d. Public address announcements and cockpit discussions.

WARN/REC 7.
GPWS must provide?

a. Visual warnings.
b. Aural and visual warnings.
c. Aural warnings which may be supplemented by visual warnings.
d. Visual and aural warnings, which may be supplemented by tactile warnings.

WARN/REC 8.
A stall warning system in a large JAR certificated aircraft must include?

a. Stick shaker and stick pusher.
b. Monitoring of speed brake position and angle of attack, a warning module, and visual or aural warning system.
c. Monitoring of landing gear squat switch and A of A, a warning module and an aural warning.
d. Monitoring of A of A and TAS, plus aural and visual warnings.

WARN/REC 9.
An altitude warning system?

a. Automatically disengages autotrim at 500 ft.
b. Automatically engages autotrim at 500 ft.
c. Provides visual alerts when approaching a selected altitude.
d. Activates a warning light and bell when approaching a selected altitude.

WARN/REC 10.
A combined FDR and CVR records?

1. Cockpit voice discussions.
2. Cabin voice discussions.
3. Radio discussions.
4. All Public address messages from the cockpit.

a. 1, 2, 3.
b. 1, 2, 4.
c. 2, 3, 4.
d. 1, 3, 4.

WARN/REC 11.
An altitude alert system?

a. Alerts the pilot if the aircraft deviates from selected altitude.
b. Alerts the pilot when decision height is reached.
c. Alerts the pilot when the selected height is reached.
d. Alerts the pilot when the actual altitude is equal to the reference altitude.

WARN/REC 12.
The FDR starts recording when?

a. Before the aircraft starts to move under its own power.
b. When the brakes are released.
c. When the landing gear squat switch detects lift-off.
d. When the undercarriage retract button is pressed.

WARN/REC 13.
For certification of a heavy aircraft after 1 April 1998 the FDR and CVR must record for……. and …… respectively.

a. 10 hours 1 hour.
b. 10 hours 2 hours.
c. 25 hours 1 hour.
d. 25 hours 2 hours.

WARN/REC 14.
GPWS modes include?

1. Stall.
2. Incorrect flap position.
3. High altitude descents.
4. High ROC.
5. Excessive glideslope deviations.
6. Loss of altitude after take-off and go-around.
7. Excessive sink rate.

a. 1, 2, 3, 4, 5.
b. 1, 3, 4, 5, 6, 7.
c. 2, 5, 6, 7.
d. 4, 5, 6, 7.

WARN/REC 15.
GPWS can indicate?

1. Excessive bank angle.
2. Excessive terrain closure rate.
3. Excessive sink rate after lift-off.
4. Excessive glideslope deviations.
5. Too close to ground when not in landing configuration.
6. Excessive rate of descent.
7. Altitude call-outs.

a. All of the above.
b. 1, 2, 3, 5, 6, 7.
c. 2, 3, 4, 5, 6, 7.
d. 1, 4, 5, 6, 7.

WARN/REC 16.
JAR OPS require a CVR to start and stop recording?

a. From when the aircraft is first able to move under its own power to the time of engine shut down.
b. From when the aircraft is first able to move under its own power to the time at which it is next unable to do so.
c. From engine start up to engine shut down.
d. From when the APU or first engine is started to when the APU or last engine is shut down.

WARN/REC 17.
The GPWS mode 3 audible alert is?

a. Repeated "Don't sink, Don't sink".
b. Repeated "Whoop, Whoop, Don't sink, Don't sink".
c. Repeated "Pull up, Pull up".
d. Repeated "Sink rate, Sink rate, Whoop, Whoop".

WARN/REC 18.
A CVR system includes?

1. Microphones.
2. FDR.
3. Independent battery power supply.
4. Crash and fire resistant construction.

a. 1, 4.
b. 1, 3.
c. 2, 3.
d. 3, 4.

WARN/REC 19.
A JAR certificated altitude alerting system must be capable of warning of at least?

1. Deviation from selected altitude.
2. Approaching selected altitude.
3. Excessive vertical speed.
4. excessive terrain closure rate.
5. Abnormal flap and landing gear configuration for current height.

a. 1, 4.
b. 2, 3.
c. 1, 2, 3, 4, 5.
d. 2, 3, 5.

WARN/REC 20.
JAR OPS requires a 50 seat turbo-prop aircraft CVR to record.

a. From battery master switch on to off.
b. From BRP to touch-down.
c. Whenever the aircraft is able to move under its own power.
d. Before starting to taxi to when the parking brake is applied.

WARN/REC 21.
A FDR must be fitted?

a. At the front of an aircraft.
b. At the back of an aircraft.
c. In the cockpit.
d. Close to the engines.

WARN/REC 22.
The altitude alerting system?

a. Alerts pilot upon reaching selected altitude.
b. Alerts pilot when approaching selected altitude.
c. Alerts pilot at decision height.
d. Alerts pilot of all changes in altitude.

WARN/REC 23.
GPWS operates between?

a. Zero and 500 ft.
b. Zero and 5000 ft.
c. Zero and 1500 ft.
d. 50 ft and 2450 ft.

WARN/REC 24.
A JAR certificated CVR must record?

1. All voce communications within the aircraft.
2. All crew voice communications within the aircraft.
3. All PA announcements.
4. All discussions between crew and ATC.
5. All signals from navigation aids.

a. 5.
b. 1, 3.
c. 3,5.
d. 4.

WARN/REC 25.
If sink rate is excessive the GPWS indication will be?

a. Too low, Too low, Whoop, Whoop, Pull up.
b. Too low gear, Too low gear, Whoop, Whoop, Pull up, Pull up.
c. Don't sink, Whoop, Whoop, Pull up.
d. Sink rate, Whoop, Whoop, Pull up.

WARN/REC 26.
What level of voice recording is required in multi-turbine engined aircraft with 9 or more passenegre seats, certificated after January 1990?

1. Flight deck crew calls on intercom.
2. Flight deck crew calls on public address.
3. Internal cockpit communications.
4. External cockpit communications.
5. Cockpit environmental noises.

a. 1, 2, 3.
b. 2, 3, 4.
c. 3, 4, 5.
d. All of the above.

WARN/REC 27.
GPWS modes include?

1. Stall.
2. High alpha.
3. Excessive ROD.
4. Excessive terrain closure rate.
5. Incorrect flap position.

a. 1, 2, 3.
b. 2, 3, 4.
c. 3, 4, 5.
d. All of the above.

WARN/REC 28.
GPWS modes include?

1. Incorrect gear position.
2. Altitude loss after lift-off or during Go-around.
3. High altitude descent.
4. Excessive glide slope deviation.
5. Excessive AOB.

a. 1, 2, 4.
b. 2, 3, 4.
c. 3, 4, 5.
d. All of the above.

WARN/REC 29.
GPWS will give an altitude alert warning when?

a. AOB is excessive at low altitude.
b. The angle of attack approaches the stalling angle.
c. The aircraft loses glideslope signal.
d. Decision height is reached in a cat 2 or 3 ILS approach.

WARN/REC 30.
From what does the GPWS obtain its height information?

a. Barometric altimeter.
b. RADALT.
c. INS.
d. IRS.

WARN/REC 31.
In the altitude alerting system what lights indicate a deviation of more than 300 ft from selected altitude?

a. Steady amber.
b. Flashing amber.
c. Steady red.
d. Flashing red.

WARN/REC 32.
Over what range is GPWS operative?

a. 50 to 2450 ft agl.
b. 50 to 2450 m.
c. 50 to 2450 ft pressure altitude.
d. Zero to 2500 radio altitude.

WARN/REC 33.
The inputs to a modern jet aircraft stall warning system include?

1. Alpha.
2. Configuration.
3. Engine RPM.
4. Pitch attitude.
5. AOB.

a. 1, 2.
b. 2, 3, 4.
c. 3, 4, 5.
d. All of the above.

WARN/REC 34.
The components of a modern jet aircraft stall warning system include?

1. Angle of attack sensors.
2. Bank rate sensors.
3. Control surface position sensors.
4. Stick shaker.
5. Gear and flap sensors.

a. 1, 2, 3.
b. 2, 3, 4.
c. 1, 4, 5.
d. All of the above.

WARN/REC 35.
GPWS may give warnings of?

1. Deviations from selected altitude.
2. Excessive deviations from glideslope.
3. Excessive sink rate after lift-off.
4. Excessive ROD.

a. 1, 2.
b. 2, 3, 4.
c. 3, 4.
d. All of the above.

WARN/REC 36.
GPWS may give warnings of?

1. Excessive sink rate.
2. Excessive closure with terrain.
3. Excessive proximity with ground when not in landing configuration.
4. Excessive AOB.

a. 1, 2, 3.
b. 2, 3, 4.
c. 1, 3, 4.
d. All of the above.

WARN/REC 37.
GPWS operates between?

a. Zero and 3450 ft.
b. Zero and 2500 ft.
c. 50 ft and 2450 ft.
d. 50 ft and 2500 ft.

WARN/REC 38.
The CVR in a 50 seat turbo-prop aircraft must record?

a. From switching on to switching off electrical power.
b. From commencing pre take-off taxi to turning of the runway after landing.
c. From lift-off to touch-down.
d. From first being able to move under its own power to next becoming unable to do so.

WARN/REC 39.
The GPWS mode 3 audible alert is?

a. "Sink rate, sink rate".
b. Continuous "don't sink, don't sink".
c. "Don't sink, don't sink, whoop, whoop, pull up".
d. Initially "don't sink, don't sink", which is followed by "Whoop, whoop, pull up", if the maximum allowable sink rate is exceeded.

WARN/REC 40.
An altitude alerting system is required to alert the crew of at least the following?

1. Abnormal flap and gear configurations.
2. Excessive closure with terrain.
3. Excessive vertical speed.
4. Excessive deviation from selected altitude.
5. Approaching selected altitude.

a. 1,2.
b. 3,4.
c. 3, 4.
d. 4, 5.

WARN/REC 41.
The flight deck FDR and CVR must be capable of recording for at least?

a.	15 hrs,	60 mins.
b.	24 hrs,	60 mins.
c.	25 hrs,	30 mins.
d.	48 hrs,	45 mins.

WARN/REC 42.
Which of the following are GPWS modes?

1. Approaching stall.
2. Excessive glideslope deviation.
3. Excessive ROC.
4. Excessive ROD.
5. Incorrect flap position.
6. Sinking after lift-off and during go-around.
7. High altitude descent.

a. 1, 2, 3, 5.
b. 2, 4, 5, 6.
c. 4, 5, 6, 7.
d. 3, 4, 6, 7.

WARN/REC 43.
The FDR must start running when?

a. Before the aircraft starts moving under its own power.
b. When lined up for take-off.
c. At brake release for take-off.
d. When the gear up button is pushed.

WARN/REC 44.
What type of warning must be provided by a basic GPWS?

a. Light.
b. Aural.
c. Aural and light.
d. Tactile, aural and light.

WARN/REC 45.
A basic stall warning system in a light aircraft senses?

a. M_{NO}.
b. IAS.
c. Slat and flap positions.
d. Alpha.

WARN/REC 46.
The FDR in an aircraft of mass exceeding 5700 Kgs, certificated after April 1998 must be capable of recording for at least?

a. 30 minutes.
b. 60 minutes.
c. 24 hours.
d. 25 hours.

WARN/REC 47.
JAR OPS requires that the FDR must be located at?

a. The front of an aircraft.
b. The back of an aircraft.
c. The top of an aircraft.
d. The bottom of an aircraft.

WARN/REC 48.
The function of the altitude alert system is to?

a. Upon sensing an unacceptable situation, it is to engage autopilot and fly the aircraft into a safe condition.
b. Engage auto-trim when the aircraft reaches its selected altitude.
c. Disengage auto-trim when reaching selected altitude.
d. Illuminate a warning light as the aircraft approaches the selected altitude.

WARN/REC 49.
A cockpit voice recorder must be capable of recording?

1. Flight deck and cabin crew intercom discussions.
2. Radio discussions.
3. Public address system announcements.
4. Flight deck noise environment.
5. Navigation aid indents.

a. 1, 2, 3, 4.
b. 2, 3, 4, 5.
c. 1, 2, 4, 5.
d. 1, 3, 4, 5.

WARN/REC 50.
A flight data recorder is required in……. aircraft weighing more than 5700 Kg?

1. Turbojets.
2. Turboprops.
3. Pistonprops.

a. 1, 2.
b. 2, 3.
c. 3, 4.
d. All of the above.

TCAS 1.
The TCAS (Traffic Collision Avoidance System) is a proximity alarm system which detects a "traffic" when the conflicting traffic is equipped with a?

a. Serviceable SSR transponder.
b. Serviceable weather radar.
c. SELCAL system.
d. DME system.

TCAS 2.
Concerning the TCAS (Traffic Collision Avoidance System)?

a. Resolution Advisory (RA) must not be followed without obtaining clearance from ATC.
b. No protection is available against aircraft not equipped with a serviceable SSR transponder.
c. In one of the system modes, the warning, "TOO LOW TERRAIN" is generated.
d. In one of the system modes, the warning, "PULL UP" is generated.

TCAS 3.
The TCAS (Traffic Collision Avoidance System) gives avoidance resolutions?

a. In horizontal and vertical planes.
b. Based on speed control only.
c. In the vertical plane only.
d. In the horizontal plane.

TCAS 4.
In the event of a conflict, the TCAS (Traffic Collision Avoidance System) will give information such as?

a. Turn left/turn right.
b. Too low terrain.
c. Glide slope.
d. Climb/descent.

TCAS 5.
The principle of the TCAS (Traffic Collision Avoidance Systems) is based on the use of?

a. F.M.S. (Flight Management System).
b. Air traffic control radar systems.
c. Transponders fitted in the aircraft.
d. Airborne weather radar system.

TCAS 6.
The use of the TCAS (Traffic Collision Avoidance System) for avoiding an aircraft in flight is now general. TCAS uses for its operation?

a. Both the replies from the transponders of other aircraft and the ground-based radar echoes.
b. The replies from the transponders of other aircraft.
c. The echoes from the ground air traffic control radar system.
d. Echoes of collision avoidance radar system especially installed on board.

TCAS 7.
A "TCAS II" (Traffic Collision Avoidance System) provides?

a. The intruder relative position and possibly an indication of a collision avoidance manoeuvre within both the vertical and horizontal planes.
b. The intruder relative position and possibly an indication of a collision avoidance manoeuvre within the horizontal plane only.
c. The intruder relative position and possibly an indication of a collision avoidance manoeuvre within the vertical plane only.
d. A simple intruding airplane proximity warning.

TCAS 8.
The TCAS II data display devices can be in the form of:

1. A specific dedicated screen.
2. A screen combined with the weather radar.
3. A variometer represented on a liquid crystal screen which allows the display of Traffic Advisory (TA) and Resolution Advisory (RA).
4. An EFIS (Electronic Flight Instrument System) screen.

The combination regrouping all the correct statements is?

a. 1, 2 and 3.
b. 3 and 4.
c. 1 and 3.
d. 1, 2, 3 and 4.

TCAS 9.
A "close traffic advisory" is displayed on the display device of the TCAS 2 (Traffic Collision Avoidance System) by?

a. A blue or white full lozenge.
b. A red full square.
c. A blue or white empty lozenge.
d. An orange full circle.

TCAS 10.
A "resolution advisory" (RA) is represented on the display system of the TCAS 2 (Traffic Collision Avoidance System) by a?

a. Blue or white empty lozenge.
b. Red full circle.
c. Red full square.
d. Blue or white full lozenge.

TCAS 11.
An "intruding traffic advisory" is represented on the display system of the TCAS 2 (Traffic Collision Avoidance System) by displaying?

a. A red full square.
b. A yellow full circle.
c. A blue or white empty lozenge.
d. A blue or white full lozenge.

TCAS 12.
On a TCAS2 (Traffic Collision Avoidance System), a corrective "resolution advisory" (RA) is a "resolution advisory"?

a. Asking the pilot to modify effectively the vertical speed of his aircraft.
b. Which does not require any action from the pilot but on the contrary asks him not to modify his current vertical speed rate.
c. Asking the pilot to modify the heading of his aircraft.
d. Asking the pilot to modify the speed of his aircraft.

TCAS 13.
When the intruding aircraft is equipped with a serviceable mode C transponder, the TCAS II (Traffic Collision Avoidance System) generates a?

a. "Traffic advisory", vertical and horizontal "resolution advisory".
b. "Traffic advisory" and vertical "resolution advisory".
c. "Traffic advisory" and horizontal "resolution advisory".
d. "Traffic advisory" only.

TCAS 14.
When the intruding aircraft is equipped with a transponder without altitude reporting capability, the TCAS (Traffic Collision Avoidance System) issues a?

a. "Traffic advisory" and horizontal "resolution advisory".
b. "Traffic advisory", vertical and horizontal "resolution advisory".
c. "Traffic advisory" only.
d. "Traffic advisory" and vertical "resolution advisory".

TCAS 15.
The TCAS (Traffic Collision Avoidance System) computer receives information:

1. About the pressure altitude through the mode S transponder.
2. From the radio altimeter.
3. Specific to the airplane configuration.
4. From the inertial units.

The combination regrouping all the correct statements is?

a. 1, 2, 4.
b. 1, 2.
c. 1, 2, 3.
d. 1, 2, 3, 4.

TCAS 16.
The TCAS 2 (Traffic Collision Avoidance System) provides:

1. Traffic information (TA: Traffic Advisory).
2. Horizontal resolution (RA: Resolution Advisory).
3. Vertical resolution (RA: Resolution Advisory).
4. Ground proximity warning.

The combination regrouping all the correct statements is?

a. 1, 2, 3.
b. 1, 2, 3, 4.
c. 1, 3.
d. 1, 2.

TCAS 17.
The TCAS 1 (Traffic Collision Avoidance System) provides:

1. Traffic information.
2. Horizontal resolution (RA: Resolution Advisory).
3. Vertical resolution (RA: Resolution Advisory).
4. Ground proximity warning.

The combination regrouping all the correct statements is?

a. 1, 2, 3.
b. 1, 2, 3, 4.
c. 1.
d. 1, 2.

TCAS 18.
On a TCAS 2 (Traffic Collision Avoidance System) the preventive "resolution advisory" (RA) is a "resolution advisory"?

a. That advises the pilot to avoid certain deviations from the current vertical rate but does not require any change to be made to that rate.
b. Asking the pilot to modify effectively the vertical speed of his aircraft.
c. Asking the pilot to modify the heading of his aircraft.
d. Asking the pilot to modify the speed of his aircraft.

TCAS 19.
What information will TCAS provide to indicate an intruder aircraft with no altitude reporting facility?

a. TA.
b. TO plus preventative RA.
c. Preventative RA.
d. Corrective RA.

TCAS 20.
Where is the TCAS information displayed?

1. On a dedicated TCAS display.
2. On the weather radar screen.
3. On EFIS.
4. On an LCD variometer.

a. 1, 2.
b. 1, 3.
c. 2, 4.
d. All of the above.

TCAS 21.
Inputs to TCAS 2 include?

a. Mode S transponders to coordinate avoidance manoeuvres.
b. Mode A transponders providing TA and RA data.
c. Mode C transponders coordinating avoidance manoeuvres.
d. Mode C and s transponders giving RA and TA data and coordinating avoidance manoeuvres.

TCAS 22.
The correct response to a TCAS RA is?

a. Immediately Turn 45° left and comply with the descent/climb commands.
b. Do nothings because ATC instruction override RA.
c. Comply with descent/climb commands immediately and smoothly.
d. Seek ATC approval before changing altitude, speed or track.

TCAS 23.
TCAS is based on?

a. Ground-based radar.
b. Primary radar.
c. Airborne transponders.
d. RT communications and direction finding.

TCAS 24.
TCAS 2 data is obtained from?

1. Radio altimeters.
2. INS/IRS.
3. Pressure altitude data from mode s transponders.
4. Additional equipment specific to each aircraft type.

a. 1, 2, 3.
b. 1, 2, 4.
c. 2, 3, 4.
d. All of the above.

TCAS 25.
Preventative RA's include?

a. Turn right.
b. Monitor vertical speed.
c. Climb now.
d. Traffic, traffic.

TCAS 26.
A preventative RA is represented by a .... On a TCAS PPI?

a. Red square.
b. Red circle.
c. Red lozenge.
d. Amber square.

TCAS 27.
When fitted with mode c transponders a TCAS 2 system may provide?

a. RA only.
b. TA only.
c. Horizontal plane TA and RA.
d. Vertical plane TA and RA.

TCAS 28.
What level of warning does TCAS provide to indicate aircraft not equipped with TCAS?

a. TA.
b. RA.
c. None.
d. TA and RA.

TCAS 29.
TCAS will give...... warning of an aircraft without transponders fitted?

a. No warning.
b. Bearing only.
c. Altitude only.
d. Range and bearing.

TCAS 30.
Non-conflicting traffic is indicated by?

a. Red.
b. Yellow.
c. Solid cyan.
d. Hollow cyan.

TCAS 31.
TCAS 2 gives RA in?

a. Vertical plane only.
b. Horizontal plane only.
c. Both vertical and horizontal planes.
d. None of the above.

TCAS 32.
TCAS RA is indicated by?

a. Amber circle.
b. Amber square.
c. Red square.
d. Red circle.

TCAS 33.
TCAS 2 display may be provided on?

a. Dedicated PPI.
b. Weather radar display.
c. EFIS display.
d. Any of the above depending on aircraft type.

TCAS 34.
TCAS 2 fitted with mode C transponders only can provide?

a. Ra only.
b. TA only.
c. Vertical TA and RA.
d. Horizontal TA and RA.

TCAS 35.
Other traffic not constituting a threat is indicated by ...... on TCAS?

a. Solid red square.
b. Solid yellow circle.
c. Solid cyan or white diamond.
d. Hollow cyan or white diamond.

TCAS 36.
Corrective actions given by TCAS include?

1. Turn right or left.
2. Descend or climb.
3. Increase rate of descent or climb.
4. Stop climb or descent.
5. Monitor vertical speed.
6. Contact ATC.

a. 1, 2, 3, 5.
b. 2, 3, 4, 5.
c. 1, 3, 4, 6.
d. 1, 2, 3, 6.

TCAS 37.
How should a pilot respond to a TCAS RA?

a. Visually identify the intruder to before taking corrective action.
b. Disengage the autopilot the immediately comply with climb and descent commands in a smooth manner.
c. Contact ATC before manoeuvring.
d. Allow autopilot to follow TCAS commands, and advise ATC of situation as soon as it is safe to do so.

TCAS 38.
How should a pilot respond to a TCAS TA?

a. Visually identify the intruder to before taking corrective action.
b. Disengage the autopilot the immediately comply with climb and descent commands in a smooth manner.
c. Contact ATC before manoeuvring.
d. Allow autopilot to follow TCAS commands, and advise ATC of situation as soon as it is safe to do so.

TCAS 39.
What corrective action is given by TCAS?

a. Contact ATC.
b. Climbing or descending right turn.
c. Climbing or descending left turn.
d. Climb or descend.

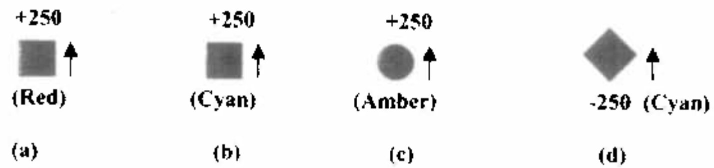
TCAS 40.
What does the TCAS indication (in red) at the right mean?

a. An aircraft 300 ft below is climbing at 500 fpm or more.
b. An aircraft 300 ft above is descending at more than 1000 fpm.
c. An aircraft 300 ft above is climbing at 500 fpm or more.
d. An aircraft 300 ft below is descending at more than 1000 fpm.

TCAS 41.
What does the TCAS indication (in red) at the right mean?

a. An aircraft 300 ft below is climbing at 1000 fpm or more.
b. An aircraft 300 ft above is descending at 500 fpm or more.
c. An aircraft 300 ft above is climbing at 1000 fpm.
d. An aircraft 300 ft below is descending at 500 fpm or more.

TCAS 42.
An intruder 250 ft above, climbing at 500 fpm or more, will be indicated by?



TCAS 43.
Proximity traffic is defined as?

a. Traffic with a 6 nm radius and within 1200 ft above or below.
b. Traffic within 10 nm and within 1000 ft above or below.
c. Traffic within the selected range and within 1000 ft above or below.
d. Traffic within the selected range and within 1200 ft above or below.

TCAS 44.
Other traffic is defined as?

a. Traffic not qualifying as proximity or intruder but within the display range and within 2700 ft above or below.
b. Traffic not qualifying as proximity but within 16 nm and within 2500 ft above or below.
c. All traffic other than proximity and intruder traffic.
d. All non intruder traffic within the range sale and within 2700 ft above or below.

TCAS 45.
A TCAS TA is?

a. A traffic advisory message indicating aircraft in the vicinity which may become a threat.
b. A traffic advisory message indicating aircraft within the vicinity which constituted an immediate threat.
c. A traffic advisory message indicating aircraft within the vicinity but moving away.
d. A traffic advisory message indicating aircraft in the vicinity which are on a parallel course.

TCAS 46.
A TCAS RA is?

a. A resolution advisory is an aural and visual indication of aircraft in the vicinity which constitute an immediate threat.
b. A resolution advisory is an aural and visual recommendation of the manoeuvres or manoeuvre restrictions in the vertical plane, to resolve conflicts with mode C SSR capable aircraft.
c. A resolution advisory is an aural and visual recommendation of the manoeuvres or manoeuvre restrictions in the vertical plane, to resolve conflicts with made S SSR capable aircraft.
d. A resolution advisory is a visual indication of the intentions of immediate threat traffic.

TCAS 47.
A corrective advisory is?

a. A resolution advisory which tells the pilot which rates of climb or descent to use to resolve conflicts.
b. A resolution advisory which tells the pilot which rates of turn to use to resolve conflicts.
c. A resolution advisory which tells the pilot which rates of climb or descent to avoid to resolve conflicts.
d. A resolution advisory which tells the pilot which way to turn to resolve conflicts.

TCAS 48.
When TCAS indications are provided on the VSI they will include?

1. Symbols to indicate the vertical positions of intruder and proximate traffic.
2. Arrows to indicate the vertical motion of intruder and proximate traffic.
3. The rates of climb or descent to be avoided to resolve conflicts.
4. The recommended rate of climb or decent to resolve conflicts.
5. The track and CAS of intruder and proximate traffic.

a. 1, 2, 3, 4.
b. 2, 3, 4, 5.
c. 1, 3, 4, 5.
d. 1, 2, 4, 5.

TCAS 49.
How does TCAS indicate other traffic that is not assessed as a threat?

a. A cyan lozenge.
b. A cyan hollow diamond.
c. A white solid diamond.
d. An amber solid square.

TCAS 50.
On what principle is TCAS II based?

a. Radio altimeters.
b. Two S mode transponders.
c. IRS/INS inputs to the autopilot.
d. Ground based radars.

TCAS 51.
TCAS gives RA's in the …….. plane?

a. Horizontal.
b. Vertical.
c. Lateral and vertical.
d. All of the above.

TCAS 52.
A TCAS2 RA is indicated by ?

a. Red circle.
b. Red square.
c. Amber circle.
d. Amber square.

TCAS 53.
TCAS2 RA's are?

a. Vertical only.
b. Vertical and directional.
c. Directional only.
d. Directional only on mode C SSR.

TCAS 54.
Corrective actions given by TCAS include?

a. Descend or climb.
b. Turn right or left.
c. Accelerate or decelerate.
d. Inform ATC.

TCAS 55.
TCAS uses?

a. Transponders.
b. Radio.
c. Barometric altimeters.
d. Autopilots.

TCAS 56.
TCAS is displayed?

1. EFIS.
2. EICAS.
3. ECAM.
4. Dedicated TCAS displays.
5. Weather radar display.

a. 1, 2.
b. 2, 3.
c. 1, 4.
d. 3, 5.

TCAS 57.
From what does TCAS obtain its data?

1. Inertial reference unit.
2. Barometric altimeter.
3. RADALT.
4. Mode S transponders.
5. Additional equipment specific to each aircraft type.

a. 2, 3, 4.
b. 3, 4, 5.
c. 2, 3, 5.
d. 1, 2, 4.

TCAS 58.
The symbol for a TCAS RA is?

a. Red circle.
b. Red square.
c. Red diamond.
d. Red lozenge.

TCAS 59.
TCAS corrective RA's include?

a. Climb.
b. Turn left.
c. Traffic.
d. Monitor vertical speed.

TCAS 60.
If an intruder aircraft has a mode C transponder, TCAS 2 can give?

a. TA and RA in the horizontal plane only.
b. TA only.
c. RA only.
d. TA and RA in the vertical plane only.

TCAS 61.
TCAS indicates proximate traffic as a?

a. Red solid square.
b. Red hollow square.
c. Cyan solid diamond.
d. Cyan solid circle.

TCAS 62.
TCAS indicates relative height as?

a. Vertical arrow.
b. Horizontal arrow.
c. The position of the symbol.
d. A + or – sign and numbers.

TCAS 63.
TCAS indicates other non-threat traffic as a?

a. Red hollow circle.
b. Red hollow square.
c. Yellow hollow square.
d. Cyan or white hollow diamond.

CRP5 1.
An aircraft is flying at an indicated altitude of 16000 ft. The outside air temperature is -30°C. What is the true altitude?

a. 16200 ft.
b. 15200 ft.
c. 18600 ft.
d. 13500 ft.

CRP5 2.
What is the TAS when pressure altitude = 15000 ft, OAT = -15°C, CAS = 145 Kts?

a. 133 Kts.
b. 148 Kts.
c. 183 Kts.
d. 198 Kts.

CRP5 3.
What is the TAS when pressure altitude = 20000 ft, OAT = -20°C, CAS = 200 Kts?

a. 194 Kts.
b. 273 Kts.
c. 239 kts.
d. 296 Kts.

CRP5 4.
Cruising at FL390, M0.84, is found to give a TAS of 499 Kts. The ISA deviation at this level is?

a. -17.
b. +17.
c. +19.
d. -19.

CRP5 5.
The velocity of the speed of sound at sea level in the standard atmosphere is?

a. 644 kts.
b. 1059 Kts.
c. 661 Kts.
d. 332 kts.

CRP5 6.
If outside air temperature at 35000 ft is -40°C, the local speed of sound is?

a. 307 kts.
b. 247 Kts.
c. 596 Kts.
d. 686 Kts.

CRP5 7.
An aircraft is flying at 310 Kts TAS at FL290, Temperature deviation is -6°C. The local speed of sound is?

a. 570 Kts.
b. 583 Kts.
c. 596 Kts.
d. 563 Kts.

CRP5 8.
An aircraft flying at FL310 is cruising at a CAS of 280 Kts. If the correct outside air temperature is -48°C, this will give a mach number of?

a. 0.76.
b. 0.71.
c. 0.78.
d. 0.82.

CRP5 9.
The temperature at the airport is 23°C, what is the local speed of sound?

a. 615 Kts.
b. 644 Kts.
c. 671 Kts.
d. 694 Kts.

CRP5 10.
An aircraft is flying at 1100 Kts TAS at FL650. A change of 0.1M gives a change of 57 Kts TAS. The temperature deviation at FL650 assuming an ISA atmosphere is?

a. -5.
b. +5.
c. -2.5.
d. +2.5.

CRP5 11.
An aircraft is flying at FL290 at 500 Kts TAS, 0.86M, the temperature deviation is?

a. -8.
b. +7.
c. -15.
d. +25.

CRP5 12.
An increase of 0.15 in mach number results in an increase of 93 Kts TAS. If temperature deviation from ISA is +9°C, the FL is?

a. FL200.
b. FL220.
c. FL170.
d. FL90.

CRP5 13.
An aircraft is flying at FL390, temperature is -56.5°C at mach 0.85. The TAS is?

a. 561 Kts.
b. 476 Kts.
c. 485 Kts.
d. 472 Kts.

CRP5 14.
An increase of 0.15 mach results in an increase of 93 Kts TAS. The local speed of sound is?

a. 560 Kts.
b. 685 Kts.
c. 620 Kts.
d. 580 Kts.

CRP5 15.
An increase of 0.15 mach results in an increase of 93 Kts TAS. If temperature deviation from ISA is +5°C, the approximate flight level is?

a. FL200.
b. FL150.
c. FL220.
d. FL250.

SECTION 3

ANSWERS AND EXPLANATIONS

PITOT STATICS 1. d.

Barometric altimeters provide an indication of altitude by measuring the static air pressure around the aircraft. The higher the altitude, the lower will be the static pressure. But in order to provide accurate altitude indications the altimeter must be fed with an accurate sample of local static pressure.

When an aircraft is in side slipping flight, the airflow striking the upwind side of the fuselage causes a slight increase in static pressure, and the static pressure on the other side of the aircraft would be slightly reduced. If the static pressure were to be measured only at the upwind side of the aircraft, then the altimeter would give an artificially low altitude indication. If the static pressure were to be measured only at the downwind side of the aircraft the altimeter would give an artificially high altitude indication.

In order to overcome this problem large aircraft employ two static ports, one of which is located on each side of the fuselage. The pressure fed to the altimeter is the average of that sensed on each side of the aircraft. So in side slipping flight, the slight pressure increase on the upwind side is cancelled out by the slight decrease on the downwind side. But if one of the static ports is blocked, this self canceling effect will be lost and the measured static pressure will be artificially high or low when side slipping, depending on which port is blocked. The measure of static pressure would then be accurate only in symmetric (non side slipping) flight.

So if the left port becomes blocked, the altimeter will over read when side slipping to the right, but display the correct reading when in symmetrical flight. (option d).

PITOT STATICS 2. d.

Barometric altimeters provide an indication of altitude by measuring the static air pressure around the aircraft. The higher the altitude, the lower will be the static pressure. But in order to provide accurate altitude indications the altimeter must be fed with an accurate sample of local static pressure.

When flying at high speeds the airflow around the aircraft causes a slight reduction in local static pressure. If left uncorrected this would cause the altimeters to over read by a progressively greater degree as airspeed increased. In order to overcome this problem high speed aircraft are fitted with compensated altimeters, which automatically adjust their reading with changes in airspeed. In this way compensated altimeters are able to provide accurate altitude indications throughout the speed range of the aircraft.

If an aircraft is equipped with one altimeter which is compensated for position error and another altimeter which is not, and all other factors being equal, at high speed, the non-compensated altimeter will indicate a higher altitude (option d).

PITOT STATICS 3. b.

Conventional pitot static instruments use flexible capsules or bellows to measure the variations in static and dynamic pressure. By expanding or contracting in response to changes in pressures, these capsules or bellows move mechanical

linkages to give indications of such things as altitude, airspeed and vertical speed. But such mechanical instruments are subject to a range of errors due to factors such as friction and hysteresis.

In order to overcome these problems modern aircraft employ electrically driven instruments. These instruments do not measure pressure directly but receive electrical signals, which are proportional to these pressures. These electrical signals are generated by air data computers and fed to the instruments. An air data computer transforms air data measurement into electrical impulses, which are then used to dive servo motors within the instruments (option b).

PITOT STATICS 4. d.

Conventional barometric altimeters use flexible capsules to measure the variations in static pressure. By expanding or contracting in response to changes in pressures, these capsules move mechanical linkages to give indications of altitude, airspeed and vertical speed. But such mechanical instruments are subject to a range of errors due to factors such as friction and hysteresis.

In order to overcome these problems modern aircraft employ electrically driven instruments. These altimeters do not measure pressure directly but receive electrical signals, which are proportional to these pressures. These electrical signals are generated by air data computers and fed to the altimeters. The air data computer obtains its samples of static pressure from static pressure ports located on the sides of the fuselage. So in an air data computer aircraft, the altitude is calculated from the measurement of absolute barometric pressure from a static source on the fuselage (option d).

PITOT STATICS 5. a.

An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum to the inside of the capsule and feeding static pressure to the inside of the altimeter case. If however the static pressure source became blocked, the altimeter would be unable to sense changing static pressure, so its indication would freeze at the altitude at which the blockage occurred. This problem could be overcome by breaking the altimeter or rate of climb indicator glass, thereby allowing cabin pressure into the altimeter case (option a). In an un-pressurised aircraft this would give a slightly excessive indication of altitude, because cabin pressure in such aircraft is usually slightly lower than ambient due to air being drawn out by the slipstream. This solution would be less effective in a pressurised aircraft however, because the altimeter would sense cabin pressure rather than static pressure.

PITOT STATICS 6. b.

An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum or very low pressure to the inside of the capsule (i) and feeding static pressure to the inside of the altimeter case (ii) (option b).

PITOT STATICS 7. a.

Flight levels are based on the ISA standard subscale setting 1013.25 hPa at msl, so the term "standard + 10" in this question has no relevance. FL70 is 7000 ft and from the ISA table on page 35 it can be seen that the pressure at this altitude is 781 hPa. This is closest to 781.85 hPa (option b).

PITOT STATICS 8. c.

QNH is often interpreted as the static pressure at nil height above sea level. This is a reasonably accurate interpretation in that QNH is the actual static pressure at mean sea level at any given moment in time. It varies from minute to minute, depending primarily on ambient temperature. This means that with QNH set on the altimeter subscale, the needles of the altimeter will indicate the altitude of the location for which it (the QNH) is given (option c).

PITOT STATICS 9. b.

The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding total (dynamic plus static) pressure to the inside of a capsule and static pressure to the outside. This means that total pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between total and static pressures. But total pressure is the sum of static pressure plus dynamic pressure, so the difference between total and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

As an aircraft climbs, the static pressure gradually decreases. But because static pressure is part of the total pressure, the gradual reduction affects each of these pressures to the same degree. A gradually decreasing total pressure minus a gradually decreasing static pressure will result in a constant value of dynamic pressure. This means that under normal circumstances, the airspeed indication remains constant.

But if the total pressure probe becomes blocked, the total pressure trapped in the pipe will remain constant. This means that as the aircraft climbs, only the static pressure will gradually decrease. This will cause the airspeed indication to increase steadily (option b).

PITOT STATICS 10. c.

The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot (dynamic plus static) pressure to the inside of a capsule and static pressure to the outside. This means that pitot pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between total and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between pitot and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

As an aircraft descends, the static pressure gradually increases. But because static pressure is part of the pitot pressure, the gradual increase affects each of these pressures to the same degree. A gradually increasing pitot pressure minus a gradually increasing static pressure will result in a constant value of dynamic pressure. This means that under normal circumstances, the airspeed indication remains constant.

But if the pitot pressure probe becomes blocked, the pitot pressure trapped in the pipe will remain constant. This means that as the aircraft descends, only the static pressure will gradually increase. This will cause the airspeed indication to decrease steadily (option c).

<u>PITOT STATICS 11. c.</u>

The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding total (dynamic plus static) pressure to the inside of a capsule and static pressure to the outside. This means that total pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between total and static pressures. But total pressure is the sum of static pressure plus dynamic pressure, so the difference between total and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

As an aircraft descends, the static pressure gradually increases. But because static pressure is part of the total pressure, the gradual increase affects each of these pressures to the same degree. A gradually increasing total pressure minus a gradually increasing static pressure will result in a constant value of dynamic pressure. This means that under normal circumstances, the airspeed indication remains constant.

But if the total pressure probe becomes blocked, the total pressure trapped in the pipe will remain constant. This means that as the aircraft descends, only the static pressure will gradually increase. This will cause the airspeed indication to decrease steadily (option c).

<u>PITOT STATICS 12. b.</u>

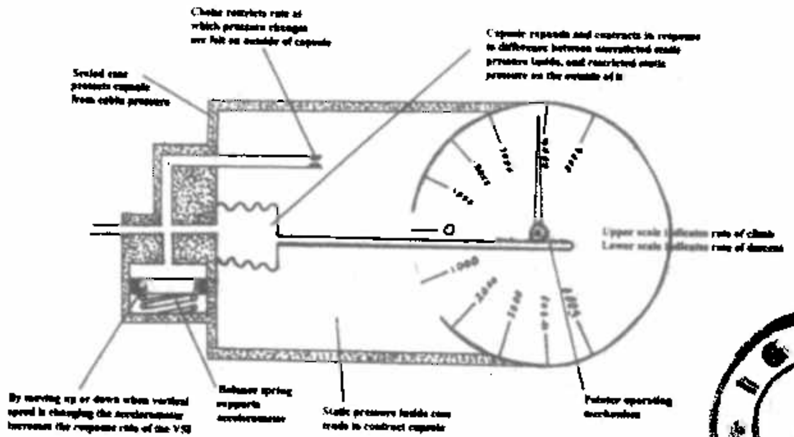
The values of the static pressure sensed by the static ports of an aircraft are affected by a number of variables. The principal of these is the aircraft attitude. But in any given combination of configuration and power setting there is a fixed relationship between airspeed and attitude. It can therefore be said that airspeed is also a major factor in determining the static pressure errors affecting the static vents. The options offered in this question do not include attitude or airspeed. But Mach number is simply the true airspeed expressed as a fraction of the local speed of sound. So option b is the most accurate in this question.

<u>PITOT STATICS 13. c.</u>

The term pressure altitude of any given point is the altitude in the International Standard Atmosphere at which the static pressure at that point would occur. Option c is therefore the most accurate in this question.

<u>PITOT STATICS 14. a.</u>

A VSI provides an indication of vertical speed based on the rate of change of static pressure. In the case of very small vertical speeds, the rates of change of static pressure are very low. Such changes are difficult to measure accurately, so VSIs are less accurate at low rates of climb or descent. In the Instantaneous Vertical Speed Indicator or IVSI, this problem is overcome by the use of acceleration sensors as illustrated below.



Typlval Instantaneous Vertical Speed Indicator (IVSI)

These acceleration sensors are small metal weights or pistons supported by light springs, and housed in chambers attached to the VSI pressure inlets. When an aircraft begins to climb or descend, the vertical acceleration causes these weights to move down or up respectively. This instantly changes the pressure acting on the capsule within the VSI, so that the change in vertical speed is immediately indicated. When the aircraft settles into a constant vertical speed, the weights settle into a balanced position against the springs, and cease to affect the pressure in the instrument. So the response time of a Vertical Speed Indicator can be improved by the use of acceleration sensors (option a).

<u>PITOT STATICS 15. a.</u>

The pressure altitude of any given point is the altitude in the International Standard Atmosphere at which the static pressure at that point would occur. But the air density at any given point is also affected by ambient temperature.

The term "Density Altitude" means the pressure altitude corrected for non-standard ambient temperatures. The density altitude of a given point in the actual atmosphere is the altitude at which the same air density would occur in the International standard atmosphere. Option a, "The density altitude is the altitude of the standard atmosphere on which the density is equal to the actual density in the atmosphere" is the most accurate in this question.

PITOT STATICS 16. b.

The pressure altitude of any given point is the altitude in the International Standard Atmosphere at which the static pressure at that point would occur. Pressure altitude is indicated on a correctly calibrated barometric altimeter when the standard msl setting of 1013.25 hPa is set on the altimeter subscale.
It should however be noted that pressure altitude will not be indicated if any other subscale setting is used. So none of the options in this question are strictly correct. But option b is the most accurate.

PITOT STATICS 17. d.

An Air Data Computer (ADC) takes in pitot pressure, static pressure and TAT, and uses these to compute CAS, TAS, mach number, altitude, vertical speed and SAT. The ADC then sends electrical signals representing these values, to the relevant instruments. The instruments themselves are simple electro-mechanical or LED displays, and hence do not contain any capsules or complex mechanical linkages. This virtually eliminates instrument lag. The computing capabilities of an ADC, enable it to make automatic corrections for position errors and compressibility errors (1). Because the ADC outputs are simple electrical signals, a single ADC is able to provide remote data transmission (3), to feed a large number of instruments (4). Because the ADC uses mechanical devices such as capsules to measure air pressures, it is unable to eliminated hysteresis errors (2). Option d (1, 3, 4.) is the most accurate in this question.

PITOT STATICS 18. d.

The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding total (dynamic plus static) pressure to the inside of a capsule and static pressure to the outside. This means that total pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between total and static pressures. But total pressure is the sum of static pressure plus dynamic pressure, so the difference between total and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

As an aircraft descends, the static pressure gradually increases. But because static pressure is part of the total pressure, the gradual increase affects each of these pressures to the same degree. A gradually increasing total pressure minus a gradually increasing static pressure will result in a constant value of dynamic

pressure. This means that under normal circumstances, the airspeed indication remains constant.

But if the static pressure probe becomes blocked, the static pressure trapped in the pipe will remain constant. This means that as the aircraft descends, only the total pressure will gradually increase. The subtraction of the constant value of static pressure from the increasing value of total pressure would produce an over estimation of the dynamic pressure. This would cause the ASI to over read as altitude decreased (option d).

PITOT STATICS 19. a.

An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum or very low pressure to the inside of the capsule and feeding static pressure to the inside of the altimeter case. If the static source becomes blocked the pressure trapped within the instrument case will remain constant. This means that the altimeter will continue to indicate the reading at which the blockage occurred (option a).

PITOT STATICS 20. d.

An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum or very low pressure to the inside of the capsule and feeding static pressure to the inside of the altimeter case. If the static source becomes blocked the pressure trapped within the instrument case will remain constant. This means that the altimeter will continue to indicate the reading at which the blockage occurred (option d).

PITOT STATICS 21. a.

Pitot or total air pressure is made up of static pressure and dynamic pressure. Dynamic pressure is caused by the kinetic energy given up by the airflow as it is brought to rest by impact with the aircraft structure. The magnitude of dynamic pressure is proportional to airspeed, so the ASI uses dynamic pressure to provide an indication of airspeed. The pitot probe is a forward-facing tube, which captures a sample of total pressure from the air stream. Pressure within the pitot tube is therefore greater than ambient pressure. If the pitot tube develops a leak, some of the dynamic pressure will escape, so that the ASI will sense in abnormally low pressure. This will cause the ASI to under read (option a).

PITOT STATICS 22. c.

Pitot or total air pressure is made up of static pressure and dynamic pressure. Dynamic pressure is caused by the kinetic energy given up by the airflow as it is brought to rest by impact with the aircraft structure. The magnitude of dynamic pressure is proportional to airspeed, so the ASI uses dynamic pressure to provide an indication of airspeed. The pitot probe is a forward-facing tube, which captures a sample of total pressure from the air stream. So the pressure measured at the forward facing orifice of a pitot tube is total pressure (option c).

PITOT STATICS 23. a.
Pitot or total air pressure is made up of static pressure and dynamic pressure. Dynamic pressure is caused by the kinetic energy given up by the airflow as it is brought to rest by impact with the aircraft structure. The magnitude of dynamic pressure is proportional to airspeed, so the ASI uses dynamic pressure to provide an indication of airspeed. The pitot probe is a forward-facing tube, which captures a sample of total pressure from the air stream. So the pitot tube directly supplies total pressure (option a).

PITOT STATICS 24. a.
Barometric altimeters provide an altitude indication that is based upon the measurement of the static pressure in the atmosphere around the aircraft. In order to provide accurate indications of altitude it is essential that the altimeter receive accurate samples of the local static pressure.

But as an aircraft flies through the air, it causes localized accelerations and decelerations of the air flowing over its surfaces. These accelerations and decelerations cause localized changes in the static pressure. This means that great care must be taken to ensure that the static pressure sources are located in areas where these changes in static pressure are a minimum. Because these changes are caused by the position of the static pressure sources, the resulting errors are called position pressure errors (option a).

PITOT STATICS 25. d.
The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot pressure to the inside of a capsule and feeding static pressure to the outside. This means that pitot pressure is attempting to expand the capsule while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between pitot and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between the two is simply dynamic pressure. So in normal operation the capsule moves and the ASI indications change, in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

If the pitot tapping and drain hole become blocked, the capsule will be unable to sense changes in pitot pressure. It will therefore no longer respond to changes in dynamic pressure. So changes in speed will not cause changes in the airspeed indication. So options a, b and c are incorrect. But the outer surface of the capsule will still be subjected to changes in static pressure. Static pressure changes with pressure altitude, so rather than simply not indicating, the ASI will produce indications proportional to changes in pressure altitude. So the ASI will react like an altimeter (option d).

PITOT STATICS 26. b.
Pitot static systems typically provide pitot pressure to airspeed indicators and mach meters and provide static pressure to airspeed indicators, mach meters, altimeters and vertical speed indicators. So if the pitot tube is covered by ice which blocks the ram air (pitot) inlet, only those instruments which use pitot pressure will be affected. This means that only airspeed indicators and mach meters will be affected. None of the options include both of these instruments, but option b is the most accurate in this question.

PITOT STATICS 27. b.
The correct equation is $Tt = Ts(1+0.2\ Kr.M^2)$, option b.

PITOT STATICS 28. b.
Barometric altimeters provide an altitude indication that is based upon the measurement of the static pressure in the atmosphere around the aircraft. In order to provide accurate indications of altitude it is essential that the altimeter receive accurate samples of the local static pressure (option b).

PITOT STATICS 29. b.
A VSI provides an indication of vertical speed based on the rate of change of static pressure. As illustrated in the diagram in answer PITOT STATICS 14 above, the choke is fitted in the pipe carrying static pressure into the space around the capsule in a VSI.

Static pressure is fed at an unrestricted rate into a capsule. This means that the rate of change of static pressure inside the capsule is determined only by the vertical speed of the aircraft. Static pressure is also fed, at a restricted rate into the space around the capsule. This restricted flow into the spaces around the capsule is maintained by a choke. At any instant in a climb or descent, the difference between the pressures inside and outside the capsule will be proportional to the difference between the two flow rates. The restricted rate is constant, so the pressure difference between that inside and outside the capsule is determined by the rate of change of ambient static pressure. This in turn is determined by vertical speed. Option b is therefore the most accurate in this question.

PITOT STATICS 30. b.
A VSI provides an indication of vertical speed based on the rate of change of static pressure. As illustrated in the diagram in answer PITOT STATICS 14 above, the choke is fitted in the pipe carrying static pressure into the space around the capsule in a VSI.

Static pressure is fed at an unrestricted rate into a capsule. This means that the rate of change of static pressure inside the capsule is determined only by the vertical speed of the aircraft. Static pressure is also fed, at a restricted rate into the space around the capsule. This restricted flow into the spaces around the capsule is maintained by a choke. At any instant in a climb or descent, the difference between the pressures inside and outside the capsule will be proportional to the difference between the two flow rates. The restricted rate is constant, so the pressure difference between that inside and outside the capsule is determined by the rate of change of ambient static pressure. This in turn is determined by vertical speed. Option b is therefore the most accurate in this question.

PITOT 31. b.
An Air Data Computer (ADC) takes in pitot pressure, static pressure and TAT, and uses these to compute CAS, TAS, mach number, altitude, vertical speed and SAT. The ADC then sends electrical signals representing these values, to the relevant instruments. The instruments themselves are simple electro-mechanical or LED displays, and hence do not contain any capsules or complex mechanical linkages. This virtually eliminates instrument lag (1). The computing capabilities of an ADC, enable it to make automatic corrections for position errors and compressibility errors(2 & 3). Because the ADC outputs are simple electrical signals, a single ADC is able to feed a large number of instruments (4). In the event of a power supply failure, or failure of the ADC, the system will fail totally. An ADC is not therefore capable of providing emergency altimeter in the event of a main system failure (5).

PITOT 32. c.
An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum to the inside of the capsule and feeding static pressure to the inside of the altimeter case. If however the static pressure source became blocked, the altimeter would be unable to sense changing static pressure, so its indication would freeze at the altitude at which the blockage occurred. This problem could be reduced by breaking the altimeter glass in order to allow cabin pressure to enter the altimeter case (option c). In an un-pressurised aircraft this would give a slightly excessive indication of altitude, because cabin pressure in such aircraft is usually slightly lower than ambient due to air being drawn out by the slipstream. This solution would be less effective in a pressurised aircraft however, because the altimeter would sense cabin pressure rather than static pressure.

PITOT 33. a.
The manner in which an ADC obtains altitude data is essentially the same as that employed by a barometric altimeter. Static pressure is taken from static ports at the surface of the fuselage and fed into a capsule. This then produces an electrical signal proportional to changes in static pressure. Pitot pressure (options b & c) is not proportional to altitude and hence cannot be used by an ADC to compute altitude. Option d, refers to a radio altimeter. This does not constitute air data and hence it is not an input to the ADC.

PITOT 34. c.
An Air Data Computer (ADC) takes in pitot pressure, static pressure and TAT, and uses these to compute CAS, TAS, mach number, altitude, vertical speed and

SAT. The principle inputs used to achieve this are TAT (2), static pressure (5) and total pressure (6). Many ADCs are also able to automatically apply corrections for position error. To do this they require an AOA (1) input. The ADC also requires an electrical supply, which might conceivably be either AC (7) DC. It should be noted that Outside Air temperature or OAT (3) is SAT, which is an ADC output. Dynamic air pressure (4) is part of the total air pressure (6), so it is not a specific ADC input.

PITOT 35. a.
The total pressure (P_{Tot}) exerted upon the forward facing parts of an aircraft is made up of two parts. The first of these is static pressure (P_{Stat}), which acts upon all parts of the aircraft. In addition to this the forward facing parts are subjected to a dynamic pressure (P_{Dyn}). This is caused by the kinetic energy released by the air as it is brought to rest by the impact with the aircraft structure. So $P_{Tot} = P_{Stat} + P_{Dyn}$.

PITOT 36. c.
When an aircraft is very close to the ground, during take-off and landing, the downwash form its wings is restricted by the close proximity of the ground. This changes the direction of the relative airflow and also increases the local static pressure. The combined effects of this is an increase the magnitude of the pressure sensing error or position error affecting the pitot static system.

PITOT 37. b.
Pitot or total air pressure is made up of static pressure and dynamic pressure. Dynamic pressure is caused by the kinetic energy given up by the airflow as it is brought to rest by impact with the aircraft structure. The magnitude of dynamic pressure is proportional to airspeed, so the ASI uses dynamic pressure to provide an indication of airspeed. The pitot probe is a forward-facing tube, which captures a sample of total pressure from the air stream. Pressure within the pitot tube is therefore greater than ambient pressure. If the pitot tube develops a leak, some of the dynamic pressure will escape, so that the ASI will sense in abnormally low pressure. This will cause the ASI to under indicate CAS (option b). It should be noted that the altimeter uses only static pressure, so it will not be affected by a pitot tube leak.

PITOT 38. c.
The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot pressure to the inside of a capsule and static pressure to the outside. This means that pitot pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between pitot and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between pitot and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change, in response to changes in dynamic

pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

If the static pipe becomes blocked, the sensing of changes in static pressure by the outside of the capsule will be prevented. The sensing of changes in pitot pressure inside the capsule will continue as normal, because these are felt through a separate pitot pipe. But pitot pressure includes static pressure, so whenever static pressure is changing, the changes will act as part of the pitot pressure on the inside of the capsule but they will not act on the outside of it.

So when climbing, too high a value of static pressure on the outside of the capsule, will be subtracted from the correct value of total pressure on the inside, to give an excessively low value of dynamic pressure. This will cause the ASI to under indicate airspeed. When descending, too low a value of static pressure will be subtracted, causing the ASI to over indicate airspeed. So the ASI will over indicate or under indicate depending on altitude.

PITOT 39. d.

An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum to the inside of the capsule and feeding static pressure to the inside of the altimeter case. If however the static pressure source became blocked, the static pressure in the pipe at the time of the blockage would remain trapped. The altimeter would then be unable to sense changing static pressure, so its indication would freeze at the altitude at which the blockage occurred. The altimeter will then over indicate if the aircraft descends and under indicate if it climbs.

PITOT 40. b.

An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum to the inside of the capsule and feeding static pressure to the inside of the altimeter case. As altitude increases the reducing static pressure would allow the capsule to expand, giving an indication of altitude. Descending would have the opposite effect, with increasing static pressure causing the capsule to compress.

The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot pressure to the inside of a capsule and static pressure to the outside. This means that pitot pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between pitot and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between pitot and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change, in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

In some aircraft the static pressure source is made up of slots in the outside surface of the pitot probe. Blockage of these slots would constitute a blockage of the static

pressure source. The static pressure in the pipe leading to the altimeter and ASI, at the time of the blockage would remain trapped. These instrument would then be unable to sense changes in static pressure if the aircraft climbed of descended.
If the static slots become blocked, the sensing of changes in static pressure by the outside of the ASI capsule will be prevented. The sensing of changes in pitot pressure inside the capsule will continue as normal, because these are felt through a separate pitot pipe. But pitot pressure includes static pressure, so whenever static pressure is changing, the changes will act as part of the pitot pressure on the inside of the capsule but they will not act on the outside of it.

When climbing at constant CAS, the dynamic pressure will remain constant, but the static pressure will decrease. This means that total pressure inside the capsule will decrease, while that trapped on the outside remains constants. So the capsule will contract. Descending will cause the opposite effect, with increasing total pressure inside the capsule and constant static pressure trapped outside, causing it to expand. So if an aircraft with blocked static source climbs its ASI capsule contracts, an if it descends its ASI capsule expands. This is the opposite to the action of an altimeter capsule, so option b is correct.

PITOT 41. c.

The pitot tapping provides pitot or total pressure to a number of air instruments. The principle use for pitot pressure is as a source of dynamic pressure, which is proportional to airspeed. Pitot pressure is the sum of static pressure plus dynamic pressure. Both the ASI (1) and mach meter (4), obtain dynamic pressure by subtracting static pressure, from total pressure. The other instruments listed in this question do not use pitot pressure and hence will not be affected by blockage of the pitot tapping.

PITOT 42. a.

When an aircraft sideslips, the leading side of its fuselage is subjected to a component of the dynamic pressure, while the trailing side is affected by turbulent airflow passing over and under the fuselage. This has the effect of increasing the effective static pressure at the leading side of the fuselage and decreasing that at the trailing side of the fuselage. In large aircraft types this problem is often overcome by fitting a static vent or pressure sensing port at each side of the fuselage.

The pipes leading from these ports are connected together, such that the instruments sense the average of the two values of static pressure. Under normal circumstance, the increase in pressure on the leading side is counterbalanced by an equal decrease in pressure on the trailing side, so the average sensed by the instruments is the true static pressure. But if the vent on the trailing side becomes blocked, this balancing influence is lost, so the altimeter will sense an excessively high static pressure. This will cause it to under indicate altitude. Conversely, a blockage on the leading side will cause an excessively low static pressure to be sensed, so the altimeter will over indicate altitude. So a blocked left vent in a right sideslip will cause the altimeter to under read altitude. So the altimeter of an aircraft with a blocked right static port will over indicate when side slipping to the right.

PITOT 43. d.

When an aircraft sideslips, the leading side of its fuselage is subjected to a component of the dynamic pressure, while the trailing side is affected by turbulent airflow passing over and under the fuselage. This has the effect of increasing the effective static pressure at the leading side of the fuselage and decreasing that at the trailing side of the fuselage is decreased. In large aircraft types this problem is often overcome by fitting a static vent or pressure sensing port at each side of the fuselage.

The pipes leading from these ports are connected together, such that the instruments sense the average of the two values of static pressure. Under normal circumstance, the increase in pressure on the leading side is counterbalanced by an equal decrease in pressure on the trailing side, so the average sensed by the instruments is the true static pressure. But if the vent on the trailing side becomes blocked, this balancing influence is lost, so the altimeter and mach meter will sense an excessively high static pressure. Conversely, a blockage on the leading side will cause an excessively low static pressure to be sensed by these instruments. So both the altimeter and mach meter will sense an excessively high static pressure if the right vent becomes blocked and the aircraft side slips to the left.

Static pressure decreases as altitude increases, so excessively high static pressure will produce an excessively low altitude indication. In the case of the mach meter, static pressure is employed for two purpose. Firstly it is fed to the outside of the ASI capsule. Here it is used to derive dynamic pressure by subtracting static pressure from pitot pressure. An excessively high static pressure will therefore result in an excessively low dynamic pressure being derived by this capsule. This low dynamic pressure equates to a low CAS, so the mach meter will respond as if the aircraft were flying at a lower airspeed.

The mach meter also uses static pressure on the outside of an aneroid capsule. By compressing this capsule as altitude decreases, it modifies the mach meter indication to reflect the fact that the Local Speed of Sound (LSS) increases as altitude decreases. This has the effect of reducing the mach number at any given air speed. So an excessively high static pressure will reduce the indicated mach number. So when side slipping to the left with a blocked right static vent, both the ASI and the Mach Meter will under indicate (option d).

PITOT 44. d.

The function of the static source is to feed static pressure from the local atmosphere into a number of instruments, including the ASI ,VSI and Altimeter. If the static source becomes blocked, the pressure within the pipe at the time of blockage will remain trapped. This means that the instruments will no longer be able to sense changes in static pressure. Static pressure in the atmosphere increases as altitude decreases. A blocked static source would therefore cause these instruments to react as if altitude were constant. So if the static source became blocked in a descent, the altimeter would over indicate, and the VSI would indicate zero. This VSI indication constitutes the most extreme possible degree of under indication.

In an ASI, the static pressure is fed to the outside of a capsule, while pitot pressure is fed to the inside. This effectively subtracts static pressure from pitot pressure to leave dynamic pressure. Changes in dynamic pressure expand and contract the capsule to give an indication of airspeed. In a descent with a blocked static source, the static pressure trapped in the system would be excessively low. The subtraction of this from pitot pressure would leave an excessively high dynamic pressure, causing the ASI to over indicate airspeed.

PITOT 45. a.

Pitot pressure is the sum of static pressure and dynamic pressure. Instruments used to detect airspeed do so by subtracting static pressure from pitot pressure to deduce dynamic pressure. This dynamic pressure is then used to give an indication of speed. Only the ASI (option a) and mach meter, employ pitot pressure, so only these will be affected by a pitot probe blockage. The VSI (option b) and Altimeter (option c) employ only static pressure and hence are not affected by blockage of the pitot probe.

PITOT 46. d.

The purpose of the static vent is feed local static air pressure into a number of instruments. The altimeter (option c) uses it to represent altitude, while the VSI (option b), uses the rate of change of static pressure as a measure of verticalspeed. In the ASI (option a) static pressure is subtracted from pitot pressure to derive dynamic pressure. This is then used to indicate airspeed. So all of the instruments listed in this question will be affected by blockage of the static vent (option d).

PITOT 47. c.

The purpose of the pitot probe is to feed pitot pressure to a number of instruments, including the ASI. Many types of pitot probe also include static air tappings, which feed static air pressure to instruments including the ASI, VSI and altimeter. The accuracy of all these instruments depends upon the accuracy with which pitot and static pressure are sensed by the probe. If either the pitot or static sources became blocked the pressure within the pipes at the time of blockage would become trapped. The instruments would then be unable to sense changes in these pressures. A blocked pitot source would therefore cause the ASI indications to freeze. A blocked static source would cause the altimeter indications to freeze and the VSI indications to fall to zero.

But this question specifies that debris collects on the probe but does not block it. This might however cause localised boundary layer turbulence, which would cause both static pressure an pitot pressure to fluctuate. This turbulence would probably cause the IAS, altitude and vertical speed indications to fluctuate, becoming erratic and inaccurate.

PITOT 48. c.

An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum to the inside of the capsule and feeding static pressure to the inside of the altimeter case.

If however the static pressure source became blocked, the altimeter would be unable to sense changing static pressure, so its indication would freeze at the altitude at which the blockage occurred. This problem could be reduced by breaking the altimeter glass, thereby allowing cabin pressure into the altimeter case (option c). In an un-pressurised aircraft this would give a slightly excessive indication of altitude, because cabin pressure in such aircraft is usually slightly lower than ambient due to air being drawn out by the slipstream. But in a pressurised aircraft, this action would cause the altimeter to under indicate altitude by a wide margin (option c), because cabin pressure in such aircraft is usually considerable greater than ambient static pressure.

PITOT 49. c.

An Air Data Computer (ADC) takes in pitot pressure, static pressure and TAT, and uses these to compute CAS, TAS, mach number, altitude, vertical speed and SAT. The principle inputs used to achieve this are TAT (2), static pressure (5) and pitot pressure (6). Many ADCs are also able to automatically apply corrections for position error. To do this they require an AOA (1) input. It should be noted that Outside Air temperature or OAT (3), IAS (7), and Mach number (8), are all ADC outputs. Dynamic air pressure (4) is part of the total air pressure (6), so it is not a specific ADC input.

PITOT 50. a.

Pitot pressure is the sum of static pressure and dynamic pressure. Instruments used to detect airspeed do so by subtracting static pressure from pitot pressure to deduce dynamic pressure. This dynamic pressure is then used to give an indication of speed. Only the Mach meter (option a) and ASI, employ pitot pressure, so only these will be affected by a pitot probe blockage. The VSI (option b) and Altimeter (option c) employ only static pressure and hence are not affected by blockage of the pitot probe.

ALT 1 a.

The term "hysteresis" refers to the phenomenon whereby the indications produced by a gauge, depend to some extent upon its indication at some earlier point in time. This will for example cause a gauge to under read when the measured quantity is increasing steadily and over read when the measured quantity is decreasing steadily. The overall effect is that the indications lag behind the measured values. Of the options offered in this question, option a, "Time passed at a given altitude" is the most accurate when referring to altimeter hysteresis errors.

ALT 2 d.

The altitude indication produced by a barometric altimeter is inversely proportional to the local static air pressure. Static air pressure at any point in the atmosphere is produced by the mass of air in the atmosphere above that point. If an aircraft descends, then the fraction of the atmosphere that is above it will increase. This in turn will increase the local static pressure and this will decrease the altimeter indication.

When air becomes colder at any given altitude it contracts. This causes the air in that part of the atmosphere to shrink downwards towards the Earth. This reduces the mass of air that is above any given point above the ground in that area. This reduced mass of air in the upper atmosphere will reduce the static pressure at any point above the ground. This reduced static pressure will increase the indication produced by a barometric altimeter. So when flying from a sector of warm air into one of colder air, the altimeter will over read (option d).

ALT 3 c.

All aircraft instruments are subject to mandatory accuracy requirements, which must be complied with in order to gain certification. Modern servo altimeters must be accurate to within +/-30 feet when at sea level (option c).

ALT 4 d.

The altitude indication produced by a barometric altimeter is inversely proportional to the local static air pressure. Static air pressure at any point in the atmosphere is produced by the mass of air in the atmosphere above that point. If an aircraft descends, then the fraction of the atmosphere that is above it will increase. This in turn will increase the local static pressure and this will decrease the altimeter indication.

When air becomes colder at any given altitude it contracts. This causes the air in that part of the atmosphere to shrink downwards towards the Earth. This reduces the mass of air that is above any given point above the ground in that area. This reduced mass of air in the upper atmosphere will reduce the static pressure at any point above the ground. This reduced static pressure will increase the indication produced by a barometric altimeter. So when flying in an atmosphere where all of the layers of air below an aircraft are cold, the altimeter reading will be higher than the real altitude (option d).

ALT 5 c.

All mechanical instruments are subject to inaccuracies caused by sliding friction where adjacent parts of the linkage move relative to each other. In some types of altimeter these errors are reduced by means of a vibrating device. By constantly vibrating the linkage, the effects of friction are reduced (option c). It should be noted that in the case of pressure instruments hysteresis errors are caused by the fact that work must be done when pressure changes expand or contract the sensing capsules. These errors are not directly related to sliding friction so they are not affected by the vibrating element.

ALT 6 d.
If it is assumed that the instrument in question is reading accurately, then this question becomes one of calculating the rate of descent at 100 kts when flying down a 3 degree slope. This can be solved using the 1 in 60 rule which for descent calculations states that:

Rate of Descent in ft/min = 1/60 x angle x TAS in ft/min

1 kt is approximately 100 ft/min so 100 kts = 10000 ft/min

Inserting the data provided gives:

Rate of descent in ft/min = 1/60 x 3 x 10 000 ft/min = 500 ft/min

The question asks for vertical speed so the answer is –500 ft/min (option d)

An alternative solution is to note that 3 degrees is equal to approximately 5% gradient.

And rate of descent in ft/min = approximately % gradient x TAS in kts

Inserting the data provided in the question gives:

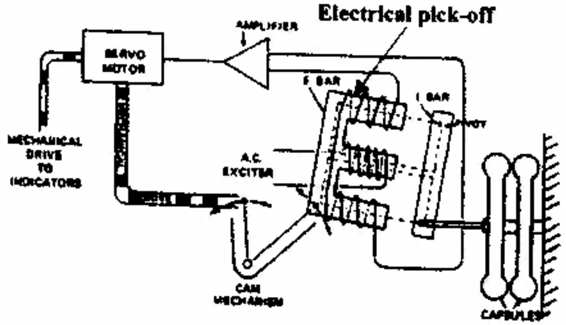
Rate of descent = 5 x 100 kts = 500 ft/min.

ALT 7 b.
The altitude indication produced by a barometric altimeter is inversely proportional to the local static air pressure. Static air pressure at any point in the atmosphere is produced by the mass of air in the atmosphere above that point. If an aircraft descends, then the fraction of the atmosphere that is above it will increase. This in turn will increase the local static pressure and this will decrease the altimeter indication.

When air becomes warmer at any given altitude it expands. This causes the air in that part of the atmosphere to move upwards away from the Earth. This increases the mass of air that is above any given point above the ground in that area. This increased mass of air in the upper atmosphere will increase the static pressure at any point above the ground. This increased static pressure will decrease the indication produced by a barometric altimeter. So when flying in an atmosphere where all of the layers of air below an aircraft are warm, the altimeter indication will be lower than the real altitude (option d).

ALT 8 b.
All mechanical instruments are subject to inaccuracies caused by sliding friction where adjacent parts of the linkage move relative to each other. In some types of altimeter these errors are reduced by means of a vibrating device. A more effective solution is to use a servo altimeter in which the mechanical linkage is replaced by an induction pick-off device as illustrated below. This reduces the friction losses

and makes the instrument more sensitive to altitude changes. So the primary factor, which makes the servo-assisted altimeter more accurate than the simple pressure altimeter is the use of an induction pick-off device (option b).



SERVO ALTIMETER

ALT 9. b.
When an aircraft sideslips, the leading side of its fuselage is subjected to a component of the dynamic pressure, while the trailing side is affected by turbulent airflow passing over and under the fuselage. This has the effect of increasing the effective static pressure at the leading side of the fuselage and decreasing that at the trailing side of the fuselage is decreased. In large aircraft types this problem is often overcome by fitting a static vent or pressure sensing port at each side of the fuselage.

The pipes leading from these ports are connected together, such that the instruments sense the average of the two values of static pressure. Under normal circumstance, the increase in pressure on the leading side is counterbalanced by an equal decrease in pressure on the trailing side, so the average sensed by the instruments is the true static pressure. But if the vent on the trailing side becomes blocked, this balancing influence is lost, so the altimeter will sense an excessively high static pressure. This will cause it to under indicate altitude. Conversely, a blockage on the leading side will cause an excessively low static pressure to be sensed, so the altimeter will over indicate altitude. So a blocked left vent in a right sideslip will cause the altimeter to under read altitude.

ALT 10. a.
True altitude can be calculated using either a CRP5 computer or by calculation using the standard equation:

True alt = Pressure alt x (1 + (temperature deviation / Absolute ambient temp)

Or True alt = Pressure alt x (1 + (temperature deviation / (OAT in 0 C + 273)))

So true altitude is normally derived from pressure altitude (option a).

ALT 11. c.
QNH is often interpreted as the static pressure at nil height above sea level. This is a reasonably accurate interpretation in that QNH is the actual static pressure at mean sea level at any given moment in time. It varies from minute to minute, depending primarily on ambient temperature. It will be the pressure on an airfield only if that airfield is located at mean sea level. Of the options offered in this question, option c, sea level pressure, is the most accurate.

ALT 12. a.
QNH is often interpreted as the static pressure at nil height above sea level. This is a reasonably accurate interpretation in that QNH is the actual static pressure at mean sea level at any given moment in time. It varies from minute to minute, depending primarily on ambient temperature. It will be the pressure on an airfield only if that airfield is located at mean sea level.

The pressure that must be set on an altimeter sub scale to obtain a reading of zero on the runway is QFE. The pressure that must be set on an altimeter sub scale to obtain pressure altitude is 1013.25 mb. Density altitude is pressure altitude corrected for temperature deviation. No pressure setting on the altimeter sub scale can be used to derive density altitude. So of the options available in this question, option a, is the only one that is true.

ALT 13. a.
This question can be solved using either a CRP5 or by calculation. The calculation method must be carried out in a number of stages. Firstly the ISA standard temperature at the specified 16000 ft must be calculated using the standard equation:

ISA temperature at altitude = 15° C – (1.98 x altitude in 1000s of ft)

This gives standard temp at 16000 ft = 15° C – (1.98 x 16) which = -16.68° C.

Subtracting this from the actual temperature (-30° C) gives the temperature deviation of –13.32° C.

This can then be used to calculated the true altitude using the standard equation:

True Altitude = Indicated Altitude x (1 + (Temp deviation / (actual temp + 273)))

So true altitude = 16000 x (1 + (-13.32 / 243))) which is approximately 15123 ft
Option a, 15200 ft is the closest to this figure.

ALT 14. b.
A pressure altimeter gives an indication of altitude based on static air pressure in the surrounding atmosphere. Static pressure at any point in the atmosphere is produced by the weight of the air above that point pressing down upon it. If the air temperature below a point decreases, the air will contract. This will enable more of

the air above, to move down to fill the space left by the contraction of the cold air. This in turn will mean that less air remains above the point, so the static pressure at the point will be reduced. Reducing static pressure equates to increasing altitude. So if an aircraft flies over a colder air mass, its altimeter will over read altitude. Conversely, if the air mass below a point is warmer, the altimeter will under read.

ALT 15. a.
In the international standard atmosphere, ambient air temperature, pressure and density each have specified values at sea level and decrease at specific rates, with increasing altitude. It is therefore possible to predict the air density at any given altitude in the ISA. But in a real atmosphere these values and lapse rates very from moment to moment. If however the ambient temperature is measured at any given pressure altitude, this can be used to calculate the pressure altitude in the ISA at which that density would occur. This is termed the density altitude. Density altitude is therefore the pressure altitude corrected for temperature deviation.

ALT 16. c.
Position errors occur when the pitot and static pressure sensing devices are placed such that the attitude of the aircraft alters the magnitude of the pitot and static pressures sensed. Such errors could only be truly eliminated by positioning the pressure sensors far ahead of the aircraft. In most aircraft the position errors increase with increasing angle of attack and when the aircraft is in ground effect close to the ground. This is because the motion of the aircraft tends to increase the static pressure in its immediate area, when close to the ground. But increasing static pressure equates to decreasing altitude. So an altimeter that is not compensated for position error will under read when close to the ground. The altimeter with position error correction will not be affected. But at high airspeeds the angle of attack will be small, so the position errors will be greatly reduced.

ALT 17. a.
Like all other mechanical systems, pressure altimeters are subject to the effects of friction as their parts move over each other. This friction resists the relative movement of the parts, thereby introducing an element of instrument error. In order to reduce these friction losses some altimeters employ a vibrator device. It should be noted that friction is only one of the factors leading to hysteresis errors, so option a, is more correct than option c. Lag and inertia losses within altimeters are reduced by the use of accelerometers.

ALT 18. a.
A pressure altimeter gives an indication of altitude based on static air pressure in the surrounding atmosphere. Static pressure at any point in the atmosphere is produced by the weight of the air above that point pressing down upon it. If the air temperature below a point decreases, the air will contract. This will enable more of the air above, to move down to fill the space left by the contraction of the cold air.

This in turn will mean that less air remains above the point, so the static pressure at the point will be reduced. Reducing static pressure equates to increasing altitude. So if an aircraft flies over a colder air mass, its altimeter will over read altitude. Conversely, if the air mass below a point is warmer, the altimeter will under read. So if an aircraft enters a cold front its altimeters will over indicate.

ALT 19. a.
Static pressure at any point in the atmosphere is produced by the weight of the air above that point pressing down upon it. As altitude increases, the amount of air pressing down decreases, so the static pressure decreases. A pressure altimeter gives an indication of altitude based on static air pressure in the surrounding atmosphere. It does this by taking static pressure and feeding it into the instrument casing. The instrument contains an aneroid capsule containing a partial vacuum. The aneroid capsule is made of very thin metal so any variations in the static pressure around it cause it to expand or contract. This motion is fed to a pointer to indicate altitude.

ALT 20. b.
This problem can be solved using the CRP5 or by calculation. The calculation must be carried out is a number of stages. Firstly the SAT can be calculated from TAT and mach number using the standard equation:

SAT = TAT / (1 + (0.2 x K x M^2))

Where SAT is absolute static air temperature .
TAT is absolute total air temperature.
K is the ram recovery factor of the temperature probe.
M is the mach number.

Assuming a perfectly accurate temperature probe with K equals 1, and inserting the data given in the question, having converted SAT into absolute by adding 273 gives:

SAT = 263 / (1 + (0.2 x 0.82^2)) Which is SAT = 231.82° K.

Subtracting 273 then converts this to – 41.175° C.

This means that the ambient temperature at 30000 ft is – 41.175° C.

This can then be used to calculate the temperature deviation using the standard equation:

Temperature deviation = Actual Sat – (15° C – (1.98 x altitude in 1000s of ft))

Inserting the SAT calculated above and the altitude of 30000 ft, gives:

Temperature deviation = – 41.175° C – (15° C – (1.98 x 30))

Which is Temperature deviation = 3.2243° C

This can then be used to calculate density altitude using the standard equation:

Density altitude = pressure altitude + (118.6 x Temperature deviation)

Which is Density altitude = 30000 ft + (118.6 x 3.2243)

Which is Density altitude = 30382.4 ft , which is closest to option b, 30472 ft.

ALT 21. d.
This problem can be solved using the standard equation:

Pressure altitude = Elevation + (30 x (1013 – QNH))

Inserting the data provided in the question gives:

Pressure altitude = 25000 ft + (30 x (1013 – 999)) which is = 25420 ft, which is closest to option d, 25400 ft.

ALT 22. a.
This problem can be solved using the standard equation:

Pressure altitude = Elevation + (30 x (1013 – QNH))

This can be rearranged to give:

QNH = 1013 – ((Pressure altitude - Elevation)) / 30)

Inserting the data provided in the question gives:

QNH = 1013 – ((22800 -22000) / 30)

Which is QNH = 986.33 hPa, which is closest to option a.

ALT 23. a.
This problem can be solved using the standard equation:

Pressure altitude = Elevation + (30 x (1013 – QNH))

Inserting the data provided in the question gives:

Pressure altitude = 4000 ft + (30 x (1013 – 900)) which is = 7390 ft, which is option a.

ALT 24. b.
This problem can be solved using the standard equation:

Pressure altitude = (30 x (1013 – QFE))

Inserting the data provided in the question gives:

Pressure altitude = (30 x (1013 –1020)) which is = - 210 ft, which is option b.

ALT 25. a.
This problem can be solved using the standard equation:

Pressure altitude = Elevation + (30 x (1013 – QNH))

This can be rearranged to give:

Elevation = Pressure altitude – (30 x (1013 – QNH))

Inserting the data provided in the question gives:

Elevation = 3700 – (30 x (1013 – 1000))

Which is Elevation = 3310, which is option a.

ALT 26. a.
In the international standard atmosphere, ambient air temperature, pressure and density each have specified values at sea level and decrease at specific rates, with increasing altitude. It is therefore possible to predict the air density at any given altitude in the ISA. But in a real atmosphere these values and lapse rates very from moment to moment. If however the ambient temperature is measured at any given pressure altitude, this can be used to calculate the pressure altitude in the ISA at which that density would occur. This is termed the density altitude.

ALT 27. c.
The pressure altitude of any point in the atmosphere can be found by setting 1013.25 on the altimeter sub scale and reading the altimeter indication when at that point (options c). Setting QNH would cause the altimeter to indicate field elevation when on the airfield. Setting QFE would cause the altimeter to indicate zero when on the airfield.

ALT 28. a.
Density altitude can be calculated using the standard equation:

Density altitude = Pressure altitude + (118 x temperature deviation)

Temperature deviation = actual temperature – ISA standard temperature

Which is Actual temperature – (15 – (Altitude in 1000s of ft x 1.98))

So density alt = Pressure alt + 118(Actual temp - (15 – (5 x 1.98))) = 7348.2 ft.

ALT 29. b.
This problem can be solved using the standard equation:

Pressure altitude = (30 x (1013 – QFE))

Inserting the data provided in the question gives:

Pressure altitude = (30 x (1013 – 1022)) = - 270 ft. (option b)

ALT 30. a.
The calculations used to solve this type of problem must be carried out in two stages. Firstly, pressure altitude at the field can be calculated using the standard equation:

Pressure altitude = Elevation + (30 x (1013 – QNH))

Inserting the data provided in the question gives:

Pressure altitude = 4500 ft + (30 x (1013 – 1000)) = 4890 ft.

This can then be used to calculate QFE using the standard equation:

Pressure altitude = (30 x (1013 – QFE))

This can be rearranged to give:

QFE = 1013 - (Pressure altitude / 30)

Inserting the pressure altitude calculated above gives:

QFE = 1013 - (4890 / 30) which = 850 (option a)

ALT 31. d.
The pressure altitude of any given point in a real atmosphere, is the altitude at which the ambient pressure at that point would occur in the ISA. It is indicated on a barometric altimeter when the sub scale is set to 1013.25 hPa. If QNH is set on the sub scale, an altimeter will read height above or below sea level. If QFE is set on the sub scale, an altimeter will read zero when at that point.

ALT 32. a.
Air density is a measure of how tightly packed the air molecules are. The more tightly packed the molecules are, the greater the mass that will be held in any given

volume. Increasing temperature causes air to expand, such that its molecules become less densely packed and so its density decreases. Increasing altitude causes static air pressure to decrease. This allows the air to expand as if it had been heated. So increasing altitude decreases air density. Humidity is a measure of the amount of water vapour in the air. Water vapour is less dense than air, so increasing humidity, decreases the density of the air/water vapour mixture. So air density is decreased by increasing humidity, increasing altitude and increasing temperature.

ALT 33. c.
Field elevation is the height of the field above or below mean sea level. This is a fixed value and will not be affected by changing atmospheric conditions. So options a and b are incorrect. Both QNH and QFE are air pressures, which vary with changing atmospheric conditions. If QNH decreases, QFE will also decrease. But this question states that QNH has increased, so option d is incorrect. So option c is the only one that is true.

ALT 34. c.
Field elevation is the height of the field above or below mean sea level. This is a fixed value and will not be affected by changing atmospheric conditions. So option a is incorrect. Both QFE and QNH are air pressures, which vary with changing atmospheric conditions. If QFE decreases, QNH will also decrease. But this question states that QFE has increased, so options b and d are incorrect. So option c is the only one that is true.

ALT 35. d.
This question does not specify whether it refers to the International Standard Atmosphere(ISA), or to the real atmosphere, so both must be considered. The ambient air temperature in the ISA, is approximately 15° C at mean sea level. It then decreases at a rate of approximately 1.98° C per 1000 ft, as altitude increases up to 36000 ft. Temperature then remains constant from 36000 ft, up to 65000 ft. Few if any commercial aircraft currently operate at or above 65000 ft, so for the purposes of JAR ATPL and CPL examinations, it can be said that air temperature decreases with increasing altitude up to 36000 ft, then remains constant (option d).

Conditions in the real atmosphere vary from minute to minute, so it is not possible to specify a fixed temperature at sea level. The real atmosphere also often includes temperature inversions and isothermal layers. An inversion is layer of atmosphere in which the temperature increases with increasing altitude. An isothermal layer is one within which temperature remains constant at all altitudes. So temperature within the real atmosphere may increase, decrease, or remain constant with increasing altitude. None of the options can therefore be said to apply generally to the real atmosphere.

ALT 36. a.
Density altitude is the altitude at which the prevailing air density would occur in the real atmosphere. As temperature increases, the air expands, causing its density to decrease. This decreased density would occur at a greater altitude in the ISA, so increasing temperature increases density altitude. Density altitude can be calculated using the equation:

Density alt = Pressure alt + (118 x temperature deviation)

So increasing air temperature decrease air density and increases density altitude.

ALT 37. a
When an aircraft sideslips, the leading side of its fuselage is subjected to a component of the dynamic pressure, while the trailing side is affected by turbulent airflow passing over and under the fuselage. This has the effect of increasing the effective static pressure at the leading side of the fuselage and decreasing that at the trailing side of the fuselage. In large aircraft types this problem is often overcome by fitting a static vent or pressure sensing port at each side of the fuselage.

The pipes leading from these ports are connected together, such that the instruments sense the average of the two values of static pressure. Under normal circumstance, the increase in pressure on the leading side is counterbalanced by an equal decrease in pressure on the trailing side, so the average sensed by the instruments is the true static pressure. But if the vent on the leading side becomes blocked, this balancing influence is lost, so the altimeter will sense an excessively low static pressure. This will cause it to over indicate altitude. Conversely, a blockage on the trailing side will cause an excessively high static pressure to be sensed, so the altimeter will under indicate altitude. So a blocked right vent in a right sideslip will cause the altimeter to under read static pressure and over read altitude (option a).

ALT 38. b.
QFE is the static air pressure at field elevation. With QFE set on the altimeter sub scale, the altimeter would read the elevation of the aircraft above or below the airfield. It would therefore read height above ground level (AGL) (option b), provided the aircraft were above the airfield. It would read the same as with QFE set (option a), height above sea level (option c), and field elevation when on the runway (option d), only if the airfield were at mean sea level, which would make QFE and QNH identical.

ALT 39. b.
When an aircraft sideslips, the leading side of its fuselage is subjected to a component of the dynamic pressure, while the trailing side is affected by turbulent airflow passing over and under the fuselage. This has the effect of increasing the effective static pressure at the leading side of the fuselage and decreasing that at the trailing side of the fuselage. In large aircraft types this problem is often overcome by fitting a static vent or pressure sensing port at each side of the fuselage.

The pipes leading from these ports are connected together, such that the instruments sense the average of the two values of static pressure. Under normal circumstance, the increase in pressure on the leading side is counterbalanced by an equal decrease in pressure on the trailing side, so the average sensed by the instruments is the true static pressure. But if the vent on the leading side becomes blocked, this balancing influence is lost, so the altimeter will sense an excessively low static pressure. This will cause it to over indicate altitude. Conversely, a blockage on the trailing side will cause an excessively high static pressure to be sensed, so the altimeter will under indicate altitude. So with one port blocked, the altimeter will under read when slipping towards the clear port and over read when slipping towards the blocked port (option b).

ALT 40. a.

An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. Changes in altitude cause the static air pressure to vary, which in turn causes the capsule to expand as pressure decreases and to contract as pressure increases. But the rate of change of static pressure with altitude is very small, so small changes in altitude apply only very small forces to the capsule. A significant proportion of these forces can often be lost in overcoming the friction in the mechanical linkages within the altimeter. These losses inevitably reduce the accuracy of the altimeter when sensing small changes in altitude.

A servo altimeter uses an electrical pick-off device in place of much of the mechanical linkage. This device greatly reduces the friction losses, and so increases the accuracy of the altimeter (option a). The electrical-pick off is however very delicate, so it cannot be said to be any more or less reliable than a conventional altimeter.

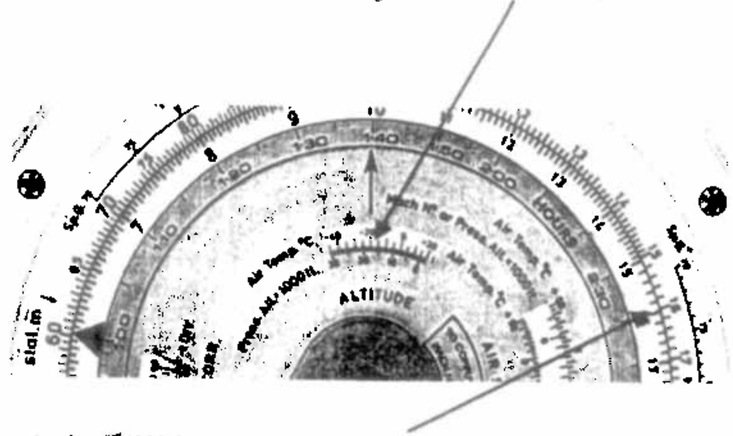
ALT 41. b.

A pressure altimeter gives an indication of altitude based on static air pressure in the surrounding atmosphere. Static pressure at any point in the atmosphere is produced by the weight of the air above that point pressing down upon it. If the air temperature below a point decreases, the air will contract. This will enable more of the air above, to move down to fill the space left by the contraction of the cold air. This in turn will mean that less air remains above the point, so the static pressure at the point will be reduced. Reducing static pressure equates to increasing altitude. So if an aircraft flies over a colder air mass, its altimeter will over read altitude (option b).

ALT 42. c.

This question can be solved using the CRP 5 as illustrated below.

1. In the altitude window set –160C against 16000 ft altitude.



2. Against 16000 ft on the inner scale read off approximately 16050 ft on the outer scale.

This is closest to 16050 ft (option c).

If a CRP5 is not available the problem can be solved by calculation. The calculation method must be carried out in a number of stages. Firstly the ISA standard temperature at the specified 16000 ft must be calculated using the standard equation:

ISA temperature at altitude = 15° C – (1.98 x altitude in 1000s of ft)

This gives standard temp at 16000 ft = 15° C – (1.98 x 16) which = -16.68° C.

Subtracting this from the actual temperature (-16° C) gives the temperature deviation of $+0.68^\circ$ C.

This can then be used to calculated the true altitude using the standard equation:

True Altitude = Indicated Altitude x (1 + (Temp deviation / (actual temp + 273)))

So true altitude = 16000 x (1 + (+0.68 / 257)) which is approximately 16042 ft
Option c, 16050 ft is the closest to this figure.

ALT 43. c.

As its name implies, the Air Data Computer (ADC) employs data from the local atmosphere. It converts pitot and static pressure information into electrical signals representing airspeed, altitude and vertical speed. In order to produce the altitude signal it employs a barometric altitude device, which is often similar to that in a conventional barometric altimeter. The ADC uses dynamic pressure as an indication of airspeed and an OAT source to sense ambient temperatures. RADALT information is not a form of air data and so is not commonly fed to an ADC.

ALT 44. c.
True altitude is calculated from pressure altitude, using the standard equation:

True Altitude = Pressure Altitude x (1 + (Temp deviation / (actual temp + 273)))

ALT 45. d.
Density altitude is the altitude at which the prevailing air density would occur in the International Standard Atmosphere. As temperature increases, the air expands, causing its density to decrease. This decreased density would occur at a greater altitude in the ISA, so increasing temperature increases density altitude. Density altitude is therefore pressure altitude corrected for temperature. It can be calculated using the standard equation:

Density alt = Pressure alt + (118 x temperature deviation)

ALT 46. c.
A pressure altimeter gives an indication of altitude based on static air pressure in the surrounding atmosphere. Static pressure at any point in the atmosphere is produced by the weight of the air above that point pressing down upon it. If the air temperature below a point decreases, the air will contract. This will enable more of the air above, to move down to fill the space left by the contraction of the cold air. This in turn will mean that less air remains above the point, so the static pressure at the point will be reduced. Reducing static pressure equates to increasing altitude. So if an aircraft flies over a colder air mass, its altimeter will read higher than true altitude.

ALT 47. b.
The question does not specify whether it refers to radio altimeters or pressure altimeters. Radio altimeters employ radio waves, and so are not affected by blockage of the static vents. But none of the options include this, so it can be assumed that the question refers to pressure altimeters.

Pressure or barometric altimeters give an indication of altitude based on static air pressure in the surrounding atmosphere. They do this by taking in static air pressure through the static vents and applying this to the outside of an evacuated capsule. Changes in altitude cause the static air pressure to vary, which in turn causes the capsule to expand as pressure decreases and to contract as pressure increases. This motion is transmitted to a pointer which indicates altitude.

If the static vents become blocked the capsule will no longer be subjected to variations in static pressure, but will continue to sense the pressure existing at the

time of blockage. Under such circumstances the altimeter reading would freeze at the altitude at which the blockage occurred.

ALT 48. c.
Pressure altitude is the altitude at which the ambient air pressure existing at any given point in the real atmosphere, would occur in the International Standard Atmosphere (ISA). It is the altitude indicated by a barometric altimeter when the ISA msl static pressure of 1013.15 hPa is set on its sub scale (option c).

ALT 49. d.
The formation of ice on the surface of an aircraft at, or immediately in front of the static pressure source, is likely to produce turbulent airflow. This will reduce the static pressure in the immediate area, thereby increasing the pressure sensing errors. The major part of errors affecting the accuracy with which pressures are sensed by the pitot static system are caused by the position of the sensors. So ice formation in the area of these sensors will increase the magnitude of these position errors (option d). the reduced static pressure due to such icing will cause the altimeters to over indicate altitude. Compressibility errors (option a) are caused by compression of the air at high speeds. Instrument errors (option b), are caused by manufacturing imperfections within individual instruments. Neither of these is affected by icing.

ALT 50. b.
A pressure altimeter gives an indication of altitude based on static air pressure in the surrounding atmosphere. Static pressure at any point in the atmosphere is produced by the weight of the air above that point pressing down upon it. If the air temperature below a point increases, the air will expand. This will cause some of the air to move upwards. This in turn will mean that more air will be above the point, so the static pressure at the point will be increased. Increasing static pressure equates to decreasing altitude. So if an aircraft meets a hotter air mass, its altimeter will under read altitude.

ALT 51. d.
An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. Changes in altitude cause the static air pressure to vary, which in turn causes the capsule to expand as pressure decreases and to contract as pressure increases. But the rate of change of static pressure with altitude is very small, so small changes in altitude apply only very small forces to the capsule. A significant proportion of these forces can often be lost in overcoming the friction in the mechanical linkages within the altimeter. These losses inevitably reduce the accuracy of the altimeter when sensing small changes in altitude.

A servo altimeter uses an electromagnetic pick-off device in place of much of the mechanical linkage. This device greatly reduces the friction losses, and so increases the accuracy of the altimeter (option d). The electromagnetic pick-off does not however sense pressures more accurately (option b) but merely transmits changes to the pointer more accurately. The use of a logarithmic scale (option a) has no relevance to altimeter accuracy and might in fact make them more difficult to read. Vibrators (option c) reduce friction-induced lag in order to improve response rate rather than absolute accuracy.

ALT 52. d.
As its name implies, the Air Data Computer (ADC) employs data from the local atmosphere. It converts pitot and static pressure information into electrical signals representing airspeed, altitude, SAT, mach number, and vertical speed. In order to provide an altitude signal it employs a barometric pressure instrument, broadly similar to a servo altimeter (option d). The ADC uses dynamic pressure as an indication of airspeed and an OAT source to sense ambient temperatures. RADALT (option b) information is not a form of air data and so is not commonly fed to an ADC.

ALT 53. b.
An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. Changes in altitude cause the static air pressure to vary, which in turn causes the capsule to expand as pressure decreases and to contract as pressure increases. But the rate of change of static pressure with altitude is very small, so small changes in altitude apply only very small forces to the capsule. A significant proportion of these forces can often be lost in overcoming the friction in the mechanical linkages within the altimeter. These losses inevitably reduce the accuracy of the altimeter when sensing small changes in altitude.

A servo altimeter uses an electromagnetic pick-off device in place of much of the mechanical linkage. This device greatly reduces the friction losses, and so increases the accuracy of the altimeter (option b).

ALT 54. b.
An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum to the inside of the capsule and feeding static pressure to the inside of the altimeter case (option b). It should be noted that altimeters do not use dynamic pressure or total pressure, so option a, c and d, are all incorrect.

ALT 55. c.
An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum to the inside of the capsule and feeding static pressure to the inside of the altimeter case. If however the static pressure source became blocked, the altimeter would be unable to sense changing static pressure, so its indication would freeze at the altitude at which the blockage occurred. This problem could be reduced by breaking the altimeter glass, thereby allowing cabin pressure into the altimeter

case. In an un-pressurised aircraft this would give a slightly excessive indication of altitude, because cabin pressure in such aircraft is usually slightly lower than ambient due to air being drawn out by the slipstream. This solution would be less effective in a pressurised aircraft however, because the altimeter would sense cabin pressure rather than static pressure.

ALT 56. d.
An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum to the inside of the capsule and feeding static pressure to the inside of the altimeter case. But altimeters do not use dynamic pressure or total pressure, so option they are not affected by blockage of the pitot pressure source.

ALT 57. a.
A pressure altimeter gives an indication of altitude based on static air pressure in the surrounding atmosphere. Static pressure at any point in the atmosphere is produced by the weight of the air above that point pressing down upon it. As altitude decreases in a descent, the static pressure increases. This causes the capsule to contract, such that the altimeter indication decreases.

If the static vent becomes partly blocked the rate at which air flows into and out of it will be reduced. This will increase the time taken for static pressure changes to be sensed by the capsule. This in turn will increase the lag rate of the altimeter. So with a partly blocked static vent, the altimeter will over read altitude in a descent. After a short period at any given altitude however, the correct static pressure will be detected, thereby allowing the altimeter to read the correct altitude at constant altitude (option a).

It should be noted that option b is incorrect because constant height does not necessarily imply constant altitude. When flying at constant height above uneven terrain the altitude will be constantly changing so the altimeter with a partly blocked static vent would read inaccurately.

ALT 58. b.
Static pressure at any point in the atmosphere is produced by the weight of the air above that point pressing down upon it. As altitude increases, the amount of air pressing down decreases, so the static pressure decreases. A pressure altimeter gives an indication of altitude based on static air pressure in the surrounding atmosphere. It does this by taking static pressure and feeding it into the instrument casing. The instrument contains an aneroid capsule containing a partial vacuum. The aneroid capsule is made of very thin metal so any variations in the static pressure around it cause it to expand or contract. This motion is fed to a pointer to indicate altitude.

But accuracy is reduced because some of the motion is lost due to internal friction in the linkages, which causes instrument errors. These errors are reduced in some altimeters by fitting a vibrator device. By constantly vibrating the linkages, this reduces instrument errors.

ALT 59. c.

In a properly balanced banked turn an aircraft will not sideslip. But if the ratio of angle of bank to TAS is incorrect, the aircraft will sideslip into the turn (slipping) or out of it (skidding). Whenever an aircraft sideslips, the leading side of the fuselage is subjected to part of the dynamic pressure, whilst the trailing side is subjected to increased turbulent airflow passing over it. This tends to increase the pressure on the leading side and decrease that on the trailing side. If these altered pressures are used to sense altitude, the altimeter reading will be inaccurate. So in a banked turn a barometric altimeter using a single static source might over or under indicate depending on the position of that static source.

ALT 60. b.

True altitude is calculated from pressure altitude, using the standard equation:

True Altitude = Pressure Altitude x (1 + (Temp deviation / (actual temp + 273)))

ALT 61. c.

Density altitude is the altitude at which the prevailing air density would occur in the International standard Atmosphere. As temperature increases, the air expands, causing its density to decrease. This decreased density would occur at a greater altitude in the ISA, so increasing temperature increases density altitude. Density altitude is therefore pressure altitude corrected for temperature. It can be calculated using the standard equation:

Density alt = Pressure alt + (118 x temperature deviation)

The term temperature altitude used in options a and b, has no generally recognised meaning.

ALT 62. c.

This is a badly constructed question. It has however been reported by a number of students and is therefore included in this book to illustrate the kinds of problems students might face in the examination.

ATC transponder replies are commonly generated by the ADC, which would compensate for position errors, so option a is incorrect. The corrected instrument is likely to read accurately in all conditions, so option d is also incorrect.

Position errors are caused when the static port is badly located, such that the static pressure acting upon it is affected by the movement of the aircraft through the air. This problem tends to be greatest at low speed, due to the high nose up attitude. So any over or under indication is most likely to affect the uncompensated altimeter and be greatest at low speed. But this option is not offered in the question. A

choice must therefore be made between options b and c. Position errors tend to reduce the local static pressure around the static vents, thereby causing the altimeters to over indicate at low level. Option c, "under indicate at high altitude" is therefore more likely to be correct than option b "over indicate at high altitude".

ALT 63. b.

Static pressure at any point in the atmosphere is produced by the weight of the air above that point pressing down upon it. As altitude increases, the amount of air pressing down decreases, so the static pressure decreases. A pressure altimeter gives an indication of altitude based on static air pressure in the surrounding atmosphere. It does this by taking static pressure and feeding it into the instrument casing. The instrument contains an aneroid capsule containing a partial vacuum. The aneroid capsule is made of very thin metal so any variations in the static pressure around it cause it to expand or contract. This motion is fed to a pointer to indicate altitude.

But accuracy is reduced because some of the motion is lost due to internal friction in the linkages, which causes instrument errors. These errors are reduced in some altimeters by fitting a vibrator device (option b). By constantly vibrating the linkages, this reduces instrument errors. It should be noted that some schools argue that friction errors and hysteresis errors (option a) are the same thing. This is not strictly correct, as friction is only one of a number of causes of hysteresis errors. So option b is more correct than option a.

ALT 64. a.

When an aircraft sideslips, the leading side of its fuselage is subjected to a component of the dynamic pressure, while the trailing side is affected by turbulent airflow passing over and under the fuselage. This has the effect of increasing the effective static pressure at the leading side of the fuselage and decreasing that at the trailing side of the fuselage. In large aircraft types this problem is often overcome by fitting a static vent or pressure sensing port at each side of the fuselage.

The pipes leading from these ports are connected together, such that the instruments sense the average of the two values of static pressure. Under normal circumstances, the increase in pressure on the leading side is counterbalanced by an equal decrease in pressure on the trailing side, so the average sensed by the instruments is the true static pressure. But if the vent on the leading side becomes blocked, this balancing influence is lost, so the altimeter will sense an excessively low static pressure. This will cause it to over indicate altitude. Conversely, a blockage on the trailing side will cause an excessively high static pressure to be sensed, so the altimeter will under indicate altitude. So with one port blocked, the altimeter reading will increase when slipping towards the blocked port and decrease when slipping towards the clear port.

ALT 65. b.

When an aircraft sideslips, the leading side of its fuselage is subjected to a component of the dynamic pressure, while the trailing side is affected by turbulent airflow passing over and under the fuselage. This has the effect of increasing the effective static pressure at the leading side of the fuselage and decreasing that at the trailing side of the fuselage. In large aircraft types this problem is often overcome by fitting a static vent or pressure sensing port at each side of the fuselage.

The pipes leading from these ports are connected together, such that the instruments sense the average of the two values of static pressure. Under normal circumstance, the increase in pressure on the leading side is counterbalanced by an equal decrease in pressure on the trailing side, so the average sensed by the instruments is the true static pressure. But if the vent on the leading side becomes blocked, this balancing influence is lost, so the altimeter will sense an excessively low static pressure. This will cause it to over indicate altitude. Conversely, a blockage on the trailing side will cause an excessively high static pressure to be sensed, so the altimeter will under indicate altitude. So with one port blocked, the altimeter reading will increase when slipping towards the blocked port and decrease when slipping towards the clear port.

ALT 66. b.
Static pressure at any point in the atmosphere is produced by the weight of the air above that point pressing down upon it. As altitude increases, the amount of air pressing down decreases, so the static pressure decreases. A pressure altimeter gives an indication of altitude based on static air pressure in the surrounding atmosphere. It does this by taking static pressure from ports or vents located at the surface of the aircraft, and feeding it into the instrument casing.

The effective static pressure at these ports varies depending upon port position, aircraft attitude and height above the ground. This can cause the altimeter readings to become inaccurate and possibly erratic in certain conditions. The effects of changing angle of attack (option d) are usually minimised by locating static ports such that they do not become shielded, or excessively affected even at high nose up attitudes. When aircraft are very close the ground however, the local static pressure is altered by ground effect (option b).

ALT 67. a.
Static pressure at any point in the atmosphere is produced by the weight of the air above that point pressing down upon it. As altitude increases, the amount of air pressing down decreases, so the static pressure decreases. A pressure altimeter gives an indication of altitude based on static air pressure in the surrounding atmosphere. It does this by taking static pressure and feeding it into the instrument casing. The instrument contains an aneroid capsule containing a partial vacuum. The aneroid capsule is made of very thin metal so any variations in the static pressure around it cause it to expand or contract. This motion is fed to a pointer to indicate altitude.

It should be noted that differential capsules (option b) are used in ASIs. Bellows are used in systems where there is a need to measure low pressure. Bourden tubes are used in high pressure sensing instruments.

ALT 68. d.
An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum to the inside of the capsule and feeding static pressure to the inside of the altimeter case. If however the static ports became blocked and the altimeter glass cracked, cabin pressure would be felt within the altimeter case. In a pressurised aircraft this would cause the instrument to read cabin pressure altitude (option d). It should be noted that option b "under read" is also true because cabin altitude in a pressurised aircraft is lower than the aircraft altitude except at very low altitude. Option d is however the more appropriate of the two.

ALT 69. b.
An altimeter provides an indication of altitude by taking in static air pressure and applying this to the outside of an evacuated capsule. This is achieved by applying a vacuum to the inside of the capsule and feeding static pressure to the inside of the altimeter case. If however the static pipe became detached from the back of the instrument, cabin pressure would be felt within the altimeter case. In a pressurised aircraft this would cause the instrument to read cabin pressure altitude (option b). It should be noted that option d "under read" is also true because cabin altitude in a pressurised aircraft is lower than the aircraft altitude except at very low altitude. Option b is however the more appropriate of the two.

RADIO ALTIMETERS 1 a.
Radio altimeters operate on the basis of transmitting a radio signal down to the surface and receiving the returning wave after it has been reflected by the ground. The signal is in the form of a frequency modulated carrier wave. This means that the signal is transmitted continuously, but its frequency is constantly changing. So at any point in time the frequency of the signal being transmitted differs from that of the reflected signal being received.

Because the rate of change of the frequency modulation is constant, the difference between the transmitted and returning signals is proportional to the time of travel of the signal. This in turn is proportional to the height of the aircraft above the ground. The radio altimeter indication is therefore an indication of the true height of the aircraft above the ground.

The velocity of radio waves through the air is constant, so time of signal travel is proportional to the height of the aerials plus the distances from the aerials to the transmitter and receiver. But these distances have no particular significance, whereas knowing the height of the main wheels above the ground is vitally important to ensure smooth landings. So most systems allow for the time the signal takes to pass through the aircraft (2) and the height of the aerials above the main wheels (3). So option a, is the most appropriate in this question.

RADIO ALTIMETERS 2 a.
Radio altimeters typically include a number of safety features. One of these is that in the event of a system failure, the needle moves behind a mask and an alert flag

appears. So failure of the radio altimeter will result in the removal of the height indication (option a).

RADIO ALTIMETERS 3 c.
Radio altimeters operate on the basis of transmitting a radio signal down to the surfaces and receiving the returning wave after it has been reflected by the ground. The signal is in the form of a frequency modulated carrier wave. This means that the signal is transmitted continuously, but its frequency is constantly changing. So at any point in time the frequency of the signal being transmitted differs from that of the reflected signal being received.

Because the rate of change of the frequency modulation is constant, the difference between the transmitted and returning signals is proportional to the time of travel of the signal. This in turn is proportional to the height of the aircraft above the ground. The radio altimeter indication is therefore an indication of the true height of the aircraft above the ground. All components of the system are housed within the aircraft, so options a and b are untrue. Taking all of the above factors into account it can be said that a radio altimeter is a self-contained on-board aid used to measure the true height of an aircraft (option c).

RADIO ALTIMETERS 4 a.
Radio altimeters operate on the basis of transmitting a radio signal down to the surfaces and receiving the returning wave after it has been reflected by the ground. The signal is in the form of a frequency modulated carrier wave. This means that the signal is transmitted continuously, but its frequency is constantly changing. So at any point in time the frequency of the signal being transmitted differs from that of the reflected signal being received.

Because the rate of change of the frequency modulation is constant, the difference between the transmitted and returning signals is proportional to the time of travel of the signal. This in turn is proportional to the height of the aircraft above the ground. The radio altimeter indication is therefore an indication of the true height of the aircraft above the ground (option a). This information is commonly used for a number of purposes including GPWS and Automatic Landing Systems. It is not however used for altitude hold because this function employs a barometric altimeter input. Options b, c and d are therefore all untrue.

RADIO ALTIMETERS 5 a.
Radio altimeters operate on the basis of transmitting a radio signal down to the surfaces and receiving the returning wave after it has been reflected by the ground. The signal is in the form of a frequency modulated carrier wave (statement 3). This means that the signal is transmitted continuously, but its frequency is constantly changing. So at any point in time the frequency of the signal being transmitted differs from that of the reflected signal being received.

Because the rate of change of the frequency modulation is constant, the difference between the transmitted and returning signals is proportional to the time of travel

of the signal. This in turn is proportional to the height of the aircraft above the ground. The radio altimeter indication is therefore an indication of the true height of the aircraft above the ground. Commercial radio altimeters have an accuracy of +/- 2 feet between 0 and 500 ft (statement 5). Such systems typically have an operating range from zero to 2500 ft above the ground so statement 4 is untrue. Typical operating frequencies are between 4200 MHz and 4400 MHz so statement 1 is untrue. Option a is therefore the most accurate in this question.

RADIO ALTIMETERS 6 c.
Radio altimeters operate on the basis of transmitting a radio signal down to the surfaces and receiving the returning wave after it has been reflected by the ground. The signal is in the form of a frequency modulated carrier wave. This means that the signal is transmitted continuously, but its frequency is constantly changing. So at any point in time the frequency of the signal being transmitted differs from that of the reflected signal being received.

Because the rate of change of the frequency modulation is constant, the difference between the transmitted and returning signals is proportional to the time of travel of the signal. This in turn is proportional to the height of the aircraft above the ground. The radio altimeter indication is therefore an indication of the true height of the aircraft above the ground.

The velocity of radio waves through the air is constant, so time of signal travel is proportional to the height of the aerials plus the distances from the aerials to the transmitter and receiver. But these distances have no particular significance, whereas knowing the height of the main wheels above the ground is vitally important to ensure smooth landings. So most systems allow for the time the signal takes to pass through the aircraft, the height of the aerials above the main wheels, and the signal processing time. It should however be noted that the signal processing time is the most significant of these factors, so option c is the most appropriate in this question.

RADIO ALTIMETERS 7 c.
Commercial aircraft low altitude radio altimeters operate between 4200 MHz and 4400 MHz, in the SHF waveband (option c).

RADIO ALTIMETERS 8 c.
Commercial aircraft radio altimeters operate between 4200 MHz and 4400 MHz, in the SHF waveband (option c).

RADIO ALTIMETERS 9 c.
Radio altimeters operate on the basis of transmitting a radio signal down to the surfaces and receiving the returning wave after it has been reflected by the ground. The signal is in the form of a frequency modulated carrier wave (option c). This means that the signal is transmitted continuously, but its frequency is constantly

changing. So at any point in time the frequency of the signal being transmitted differs from that of the reflected signal being received.

Because the rate of change of the frequency modulation is constant, the difference between the transmitted and returning signals is proportional to the time of travel of the signal. This in turn is proportional to the height of the aircraft above the ground. The radio altimeter indication is therefore an indication of the true height of the aircraft above the ground.

RADIO ALTIMETERS 10 b.
Radio altimeters operate on the basis of transmitting a radio signal down to the surfaces and receiving the returning wave after it has been reflected by the ground. The signal is in the form of a frequency modulated carrier wave. This means that the signal is transmitted continuously, but its frequency is constantly changing. So at any point in time the frequency of the signal being transmitted differs from that of the reflected signal being received.

Because the rate of change of the frequency modulation is constant, the difference between the transmitted and returning signals is proportional to the time of travel of the signal. This in turn is proportional to the height of the aircraft above the ground. The radio altimeter indication is therefore an indication of the true height of the aircraft above the ground. Option b is therefore the most appropriate in this question.

RADIO ALTIMETERS 11 c.
Commercial aircraft Radio Altimeters operate between 4200 MHz and 4400 MHz, in the SHF waveband (option c).

RADIO ALTIMETERS 12. c.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The frequency modulation of the transmitted wave is changed at a constant rate. By measuring the phase difference between the transmitted and returning waves, the system calculates the time of travel of the returning wave. The wave will have passed from the aerial, down to the surface of the earth and back again, which is twice the height of the aerial. Radio signals travel at the speed of light, so the time taken from transmission to return of the signal, is divided by twice the speed of light. This gives an indication of the true height of the aerial above the surface from which the signal was reflected. The entire system is carried within the aircraft, so option c is the most appropriate.

RADIO ALTIMETERS 13. a.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The frequency modulation of the transmitted wave is changed at a constant rate. By measuring the phase difference between the transmitted and returning waves, the system calculates the time of travel of the returning wave. The wave will have passed from the aerial, down to the surface of

the earth and back again, which is twice the height of the aerial. Radio signals travel at the speed of light, so the time taken from transmission to return of the signal, is divided by twice the speed of light.

RADIO ALTIMETERS 14. c.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The frequency modulation of the transmitted wave is changed at a constant rate. By measuring the phase difference between the transmitted and returning waves, the system calculates the time of travel of the returning wave. The wave will have passed from the aerial, down to the surface of the earth and back again, which is twice the height of the aerial. Radio signals travel at the speed of light, so the time taken from transmission to return of the signal, is divided by twice the speed of light. This gives an indication of the true height of the aerial above the surface from which the signal was reflected. This gives an indication of the true height of the aerial above the surface from which the signal was reflected. In order to increase the accuracy of the system, and to reduce landing impacts during automatic landings, the calculated distance is often adjust to represent the height of the main wheels above the ground (option c).

RADIO ALTIMETERS 15. c.
Commercial aircraft low altitude radio altimeters operate between 4200 MHz and 4400 MHz, in the SHF waveband. This means that their wavelength is 7.1 cm and 6.8 cm. So the radio altimeter signal wavelength is centimetric.

RADIO ALTIMETERS 16. d.
Commercial aircraft radio altimeters operate between 4200 MHz and 4400 MHz, in the SHF waveband.

RADIO ALTIMETERS 17. a.
A typical radio altimeter system display includes a needle mask located in a narrow segment between its maximum effective altitude of 2500 ft and its minimum effective altitude of zero ft. If a system fault develops, the needle will go behind the mask and an alarm flag will appear in the centre of the display. In some systems an audio warning is also provided.

RADIO ALTIMETERS 18. d.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The frequency modulation of the transmitted wave is changed at a constant rate. By measuring the phase difference between the transmitted and returning waves, the system calculates the time of travel of the returning wave. The wave will have passed from the aerial, down to the surface of the earth and back again, which is twice the height of the aerial. Radio signals travel at the speed of light, so the time taken from transmission to return of the signal, is divided by twice the speed of light. This gives an indication of the true height of the aerial above the ground or water over which the aircraft is flying.

RADIO ALTIMETERS 19. d.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The frequency modulation of the transmitted wave is changed at a constant rate. By measuring the phase difference between the transmitted and returning waves, the system calculates the time of travel of the returning wave. The wave will have passed from the aerial, down to the surface of the earth and back again, which is twice the height of the aerial. Radio signals travel at the speed of light, so the time taken from transmission to return of the signal, is divided by twice the speed of light. This gives an indication of the true height above the surface from which the signal was reflected. All components of the system are housed within the aircraft.

RADIO ALTIMETERS 20. d.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The frequency modulation of the transmitted wave is changed at a constant rate. By measuring the phase difference between the transmitted and returning waves, the system calculates the time of travel of the returning wave. The wave will have passed from the aerial, down to the surface of the earth and back again, which is twice the height of the aerial. Radio signals travel at the speed of light, so the time taken from transmission to return of the signal, is divided by twice the speed of light. This gives an indication of the true height of the aircraft above the terrain or water over which it is flying.

RADIO ALTIMETERS 21. d.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The frequency modulation of the transmitted wave is changed at a constant rate. By measuring the phase difference between the transmitted and returning waves, the system calculates the time of travel of the returning wave. The wave will have passed from the aerial, down to the surface of the earth and back again, which is twice the height of the aerial. Radio signals travel at the speed of light, so the time taken from transmission to return of the signal, is divided by twice the speed of light. This gives an indication of the true height of the aircraft above the terrain or water over which it is flying. So failure of the radio altimeter will result in loss of height data (option d). It should however be noted that altitude data will still be available from the barometric altimeters.

RADIO ALTIMETERS 22. d.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The frequency modulation of the transmitted wave is changed at a constant rate. By measuring the phase difference between the transmitted and returning waves, the system calculates the time of travel of the returning wave. The wave will have passed from the aerial, down to the surface of the earth and back again, which is twice the height of the aircraft. Radio signals travel at the speed of light, so the time taken from transmission to return of the signal, is divided by twice the speed of light. This gives an indication of the true height of the aerial above the surface from which the signal was reflected.

The maximum effective height is determined by the duration of each frequency modulation cycle. If height is too great there is a danger that the reflection from one cycle might be interpreted as coming from a subsequent cycle (option d). To prevent such confusion, systems are designed such that heights above their maximum effective range are ignored. It should be noted that the attenuation rate and detection range of radio signals vary with atmospheric conditions, so options a, b, and c are incorrect.

RADIO ALTIMETERS 23. a.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The frequency modulation of the transmitted wave is changed at a constant rate. By measuring the phase difference between the transmitted and returning waves, the system calculates the time of travel of the returning wave. The wave will have passed from the aerial, down to the surface of the earth and back again, which is twice the height of the aerial. Radio signals travel at the speed of light, so the time taken from transmission to return of the signal, is divided by twice the speed of light. This gives an indication of the true height above the surface from which the signal was reflected. The entire system is carried within the aircraft, so option c is the most appropriate. Some military systems employ pulse modulation, but this is unlikely to be the correct answer in a JAR ATPL or CPL examination.

RADIO ALTIMETERS 24. d.
Commercial aircraft low altitude radio altimeters operate between 4200 MHz and 4400 MHz, in the SHF waveband.

RADIO ALTIMETERS 25. a.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The frequency modulation of the transmitted wave is changed at a constant rate. By measuring the phase difference between the transmitted and returning waves, the system calculates the time of travel of the returning wave. The wave will have passed from the aerial, down to the surface of the earth and back again, which is twice the height of the aerial. Radio signals travel at the speed of light, so the time taken from transmission to return of the signal, is divided by twice the speed of light. This gives an indication of the true height above the surface from which the signal was reflected. Some military systems employ pulse modulation, but this is unlikely to be the correct answer in a JAR ATPL or CPL examination.

RADIO ALTIMETERS 26. b.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The signal is transmitted continuously, but its frequency is constantly modulated. This means that at any point in time the frequency of the signal it is transmitting differs from that of the reflected signal it is receiving. The difference between these two frequencies is proportional to the time of travel of the signal from the transmitter to the receiver. The velocity of radio waves through the

air is constant, so time of signal travel is proportional to the height of the aerials plus the distances from the aerials to the transmitter and receiver. But these distances have no particular significance, whereas knowing the height of the main wheels above the ground is vitally important to ensure smooth landings. So most systems allow for the time the signal takes to pass through the aircraft (2) and the height of the aerials above the main wheels (3). So option b is the most appropriate.

RADIO ALTIMETERS 27. d.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. Radio altimeters operate on the basis of transmitting a radio carrier wave signal down to the surfaces an measuring the time take for it to be reflected back to the aircraft. The signal is transmitted continuously, but its frequency is constantly modulated. This means that at any point in time the frequency of the signal it is transmitting differs from that of the reflected signal it is receiving. The difference between these two frequencies is proportional to the time of travel of the signal.

The maximum effective height is determined by the duration of each frequency modulation cycle. If height is too great there is a danger that the reflection from one cycle might be interpreted as coming from a subsequent cycle (option d). To prevent such confusion, systems are designed such that heights above their maximum effective range are ignored. Commercial systems are typically accurate between zero and 2500 ft agl.

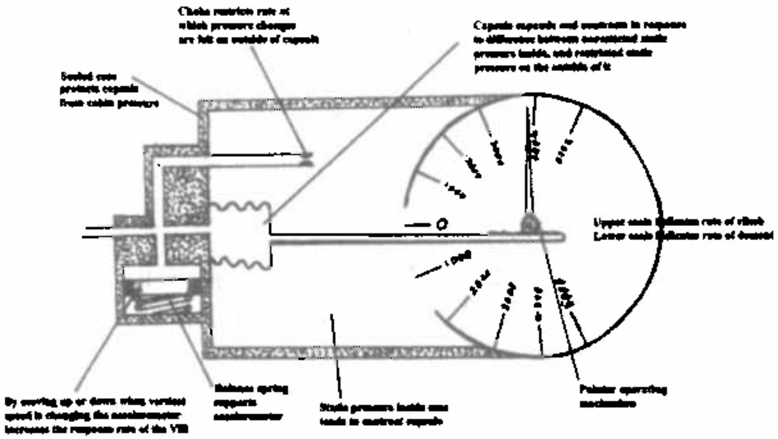
RADIO ALTIMETERS 28. d.
Commercial aircraft low altitude radio altimeters operate between 4200 MHz and 4400 MHz, in the SHF waveband.

RADIO ALTIMETERS 29. d.
Radio altimeters operate by transmitting a frequency modulated radio carrier wave down to the ground. The frequency modulation of the transmitted wave is changed at a constant rate. By measuring the phase difference between the transmitted and returning waves, the system calculates the time of travel of the returning wave. The wave will have passed from the aerial, down to the surface of the earth and back again, which is twice the height of the aerial. Radio signals travel at the speed of light, so the time taken from transmission to return of the signal, is divided by twice the speed of light. This gives an indication of the true height of the aircraft above the ground or water over which it is flying. All components of the system are housed within the aircraft, so options a, and b are untrue. It should be noted that the altitude at any given height, varies with atmospheric conditions, so options a, and c are untrue.

VSI 1. c.
A VSI provides an indication of vertical speed based on the rate of change of static pressure. It is not connected in any way to the pitot pressure source, and so it is unaffected by blockage or partial blockage of that source.

VSI 2. c.
A VSI provides an indication of vertical speed based on the rate of change of static pressure. Partial blockage of the static pipe will reduce the rate at which such changes are fed to the VSI. This will cause the VSI indications to lag behind the actual vertical speeds. So when climbing or descending, a partly blocked static pipe will cause the VSI indications to be too low. So option c is true and options a and d are untrue. It should also be noted that VSI indications are in no way related to forward accelerations, so option b is untrue.

VSI 3. a.



Typival Instantaneous Vertical Speed Indicator (IVSI)

An Instantaneous Vertical Speed Indicator (IVSI) is illustrated in the diagram above. A VSI provides an indication of vertical speed based on the rate of change of static pressure. In the case of very small vertical speeds, the rates of change of static pressure are very low. Such changes are difficult to measure accurately, so VSIs are less accurate at low rates of climb or descent. In the Instantaneous Vertical Speed Indicator or IVSI, this problem is overcome by the use of dashpots. These are small metal weights or pistons supported by light springs, and housed in chambers attached to the VSI pressure inlets. When an aircraft begins to climb or descend, the vertical acceleration causes these weights to move down or up respectively. This instantly changes the pressure acting on the capsule within the VSI, so that the change in vertical speed is immediately indicated. When the aircraft settles into a constant vertical speed, the weights settle into a balanced position against the springs, and cease to affect the pressure in the instrument.

VSI 4. d.

A VSI provides an indication of vertical speed based on the rate of change of static pressure. As illustrated in the diagram in answer number 3 above, the choke is fitted in the pipe carrying static pressure into the space around the capsule in a VSI.

Static pressure is fed at an unrestricted rate into a capsule. This means that the rate of change of static pressure inside the capsule is determined only by the vertical speed of the aircraft. Static pressure is also fed, at a restricted rate into the space around the capsule. This restricted flow into the spaces around the capsule is maintained by a choke. At any instant in a climb or descent, the difference between the pressures inside and outside the capsule will be proportional to the difference between the two flow rates. The restricted rate is constant, so the pressure difference between that inside and outside the capsule is determined by the rate of change of ambient static pressure. This in turn is determined by vertical speed.

If the choke becomes partly blocked, the flow rate through it will be further reduced. This will increase the pressure difference whenever the aircraft is climbing or descending. This in turn will cause the VSI indication to be too high when climbing or descending. So option is d is true and b is untrue. Whenever the vertical speed is zero, there is no flow into or out of the VSI, The VSI indications will therefore be correct when vertical speed is zero. So option c is untrue. It should also be noted that option a, is true but incomplete in that it does not include the high indications when descending.

VSI 5. b.

A VSI provides an indication of vertical speed based on the rate of change of static pressure. As illustrated in the diagram in answer number 3 above, the choke is fitted in the pipe carrying static pressure into the space around the capsule in a VSI.

Static pressure is fed at an unrestricted rate into a capsule. This means that the rate of change of static pressure inside the capsule is determined only by the vertical speed of the aircraft. Static pressure is also fed, at a restricted rate into the space around the capsule. This restricted flow into the spaces around the capsule is maintained by a choke. At any instant in a climb or descent, the difference between the pressures inside and outside the capsule will be proportional to the difference between the two flow rates. The restricted rate is constant, so the pressure difference between that inside and outside the capsule is determined by the rate of change of ambient static pressure. This in turn is determined by vertical speed.

If the static pipe becomes blocked, changes in static pressure will no longer be fed into the VSI, so vertical speed indications will fall to zero. In order to overcome this problem, some aircraft are provided with a standby static pressure source. This is normally located somewhere within the structure, in order to protect it from blockage by debris or icing. So if the static source becomes the blocked the problem might be overcome by selecting the standby static source (option b). It should however be noted that this will be effective only if the blockage is upstream of the point where the two sources are connected.

Although breaking the VSI glass (option a) will allow cabin pressure into the VSI casing, this will not permit the instrument to operate. This is because such action will bypass the choke, thereby allowing unrestricted flow into the space around the capsule, whilst failing to allow any pressure changes into the capsule.
Opening the cabin windows (option d)will have be ineffective, because there is no direct path from the cabin into the VSI. Calculating vertical speed mathematically might be possible, but would be unacceptably cumbersome and probably inaccurate.

VSI 6. d.

A VSI provides an indication of vertical speed based on the rate of change of static pressure. As illustrated in the diagram in answer number 3 above, the choke is fitted in the pipe carrying static pressure into the space around the capsule in a VSI.

Static pressure is fed at an unrestricted rate into a capsule. This means that the rate of change of static pressure inside the capsule is determined only by the vertical speed of the aircraft. Static pressure is also fed, at a restricted rate into the space around the capsule. This restricted flow into the spaces around the capsule is maintained by a choke. At any instant in a climb or descent, the difference between the pressures inside and outside the capsule will be proportional to the difference between the two flow rates. The restricted rate is constant, so the pressure difference between that inside and outside the capsule is determined by the rate of change of ambient static pressure. This in turn is determined by vertical speed.

If the VSI casing develops a leak, the cabin pressure will be able to flow directly into it. This will bypass the choke, so whenever static pressure is changing, the rate at which changes in cabin pressure are felt on outside of the capsule, will increase. But VSI indications are proportional to the difference between the pressures inside and outside the capsule. So one effect of a leaking VSI casing will be to reduce VSI indications whenever the aircraft is climbing or descending.

But cabin pressure in a pressurised aircraft is almost invariably greater than static pressure. So a leaking VSI case will cause the pressure on the outside of the capsule to be generally greater than the static pressure on the inside of it. This represents a rate of climb. Combining the two effects described above, means that a VSI with a leaking case is likely to over indicate when climbing and under indicate when descending (option d). Such a VSI will also indicate a climb when in level flight.

VSI 7. c.

A VSI provides an indication of vertical speed based on the rate of change of static pressure. As illustrated in the diagram in answer number 3 above, the choke is fitted in the pipe carrying static pressure into the space around the capsule in a VSI.

Static pressure is fed at an unrestricted rate into a capsule. This means that the rate of change of static pressure inside the capsule is determined only by the vertical speed of the aircraft. Static pressure is also fed, at a restricted rate into the space around the capsule. This restricted flow into the spaces around the capsule is maintained by a choke. At any instant in a climb or descent, the difference between the pressures inside and outside the capsule will be proportional to the difference between the two flow rates. The restricted rate is constant, so the pressure difference between that inside and outside the capsule is determined by the rate of change of ambient static pressure. This in turn is determined by vertical speed. This pressure difference causes the capsule to expand or contract, thereby moving a pointer to indicate vertical speed.

VSI 8. a.

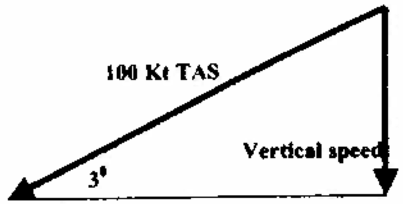
A VSI scale is illustrated in answer number 3. Whenever vertical speed is constant, the needle will remain stationary on the figure representing that rate. But whenever vertical speed is changing, the needle moves upwards or downwards to indicate that change. So whenever ROD is increasing, the needle will be move downwards. A typical VSI is illustrated below.

VSI 9. a.

A VSI provides an indication of vertical speed based on the rate of change of static pressure. When an aircraft moves very close to the ground during a landing, the flow of air around it and the downwash from the wings, are restricted by the ground. This causes a sudden increase in the local static pressure. This in turn can cause VSI indications to become erratic (option a). It should be noted that the static vents are located such that the effects of turbulence and attitude changes are minimised so options b and d are incorrect. The VSI senses only static pressure so the pitot source (option c) has no relevance.

VSI 10. d.

This situation is illustrated in the diagram at the right. From this it can be seen that the sine of the angle of descent or glideslope is equal to the vertical speed divided by the TAS. Rearranging this equation reveals that vertical speed is equal to TAS multiplied by the sine of the glideslope.



So VSI indication = 100 Kts x sin 3° which is = 5.234 Kts.

This can be converted into fpm by multiplying by the conversion factor 100 fpm / 1 Kt.

This gives VSI indication = 523.34 fpm, which is closest to option d, 524 fpm.

VSI 11. d.

A VSI provides an indication of vertical speed based on the rate of change of static pressure. As illustrated in the diagram in answer number 3 above, the choke is fitted in the pipe carrying static pressure into the space around the capsule in a VSI.

Static pressure is fed at an unrestricted rate into a capsule. This means that the rate of change of static pressure inside the capsule is determined only by the vertical speed of the aircraft. Static pressure is also fed, at a restricted rate into the space around the capsule. This restricted flow into the spaces around the capsule is maintained by a choke. At any instant in a climb or descent, the difference between the pressures inside and outside the capsule will be proportional to the difference between the two flow rates. The restricted rate is constant, so the pressure difference between that inside and outside the capsule is determined by the rate of change of ambient static pressure. This in turn is determined by vertical speed.

If the VSI casing develops a leak, the cabin pressure will be able to flow directly into it. This will bypass the choke, so whenever static pressure is changing, the rate at which changes in cabin pressure are felt on outside of the capsule, will increase. But VSI indications are proportional to the difference between the pressures inside and outside the capsule. So one effect of a leaking VSI casing will be to reduce VSI indications whenever the aircraft is climbing or descending.

But cabin pressure in a pressurised aircraft is almost invariably greater than static pressure. So a leaking VSI case will cause the pressure on the outside of the capsule to be generally greater than the static pressure on the inside of it. This represents a rate of climb. Combining the two effects described above, means that a VSI with a leaking case is likely to over indicate when climbing and under indicate when descending (option d). Such a VSI will also indicate a climb when in level flight.

VSI 12. b.
A VSI provides an indication of vertical speed based on the rate of change of static pressure. Static pressure is provided by the static vent, not the pitot tube. So blockage of the pitot pipe, will not affect the VSI indications.

VSI 13. a.
A VSI provides an indication of vertical speed based on the rate of change of static pressure. In the case of very small vertical speeds, the rates of change of static pressure are very low. Such changes are difficult to measure accurately, so VSIs are less accurate at low rates of climb or descent. In the Instantaneous Vertical Speed Indicator or IVSI, this problem is overcome by the use of dashpots. These are small metal weights or pistons supported by light springs, and housed in chambers attached to the VSI pressure inlets as illustrated in answer VSI 3.

When an aircraft begins to climb or descend, the vertical acceleration causes these weights to move down or up respectively. This instantly changes the pressure acting on the capsule within the VSI, so that the change in vertical speed is immediately indicated. When the aircraft settles into a constant vertical speed, the weights settle into a balanced position against the springs, and cease to affect the pressure in the instrument.

The purpose of the choke is to restrict the flow of pressure changes into and out of the casing. This does not affect the response rate of the VSI however, because the flow of static pressure changes into and out of the capsule is not restricted by the choke. VSIs do not employ bi-metallic strips or return springs.

VSI 14. a, b, or c.
When an aircraft sideslips, the leading side of its fuselage is subjected to a component of the dynamic pressure, while the trailing side is affected by turbulent airflow passing over and under the fuselage. This has the effect of increasing the effective static pressure at the leading side of the fuselage and decreasing that at the trailing side of the fuselage is decreased. In large aircraft types this problem is often overcome by fitting a static vent or pressure sensing port at each side of the fuselage.

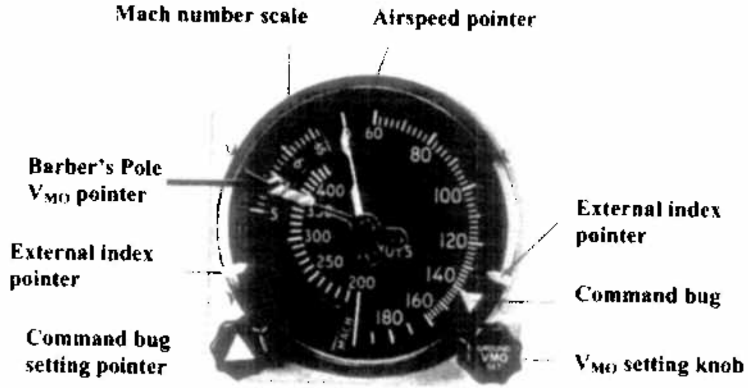
The pipes leading from these vents are connected together, such that the instruments sense the average of the two values of static pressure. Under normal circumstance, the increase in pressure on the leading side is counterbalanced by an equal decrease in pressure on the trailing side, so the average sensed by the instruments is the true static pressure.

But if the vent on the trailing side becomes blocked, this balancing influence is lost, so the instruments will sense an excessively high static pressure. Conversely, a blockage on the leading side will cause an excessively low static pressure to be sensed.

But VSI indications are related not to static pressure, but to the rate of change of static pressure. So if we consider only the sideslip (and ignore the vertical speed),

then the effect of a blocked vent will depend upon the nature of the sideslip. If the rate of sideslip is increasing, towards the blocked port, the static pressure sensed by the VSI will be decreasing. If the sideslip rate is decreasing, then the static pressure sensed by the VSI will be increasing. If the rate of sideslip is constant, then the static pressure will be constant. If we now add on the effects of the descent specified in the question, the effects will be over indicated ROD (option a) in accelerating side slip, Under indicated ROD (option b) in decelerating side slip, and correctly indicated ROD (option c) in constant side slip. This question is badly worded in that the answer depends upon the nature of the sideslip. Option d, fluctuating ROD is improbable.

ASI 1. d.
The term "Barber's Pole" refers to the red and white striped pointer on some combined ASI/Mach Meters. Its purpose is the indicate how V_{MO} varies with changing atmospheric conditions, thereby making the pilot aware of his limiting speed. The principle factor affecting V_{MO} is air density, and this varies with temperature. Option d is therefore the most appropriate in this question. A typical ASI with "Barbers Pole" is illustrated below.



ASI 2. a.
V_{NO} is the maximum speed for normal operations (Velocity Normal Operations). It is based upon the ability of an aircraft to withstand the stresses placed upon it by aerodynamic forces in flight. These forces increase in turbulent conditions, so V_{NO} may be exceeded only with caution and in still air conditions. Option b refers to V_{NE}, the Velocity Never Exceed, which must never be exceeded under any conditions. Option c refers to V_{MO}, the Velocity Maximum Operating, which may be exceeded only in exceptional circumstances such as emergencies. Option d refers to V_A, which is the design control speed.

ASI 3. b.
V_{MO} is the Velocity Maximum Operating. It is based upon the ability of the structure of an aircraft to withstand the stresses placed upon it by the dynamic

pressure in flight. Dynamic pressure equals $1/2\rho V^2$, where V is TAS. So the loads applied to an aircraft in flight are proportional to air density multiplied by TAS^2. But air density varies with altitude and atmospheric conditions, thereby changing the dynamic pressure at any given TAS. So V_{MO} cannot be calculated in terms of TAS (option a).

CAS and RAS are just different terms for the same thing. This is the Indicated Airspeed IAS corrected for instrument errors and position errors. But the IAS indication is generated by sensing dynamic pressure. This means that the dynamic pressure will be constant at any given IAS, CAS and RAS, regardless of changes in atmospheric conditions. So CAS or RAS (options c and d) would give a more accurate measure of V_{MO} than would TAS. Such indication would not however be entirely accurate. This is because V_{MO} is a comparatively high speed and at high speeds, the density of the air is increased by the dynamic pressure itself. This means that at high speed the airspeed indicator over reads by an amount that is dependent upon speed. When this slightly higher CAS indication is reduced by applying the compressibility correction factor, the result is called the Equivalent Airspeed EAS. This is the parameter that is used to calculate V_{MO} (option b). It should however be noted that V_{MO} is specified in terms of CAS.

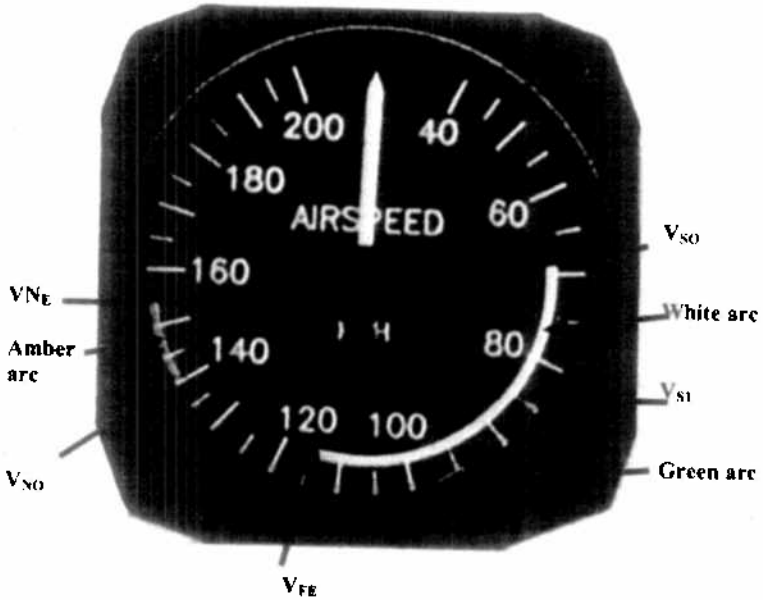
ASI 4. a.

The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot pressure to the inside of a capsule and feeding static pressure to the outside. This means that pitot pressure is attempting to expand the capsule while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between pitot and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between the two is simply dynamic pressure. So in normal operation the capsule moves and the ASI indications change, in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

If the pitot tapping and drain hole become blocked, the capsule will be unable to sense changes in pitot pressure. It will therefore no longer respond to changes in dynamic pressure. So changes in speed will not cause changes in the airspeed indication. So options c and d are incorrect. But the outer surface of the capsule will still be subjected to changes in static pressure. Static pressure changes with pressure altitude, so rather than simply not indicating, the ASI will produce indications proportional to changes in pressure altitude. So option b is incorrect and option a is correct.

ASI 5. a.

The dials of ASIs often include coloured arcs to indicate various significant speeds. A yellow arc is intended to indicate the cautionary, high speed zone, where extra care must be observed to avoid over stressing the structure. This zone is between the maximum Velocity for Normal Operations, V_{NO}, to the Velocity that must Never be Exceeded, V_{NE}. So the upper end marks V_{NE} and the lower end V_{NO}. A typical ASI is illustrated below.



TYPICAL AIRSPEED INDICATOR

ASI 6. a.

The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot pressure to the inside of a capsule and feeding static pressure to the outside. This means that pitot pressure is attempting to expand the capsule while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between pitot and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between the two is simply dynamic pressure. So in normal operation the capsule moves and the ASI indications change, in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

If the pitot tapping and drain hole become blocked, the capsule will be unable to sense changes in pitot pressure. It will therefore no longer respond to changes in dynamic pressure. So changes in speed will not cause changes in the airspeed indication. But the outer surface of the capsule will still be subjected to changes in static pressure. Static pressure changes with pressure altitude, so rather than simply not indicating, the ASI will produce indications proportional to changes in pressure altitude. When descending, the increasing static pressure will be felt only on the outside of the capsule, causing it to contract. This will reduce the airspeed indication, thereby causing the ASI to under read when descending.

ASI 7. a.
An airspeed indicator produces an indication of airspeed IAS that is proportional to $\frac{1}{2} \rho V^2$, where ρ is air density and V is TAS. For any given value of $\frac{1}{2} \rho V^2$ the IAS will be constant. But density decreases with increasing altitude so that for a given IAS, the TAS must increase such that the rate of increase in V^2 balances the rate of decrease in ρ, such that $\frac{1}{2} \rho V^2$ remains constant. At 40000 feet ISA, for example, air density is ¼ of its msl value, so for any given IAS, V^2 must be 4 times its MSL value. This means that V, which is TAS, must be twice its sea level value.

The accuracy of airspeed indications is of greatest importance close to the ground, where take-off and landing involves flight very close to the stalling speed. Under ideal circumstances a perfect ASI sensing pressures with perfect accuracy, would be calibrated such that IAS and TAS were equal at ground level. But individual instruments exhibit differing degrees of mechanical imperfections causing instrument error, and pitot probes cannot be arranged to sense pitot and static pressures accurately under all flight conditions. The Calibrated Airspeed or CAS, takes account of these errors, so ASIs are calibrated such that CAS = TAS at msl in the international standard atmosphere.

ASI 8. a.
The weight of the air above any point in the atmosphere presses down upon it, exerting a static pressure. This static pressure at any point in still air, acts with equal magnitude in all directions, so the pitot probe will sense static pressure. But the pitot probe faces in the direction of flight, so air flowing into it is brought to rest. This exerts an additional dynamic pressure that is equal to $\frac{1}{2} \rho V^2$, where ρ is air density and V is the true speed of the air or TAS. So a pitot probe senses the sum of the static and dynamic pressures. This is termed the total pressure or stagnation pressure.

ASI 9. d.
The dials of ASIs often include coloured arcs to indicate various significant speeds. In twin engine aircraft, the failure of one engine during or after take-off will reduce the ability of the aircraft to climb away from the ground. This is potentially hazardous, so it is important that the pilot should be aware of the speed at which rate of climb in this single engine condition will be greatest. The speed at which rate of climb is greatest is termed V_Y, and in the single engine condition this is termed V_Y Single Engine or V_{YSE}. On twin piston engine aircraft the ASI includes a blue radial line indicating V_{YSE}. In the case of an engine failure after V_1 during take-off, the pilot must immediately feather the failed prop and accelerate to the blue line speed V_{YSE}. This process is commonly referred to as "blue lining it".

ASI 10. b.
The dials of ASIs often include coloured arcs to indicate various significant speeds. The white arc indicates the range of speeds between the minimum and maximum speeds for flight with flaps extended to the take-off position. The lowest flight speed in this condition is the stalling speed, which is usually termed V_{S0}. The highest Velocity for flight with Flaps Extended is V_{FE}. The ends of the white arc are V_{S0} and V_{FE} (option b).

ASI 11. a.
V_{FE} is the maximum Velocity with Flaps Extended. This is sometimes confused with V_{FO}, which some students misinterpret as maximum Velocity with Flaps Out. V_{FO} is in fact the maximum Velocity at which the Flap system can be Operated (extended or retracted)

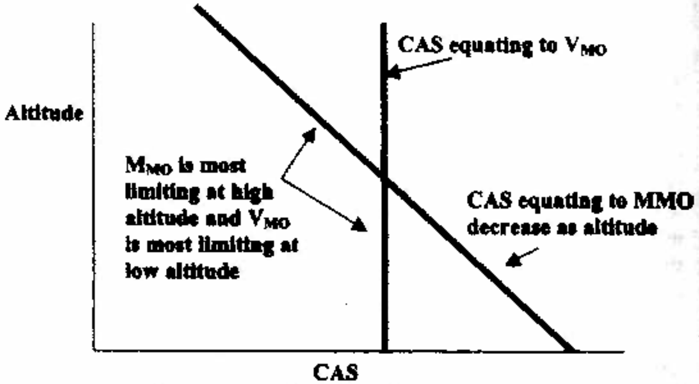
ASI 12. b.
The ASI indication is proportional to dynamic pressure, which is the difference between pitot pressure and static pressure. If the pitot tube fractures, within the structure of the aircraft, air will either leak into or out of the pitot tube, depending on whether the static pressure in the aircraft is lower or higher than pitot pressure. In an unpressurised aircraft, the static pressure within the structure will always be less than pitot. So air will leak out of the fractured pipe causing pitot pressure to decrease. This will cause the ASI to under read. In a pressurised aircraft however, the static pressure in the cabin might be greater than pitot, in which case the ASI would over read.

ASI 13. a.
CAS is IAS corrected for instrument error and position error, so CAS is directly proportional to IAS. IAS is proportional to dynamic pressure $1/2\rho V^2$, where ρ is air density and V is TAS. So the same CAS will always occur at the same value of $1/2\rho V^2$. But Lift is also proportional to $1/2\rho V^2$. Lift-off will occur when the lift is equal to the weight of an aircraft, so for any given weight, lift-off will always occur at the same value $1/2\rho V^2$, and therefore at the same value of CAS. But TAS and EAS at any given CAS vary with altitude, whilst groundspeed at any given CAS varies with wind speed. So only option a is correct.

ASI 14. b.
The accuracy of airspeed indications is of greatest importance close to the ground, where take-off and landing involves flight very close to the stalling speed. Under ideal circumstances a perfect ASI sensing pressures with perfect accuracy, would be calibrated such that IAS and TAS were equal at ground level. But individual instruments exhibit differing degrees of mechanical imperfections causing differing instrument errors, and pitot probes cannot be arranged to sense pitot and static pressures accurately under all flight conditions. The Calibrated Airspeed or CAS, takes account of these errors, such that CAS is IAS corrected for instrument error and position error.

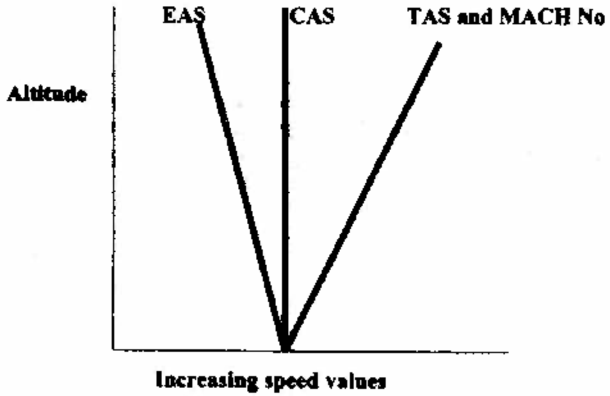
ASI 15. c.
The maximum speed at which an aircraft may be routinely flown is limited by the ability of the structure to support the resulting aerodynamic loads and by the compressibility effects encountered when flying close to the local speed of sound.

At low altitudes the calibrated airspeed producing limiting aerodynamic loads is the limiting value. This is called V_{MO}. The mach number at which compressibility effects become the limiting value is termed M_{MO}. As altitude is increased, the local speed of sound decreases, thereby reducing the CAS equating to M_{MO}. At the crossover altitude, the speed equating to M_{MO} is equal to that equating to V_{MO}. At higher altitudes V_{MO} is greater than M_{MO} and at lower altitudes M_{MO} is greater than V_{MO}. When attempting to maintain maximum ground speed in a descent, M_{MO} will be the limiting value at high altitude and V_{MO} will be the limiting value at lower altitude. This relationship is illustrated below.



ASI 16. a.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When descending, whether in an isothermal layer or in a normal atmosphere, the pressure increases. This causes the TAS at any given CAS to decrease. So when descending at constant CAS the TAS decreases. An isothermal layer is one in which the temperature does not vary with altitude. Although this alters the rate of change of density and TAS:CAS ratio, TAS still decreases in a constant CAS descent. The graphical representation of these effects is illustrated below.



Relationship between EAS, CAS, TAS and Mach number in an isothermal layer

ASI 17 a.

In an inversion the normal relationship between temperature and altitude is reversed, so descending causes temperature to decrease. The local speed of sound (LSS) is determined by temperature alone, so decreasing temperature causes the local speed of sound to decrease. Mach number represents TAS as a fraction of LSS, so as the LSS decreases, the Mach number at any given TAS increases. So when descending through an inversion at any given TAS, the temperature and LSS decrease, causing the mach number to increase. This is the opposite to what happens in a normal atmosphere. So option a is correct and options b and c are incorrect.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When descending, whether in an inversion or in a normal atmosphere, the pressure increases. This causes the CAS at any given TAS to increase. So option d is incorrect.

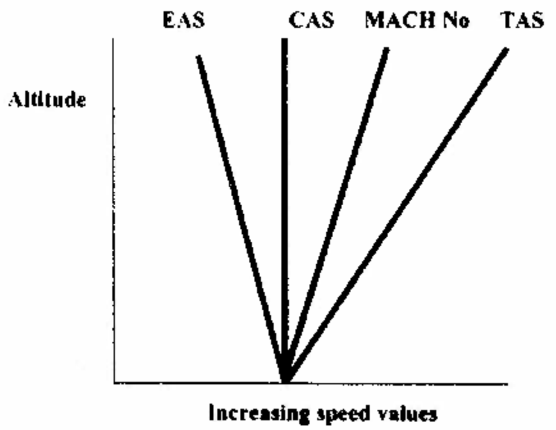
ASI 18 b.

In an inversion the normal relationship between temperature and altitude is reversed, so climbing causes temperature to increase. The local speed of sound (LSS) is determined by temperature alone, so increasing temperature causes the local speed of sound to increase. Mach number represents TAS as a fraction of LSS, so as the LSS increases, the Mach number at any given TAS decreases. So when climbing through an inversion at any given TAS, the temperature and LSS increase, causing the mach number to decrease. This the opposite to what happens in a normal atmosphere. So option b is correct and options a and c incorrect.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When climbing, whether in an inversion or in a normal atmosphere, the pressure decreases. This causes the CAS at any given TAS to decrease. So when climbing at constant TAS the CAS decreases. So option d is incorrect.

ASI 19 d.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When descending, whether in an inversion or in a normal atmosphere, the pressure increases. This causes the TAS at any given CAS to decrease. So when descending at constant CAS, the TAS decreases. So option d is correct. The relationship between EAS, CAS, TAS and Mach number in an inversion is illustrated below.



Relationship between EAS, CAS, TAS and Mach number in an Inversion

ASI 20 a.
As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When climbing, whether in an inversion or in a normal atmosphere, the pressure decreases. This causes the TAS at any given CAS to increase. So when climbing at constant CAS, the TAS increases. So option a is correct.

ASI 21 d.
In an inversion the normal relationship between temperature and altitude is reversed, so climbing causes temperature to increase. The local speed of sound (LSS) is determined by temperature alone, so increasing temperature causes the local speed of sound to increase. Mach number represents TAS as a fraction of LSS, so if the LSS increases, the mach number at any given TAS decreases. So when climbing through an inversion at any given mach number, the temperature and LSS increase, causing the TAS to increase. So option d is correct.

ASI 22 b.
In an inversion the normal relationship between temperature and altitude is reversed, so descending causes temperature to decrease. The local speed of sound (LSS) is determined by temperature alone, so decreasing temperature causes the local speed of sound to decrease. Mach number represents TAS as a fraction of LSS, so if the LSS decreases, the TAS at any given mach number decreases. So when descending through an inversion at any given mach number, the temperature and LSS decrease, causing the TAS to decrease (option b).

ASI 23 d.
In an inversion the normal relationship between temperature and altitude is reversed, so climbing causes temperature to increase. The local speed of sound (LSS) is determined by temperature alone, so increasing temperature causes the local speed of sound to increase. Mach number represents TAS as a fraction of LSS, so if the LSS increases, the mach number at any given TAS decreases. So when climbing through an inversion at any given mach number, the temperature and LSS increase, causing the TAS to increase. Option d is therefore correct.

ASI 24 d.
In an inversion the normal relationship between temperature and altitude is reversed, so descending causes temperature to decrease. The local speed of sound (LSS) is determined by temperature alone, so decreasing temperature causes the local speed of sound to decrease. Mach number represents TAS as a fraction of LSS, so if the LSS decreases, the mach number at any given TAS increases. So when descending through an inversion at any given mach number, the temperature and LSS decrease, causing the TAS to decrease. Option d is therefore correct and option c incorrect. Also because temperature and LSS both decrease when descending in an inversion, option b is incorrect.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When descending, whether in an inversion or in a normal atmosphere, the pressure increases. This causes the TAS at any given CAS to decrease. So when descending at constant TAS the CAS increases. So option a is also incorrect.

ASI 25 a.
As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When climbing, whether in an inversion or in a normal atmosphere, the pressure decreases. This causes the TAS at any given CAS to increase. So when climbing at constant CAS the TAS increases (option a).

ASI 26 b.
As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When descending, whether in an inversion or in a normal atmosphere, the pressure increases. This causes the TAS at any given CAS to decrease. So when descending at constant CAS the TAS decreases. So option b is correct.

ASI 27 c.
An isothermal layer is one in which the temperature does not vary with altitude. The local speed of sound is determined by temperature alone, so in an isothermal layer the LSS is constant at all altitudes. Mach number represents the TAS as a fraction of the LSS, so in an isothermal layer the Mach number at any given TAS is constant. So option c is correct and options a and b are incorrect.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When descending, whether in an isothermal layer or in a normal atmosphere, the pressure increases. This causes the CAS at any given TAS to increase. So when descending at constant TAS the CAS increases. So option d is incorrect.

ASI 28 c.
An isothermal layer is one in which the temperature does not vary with altitude. The local speed of sound is determined by temperature alone, so in an isothermal Layer the LSS is constant at all altitudes. Mach number represents the TAS as a fraction of the LSS, so in an isothermal layer the Mach number at any given TAS is constant. So option c is correct and options a and b are incorrect.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When descending, whether in an isothermal layer or in a normal atmosphere, the pressure increases. This causes the CAS at any given TAS to increase. So when climbing at constant TAS the CAS increases. So option d is incorrect.

ASI 29 b.
As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When descending, whether in an isothermal layer or in a normal atmosphere, the pressure increases. This causes the TAS at any given CAS to decrease. So when descending at constant CAS the TAS decreases. So option d is incorrect.

An isothermal layer is one in which the temperature does not vary with altitude. The local speed of sound is determined by temperature alone, so in an isothermal layer the LSS is constant at all altitudes. Mach number represents the TAS as a fraction of the LSS, so in an isothermal layer the Mach number at any given TAS is constant. But when descending at constant CAS the TAS decreases so the Mach number decreases. Option b is therefore correct and option a and c incorrect.

ASI 30 a.
As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When climbing, whether in an isothermal layer or in a normal atmosphere, the pressure decreases. This causes the TAS at any given CAS to increase. So when climbing at constant CAS the TAS increases. So option d is incorrect.

An isothermal layer is one in which the temperature does not vary with altitude. The local speed of sound is determined by temperature alone, so in an isothermal layer the LSS is constant at all altitudes. Mach number represents the TAS as a fraction of the LSS, so in an isothermal layer the Mach number at any given TAS is constant. But when climbing at constant CAS the TAS increases so the Mach number increases. Option a is therefore correct and option b and c incorrect.

ASI 31 c.
An isothermal layer is one in which the temperature does not vary with altitude. The local speed of sound is determined by temperature alone, so in an isothermal layer the LSS is constant at all altitudes. Mach number represents the TAS as a fraction of the LSS, so in an isothermal layer the Mach number at any given TAS is constant. So when climbing at constant Mach number in an isothermal the TAS remains constant. Option c is therefore correct and option a and b incorrect.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When climbing, whether in an isothermal layer or in a normal atmosphere, the pressure decreases. This causes the CAS at any given TAS to decrease. So when climbing at constant Mach number and constant TAS in an isothermal, CAS decreases. So option d is incorrect.

ASI 32 c.
An isothermal layer is one in which the temperature does not vary with altitude. The local speed of sound is determined by temperature alone, so in an isothermal layer the LSS is constant at all altitudes. Mach number represents the TAS as a fraction of the LSS, so in an isothermal layer the Mach number at any given TAS is constant. So when descending at constant mach number in an isothermal the TAS remains constant. Option c is therefore correct and option a and b incorrect.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When descending, whether in an isothermal layer or in a normal atmosphere, the pressure increases. This causes the CAS at any given TAS to increase. So when descending at constant Mach number and constant TAS in an isothermal, CAS increases. So option d is incorrect.

ASI 33 b.
An isothermal layer is one in which the temperature does not vary with altitude. The local speed of sound is determined by temperature alone, so in an isothermal layer the LSS is constant at all altitudes. Mach number represents the TAS as a fraction of the LSS, so in an isothermal layer the Mach number at any given TAS is constant. So when climbing at constant Mach number in an isothermal the TAS remains constant. Option d is therefore incorrect.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When climbing , whether in an isothermal layer or in a normal atmosphere, the pressure decreases. This causes the CAS at any given TAS to decrease. So when climbing at constant Mach number and constant TAS in an isothermal, CAS decreases. So option b is correct and a and c incorrect.

ASI 34 c.
An isothermal layer is one in which the temperature does not vary with altitude. The local speed of sound is determined by temperature alone, so in an isothermal layer the LSS is constant at all altitudes. Mach number represents the TAS as a fraction of the LSS, so in an isothermal layer the Mach number at any given TAS is

constant. So when descending at constant CAS in an isothermal the LSS remains constant. Option c is therefore correct and options a and b incorrect.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When descending , whether in an isothermal layer or in a normal atmosphere, the pressure increases. This causes the TAS at any given CAS to decrease. So when descending at constant CAS in an isothermal, TAS decreases. So option d is incorrect.

ASI 35 a.

An isothermal layer is one in which the temperature does not vary with altitude. The local speed of sound is determined by temperature alone, so in an isothermal layer the LSS is constant at all altitudes. Mach number represents the TAS as a fraction of the LSS, so in an isothermal layer the Mach number at any given TAS is constant. So when climbing at constant CAS in an isothermal the LSS remains constant.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When climbing, whether in an isothermal layer or in a normal atmosphere, the pressure decreases. This causes the TAS at any given CAS to increase. So when climbing at constant CAS in an isothermal, TAS increases. But LSS is constant in an isothermal, so increasing TAS causes Mach number to increase. So option a is correct and option b, c and d, are incorrect.

ASI 36 b.

As altitude changes, the main factor controlling the ratio of TAS : CAS is the ambient air pressure. When descending, whether in an isothermal layer or in a normal atmosphere, the pressure increases. This causes the TAS at any given CAS to decrease. So when descending at constant CAS in an isothermal, TAS decreases. So option b is correct and option a and c incorrect.

An isothermal layer is one in which the temperature does not vary with altitude. The local speed of sound is determined by temperature alone, so in an isothermal layer the LSS is constant at all altitudes. Mach number represents the TAS as a fraction of the LSS, so in an isothermal layer the Mach number at any given TAS is constant. So when descending at constant CAS in an isothermal the decreasing TAS causes Mach number to decrease. Option d is therefore incorrect.

ASI 37 d.

The main factor that determines the CAS at any given TAS is air density. If density decreases then the CAS at any given TAS decreases. Increasing air pressure compresses air thereby increasing its density. Increasing temperature causes air to expand, thereby reducing its density. So if temperature increases at constant pressure the air will expand and its density will decrease. This will decrease the CAS to TAS ratio. So if pressure remains constant and temperature increases the density will decrease and the CAS:TAS ratio will decrease (option d).

ASI 38 d.

The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot pressure to the inside of a capsule and static pressure to the outside. This means that pitot pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between pitot and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between pitot and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change, in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

If the pitot tapping and drain hole become partly blocked, the sensing of changes in pitot pressure will be delayed. It will therefore take longer for the ASI to respond to changes in dynamic pressure. This means that the ASI indication will lag whenever IAS is changing. So when accelerating it will under read and when decelerating it will over read. But after a short period at any steady speed it will give the correct reading.

Changes in altitude do not cause changes in the dynamic pressure at any given IAS. But changes in altitude do cause changes in static pressure. Under normal circumstances these changes in static pressure would be felt simultaneously on both sides of the ASI capsule, so the ASI indication would not change. But with a partly blocked pitot tube, the changes in static pressure will be delayed in getting to the inside of the capsule, but will not be delayed in getting to the outside. So whenever altitude is changing, the resultant force on the capsule will also change. This will cause the capsule to contract when descending and expand when climbing. So the ASI will over indicate when climbing and under indicate when descending.

ASI 39 d.

The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot pressure to the inside of a capsule and static pressure to the outside. This means that pitot pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between pitot and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between pitot and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change, in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

If the pitot tapping and drain hole become partly blocked, the sensing of changes in pitot pressure will be delayed. It will therefore take longer for the ASI to respond to changes in dynamic pressure. This means that the ASI indication will lag whenever IAS is changing. So when accelerating it will under read and when decelerating it will over read. But after a short period at any steady speed it will give the correct reading. So IAS will be too low when accelerating (option d).

ASI 40 a.
The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot pressure to the inside of a capsule and static pressure to the outside. This means that pitot pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between pitot and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between pitot and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change, in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

If the static pipe becomes partly blocked, the sensing of changes in static pressure will be delayed. But the sensing of changes in pitot pressure will not be delayed because these are felt through a separate pitot pipe. So whenever static pressure is changing, the changes will act on the inside of the capsule before they can act on the outside of it. So when descending, the increasing static pressure will expand the capsule causing the ASI to give too high a reading. When climbing the decreasing static pressure will contract the capsule causing the ASI to give too low a reading. This means that the IAS will be too high when descending and too low when climbing.

The vertical speed indicator or rate of climb indicator, gives an indication that is proportional to the rate of change of static pressure. So a partly blocked static pipe will cause the ROC to be too low when climbing and the ROD to be too low when descending.

It should be noted that after a brief period at any given combination of airspeed and altitude both the IAS and ROC indications will be correct. So option a, the IAS and ROC will be too low when climbing , is the most accurate.

ASI 41 a.
The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot pressure to the inside of a capsule and static pressure to the outside. This means that pitot pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between pitot and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between pitot and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change, in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

If the static pipe becomes partly blocked, the sensing of changes in static pressure will be delayed. The sensing of changes in pitot pressure will not be delayed however, because these are felt through a separate pitot pipe. But pitot pressure includes static pressure, so whenever static pressure is changing, the changes will act as part of the pitot pressure on the inside of the capsule before they can act as static pressure on the outside of it. So when descending, the increasing static

component of pitot pressure will expand the capsule causing the ASI to give too high a reading. When climbing, the decreasing static pressure will contract the capsule causing the ASI to give too low a reading. This means that the IAS indication will be too high when descending and too low when climbing at constant IAS. But because the sensing of changes in pitot pressure is not affected, the ASI will remain accurate when accelerating or decelerating at constant altitude. So of the option offered in this question, only option a, "The IAS will be too high when descending at constant IAS", is correct.

ASI 42 b.
The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot pressure to the inside of a capsule and static pressure to the outside. This means that pitot pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between pitot and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between pitot and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change, in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

If the pitot pipe becomes partly blocked, the sensing of changes in pitot pressure on the inside of the capsule will be delayed. The sensing of changes in static pressure on the outside of the capsule will not be delayed however, because these are felt through a separate static pipe. So whenever speed is changing at constant altitude, the ASI indications will lag behind the actual speed. So the ASI will under read when accelerating and over read when decelerating at constant altitude.

But pitot pressure includes static pressure, so whenever static pressure is changing, the changes will act on the outside of the capsule before they can act as part of the delayed pitot pressure on the inside of it. So when descending, the capsule will contract and when climbing it will expand. This means that the ASI indications will be too low when descending and too high when climbing. It should however be noted that the ASI will read accurately after a short period in any combination of speed and altitude.

When climbing at constant CAS, the dynamic pressure remains constant, so the changes in pitot pressure are caused entirely by the reducing static pressure. But when climbing at constant TAS, the CAS is decreasing. This means that in a constant TAS climb, the rate of change of pitot pressure is greater than in an equivalent constant CAS climb. So the ASI errors caused by a partly blocked pitot pipe are greater in a constant TAS climb than in a constant CAS climb (option b)..

ASI 43 a.
Airspeed is expressed in a number of forms. The speed indication provided by an Airspeed Indicator or ASI, corrected for the instrument errors affecting individual instruments is termed Indicated Airspeed or IAS. When IAS has been corrected to account for the inaccuracies that occur in the sensing of pitot and static pressures,

the result is termed Calibrated Airspeed CAS, or Rectified Airspeed RAS. The pressure sensing inaccuracies are caused primarily by the position of the pressure sensors and are called position errors. So CAS is IAS corrected for position errors.

As airspeed increases the air is compressed by the aircraft flow through it. This increases the air density, which in turn increases the IAS at any given combination of airspeed and altitude. When CAS has been corrected to take this compressibility error into account, the result is termed Equivalent airspeed, or EAS. The real or true speed of the aircraft or airflow is called its True airspeed or TAS.

<u>ASI 44 a.</u>

The dials of ASIs often include coloured arcs to indicate various significant speeds. The white arc indicates the range of speeds between the minimum and maximum speeds for flight with flaps extended to the take-off position. The lowest flight speed in this condition is the stalling speed, which is usually termed V_{S0}. The highest <u>V</u>elocity for flight with <u>F</u>laps <u>E</u>xtended is V_{FE}. So the ends of the white arc are V_{S0} and V_{FE}.

It should be noted that some students have reported similar questions, but without the option of V_{S0} and V_{FE}. In such cases, although not strictly accurate the option V_{S1} (which is the flaps up 1g stalling speed) and V_{FE} might be the best one available. But in this question both V_{S1}-V_{FE} and V_{S0}-V_{FE}, are options, so V_{S0}-V_{FE} is the most appropriate. A typical ASI is illustrated below.

<u>TYPICAL AIRSPEED INDICATOR</u>

<u>ASI 45 d.</u>

The ASI produces an indication of speed that is proportional to dynamic pressure. It does this by feeding pitot pressure to the inside of a capsule and static pressure to the outside. This means that pitot pressure is attempting to expand the capsule, while static pressure is attempting to compress it. The resulting expansion is therefore produced by the difference between pitot and static pressures. But pitot pressure is the sum of static pressure plus dynamic pressure, so the difference between pitot and static, is dynamic pressure. So in normal operation the capsule moves and the ASI indications change, in response to changes in dynamic pressure. But dynamic pressure is proportional to indicated airspeed so the capsule moves in proportion to changes in IAS.

If the pitot pipe becomes blocked, changes in pitot pressure will no longer be fed to the inside of the capsule. So the pressure inside the capsule will remain constant and the ASI will cease to respond to changes in airspeed. But changes in static pressure will continue to be sensed by the outside of the capsule. This will cause the ASI to respond to changes in static pressure, in a manner similar to that of a barometric altimeter. As altitude increases, decreasing static pressure will allow the capsule to expand, giving an indication of increasing airspeed. Descending will have the opposite, with increasing static pressure compressing the capsule to give an indication of decreasing airspeed. So with the pitot source blocked the ASI will give an indication proportional to altitude.

<u>ASI 46 d.</u>

The weight of the air above any point in the atmosphere presses down upon it, exerting a static pressure. This static pressure at any point in still air, acts with equal magnitude in all directions, so the pitot probe will sense static pressure. But the pitot probe faces in the direction of flight, so air flowing into it is brought to rest. This exerts an additional dynamic pressure that is equal to $\frac{1}{2} \rho V^2$, where ρ is air density and V is the true speed of the air or TAS. So a pitot probe senses the sum of the static and dynamic pressures. This is termed the total pressure or stagnation pressure.

<u>ASI 47 c.</u>

The term "Barber's Pole" refers to the red and white striped pointer on some combined ASI/Mach Meters. Its purpose is to indicate how V_{MO} varies with changing atmospheric conditions, thereby making the pilot aware of his limiting speed. The principle factor affecting V_{MO} is air density, and this varies with temperature. Option c, is therefore the most appropriate in this question.

<u>ASI 48 b.</u>

Mach number is the ratio of the True Airspeed (TAS) of an aircraft, as a fraction of the local speed of sound (LSS). The LSS is proportional to ambient temperature, so as altitude increases up to the tropopause at 36000 ft, the LSS decreases. So if an aircraft climbs at constant mach number, it will be climbing at reducing TAS. Above 36000 ft, temperature and LSS remain constant. So climbing at constant mach number above 36000 ft means climbing at constant TAS. But as altitude

increases throughout the atmosphere, the CAS at any given TAS decreases. So when climbing at constant mach number at any altitude, the CAS decreases. This rate of decrease is greatest below 36000 ft.

ASI 49 c.

The dials of ASIs often include coloured arcs to indicate various significant speeds. In twin engine aircraft, the failure of one engine during or after take-off will reduce the ability of the aircraft to climb away from the ground. This is potentially hazardous, so it is important that the pilot should be aware of the speed at which rate of climb in this single engine condition will be greatest. The speed at which rate of climb is greatest is termed V_Y, and in the single engine condition this is termed V_Y Single Engine or V_{YSE}. On twin prop aircraft the ASI includes a blue radial line indicating V_{YSE}. In the case of an engine failure after V_1 during take-off, the pilot must immediately feather the failed prop and accelerate to the blue line speed V_{YSE}. This process is commonly referred to as "blue lining it".

ASI 50 a.

The dials of ASIs often include coloured arcs to indicate various significant speeds. A yellow arc is intended to indicate the cautionary, high speed zone, where extra care must be observed to avoid over stressing the structure. This zone is between the maximum Velocity for Normal Operations, V_{NO}, to the Velocity that must Never be Exceeded, V_{NE}. So the lower end marks V_{NO} and the upper end V_{NE}. It should however be noted that on some altimeters, the upper end of the yellow band marks the rough air penetration speed, V_{RA}.

ASI 51 a.

V_{NE}, is the maximum speed at which an aircraft may be flown under any circumstances. The letters V_{NE} indicate the Velocity that must Never be Exceeded. The maximum Velocity for Normal Operations is V_{NO}. The best climb speed is termed V_X and the maximum speed permitted in a dive under exceptional circumstances is the Velocity Maximum Operating, which is termed V_{MO}.

ASI 52 b.

The maximum Velocity permitted for flight with Flaps Extended is V_{FE}. The maximum Velocity permitted for Flap system Operation (retracting or lowering the flaps) is V_{FO}. The maximum speed permitted at any point in the flight envelope is the Velocity Never Exceed, or V_{NE}.

ASI 53 b.

V_{LO} is the maximum permitted Velocity for Landing gear Operation (retracting or lowering) (option b). The maximum permitted Velocity for flight with Landing gear Extended is V_{LE}. There is no minimum permitted speed for the lowering or raising of landing gear, but the extra drag caused by open gear doors in some aircraft types, makes gear retraction undesirable during climb out following single engine failure.

ASI 54 d.

The dials of ASIs often include coloured arcs to indicate various significant speeds. A green arc indicates the speed range for normal operations. The lower end of the green arc represents 1.1 x V_{S1} at maximum all up weight. The upper end indicates the maximum cruising speed V_{MO}/V_{NO} or in some cases the rough air penetration speed V_{RA}. Option d is therefore the most appropriate of those offered in this question.

ASI 55 c.

The maximum speed for routine cruising is V_{NO}, or the Velocity for Normal Operations. The maximum operating speed for emergency operations, or when diving is the Velocity Never Exceed, V_{NE}. None of the options offered in this question are strictly correct, but option c is the most accurate

ASI 56 a.

V_{FE} is the maximum Velocity for flight with Flaps Extended. It is indicated by the upper end of the white arc on a ASI.

ASI 57 d.

V_{FO} is the maximum Velocity at which the Flap extension and retraction system may be Operated. It is not specifically marked on a standard ASI. But because the flaps are strongest when locked in either their up or down positions, V_{FO} is usually less than the maximum Velocity for flight with Flaps Extended, VF_E.

ASI 58 a.

V_{MO} is the Velocity Maximum Operating. It is normally indicated by the upper end of the green arc and the lower end of the yellow arc on an ASI. It should be noted that the terms V_{MO} and V_{NO} are interchangeable in that V_{NO} is old terminology and is being replaced by the newer term V_{MO}.

ASI 59 a.

V_{NO} is the maximum Velocity for Normal operations. It is normally indicated by the upper end of the green arc and the lower end of the yellow arc on an ASI. . It should be noted that the terms V_{MO} and V_{NO} are interchangeable in that V_{NO} is old terminology and is being replaced by the newer term V_{MO}.

ASI 60 c.

The dials of ASIs often include coloured arcs to indicate various significant speeds. In twin engine aircraft, the failure of one engine during or after take-off will reduce the ability of the aircraft to climb away from the ground. This is potentially hazardous, so it is important that the pilot should be aware of the speed at which rate of climb in this single engine condition will be greatest. The speed at which rate of climb is greatest is termed V_Y, and in the single engine condition this is termed V_Y Single Engine or V_{YSE}. On twin prop aircraft the ASI includes a blue radial line indicating V_{YSE}. In the case of an engine failure after V_1 during take-off, the pilot must immediately feather the failed prop and accelerate to the blue line speed V_{YSE}. This process is commonly referred to as "blue lining it".

ASI 61 c.
V_{NE} is the Velocity Never Exceed. It is the maximum speed at which an aircraft may be flown under any circumstances. It is indicated on an ASI by a red radial line which marks the upper limit of the yellow cautionary zone.

ASI 62 c.
V_{LO} is the maximum Velocity at which the Landing gear extension and retraction system may be Operated. It is not specifically marked on a standard ASI. But because the landing gear is stronger when locked in either its up or down positions rather than at any point between the two, V_{LO} is usually less than the maximum Velocity for flight with Landing gear Extended, V_{LE}.

ASI 63 c.
Flaps up stalling speed is termed V_{S1}. The lower end of the green arc on an ASI indicates 1.1 of this value. Although this does not exactly match the question, it is the best option offered.

ASI 64 b.
V_{FE} is the maximum Velocity for flight with Flaps Extended. It is indicated by the upper end of the white arc on an ASI.

ASI 65 b.
V_{NO} is the maximum Velocity for Normal Operations. It is marked by the upper end of the green arc and the lower end of the yellow arc on an ASI.

ASI 66 c.
V_{NE} is the Velocity Never Exceed. It is indicated by a red radial line at the upper end of the yellow arc on an ASI.

AIRSPEEDS 1 c.
The maximum speed at which an aircraft may be operated is limited by two factors. The first of these is the physical stresses imposed by the dynamic pressure acting on the structure. Dynamic pressure is equal to $1/2\rho V^2$, where ρ is the air density and V is the true airspeed. As true airspeed increases, the dynamic pressure increases until the loads imposed on the structure become excessive.

The airspeed indicator measures dynamic pressure in order to give an indication of the CAS. This means that the dynamic pressure at any given CAS is constant at all altitudes. This in turn means that the maximum CAS at which dynamic pressure

loads acting on the structure are acceptable is constant at all altitudes. It is therefore useful to express this limiting speed in terms of CAS. The Velocity Maximum Operating or VMO is the maximum calibrated airspeed (CAS) at which the aircraft may be operated without imposing excessive loads on the structure.

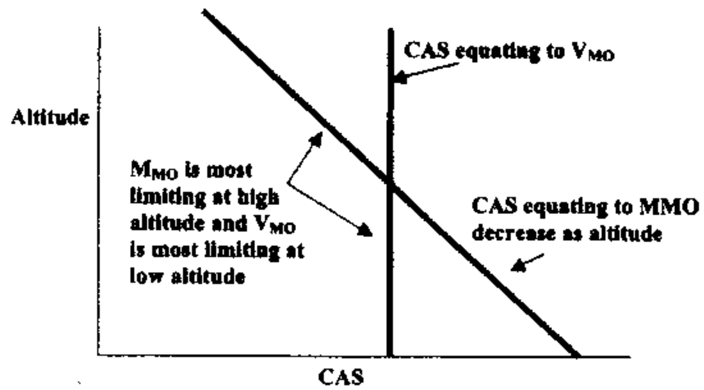
The second factor that limits maximum airspeed is the formation of shockwaves as airflow passing over the surface of the aircraft becomes sonic. The lowest speed at which this occurs is called the critical mach number or M_{CRIT}. For aircraft not designed for supersonic flight these shockwaves cause the boundary layer to separate, thereby producing a sudden increase in drag and loss of lift. This phenomenon is called shock stall. In extreme cases it will cause the aircraft to pitch nose down and dive towards the ground. This effect is called mach tuck under.

At airspeeds just above M_{CRIT}, the boundary layer begins to separate and produces a vibrating or buffeting effect similar to that experienced just before the onset of low speed stall. This is called high speed buffet and it is the first indication of imminent high speed stall. Aircraft must never be operated at speeds above that at which high speed buffet begins. The Maximum Operating Mach number or M_{MO}, is the maximum mach number that can be achieved without incurring high speed buffet.

The above factors mean that maximum airspeed must be not greater than V_{MO} and M_{MO}. But M_{MO} is a constant Mach number and the CAS at any given mach number decreases with increasing altitude. This means that V_{MO} is the limiting speed at low altitude and M_{MO} is the limiting speed at high altitude. The changeover from V_{MO} to M_{MO} occurs at the altitude at which V_{MO} and M_{MO} are equal.

The groundspeed in descent is proportional to the airspeed, so to maintain maximum groundspeed in a descent the flight speed must be initially limited by the M_{MO}, then by the V_{MO} below a certain flight level (option c).

This relationship is illustrated below.



AIRSPEEDS 2 b.

The airspeed indicator measures the dynamic pressure in order to produce an indication of CAS. Dynamic pressure is equal to $1/2\rho V^2$, where ρ is the air density and V is the true airspeed. This means that provided the air density remains constant the dynamic pressure and CAS will be constant at any given true airspeed. If however air density changes, then the relationship between CAS and TAS will change. But air density changes with changing altitude, so an airspeed indicator can be accurate at only one altitude. All airspeed indicators are calibrated such that CAS is equal to TAS at means sea level in the International Standard Atmosphere (option b).

AIRSPEEDS 3 a.

An aircraft will always lift-off from the ground at the speed at which the lift is equal to its weight.

Lift is equal to $C_L 1/2\rho V^2 S$ where:

- C_L is the coefficient of lift
- ρ is the air density
- V is the true airspeed
- S is the wing area generating the lift

This means that provided aircraft weight, C_L and S remain constant, then the $1/2\rho V^2$ at lift-off will also be constant. But $1/2\rho V^2$ is the dynamic pressure and is used by the airspeed indicator to give an indication of the calibrated airspeed or CAS. This means that if $1/2\rho V^2$ is constant then CAS will also be constant.

Changes in altitude will cause changes in ρ. This means that to maintain a constant value of $1/2\rho V^2$, the V must increase such that the increase in V^2 is exactly equal to the decrease in ρ. This means that the TAS at lift-off will vary with altitude. But the CAS at any given $1/2\rho V^2$ will remain constant. So with a constant weight, irrespective of the airfield altitude, an aircraft always takes off at the same calibrated airspeed (option a).

AIRSPEEDS 4 b.

The airspeed indicator (ASI) provides an indication of airspeed (IAS) by measuring the dynamic pressure $1/2\rho V^2$ where ρ is air density and V is the TAS. The dynamic pressure is used to distort a thin differential pressure capsule in order to move the pointer over the speed scale on the face of the ASI. But due to manufacturing imperfections, the speed indication produced by each individual ASI, at any given dynamic pressure is slightly different. These slight differences are called instrument errors.

In order to provide an accurate indication of airspeed the ASI must be provided with an accurate sample of the dynamic pressure. But inaccuracies in the sampling process will always occur because the movement of the aircraft through the air changes the dynamic pressure at each point on its surface. These inaccuracies are minimized by positioning the pitot probe and static vents at points at which the changes are minimum. But despite the best efforts of the designers, some errors in

the sampling process will always exist. These errors are called position/pressure sensing errors. The calibrated airspeed (CAS) is obtained by applying to the indicated airspeed (IAS) an instrument error and position/pressure error correction (option b).

AIRSPEEDS 5 c.

The maximum speed at which an aircraft may be operated is limited by two factors. One of these factors is the physical stresses imposed by the dynamic pressure acting on the structure. Dynamic pressure is equal to $1/2\rho V^2$, where ρ is the air density and V is the true airspeed. As true airspeed increases, the dynamic pressure increases until the loads imposed on the structure become excessive.

The airspeed indicator measures dynamic pressure in order to give an indication of the CAS. This means that the dynamic pressure at any given CAS is constant at all altitudes. This in turn means that the maximum CAS at which dynamic pressure loads acting on the structure are acceptable is constant at all altitudes. It is therefore useful to express this limiting speed in terms of CAS. The Velocity Maximum Operating or V_{MO} is the maximum calibrated airspeed (CAS) at which the aircraft may be operated without imposing excessive loads on the structure (option c).

AIRSPEEDS 6 d.

In order to provide the pilot with readily available indications of the various speed limits, the face of the airspeed indicator is marked with coloured arcs. The ends of the white arc indicate the stalling speed in the landing configuration (VSO) at the lower limit and the maximum speed with flaps extended (VFE) at the higher limit (option d)

AIRSPEEDS 7 c.

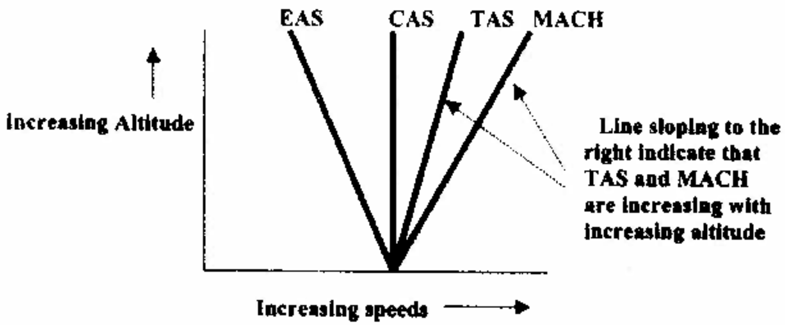
In order to provide the pilot with readily available indications of the various speed limits, the face of the airspeed indicator is marked with coloured arcs. The ends of the green arc indicate the stalling speed in the clean configuration (VS1) at the lower limit and the maximum speed for normal operations (VNO) at the higher limit (option c).

AIRSPEEDS 8 d.

In order to provide the pilot with readily available indications of the various speed limits, the face of the airspeed indicator is marked with coloured arcs. The ends of the yellow arc indicate the maximum speed for normal operations (VNO) at the lower limit and the never exceed speed (VNE) at the upper limit (option d).

AIRSPEEDS 9 a.

The relationships between the various airspeeds EAS, CAS, TAS and Mach number depend upon variations in air pressure, density and temperature. The most simple method of solving this type of problem is to use the ECTM lines shown in the key fact section of this book. The question does not specify any unusual atmospheric conditions such as inversions or isothermal layers, so it may be assumed to be ISA conditions. In this case the CAS is constant so the C line should be vertical and the other lines fanning out from it as illustrated below.



From the above diagram it can be seen that as altitude increases at constant CAS, the TAS and Mach both increase (option a) while the EAS decreases.

AIRSPEEDS 10 b.

Limiting airspeeds are specified in terms of three letter. The first letter (V) indicates velocity. The second letter indicate the specific conditions in which the speed limit applies. In this case the LE indicates that the limit applies to flight with Landing gear Extended. So VLE is the maximum speed for flight with the landing gear down or extended (option b).

AIRSPEEDS 11 a.

Limiting airspeeds are specified in terms of three letter. The first letter (V) indicates velocity. The second letter indicate the specific conditions in which the speed limit applies. In this case the LO indicates that the limit applies to flight with Landing gear Operated. So VLO is the maximum speed at which the landing gear can be operated with full safety (option a). It should be noted that the most limiting condition may be extending or retracting the gear or both, depending on the type of aircraft.

AIRSPEEDS 12 c.

Limiting airspeeds are specified in terms of three letter. The first letter (V) indicates velocity. The second letter indicate the specific conditions in which the speed limit applies. In this case the NE indicates that the limit is the speed that must Never be Exceeded. So VNE is the maximum which must never be exceeded (option c).

AIRSPEEDS 13 d.

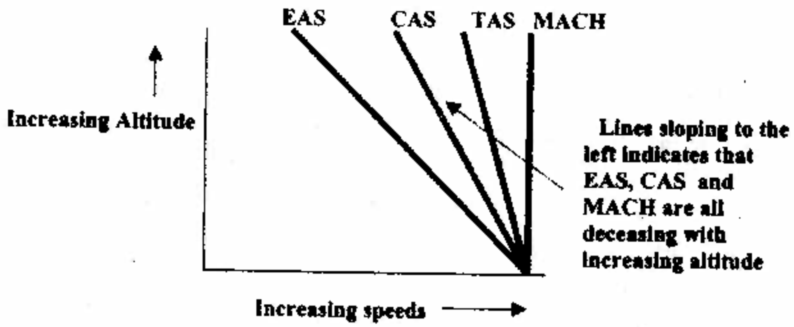
Limiting airspeeds are specified in terms of three letter. The first letter (V) indicates velocity. The second letter indicate the specific conditions in which the speed limit applies. In this case the NO indicates that the limit must not be exceed for Normal Operations. This speed may however be exceeded up to VNE provided it is done with caution an only in still air conditions. So VNO is the maximum speed that must not be exceeded except in still air and with caution (option d).

AIRSPEEDS 14 b.

The airspeed indicator provides an indication of airspeed that is proportional to the dynamic pressure. Dynamic pressure is $1/2\rho V^2$ where ρ is air density and V is the true airspeed. Provided dynamic pressure remains constant then the indicated CAS will remain constant. This means that in constant CAS flight the $1/2\rho V^2$ is also constant. But if temperature decreases then the air with contract causing its density to increase. In order to maintain constant CAS and $1/2\rho V^2$ it will then be necessary for the V^2 to decrease by exactly the same proportion as the increase in density, in order to offset the effects of increased density. So for a constant Calibrated Airspeed (CAS) and a level flight, a fall in ambient temperature will result in a lower True Airspeed (TAS) due to an increase in air density (option b).

AIRSPEEDS 15 a.

The relationships between the various airspeeds EAS, CAS, TAS and Mach number depend upon variations in air pressure, density and temperature. The most simple method of solving this type of problem is to use the ECTM lines shown in the key facts section of this book. In this case the Mach number is constant so the MACH line should be vertical and the other lines fanning out from it as illustrated below.



From the above diagram it can be seen that when climbing at constant MACH the CAS decreases (option a).

AIRSPEEDS 16 b.

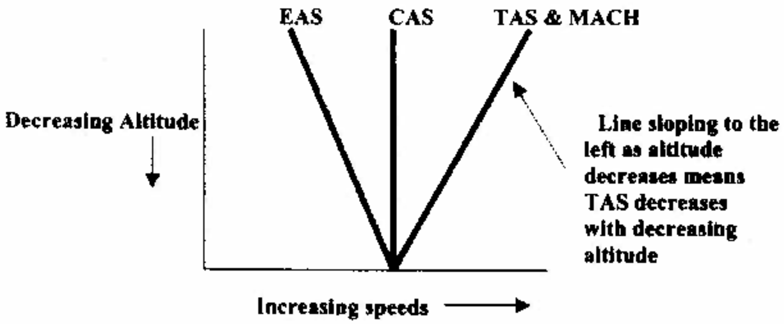
This type of problem can be solved using the following equation:

LSS in Kts = 38.94 √Absolute temperature — where the absolute temperature is the temperature in degrees Celsius plus 273.

So if temperature = -40^0C then LSS = 38.94 $\sqrt{(-40^0 + 273)}$ = 594.4 Kts which is closest to 596 Kts (option b).

AIRSPEEDS 17 a.

The relationships between the various airspeeds EAS, CAS, TAS and Mach number depend upon variations in air pressure, density and temperature. The most simple method of solving this type of problem is to use the ECTM lines shown in the key fact section of this book. The question specifies an isothermal layer, so the temperature will be constant. This means that the relationship between TAS and MACH will be constant, so a single line can be used to represent both TAS and MACH number. In this case the CAS is constant so the C line should be vertical and the other lines fanning out from it as illustrated below.



From the above diagram it can be seen that when descending through an isothermal layer at constant CAS, the TAS decreases (option a).

AIRSPEEDS 18 d.

This question specifies a climb at constant CAS with constant total temperature (TAT). The question does not specify an unusual static air temperature (SAT) effects so it can be assumed that the atmospheric is standard ISA and the SAT is decreasing as altitude increases. This enables the problem to be solved using the standard equation below.

TAT = SAT x (1+(0.2 x k x M^2)) — where k is the ram recovery factor for The temperature probe. M is the mach number.

The k factor is a function of the type of temperature probe used and is constant at all altitudes. So the above equation can be amended to read:

TAT is proportional to SAT x M^2

But the SAT decreases as altitude increases, so the M^2 must increase to maintain constant TAT as specified in the question. But M^2 is the mach number squared, so if M^2 increases then mach must also increase. So in a steady climb with the auto-throttle maintaining a constant calibrated airspeed, if the total temperature remains constant, the Mach number increases (option d). It should be noted that the use of auto-throttle has no relevance to the solution of this problem.

AIRSPEEDS 19 b.

In order to provide the pilot with readily available indications of the various speed limits, the face of the airspeed indicator is marked with coloured arcs and radial lines. In multi-engine aircraft the blue line indicates the speed at which the aircraft will achieve its best rate of climb with one engine inoperative. This speed is called V_{YSE}. So the blue line corresponds to the optimum climbing speed with one engine inoperative, or Vy (option b).

AIRSPEEDS 20 c.

The maximum speed at which an aircraft may be operated is limited by two factors. The first of these is the physical stresses imposed by the dynamic pressure acting on the structure. Dynamic pressure is equal to $1/2\rho V^2$, where ρ is the air density and V is the true airspeed. As true airspeed increases, the dynamic pressure increases until the loads imposed on the structure become excessive.

The airspeed indicator measures dynamic pressure in order to give an indication of the CAS. This means that the dynamic pressure at any given CAS is constant at all altitudes. This in turn means that the maximum CAS at which dynamic pressure loads acting on the structure are acceptable is constant at all altitudes. It is therefore useful to express this limiting speed in terms of CAS. The Velocity Maximum Operating or VMO is the maximum calibrated airspeed (CAS) at which the aircraft may be operated without imposing excessive loads on the structure.

The second factor that limits maximum airspeed is the formation of shockwaves as airflow passing over the surface of the aircraft becomes sonic. The lowest speed at which this occurs is called the critical mach number or M_{CRIT}. For aircraft not designed for supersonic flight these shockwaves cause the boundary layer to separate, thereby producing a sudden increase in drag and loss of lift. This phenomenon is called shock stall. In extreme cases it will cause the aircraft to pitch nose down and dive towards the ground. This effect is called mach tuck under.

At airspeeds just above M_{CRIT}, the boundary layer begins to separate and produces a vibrating or buffeting effect similar to that experienced just before the onset of low speed stall. This is called high speed buffet and it is the first indication of imminent high speed stall. Aircraft must never be operated at speeds above that at which high speed buffet begins. The Maximum Operating Mach number or M_{MO}, is the maximum mach number that can be achieved without incurring high speed buffet.

The above factors mean that maximum airspeed must be not greater than V_{MO} and M_{MO}. But M_{MO} is a constant Mach number and the CAS at any given mach number decreases with increasing altitude. This means that V_{MO} is the limiting speed at low altitude and M_{MO} is the limiting speed at high altitude. The changeover from V_{MO} to M_{MO} occurs at the altitude at which V_{MO} and M_{MO} are equal.

In order to provide the pilot with readily available indications of the various speed limits, the face of the airspeed indicator is marked with coloured arcs and radial lines and pointers. Some such instruments include a red and white hatched pointer commonly called the barbers' pole. This pointer indicates the variations in the maximum operating speed in VMO versus altitude (option c).

AIRSPEEDS 21 c.
Limiting airspeeds are specified in terms of three letters. The first letter (V) indicates velocity. The second and third letters indicate the specific conditions in which the speed limit applies. In this case the FE indicates that the limit must not be exceed in flight with Flaps Extended in a given position. Aircraft for which various flap extended positions are possible, may have a different VFE for each flap extended position. So VFE is the maximum speed that must not be exceeded wit the flaps extended in a given position (option c).

AIRSPEEEDS 22 c.
This question specifies a steady descent at constant Mach number with constant total temperature (TAT). This problem can be solved using the standard equation below.

$TAT = SAT \times (1+(0.2 \times k \times M^2))$ where k is the ram recovery factor for The temperature probe. M is the mach number.

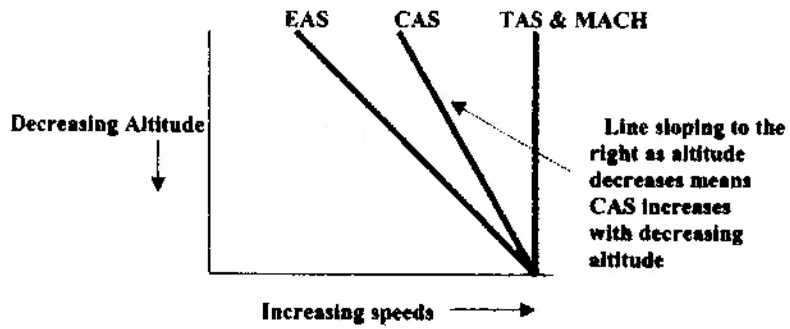
The k factor is a function of the type of temperature probe used and is constant at all altitudes. So the above equation can be amended to read:

TAT is proportional to $SAT \times M^2$

But the question specifies constant TAT and constant Mach number, so above equation indicates that SAT must also be constant. But if SAT is constant with changing altitude then the local atmosphere must be an isothermal layer. The question is therefore one of a constant mach descent in a isothermal layer.

The relationships between the various airspeeds EAS, CAS, TAS and Mach number depend upon variations in air pressure, density and temperature. The

most simple method of solving this type of problem is to use the ECTM lines shown in the key fact section of this book. The question specifies an isothermal layer, so the temperature will be constant. This means that the relationship between TAS and MACH will be constant, so a single line can be used to represent both TAS and MACH number. In this case the CAS is constant so the C line should be vertical and the other lines fanning out from it as illustrated below.



From the above diagram it can be seen that when descending through an isothermal layer at constant MACH, the CAS increases (option c).

AIRSPEEDS 23 b.
The relationship between TAT, SAT and MACH is in accordance with the standard equation:

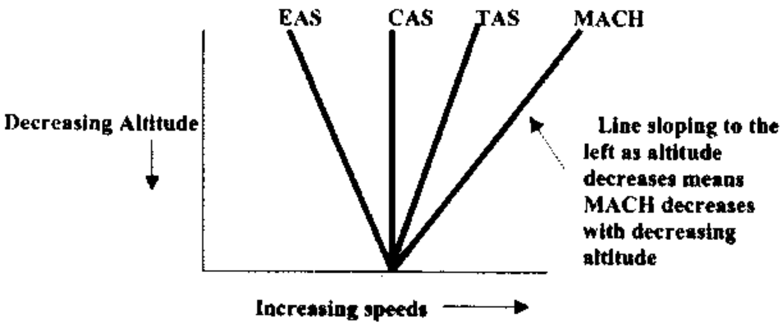
$TAT = SAT \times (1+(0.2 \times k \times M^2))$ where k is the ram recovery factor for The temperature probe. M is the mach number.

The k factor is a function of the type of temperature probe used and is constant at all altitudes. So the above equation can be amended to read:

TAT is proportional to $SAT \times M^2$

This question specifies constant TAT and constant CAS in a descent in the ISA, so as the SAT increases, the Mach number must decrease to maintain constant TAT (option b).

This result can also be obtained by using the ECTM lines shown in the key fact section of this book. These are illustrated below for flight below the tropopause in the ISA as specified in the question.



From the above diagram it can be seen that for an aeroplane in a steady descent with the auto-throttle maintaining constant CAS at constant TAT below the tropopause, in the ISA, the Mach number decreases (option b).

<u>AIRSPEEDS 24 b.</u>
The relationship between TAT, SAT and MACH is in accordance with the standard equation:

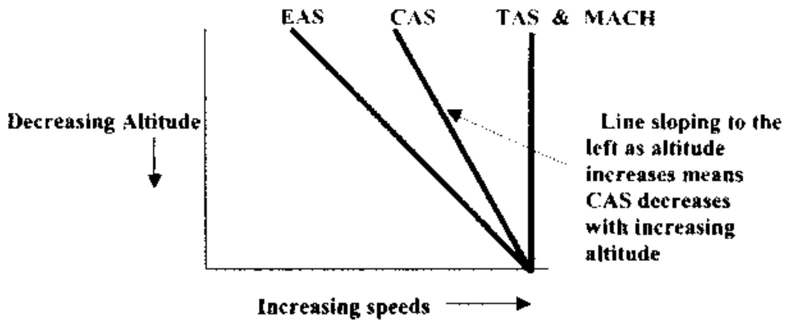
TAT = SAT x $(1+(0.2 \times k \times M^2))$ where k is the ram recovery factor for The temperature probe. M is the mach number.

The k factor is a function of the type of temperature probe used and is constant at all altitudes. So the above equation can be amended to read:

TAT is proportional to SAT x M^2

This question specifies constant TAT and constant Mach, so the SAT must also be constant. This means that the aircraft is climbing through an isothermal layer.

The relationships between the various airspeeds EAS, CAS, TAS and Mach number depend upon variations in air pressure, density and temperature. The most simple method of solving this type of problem is to use the ECTM lines shown in the key fact section of this book. As discussed above, this question implies an isothermal layer, so the temperature will be constant. This means that the relationship between TAS and MACH will be constant, so a single line can be used to represent both TAS and MACH number. In this case the MACH is constant so the MACH line should be vertical and the other lines fanning out from it as illustrated below.



From the above diagram it can be seen that for an aeroplane in a steady climb with the auto-throttle maintaining constant MACH at constant TAT, the CAS decreases (option b).

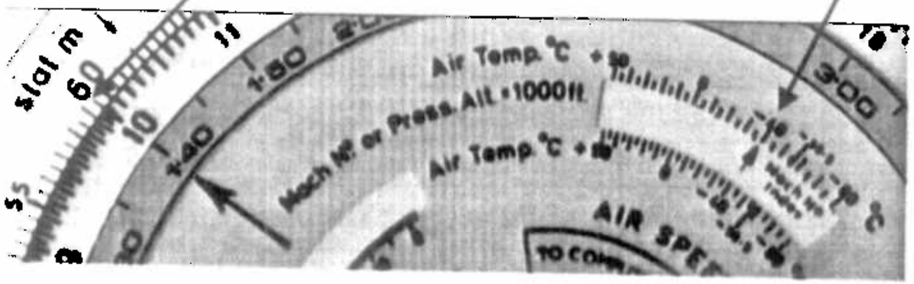
<u>MACH 1. a.</u>
A mach meter produces an indication of mach number based on the ratio of dynamic pressure to static pressure. Decreasing temperature will cause the air to contract. This will reduce the mass of the air above any given point in the atmosphere, so the static pressure at any point will decrease. Decreasing static pressure will cause the pressure altitude and flight level at any point to increase. (This effect is illustrated in a number of altimeter questions in this book). But this question specifies constant flight level. This mean when the aircraft enters the colder air mass, its height must be reduced to maintain constant flight level and pressure altitude. But pressure altitude is proportional to static pressure, so by descending to maintain constant pressure altitude, the aircraft will also maintain constant static pressure.

The question also specifies constant CAS. CAS is proportional to dynamic pressure, so by flying at constant CAS the aircraft is also flying at constant dynamic pressure. The mach meter indication is derived from the ratio of dynamic pressure to static pressure. But in the situation described above, both of these pressures remain constant, so the indicated mach number also remains constant. So when flying at constant CAS at constant pressure altitude and flight level, the indicated mach number is unaffected by temperature changes.

MACH 2. d.
This type of problem can be solved using the CRP5 as illustrated below:

1. In the Airspeed window set the mach index pointer against the temperature of -40^0C

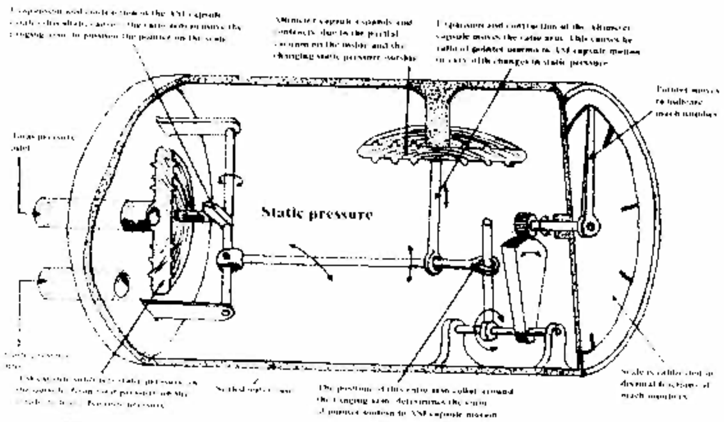
2. Against the number 10 on the inner scale read off 595 Kts TAS on the outer scale.



This gives a local speed of sound of approximately 595 Kts at -40^0C (option d).

MACH 3. a.
Mach number is the true airspeed (TAS) of an aircraft expressed as a fraction of the local speed of sound (LSS). So mach number is the ratio of TAS:LSS.

MACH 4. a.
The internal construction of a typical Mach Meter is illustrated below.



TYPICAL MACH METER INTERNAL CONSTRUCTION

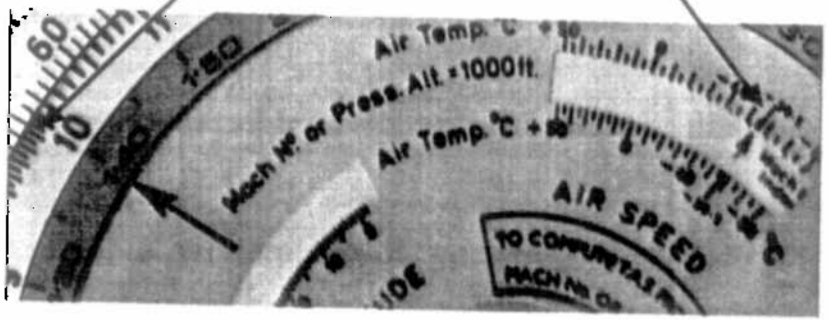
A mach meter produces an indication of mach number based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure. So a mach meter can be said to comprise of a combination of an ASI and an altimeter.

MACH 5. c.
This type of problem can be solved using the CRP 5 in the following manner:

In the ISA the temperature is approximately 15^0C at msl and -56.5^0C between 36000 ft and 65000 ft. So at 40000 ft the temperature is approximately -56.5^0C.

1. In the Airspeed window set the Mach index against the temperature of -56.5^0C.

2. Against 10 on the inner scale read off approximately 573 Kts TAS on the outer scale.



This gives approximately 573 Kts Tas for LSS at 40000 ft in the ISA (option c).

MACH 6. a.
Mach number is the TAS of an aircraft expressed as a fraction of the local speed of sound (LSS). LSS is proportional to air temperature. As altitude increases up to 36000 ft ISA, air temperature and the TAS value of LSS decrease. Above 36000 ft air temperature and LSS remain constant up to 65000 ft. So if an aircraft climbs at constant TAS its mach number would increase up to 36000 ft then remain constant.

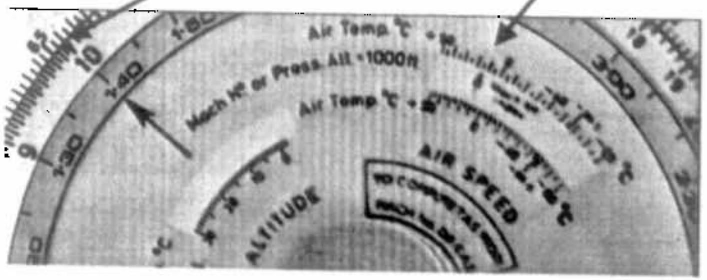
But the TAS at any given CAS is related to air density. As altitude increases, air density decreases, causing the TAS to increase. So in a constant CAS climb, both TAS and mach number indication increase (option a).

MACH 7. d

This type of problem can be solved using the CRP 5 in the following manner:

1. In the Airspeed window set the mach index pointer against the temperature of 15°C.

2. Against the 10 on the inner scale read off approximately 660 kts TAS on the outer scale.



This figure is closest to 661 Kts (option d) in this question.

MACH 8. b.

A mach meter produces an indication of mach number based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

Although changes in altitude or temperature each produce changes in air density, such changes affect dynamic pressure and static pressure to the same degree. They do not therefore alter the ratio of dynamic pressure to static pressure, and so they do not affect mach meter indications. But changes in airspeed alter dynamic pressure without affecting static pressure. This causes a change in the ratio of dynamic pressure : static pressure, so mach meter indications change. So mach meter indications vary only with changes in airspeed.

MACH 9. c.

A mach meter produces an indication of mach number based on the ratio of dynamic pressure to static pressure. Decreasing temperature will cause the air to contract. This will reduce the mass of the air above any given point in the atmosphere, so the static pressure at any point will decrease. Decreasing static pressure will cause the pressure altitude and flight level at any point to increase. (This effect is illustrated in a number of altimeter questions in this book). But this question specifies constant flight level. Flight level is based on the ISA msl standard subscale setting of 1013.25 hPa. So any change in static pressure will cause a change in the height at which any given flight level occurs. This mean

when the aircraft enters the colder air mass, its height must be reduced to maintain constant flight level and pressure altitude. But pressure altitude is proportional to static pressure, so by descending to maintain constant pressure altitude, the aircraft will also maintain constant static pressure.

The question also specifies constant CAS. CAS is proportional to dynamic pressure, so by flying at constant CAS the aircraft is also flying at constant dynamic pressure. The mach meter indication is derived from the ratio of dynamic pressure to static pressure. But in the situation described above, both of these pressures remain constant, so the indicated mach number also remains constant. So when flying at constant CAS at constant pressure altitude or flight level, the indicated mach number is unaffected by temperature changes.

MACH 10. b.

A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

In a constant CAS climb, dynamic pressure will remain constant while static pressure decreases. This will cause the mach meter indication to increase with increasing altitude.

But with the static pressure source blocked, the correct pitot pressure will continue to be fed into the ASI capsule. But the failure of reducing static pressure to reach the outside of this capsule will cause it to subtract too high a value of static from pitot. The resultant will therefore be lower than true dynamic pressure. The magnitude of this error will increase with increasing altitude, so the instrument will react as if dynamic pressure were reducing.

So the ASI capsule will gradually contract instead of remaining at a constant size. The failure of the decreasing static pressure to reach the outside of the altimeter capsule will prevent the capsule from expanding, so it will not modify the motion of the mechanism. The mach meter will therefore respond as if it were sensing reducing CAS at constant altitude. So the mach meter indication will gradually decrease with increasing altitude (option b).

MACH 11. b.

A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule, which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

In a constant TAS climb, CAS will decrease. This decreasing CAS will in turn cause dynamic pressure to decrease. But increasing altitude also causes temperature to decrease. The local speed of sound (LSS) is proportional to air temperature. So as altitude increases, the decreasing temperature will cause the local speed of sound to decrease. Mach number is TAS divided by LSS. So the decreasing LSS will cause the mach number at any given TAS to increase as altitude increases. So the mach meter indications will increase in a constant TAS climb.

With the static pressure source blocked, the correct pitot pressure will continue to be fed into the ASI capsule, but the decreasing static pressure will not get into the case of the mach meter. The failure of reducing static pressure to reach the outside of this capsule will cause it to subtract too high a value of static pressure from pitot pressure. The resultant will therefore be lower than true dynamic pressure. The magnitude of this error will increase with increasing altitude. The instrument will therefore react as if dynamic pressure is reducing at a greater rate than is actually the case. So the tendency of the ASI capsule to contract will be too great.

The failure of the decreasing static pressure to reach the outside of the altimeter capsule will prevent this capsule from expanding, so it will not modify the motion of the mechanism. The mach meter will therefore respond as if it is sensing decreasing CAS at constant altitude. So the mach meter indication will gradually decrease with increasing altitude (option b).

MACH 12. b.

A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule, which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

In a constant mach number climb, the rate of decrease in dynamic pressure due to decreasing airspeed should exactly match the rate of decrease in static pressure due to increasing altitude. This should cause the mach meter indication to remain constant.

With the static pressure source blocked, the reducing pitot pressure would continue to be fed into the ASI capsule. But the failure of reducing static pressure to reach the outside of this capsule would cause it to subtract too high a value of static pressure from pitot pressure. The resultant would therefore be lower than true dynamic pressure. The magnitude of this error would increase with increasing altitude. The instrument would therefore react as if dynamic pressure were reducing at a greater rate than was actually the case. So the tendency of the ASI capsule to contract would be too great.

The failure of the decreasing static pressure to reach the outside of the altimeter capsule would prevent this capsule from expanding, so it would not modify the

motion of the mechanism. The mach meter would therefore respond as if it were sensing decreasing CAS at constant altitude. So the mach meter indication would gradually decrease with increasing altitude (option b).

MACH 13. b.

A mach meter produces an indication of mach number based on the ratio of dynamic pressure to static pressure. Changes in air temperature cause air density to change. But changes in density affect both dynamic pressure and static pressure by the same proportion. This means that changes in temperature do not alter the ratio of dynamic pressure to static pressure. Dynamic pressure is proportional to CAS, and static pressure is proportional to altitude. So provided both CAS and altitude remain constant, the mach meter reading will also remain constant, regardless of ambient temperature changes.

MACH 14. a.

A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

RAS is IAS corrected for position error. IAS is directly proportional to dynamic pressure, so the dynamic pressure at any given RAS remains constant at all altitudes. So in a constant RAS climb, dynamic pressure remains constant, while static pressure decreases. This increases the ratio of dynamic pressure to static pressure, so the mach meter indication increases with increasing altitude. This effect is independent of changing temperature, and so continues regardless of altitude, isothermals or inversions. This solution could also be obtained using the ECTM curves in the key facts section of this book, but to do so would require the CAS line to be renamed RAS.

MACH 15. a.

A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

If the static pipe became detached from the back of a mach meter in a pressurised aircraft, the outside of the ASI capsule and the altimeter capsule would be subjected to cabin pressure. Cabin pressure at high altitude would be greater than ambient static pressure. So the ASI capsule would subtract too great a value of static pressure from pitot, to give an unrealistically low value of dynamic pressure.

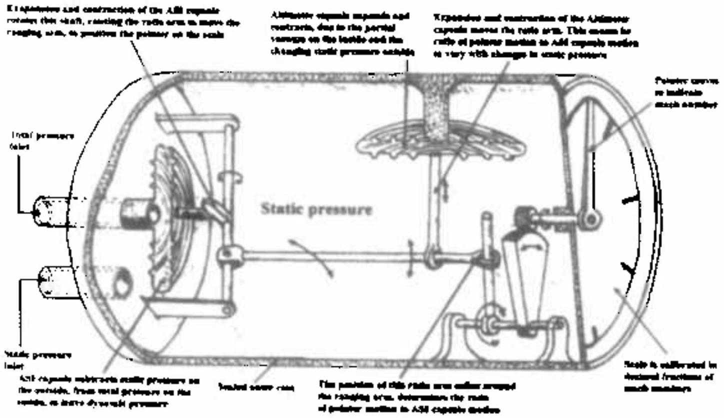
The altimeter capsule would then compare this unrealistically low dynamic pressure with an unrealistically high static pressure, giving an unrealistically low ratio of the two. Mach meter indication is proportion to this ratio, so the mach meter would under read (option a).

MACH 16. c.

Mach number is the ratio of TAS:LSS. LSS is proportional to absolute temperature, so if absolute temperature falls, the mach number equating to any given TAS will increase. As altitude increases in the ISA, the temperature and LSS decrease up to 36000 ft (FL360), then remain constant at higher altitudes up to 65000 ft (FL650). Few if any commercial aircraft operate at or above 65000 ft so this area of the atmosphere can be ignored for the purposes of JAR ATPL examination. So as altitude increases, the mach number at any given TAS increases up to 36000 ft then remains constant at higher altitudes. So in a constant TAS climb, the mach meter reading will increase then remain constant (option c).

MACH 17. b.

A mach meter produces an indication of mach number based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure. So an mach meter can be said to comprise of a combination of an ASI and an altimeter. A typical mach meter is illustrated below.



TYPICAL MACH METER INTERNAL CONSTRUCTION

MACH 18. d.

V_{MO} is the maximum speed at which an aircraft can be operated without subjecting its structure to excessive aerodynamic pressures. At low speeds these pressures are proportional to IAS. CAS is IAS corrected for pressure sensing or position errors. But at higher speeds the high dynamic pressures compress the air, changing the relationship between IAS/CAS and dynamic pressure. For most aircraft types, V_{MO} is a comparatively high airspeed, so EAS gives the most accurate representation of its value. So V_{MO} is calculated based on EAS (option d). It should however be noted that V_{MO} is actually specified in terms of CAS, because EAS cannot be seen on the airspeed indicator.

MACH 19. c.

Mach number represents the true airspeed (TAS) of an aircraft expressed as a fraction of the local speed of sound (LSS) So mach number is the ratio of TAS:LSS. But the ratios of CAS, IAS and EAS to TAS, each change with altitude, so it cannot be said that mach number is the ratio of CAS:LSS, IAS:LSS or EAS:LSS.

MACH 20. b.

A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

With the static pressure source blocked, the correct pitot pressure would continue to be fed into the ASI capsule. But if altitude increased, the failure of reducing static pressure to reach the outside of this capsule would cause it to subtract too high a value of static from pitot. The resultant would therefore be lower than true dynamic pressure. The magnitude of this error would increase with increasing altitude, so the instrument would react as if dynamic pressure were reducing.

So the ASI capsule would gradually contract instead of remaining at a constant size. The failure of the decreasing static pressure to reach the outside of the altimeter capsule would prevent the capsule from expanding, so it would not modify the motion of the mechanism. The mach meter would therefore respond as if it were sensing reducing CAS at constant altitude. So the mach meter indication would gradually decrease with increasing altitude. The mach meter would therefore under indicate in a climb (option b).

MACH 21. c

A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

A mach meter produces an indication of mach number based on the ratio of dynamic pressure to static pressure. Decreasing temperature will cause the air to contract. This will reduce the mass of the air above any given point in the atmosphere, so the static pressure at any point will decrease. Decreasing static pressure will cause the pressure altitude and flight level at any point to increase. (This effect is illustrated in a number of altimeter questions in this book). But this question specifies constant flight level. This mean when the aircraft enters the colder air mass, its height must be reduced to maintain constant flight level and pressure altitude. But pressure altitude is proportional to static pressure, so by descending to maintain constant pressure altitude, the aircraft will also maintain constant static pressure.

The question also specifies constant CAS. CAS is proportional to dynamic pressure, so by flying at constant CAS the aircraft is also flying at constant dynamic pressure. The mach meter indication is derived from the ratio of dynamic pressure to static pressure. But in the situation described above, both of these pressures remain constant, so the indicated mach number also remains constant. So when flying at constant CAS at constant pressure altitude and flight level, the indicated mach number is unaffected by temperature changes. So mach meter indication and true mach number will not change (option c).

<u>MACH 22. d.</u>

A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

Although changes in temperature produce changes in air density, such changes affect dynamic pressure and static pressure to the same degree. They do not therefore alter the ratio of dynamic pressure to static pressure, and so they do not affect mach meter indications at any given CAS.

Changes is temperature also change the TAS at any given CAS, and the LSS at any given altitude. But once again , the effect is of the same proportion for both TAS and LSS. So changing temperature at any given altitude does not change the actual mach number at any given CAS. So when flying at constant CAS at any given altitude of flight level, the indicated and true mach numbers are unaffected.

<u>MACH 23. c.</u>

This problem must be solved in two stages. First the absolute temperature at msl ISA must be calculated.

Temp at altitude in ISA = 15° C which can be converted to absolute temperature by adding 273 to give 288° K.

The LSS can then be calculated using the standard equation:

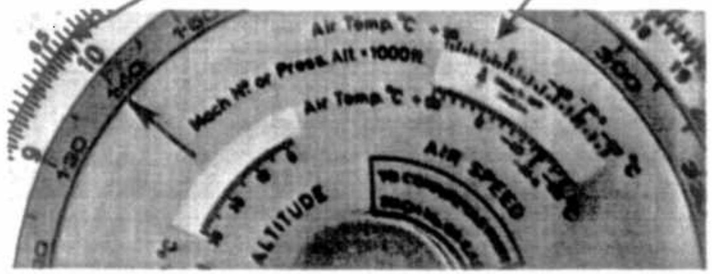
LSS in Kts = 38.94 √ Absolute temperature.

Which in this case is LSS = 38.94 √ 288 which is 660.83 Kts or approximately 660 Kts.

This type of problem can alos be solved using the CRP 5 in the following manner:

2. Against the 10 on the inner scale read off approximately 660 kts TAS on the outer scale.

1. In the Airspeed window set the mach index pointer against the temperature of 15°C.



This figure is closest to 660 Kts (option c) in this question.

<u>MACH 24. c.</u>

This problem must be solved in two stages. Firstly, the LSS must be calculated using the following standard equation:

LSS in Kts = 38.94 √ Absolute temperature.

To use this equation 273 must be added to the given (- 10° C) ambient temperature to give the absolute temperature of 263° K.

Inserting this into the standard equation gives:

LSS in Kts = 38.94 √ 263 which is 631.5 Kts.

This can now be converted into mach number using the standard equation:

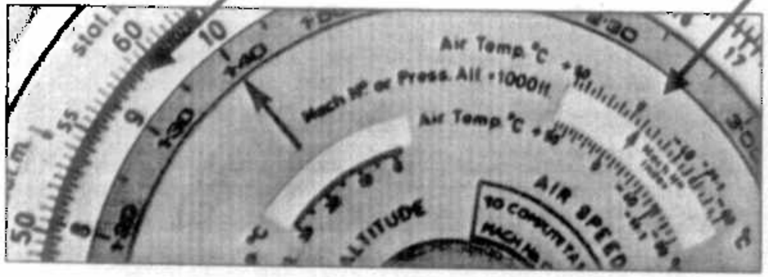
Mach number = TAS/LSS to give mach number = 594 / 631.5 = 0.94.

So the mach number is 0.94M

This type of problem can also be solved using the CRP 5 as illustrated below.

1. In the airspeed window set the mach index pointer against the temperature -10^0C.

2. Against 594 Kts on the outer scale read off mach 0.94 on the inner scale.



So at 594 Kts TAS with temperature -10^0C, the mach number is M0.94 (option c).

MACH 25. b.

This problem must be solved in two stages. Firstly the absolute temperature at 25000 ft ISA, must be calculated using the standard equation:

Temp at Altitude = 15^0 C – (1.98 x Altitude in 1000s of ft)

For 25000 ft this gives 15^0 C – (1.98 x 25) which is – 34.5^0 C.

This ca be converted in absolute by adding 273 to give 238.5^0 K.

This can then be used to calculate LSS using the standard equation:

LSS in Kts = 38.94 √ Absolute temperature.

Inserting the calculated absolute temperature gives:

MACH 26. b.

This problem must be solved in a number of stages. Firstly the absolute temperature at 25000 ft ISA, must be calculated using the standard equation:

Temp at Altitude = 15^0 C – (1.98 x Altitude in 1000s of ft)

For 25000 ft this gives 15^0 C – (1.98 x 25) which is – 34.5^0 C.

This can be converted in absolute by adding 273 to give 238.5^0 K.

This can then be used to calculate LSS using the standard equation:

LSS in Kts = 38.94 √ Absolute temperature.

Inserting the calculated absolute temperature gives:

LSS in Kts = 38.94 √ 238.5 which is 601.36 Kts or approximately 602 Kts.

True mach number at 500 Kts can then be calculated using the standard equation:

Mach number = TAS/LSS which in this case is 500/602 = 0.83M

LSS in Kts = 38.94 √ 238.5 which is 601.36 Kts or approximately 602 Kts.

This type of problem can be solved in two stages using the CRP 5 as follows.

The first stage is to find the temperature at 25000 ft as illustrated below.

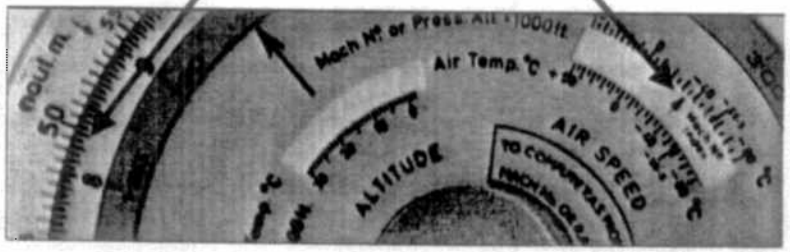
1. In the Altitude window set the ISA msl standard tempearture of +15°C against zero ft altitude.

2. Against 25000 ft read off the ISA temperature of approximately -34°C.

The second stage is to use the temperature of –34°C to find the true mach number at 500 Kts TAS as illustrated below.

1. In the Airspeed window set the mach index pointer against the temperature –34°C.

2. Against 500 Kts TAS on the outer scale read off mach 0.833 on the inner scale.



This gives a mach number of M0.833 which is closest to M0.83 (option b) in this question.

MACH 27. c.
A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

MACH 28. c.
A mach meter produces an indication of mach number based on the ratio of dynamic pressure to static pressure. Decreasing temperature will cause the air to contract. This will reduce the mass of the air above any given point in the atmosphere, so the static pressure at any point will decrease. Decreasing static pressure will cause the pressure altitude and flight level at any point to increase. (This effect is illustrated in a number of altimeter questions in this book). But this question specifies constant flight level. This mean when the aircraft enters the colder air mass, its height must be reduced to maintain constant flight level and pressure altitude. But pressure altitude is proportional to static pressure, so by descending to maintain constant pressure altitude, the aircraft will also maintain constant static pressure.

The question also specifies constant CAS. CAS is proportional to dynamic pressure, so by flying at constant CAS the aircraft is also flying at constant dynamic pressure. The mach meter indication is derived from the ratio of dynamic pressure to static pressure. But in the situation described above, both of these pressures remain constant, so the indicated mach number also remains constant. So when flying at constant CAS at constant pressure altitude and flight level, the indicated mach number is unaffected by temperature changes.

MACH 29. d.
This problem can be solved by examining the following standard equation for TAT:

$TAT = SAT \times (1 + (0.2 \times K \times M^2))$

Where TAT is total air temperature.
SAT is static air temperature.
K is the ram recovery factor of the temperature probe.
M is the true mach number.

When descending below 36000 ft in the ISA, at constant mach number, K will remain constant while SAT increases at a rate of +1.98^0 C per 1000 ft. Examination of the equation above will reveal that such changes will cause TAT to increase in direct proportion to the increase in SAT.

MACH 30. b.
A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

So a mach meter actually measures the ratio of

(Pitot pressure – static pressure) : Static pressure

MACH 31. b.
Decreasing altitude causes air density to increase. The TAS at any given CAS is related to density such that as density increases, the TAS decreases. So descending at constant CAS causes TAS to decrease. The local speed of sound (LSS) is related to air temperature such that LSS increases as temperature increases. Decreasing altitude below 36000 ft in the ISA causes air temperature to increase. So descending causes LSS to increase. Mach number is equal to TAS/LSS, so when descending at constant CAS, the decreasing TAS and increasing LSS cause mach number to decrease. So mach number indications will decrease in a constant CAS descent.

Total air temperature (TAT) = SAT x (1 + (0.2 x K x M^2))

Where TAT is total air temperature.
SAT is static air temperature.
K is the ram recovery factor of the temperature probe.
M is the true mach number.

When descending below 36000 ft in the ISA, at constant CAS, SAT increases at a rate of 1.98^0 C per 1000 ft, while mach number decreases. The overall effect on TAT is determined by the relative magnitudes of the rates of change of mach number and SAT. The overall effect however is that TAT increases in a constant CAS descent below 36000 ft.

The above effects are illustrated by the example figures for 40000 ft and msl ISA detailed overleaf. These have been calculated using the equation listed in this book.

Pressure Altitude	40000 ft ISA	msl ISA
SAT	216.72^0 K	288^0 K
LSS	573 Kts	661 Kts
CAS	661 Kts	661 Kts
TAS	1322 Kts	661 Kts
Mach number	2.3M	1.0M
TAT	282.45^0 K	345.6^0 K

MACH 32. c.

A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in total pressure (P_T) and static pressure (P_S). An ASI differential capsule is then used to subtract P_S from P_T, to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

Mach meter indications are therefore derived from $(P_T - P_S)/P_S$.

Where PT is total or pitot pressure
PS is static pressure.

MACH 33. a.

This question is ambiguous in that it might be taken to mean a temperature increase at constant altitude, or a temperature increase due to decreasing altitude in the ISA.

If it is taken to mean increasing temperature at constant altitude, then CAS at any given mach number will be unaffected. This is because temperature changes alter the CAS:TAS ratio in exactly the same manner as they alter the LSS.

If however the temperature increase were brought about by decreasing altitude in the ISA, then the CAS at constant mach number would change. In the ISA the temperature decreases at approximately 1.98° C per 1000 ft. So a temperature increase of 5° C would reflect an altitude decrease of approximately 2500 ft.

The LSS both before and after the temperature change can be calculated by selecting two representative altitudes. If for example the selected altitude were 2500 ft and msl ISA, then the absolute temperatures would be 283° K and 288° K respectively. These can then be used to calculate the LSS at each altitude using the standard equation:

LSS in Kts = 38.94 $\sqrt{}$ Absolute temperature.

Inserting the calculated absolute temperature gives:

LSS at 2500 ft = $38.94\sqrt{283}$ which is 655 Kts.

And LSS at msl ft = $38.94\sqrt{288}$ which is 661 Kts.

This represents an increase in TAS of 6 Kts.

Similar calculations using example altitudes of 32500 ft and 30000 ft give 582 Kts at 32500 ft and 588 Kts at 30000 ft. This again indicates a change of about 6 Kts. So option a, "increase by 5 Kts" is the most accurate.

In considering the validity of these figures it should be noted that the difference in absolute temperature between msl and 36000 ft in the ISA is 71° K, whereas the difference in LSS is approximately 87 Kts. This is close to being a 1:1 ratio of 1 Kt change in LSS for each 1° K change in temperature due to altitude change. It should however be noted that this approximation can be used only where the temperature change has been brought about by an altitude change.

MACH 34. c.

A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in total pressure (P_T) and static pressure (P_S). An ASI differential capsule is then used to subtract P_S from P_T, to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

So a mach meter compares $(P_T - P_S)$ to P_S.

Where PT is total or pitot pressure
PS is static pressure.

MACH 35. c.

Mach number represents the true airspeed (TAS) of an aircraft expressed as a fraction of the local speed of sound (LSS). But the ratios of CAS, IAS and EAS to TAS, each change with altitude, so it cannot be said that mach number is the CAS, IAS, or LSS expressed as a fraction of the LSS or CAS.

MACH 36. b.

The question states that the ambient temperature is 200 C. This can be converted into absolute by adding 273 to give 293° K.

This can then be used to calculate LSS using the standard equation:

LSS in Kts = 38.94 $\sqrt{}$ Absolute temperature.

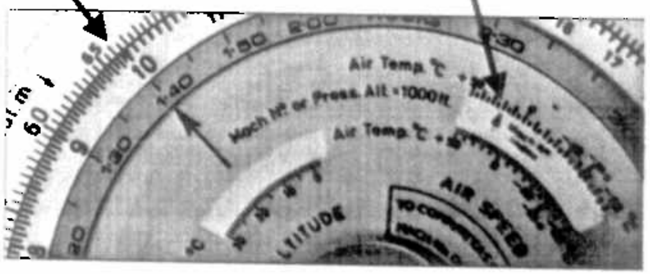
Inserting the calculated absolute temperature gives:

LSS in Kts = $38.94\sqrt{293}$ which is 666.54 Kts or approximately 666 Kts.

This type of problem can also be solved using the CRP5 as illustrated below.

2. Against 10 on the inner scale read off 666 Kts TAS on the outer scale.

1. In the airspeed window set the mach index pointer against the temperature of 20^{0}C.



MACH 37. b.

Mach number is the ratio of TAS:LSS, where LSS is the local speed of sound. LSS is proportional to absolute temperature, so if temperature increases, the true mach number at any given TAS will decrease.

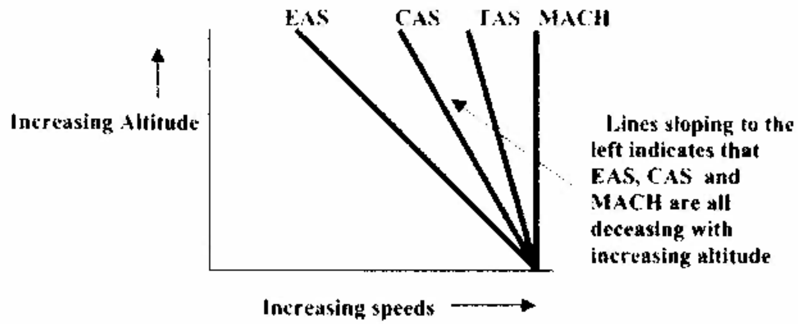
A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure.

Although changes in temperature produce changes in air density, such changes affect dynamic pressure and static pressure to the same degree. They do not therefore affect the accuracy of mach meter indications. This is because the reduced density will reduce the dynamic pressure at any given TAS. So the ratio of dynamic pressure to static pressure will alter to reflect the changing mach number. So if temperature increases when flying at constant TAS, both true and indicated mach number will decrease by the same amount (option b).

MACH 38. b.

Mach number is the TAS of an aircraft expressed as a fraction of the local speed of sound (LSS). So in a constant mach number climb, the TAS will change in the same manner as the LSS. LSS is proportional to absolute temperature, so as temperature falls, so does LSS, and the TAS at any given mach number. As altitude increases below the tropopause in the in the ISA, temperature decreases at a rate of 1.98^0 C per 1000 ft. So as altitude increases at constant mach number, below the tropopause, the TAS decreases.

The CAS at any given TAS is related to air density, such that decreasing density at constant TAS, causes CAS to decrease. As altitude increases, air density decreases, so in a constant mach number climb, the temperature, LSS, TAS and CAS all decrease. The most simple method of solving this type of problem is to use the ECTM graphs illustrated in the Key Facts section of this book. This method is illustrated below.



From the above diagram it can be seen that when climbing at constant MACH the CAS decreases (option b).

MACH 39. c.

The dynamic pressure at any given CAS is constant, so descending at constant CAS means descending at constant dynamic pressure. But static pressure increases in a descent, so the ratio of dynamic pressure to static pressure will decrease in a constant CAS descent.

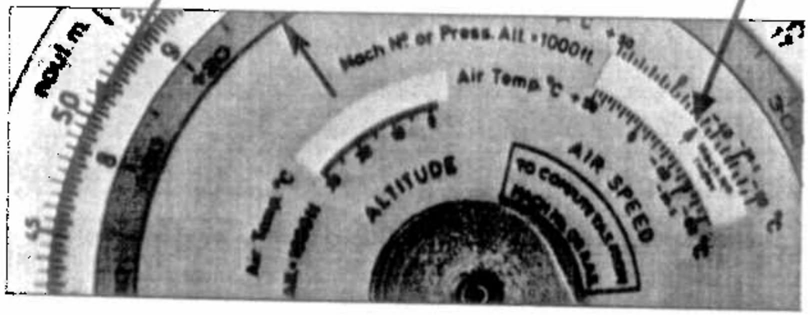
A mach meter produces an indication of mach number, based on the ratio of dynamic pressure to static pressure. It does this by taking in pitot pressure and static pressure. An ASI differential capsule is then used to subtract static pressure from pitot pressure to leave dynamic pressure. Movement of this capsule is then modified, using an altimeter aneroid capsule which senses static pressure. The mechanism is arranged such that the resultant output motion represents dynamic pressure divided by static pressure. So in a constant CAS descent, the indicated mach number will decrease to reflect the decreasing ratio of dynamic to static pressures (option c).

Although changes in temperature produce changes in air density, such changes affect dynamic pressure and static pressure to the same degree. They do not therefore affect the accuracy of mach meter indications.

MACH 40. d.
This type of problem can be solved using the CRP5 as illustrated below.

2. Against 500 Kts TAS on the outer scale read off mach 0.824 on the inner scale.

1. In the airspeed window set the mach index pointer against the temperature of -30^0C.



The solution mach 0.824 is closest to mach 0.82 (option d) in this question.

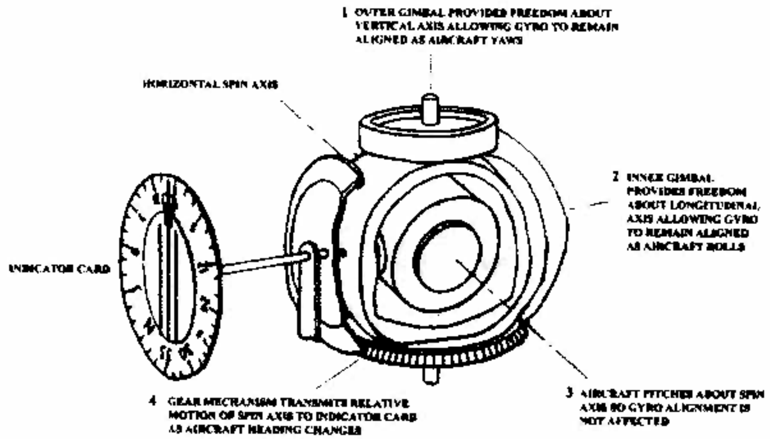
GYRO 1 b.
In the majority of gyroscopic instruments, the most important property required of the gyroscope is its rigidity. The rigidity of a gyro stems from its angular momentum, so anything that increases angular momentum will increase rigidity. Angular momentum is the product of mass multiplied by rotational velocity. At any given RPM, the rotational velocity increases with radius from the centre of rotation. So angular momentum and rigidity are increased by increasing RPM and concentrating the mass close to the periphery of a gyro. So the best efficiency is achieved by concentrating the mass on the periphery and with a high rotation speed (option b).

GYRO 2 b.
A standby horizon or emergency attitude indicator is a small self-contained gyroscopic instrument whose function is to provide attitude information following the failure of the main artificial horizon or attitude indicator. In order to achieve this it must be totally independent of the main instruments. It therefore contains its own separate gyroscope (option b).

GYRO 3 b.
In considering this question it should be noted that gyroscopes possess all five of the properties listed. But the question asks which properties are the basic properties of a gyro. Many of the above properties are common to a variety of physical objects but some are peculiar to gyroscopes. The question should therefore be interpreted as asking for properties that are peculiar to gyros. These are rigidity in space (2), and precession (5). Option b is therefore the most accurate in this question.

GYRO 4 d.
The most important properties of a gyroscope when used in a directional gyro are its rigidity in space and its precession. In order to provide valid directional information the gyroscope must point in a constant direction. This effect is provided by the rigidity of the gyroscope. But gyroscopes are rigid relative to space and not relative to any fixed point on the earth. This means that as the earth turns (statement 1) and as an aircraft moves over the surface of the earth (statement 3), the direction indicated by the gyro will appear to change. The third source of inaccuracies is the minor mechanical imperfections or defects in the structure of the gyro (statement 4). Further inaccuracies will occur whenever the gimbals of the gyro are not aligned at right angles to each other (statement 6). So option d is the most appropriate in this question.

GYRO 5 b.
A simple Directional Gyro or DGI is illustrated below. Its purpose is to provide a heading reference. It must therefore be aligned with a fixed point in the horizontal plane relative to the ground, regardless of the pitching, rolling and yawing of the aircraft. In order to do this it must have a horizontal spin axis and two degrees of freedom (option b). It should be noted that for JAR examination purposes the number of degrees of freedom possessed by a gyro is equal to the number of gimbals. So a DGI must also have two gimbals and some form of automatic erection system to enable it be erected quickly and to compensate for long term inaccuracies due to any tendency of the gyro to gradually topple.



SIMPLE DGI

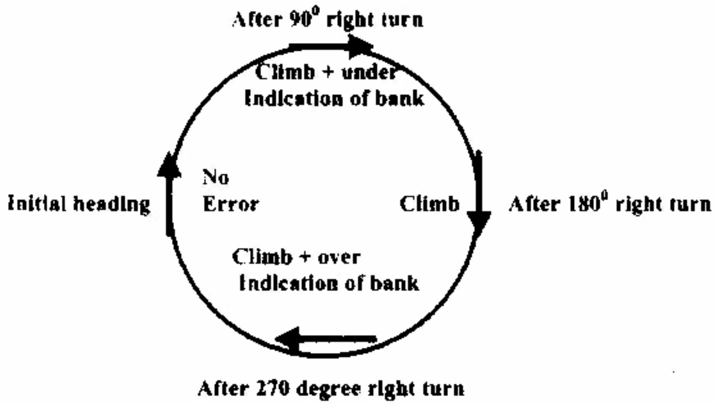
GYRO 6 a.

The purpose of a gravity erection device is to erect a gyro spin axis in the vertical plane. A vertical spin axis is employed in an artificial horizon (option a). It should be noted that a DGI, a turn indicator and a gyro-magnetic indicator all employ a horizontal spin axis.

GYRO 7 c.

The term "classical artificial horizon" when used in JAR examination questions means an air driven instrument using a pendulous vane erection system. These are subject to turning errors whenever the aircraft executes a turn. This problem is caused by the effects of centrifugal force on the erecting chamber and inertia on the pendulous vanes.

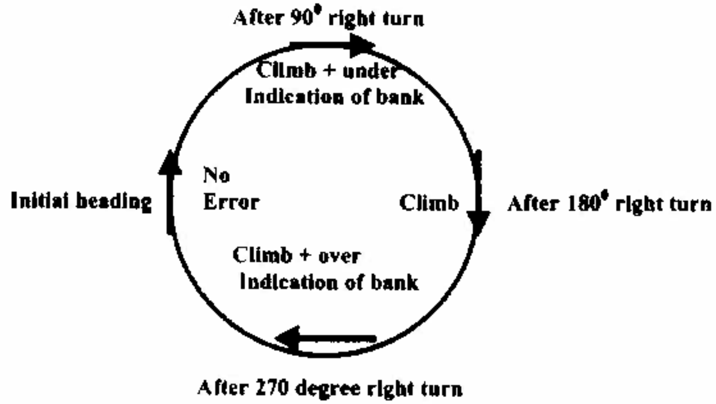
Under normal conditions, these vanes keep the spin axis vertical, by switching on and off air jets, such that the gyro is caused to precess, whenever it departs from the vertical. But the inertia of the vanes causes them to produce inappropriate precession, whenever they are subjected to accelerations, during speed changes or turns. The overall effect of centrifugal force on the erecting chamber and inertia on the pendulous vanes when turning right is the errors in the circle overleaf. After a 360 degree turn at constant bank angle the attitude and bank angle indications would be correct (option c).



GYRO 8 a.

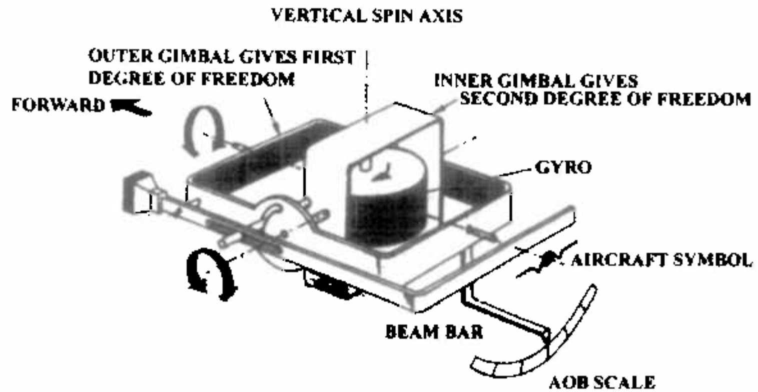
The term "classical artificial horizon" when used in JAR examination questions means an air driven instrument using a pendulous vane erection system. These are subject to turning errors whenever the aircraft executes a turn. This problem is caused by the effects of centrifugal force on the erecting chamber and inertia on the pendulous vanes. Under normal conditions, these vanes keep the spin axis vertical, by switching on and off air jets, such that the gyro is caused to precess, whenever it departs from the vertical. But the inertia of the vanes causes them to produce inappropriate precession, whenever they are subjected to accelerations, during

speed changes or turns. The overall effect of centrifugal force on the erecting chamber and inertia on the pendulous vanes when turning right is the errors in the circle overleaf. After a 270 degree turn at constant bank angle the instrument would attitude too much nose up and bank angle too high (option a).



GYRO 9 a.

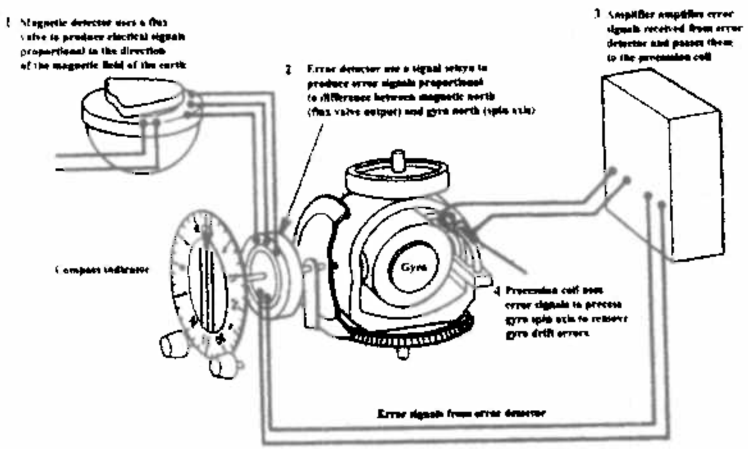
A basic artificial horizon is illustrated below.



It employs an earth gyroscope, which means that the spin axis of the gyro is kept vertically aligned with the earth. In an air driven instrument this alignment is maintained by means of pendulous vanes controlling the escape of air from an erection chamber at the base of the gyro. In electrically driven instruments alignment is maintained by a system of mercury switches and torque motors. In order to allow the spin axis to remain vertical while the aircraft pitches and rolls, the gyro has two degrees of freedom. One in roll and one in pitch. Option a is therefore the most accurate in this question.

GYRO 10 c.

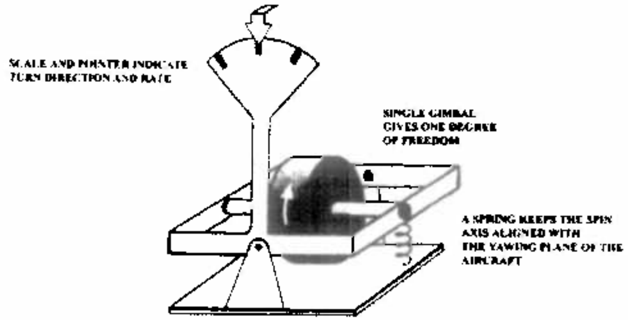
A typical gyro magnetic compass system is illustrated below. Magnetic directional signals originate in the flux valve (option c). They are then passed to the signal selsyn in the error detector unit, where they are compared with the gyro direction. Error signals are then sent to the amplifier and ultimately to the precession coil, which corrects the alignment of the gyroscope.



TYPICAL GYRO STABILISED COMPASS SYSTEM

GYRO 11 a.

When calculating the number of degrees of freedom of movement in JAR examination questions the freedom of the rotor to spin about its spin axis is not considered. A typical turn indicator is illustrated overleaf. In order to sense turn rate its gyro spin axis is aligned with the yawing plane of the aircraft. To achieve this it has one degree of freedom (in roll), (option a), but motion about this axis is limited by a calibrated spring.



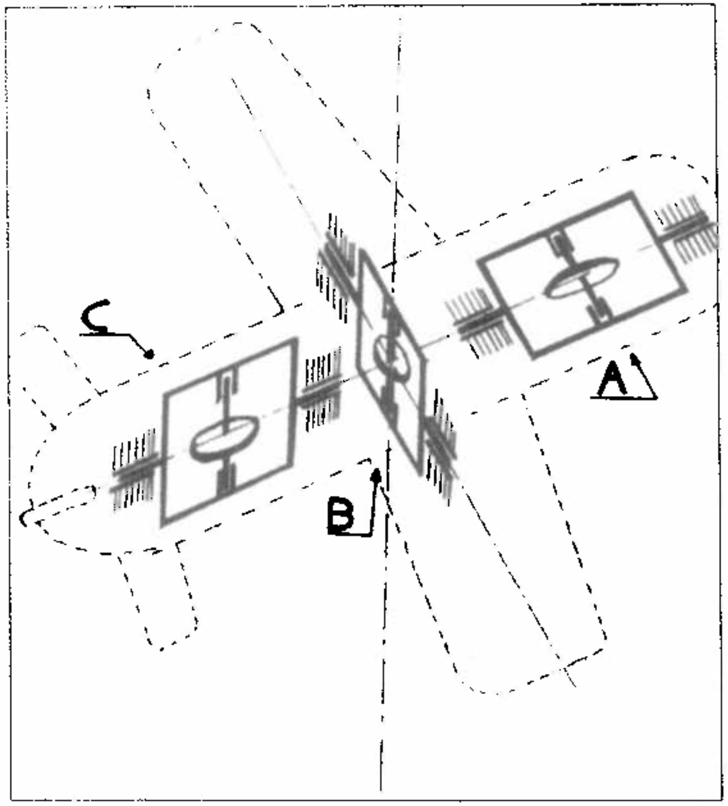
SIMPLE TURN INDICATOR

GYRO 12 d.

The diagram for this question is illsutrated overleaf.

This question is somewhat dubious in that pitch and roll are usually both sensed using a single vertical gyro in the artificial horizon unit. But the diagram provided does not permit this solution to be used.

Yawing motions are detected by a horizontal gyro with freedom of motion in pitch but not in yaw. This means that when the aircraft yaws it tends to change the orientation of the spin axis of the gyro. This causes the gyro to process at a rate that is proportional to the rate of yaw. This arrangement is illustrated in gyro A in the diagram. By applying the same logic roll will be detected by gyro B and pitch will be detected by gyro C (option d).



GYRO 13 b.

The most important properties of a gyroscope when used in a directional gyro are its rigidity and its precession. In order to provide valid directional information the gyroscope must point in a constant direction regardless of changes in the heading of the aircraft. This effect is provided by the rigidity of the gyroscope. But gyroscopes are rigid relative to space and not relative to any fixed point on the earth. This means that as the earth turns (statement 1) and as an aircraft moves over the surface of the earth (statement 2), the direction indicated by the gyro will appear to change.

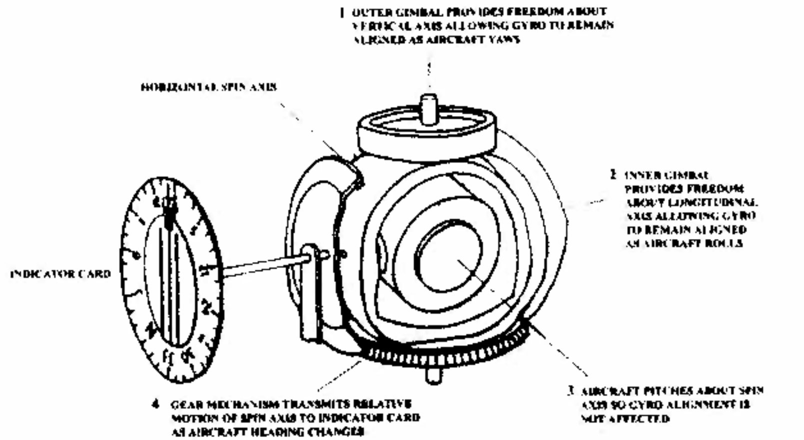
Further inaccuracies which are called gimbal errors will occur whenever the gimbals of the gyro are not aligned at right angles to each other. These errors are caused by lateral and transversal aeroplane bank angles (statement 3). The fourth cause of inaccuracies is the minor mechanical imperfections or defects in the structure of the gyro (statement 5). The term "North changes" used in statement 4 has no specific meaning with regard to gyros, so this statement is untrue. So option b is the most appropriate in this question.

GYRO 14 b.

The turn indicator indicates rate and direction of turn. In a slightly banked turn rate of turn can be said to be yaw rate. So it can be said that the rate-of-turn measurement is actually a measurement of the yaw rate of the aircraft (option b). This question is however ambiguous because under low bank conditions the yaw rate is also approximately equal to the angular velocity of the aircraft about the earth vertical axis. Which might be interpreted as being option a. But this option does not actually specify which axis is being considered, so it is less accurate than option b.

GYRO 15 d.

A simple Directional Gyro or DGI is illustrated below. Its purpose is to provide a heading reference. It must therefore be aligned with a fixed point in the horizontal plane relative to the ground, regardless of the pitching, rolling and yawing of the aircraft. In order to do this it must have a horizontal spin axis and two degrees of freedom (option d). It should be noted that for JAR examination purposes the number of degrees of freedom possessed by a gyro is equal to the number of gimbals. So a DGI must also have two gimbals and some form of automatic erection system to enable it be erected quickly and to compensate for long term inaccuracies due to any tendency of the gyro to gradually topple.



SIMPLE DGI

GYRO 16 d.

The needle of a turn and slip indicator indicates the direction and rate of turn. Needle displaced to the left indicates that a turn to the left is being carried out. The position of the ball indicates whether the aircraft is in balanced flight with no

sideslip ball central), slipping towards the centre of the turn (ball and needle in same direction), or skidding away from the centre of the turn (ball and needle in opposite directions).

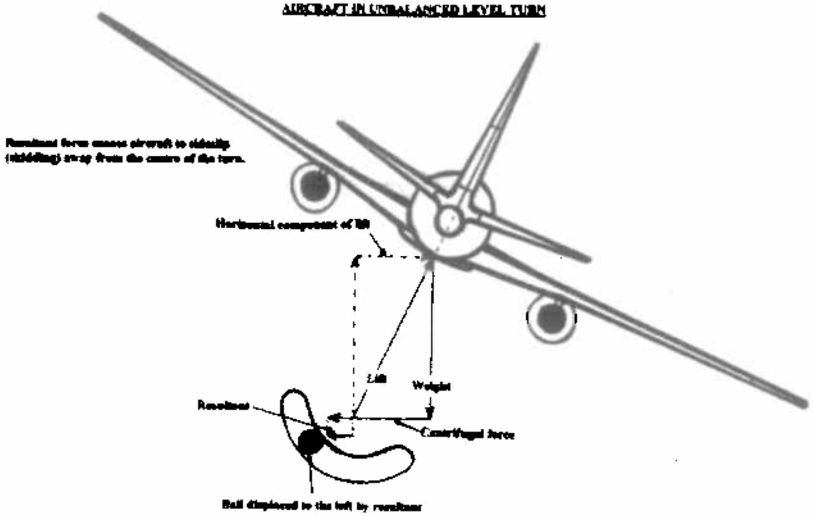
This question specifies needle left and ball right, which means a left turn with the aircraft skidding to the right. Skidding will occur when the bank angle towards the centre of the turn is insufficient to match the TAS and radius of turn. So in this question the aircraft is turning left with not enough bank (option d).

GYRO 17 b.

The needle of a turn and slip indicator indicates the direction and rate of turn. Needle displaced to the right indicates that a turn to the right is being carried out. The position of the ball indicates whether the aircraft is in balanced flight with no sideslip ball central), slipping towards the centre of the turn (ball and needle in same direction), or skidding away from the centre of the turn (ball and needle in opposite directions).

This question specifies needle right and ball left, which means a right turn with the aircraft skidding to the left. Skidding will occur when the bank angle towards the centre of the turn is insufficient to match the TAS and radius of turn. So in this question the aircraft is turning right with not enough bank (option b).

AIRCRAFT IN UNBALANCED LEVEL TURN

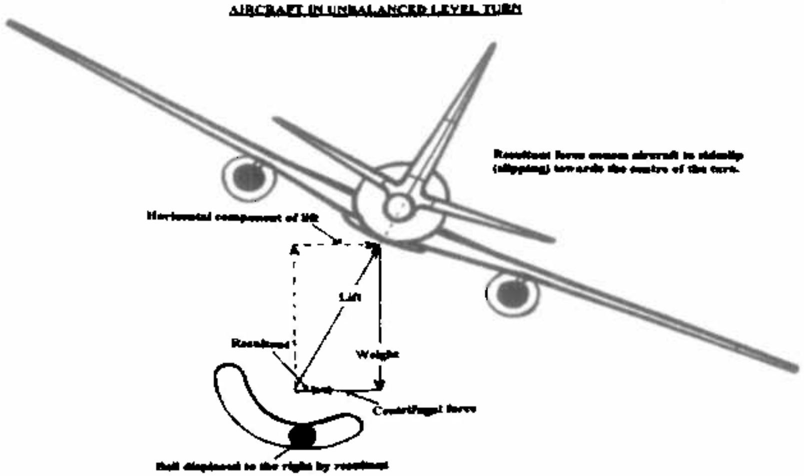


GYRO 18 c.

The needle of a turn and slip indicator indicates the direction and rate of turn. Needle displaced to the right indicates that a turn to the right is being carried out. The position of the ball indicates whether the aircraft is in balanced flight with no sideslip ball central), slipping towards the centre of the turn (ball and needle in same direction), or skidding away from the centre of the turn (ball and needle in opposite directions).

This question specifies needle and ball both to the right, which means a right turn with the aircraft slipping to the right. Slipping will occur when the bank angle towards the centre of the turn is to great to match the TAS and radius of turn. So in this question the aircraft is turning right with too much bank (option c).

AIRCRAFT IN UNBALANCED LEVEL TURN



GYRO 19 c.

The needle of a turn and slip indicator indicates the direction and rate of turn. Needle displaced to the left indicates that a turn to the left is being carried out. The position of the ball indicates whether the aircraft is in balanced flight with no sideslip ball central), slipping towards the centre of the turn (ball and needle in same direction), or skidding away from the centre of the turn (ball and needle in opposite directions).

This question specifies needle and ball both to the left, which means a left turn with the aircraft slipping to the left. Slipping will occur when the bank angle towards the centre of the turn is to great to match the TAS and radius of turn. So in this question the aircraft is turning left with too much bank (option c).

GYRO 20 d.
The needle of a turn and slip indicator indicates the direction and rate of turn. Needle displaced to the left indicates that a turn to the left is being carried out. The position of the ball indicates whether the aircraft is in balanced flight with no sideslip ball central), slipping towards the centre of the turn (ball and needle in same direction), or skidding away from the centre of the turn (ball and needle in opposite directions).

The position of the ball is determined by the forces acting upon it. In a balanced banked turn the gravitational force pull the ball vertically downwards and the centrifugal force pushing it out away from the centre of the turn, are in balance such that the ball is central. But when turning on the ground the aircraft cannot bank, so the ball moves out away from the centre of the turn. This means that the ball will always move away from the direction of turn when turning on the ground. So when turning left on the ground the needle will be to the left and the ball will be to the right (option d).

GYRO 21 b.
Whenever an aircraft carries out a banked turn in flight the turning motion is a combination of pitching and yawing. The relative magnitudes of each of these components is determined by the bank angle. At zero bank angle the turn is entirely yawing motion. At 90 degrees bank angle the turning is entirely pitching. Options a and c are therefore entirely true only under these special circumstances. But whatever angle of bank is used it can be said that the rate of turn is the change of heading rate of the aircraft (option b).

GYRO 22 c.
Whenever an aircraft carries out a banked turn in flight the turning motion is a combination of pitching and yawing. The relative magnitudes of each of these components is determined by the bank angle. At zero bank angle the turn is entirely yawing motion. At 90 degrees bank angle the turning is entirely pitching. Options a and c are therefore entirely true only under these special circumstances. So in a turn indicator the measurement of rate of turn consists for low bank angles, in measuring the yaw rate (option c).

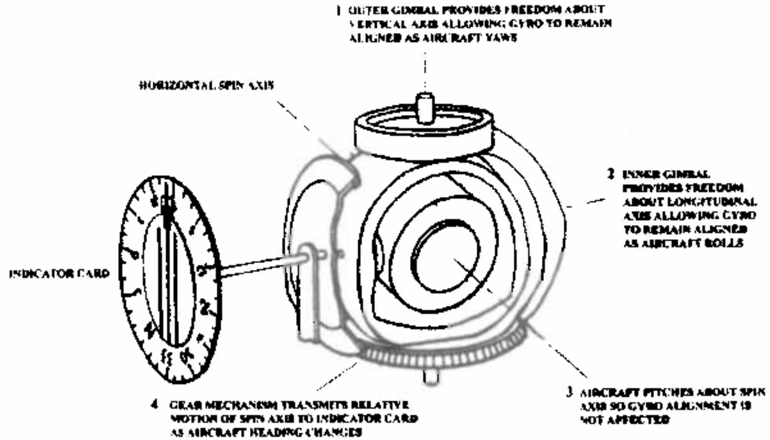
GYRO 23 d.
The rate of turn in a balanced turn can be calculated using the equation:

Rate of turn = g Tan AOB / TAS.

So it can be said that the turn indicator reading is inversely proportional to the aircraft true airspeed (option d).

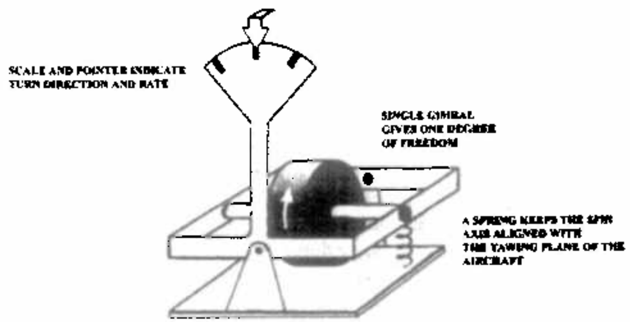
GYRO 24 a.
A simple Directional Gyro or DGI is illustrated below. Its purpose is to provide a heading reference. It must therefore aligned with a fixed pint in the horizontal

plane relative to the ground, regardless of the pitching, rolling and yawing of the aircraft. In order to do this it must have a horizontal spin axis and two degrees of freedom (option a). It should be noted that for JAR examination purposes the number of degrees of freedom possessed by a gyro is equal to the number of gimbals. So a DGI must also have two gimbals and some form of automatic erection system to enable it be erected quickly and to compensate for long term inaccuracies due to any tendency of the gyro to gradually topple.



SIMPLE DGI

GYRO 25 c.
A typical turn indicator is illustrated below.

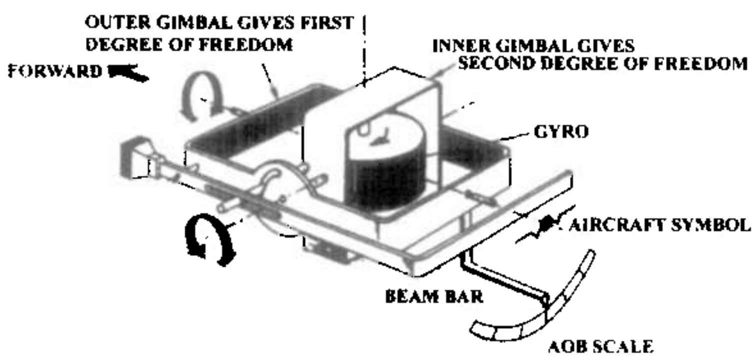


SIMPLE TURN INDICATOR

When calculating the number of degrees of freedom of movement in JAR examination questions the freedom of the rotor to spin about its spin axis is not considered.

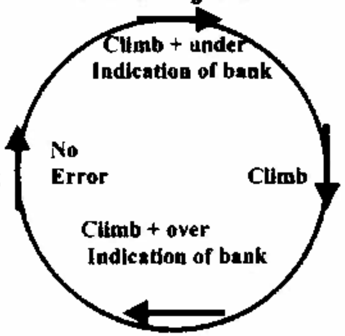
In order to sense turn rate its gyro spin axis is aligned with the yawing plane of the aircraft. To achieve this it has one degree of freedom (in roll), (option c), but motion about this axis is limited by a calibrated spring.

GYRO 26 c.
The vertical reference unit of a three-axis data generator is essentially an artificial horizon. A basic version of such an instrument is illustrated below. It employs an earth gyroscope, which means that the spin axis of the gyro is kept vertically aligned with the earth. In an air driven instrument this alignment is maintained by means of pendulous vanes controlling the escape of air from an erection chamber at the base of the gyro. In electrically driven instruments alignment is maintained by a system of mercury switches and torque motors. In order to allow the spin axis to remain vertical while the aircraft pitches and rolls, the gyro has two degrees of freedom. One in roll and one in pitch. So option c is the most accurate in this question.



GYRO 27 c.
The term "classical artificial horizon" when used in JAR examination questions means an air driven instrument using a pendulous vane erection system. These are subject to turning errors whenever the aircraft executes a turn. This problem is caused by the effects of centrifugal force on the erecting chamber and inertia on the pendulous vanes. Under normal conditions, these vanes keep the spin axis vertical, by switching on and off air jets, such that the gyro is caused to precess, whenever it departs from the vertical. But the inertia of the vanes causes them to produce

inappropriate precession, whenever they are subjected to accelerations, during speed changes or turns. The overall effect of centrifugal force on the erecting chamber and inertia on the pendulous vanes when turning right is the errors in the circle overleaf. After a 90 degree turn at constant bank angle the instrument would attitude too much nose up and bank angle too low (option c).



GYRO 28 b.
The needle of a turn and slip indicator indicates the direction and rate of turn. Needle displaced to the right indicates that a turn to the right is being carried out. The position of the ball indicates whether the aircraft is in balanced flight with no sideslip ball central), slipping towards the centre of the turn (ball and needle in same direction), or skidding away from the centre of the turn (ball and needle in opposite directions).

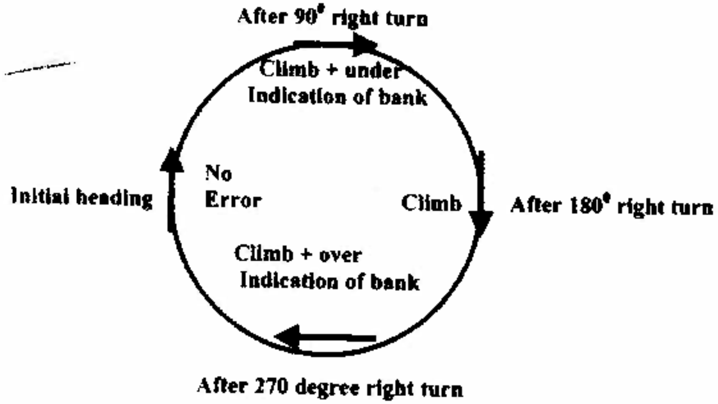
The position of the ball is determined by the forces acting upon it. In a balanced banked turn the gravitational force pull the ball vertically downwards and the centrifugal force pushing it out away from the centre of the turn, are in balance such that the ball is central. But when turning on the ground the aircraft cannot bank, so the ball moves out away from the centre of the turn. This means that the ball will always move away from the direction of turn when turning on the ground. So when turning right on the ground the needle will be to the right and the ball will be to the left (option b).

GYRO 29 a.
The heading reference unit of a three axis data generator is essentially a directional gyro. Its purpose is to provide a heading reference. It must therefore aligned with a fixed pint in the horizontal plane relative to the ground, regardless of the pitching, rolling and yawing of the aircraft. In order to do this it must have a horizontal spin axis and two degrees of freedom (option a). It should be noted that for JAR examination purposes the number of degrees of freedom possessed by a gyro is equal to the number of gimbals. So a DGI must also have two gimbals and some form of automatic erection system to enable it be erected quickly and to

compensate for long term inaccuracies due to any tendency of the gyro to gradually topple.

GYRO 30 b.

The term "classical artificial horizon" when used in JAR examination questions means an air driven instrument using a pendulous vane erection system. These are subject to turning errors whenever the aircraft executes a turn. This problem is caused by the effects of centrifugal force on the erecting chamber and inertia on the pendulous vanes. Under normal conditions, these vanes keep the spin axis vertical, by switching on and off air jets, such that the gyro is caused to precess, whenever it departs from the vertical. But the inertia of the vanes causes them to produce inappropriate precession, whenever they are subjected to accelerations, during speed changes or turns. The overall effect of centrifugal force on the erecting chamber and inertia on the pendulous vanes when turning right is the errors in the circle overleaf. After a 180 degree turn at constant bank angle the instrument would attitude too high pitch up and too low angle of bank (option b).



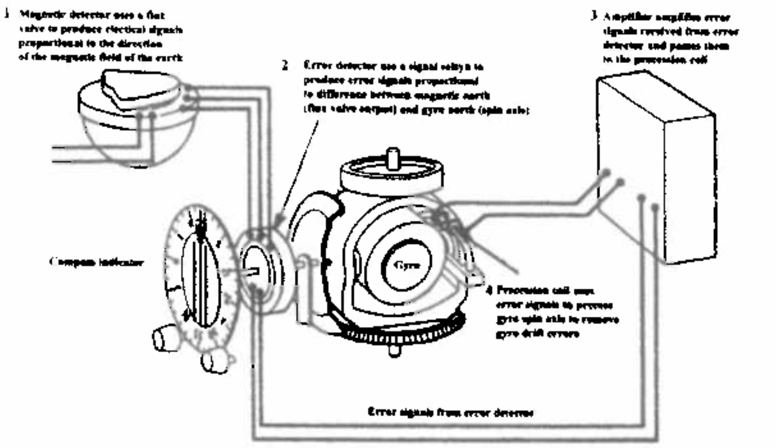
GYRO 31 a.

In a gyro stabilised magnetic compass system, The gyro and the compass magnets work in harmony to exploit the benefits of each. The gyro is largely immune to acceleration and turning errors, but suffers from drift due to earth rotation and transport wander. The compass magnets suffer from errors when accelerating or decelerating on east-west headings, and when turning on north-south headings, but is immune to earth rotation and transport wander errors.

In order to improve the accuracy of the system, the datum heading of the gyro is regularly reset using signals from the magnetic compass. This is achieved by a precession coil controlled by amplified error signals from the error detector. It is also necessary to ensure that the gyro spin axis is always in the yawing plane of the aircraft. This is achieved by a torque motor which causes the directional gyro to precess (option a).

GYRO 32 a.

A typical gyro magnetic compass system is illustrated below. Magnetic directional signals originate in the flux valve. These signals are then passed to the signal selsyn in the error detector unit (option a), where they are compared with the gyro direction. Error signals are then sent to the amplifier and ultimately to the precession coil, which corrects the alignment of the gyroscope.



TYPICAL GYRO STABILISED COMPASS SYSTEM

GYRO 33 b or c.

A typical gyro magnetic compass system is illustrated above. Magnetic directional signals originate in the flux valve. These signals are then passed to the signal selsyn in the error detector unit , where they are compared with the gyro direction. Error signals are then sent to the amplifier and ultimately to the precession coil, which corrects the alignment of the gyroscope. This means that the input signals to the amplifier originate at the flux valve but pass through the error detector immediately before entering the amplifier. Options b or c might therefore be taken to be correct in this question.

GYRO 34 a.

A rate gyro senses angular acceleration rates. When angular acceleration rate is integrated the result is angular velocity. An integrating gyro is a rate gyro, which carries out these functions. It is used in inertial attitude units (1) and in inertial navigation platforms (4). Integrating gyros are not used directly in automatic pilots (2), stabilizing servo systems (3) nor in rate-of-turn indicators (5). Option a is therefore the most accurate in this question.

GYRO 35 c.

A turn indicator gives an indication of the angular velocity of the aircraft about its yaw axis (1) and the direction of turn (3). Rate of turn is a measure of the angular velocity of the aircraft about its vertical axis. It should be noted that because an aircraft banks when turning, the true vertical axis differs from the aircraft normal axis, so statement 4 is not entirely true. The turn indicator does not measure roll rate nor bank angle so statement 2 is untrue. So option c is the most accurate in this question.

GYRO 36 a.

The term "gimbal errors" refers to the errors that are caused when the gimbals mounting a gyro are not aligned at 90 degrees to each other. This condition causes the gyro spin axis to alter as the aircraft pitches and rolls. So gimbal error of the directional gyro is due to a bank or pitch attitude of the aircraft (option a).

GYRO 37 c.

In order to ensure that a directional gyro remains horizontal as the aircraft manoeuvres, it is provided with a leveling erection system. This system uses torque motors to apply torque to the gimbals whenever the spin axis drifts or topples. These torques cause the gyro to precess such that it returns to the correct orientation. The torque motors are controlled by error signals from a pendulum type detector system. So the pendulum type detector system of the directional gyro feeds levelling erection torque motors (option c).

GYRO 38 d.

Because of its property of rigidity, a spinning gyroscope remains aligned with a fixed point in space. If a gyroscope is placed upon the earth it will initially be aligned with both a point in space and a point on the earth. As the earth rotates it carries the gyroscope with it. The gyroscope will remain aligned with the same point in space but this will no longer be aligned with the same point on the earth. This phenomenon is called earth rate error or apparent drift. The magnitude of earth rate drift is proportional to the latitude such that: Earth rate drift = 15° x the Sin of the latitude per hour. The greatest possible value that a Sin can take is 1, so the maximum possible magnitude of earth rate drift is 15°. this occurs at the North and South poles (option d).

GYRO 39 b.

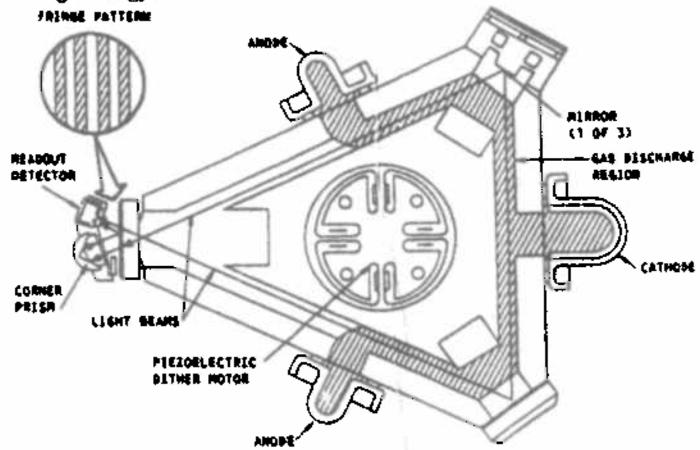
The ring laser gyro senses rates of rotation by measuring the difference between the resonant frequencies of two laser beams. The two beams travel in opposite directions around the triangle and are captured by a collecting mirror and detector unit. The detector unit then compares the resonant frequencies of the two beams to measure the difference between the two. These resonant frequencies are proportional to the length of the resonant structure through which they have passed. If the gyro is stationary the path taken by the two beams and hence the resonant frequencies are identical.

If however the aircraft yaws, the gyro will rotate with it. This means that the path of the beam travelling in the same direction as the gyro becomes slightly longer, whilst that of the other beam becomes slightly shorter. This difference in path length will cause a difference in resonant frequency that is proportional to the rate and direction of rotation.

Because they contain no moving parts, ring laser gyros:

1. Consume very little electrical power.
2. Can operate almost indefinitely without wearing out. They therefore have much longer life cycles than conventional gyros (option a).
3. Are reasonably insensitive to temperature changes.
4. Require very short start up times.

A simple ring laser gyro is illustrated below.



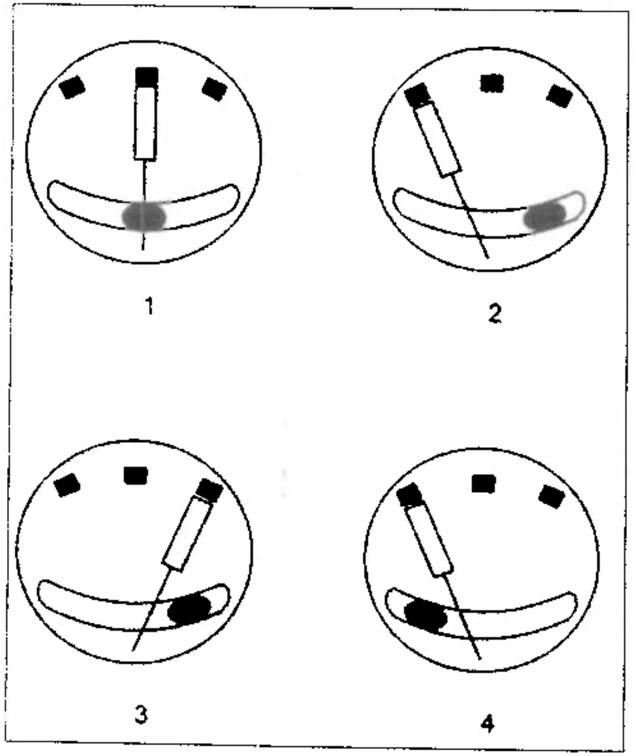
RING LASER GYROSCOPE

GYRO 40 c.

The needle of the turn and slip indicator indicates the direction and rate of turn. So in a left turn the needle will be to the left. The slip ball indicates whether the aircraft is in balanced flight or is slipping towards the centre of the turn or skidding away from the centre of the turn.

The radius of the turn depends upon the gravitational acceleration, angle of bank and airspeed. If these factors are balanced then the aircraft will be in balanced flight and the ball will be central. If however the radius of the turn is too large to balance the other factors, then the aircraft will slip towards the centre of the turn until the correct radius is achieved.

This slipping can be avoided by using the rudder to steer the aircraft into the correct radius. In a left turn with insufficient rudder the turn radius will be too large so the aircraft will be slipping to the left. The ball and needle will therefore both be to the left as in diagram 4. so option c is correct.



GYRO 41 b.
The rate of turn of an aircraft in flight can be calculated using the equation:
Rate of turn = g x Tangent of angle of bank / TAS

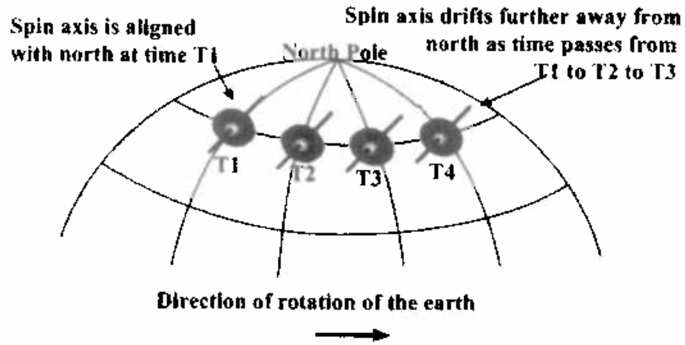
G is the gravitational acceleration caused by earth gravity, which is approximately constant. So the only factors that determine the rate of turn are the bank angle (statement 1) and the aeroplane speed (statement 2). So option b is correct.

GYRO 42 d.
A classical artificial horizon uses a pendulous weight system to maintain the gyro spin axis vertical. In effect this is a weight hanging below the spin axis of the gyro. When an aircraft accelerates, the inertia of this weight tends to cause it to lag behind the aircraft. This has the effect of tilting the bottom of the spin axis in an

aft direction and the top in a forward direction. This tilting of the spin axis cause the instrument to give a nose up indication (option d).

GYRO 43 d.
In order to sense changes in any given plane a gyro must have its spin axis aligned in the direction of that plane. Heading changes take place in the horizontal plane, so to provide heading information a gyro must have a horizontal spin axis. In order to keep the spin axis horizontal as the aircraft pitches rolls and yaws, the gyro must have two degrees of freedom (option d).

GYRO 44 d.
Because of its property of rigidity, a spinning gyroscope remains aligned with a fixed point in space. If a gyroscope is placed upon the earth it will initially be aligned with both a point in space and a point on the earth. This might for example be the North Pole. As the earth rotates it carries the gyroscope with it. The gyroscope will remain aligned with the same point in space but this will no longer be aligned with the same point on the earth. This phenomenon is called earth rate error or apparent drift. The magnitude of earth rate drift is proportional to the latitude such that: Earth rate drift = 15^0 x the Sin of the latitude per hour. In the northern hemispheres this drift is to the right. This effect is illustrated below.

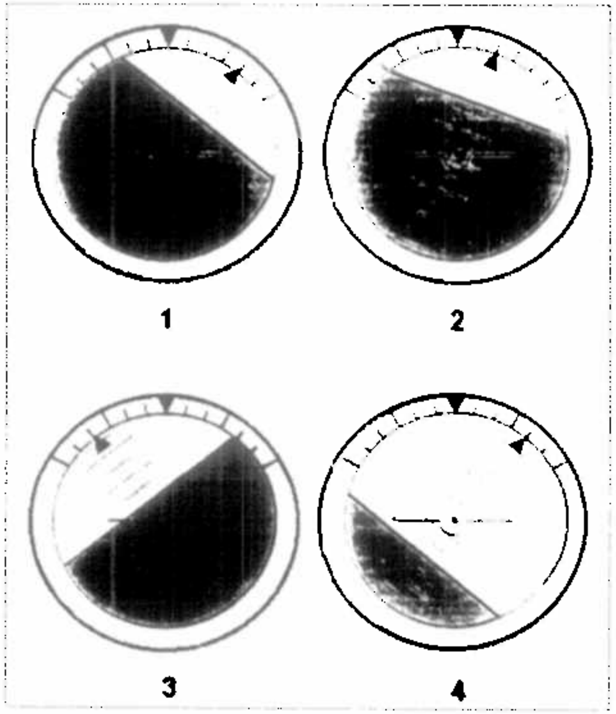


So at a latitude of 45^0, the earth rate drift is 15^0. x sin 45^0 = 10.605^0 per hour or approximately 10.5^0 per hour (option d).

GYRO 45 a.
On a typical artificial horizon the earth and the sky are identified by different colours. In the diagrams in this question the earth appears as a dark colour and the sky appears as a lighter colour. The horizon is the line between the earth and the sky. When an aircraft is banked to the left, the horizon will appear to be tilted right side down as in diagrams 1, 2 and 4.

The aircraft is represented by a small winged symbol at the centre of the instrument display. When the aircraft is pitched nose down, the aircraft symbol will be below the horizon as in diagrams 1, 2 and 4. taking into account the above factors only diagrams 1 and 2 indicate left bank and nose down.

The bank angle is indicated by pointer and scale above the globe. This is marked in 10° increments. The degree of pitch is indicated by the scale passing through the aircraft symbol. This is marked in 5° increments. Examination of diagrams 1 and 2 reveals that only diagram 1 (option a) shows 40° left bank and 15° nose down pitch. If this diagram is rotated anticlockwise until the horizon line is horizontal the true situation is indicated by the position of the aircraft symbol.



GYRO 46 c.
A directional gyro has a spin axis that is aligned in the horizontal plane. Because of its rigidity the spin axis of a gyro is aligned with a fixed point in space, rather than with any fixed point on the earth. This means that if the directional gyro is moved across the surface of the earth, the alignment of its spin axis relative to the earth will appear to change. This effect is called Transport Wander which in its abbreviated form is written TW.

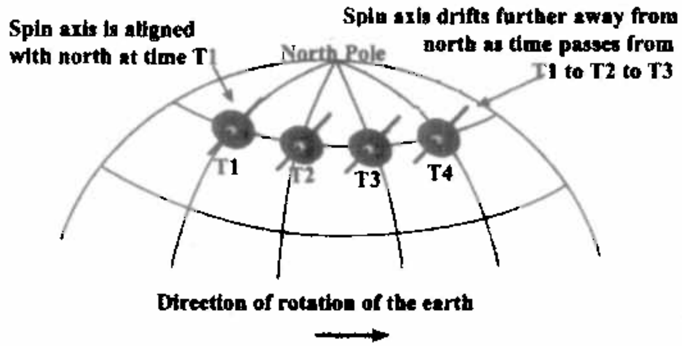
The rate of Transport Wander can be calculated using the standard equation:

TW = (East/West groundspeed (in Kts) x Tan latitude) / 60) degrees per hour

This means that transport wander is dependent upon the ground speed of the aircraft, its true track and the average latitude of the flight (option c).

GYRO 47 a.
A gravity erection system is fitted to a vertical gyro in order to keep its spin axis vertical. Of the options listed in this question only the artificial horizon device (option a) uses a gyro with a vertical spin axis.

GYRO 48c.
Because of its property of rigidity, a spinning gyroscope remains aligned with a fixed point in space. If a gyroscope is placed upon the earth it will initially be aligned with both a point in space and a point on the earth. This might for example be the North Pole. As the earth rotates it carries the gyroscope with it. The gyroscope will remain aligned with the same point in space but this will no longer be aligned with the same point on the earth. This phenomenon is called earth rate error or apparent drift. The magnitude of earth rate drift is proportional to the latitude such that: Earth rate drift = 15° x the Sin of the latitude per hour. In the northern hemispheres this drift is to the right. This effect is illustrated below. This means that earth rate is greatest at the latitude at which the sin of the latitude



is greatest. This occurs at the north and south poles (90° north and south), where the sin is equal to 1. At these locations the earth rate is equal to 15°. x sin 90° which is 15° x 1 which is 15° per hour (option c).

GYRO 49 a.
To detect changes in heading a directional gyro has a horizontal spin axis. To enable this to be maintained as the aircraft pitches yaws and rolls, the gyro must have two degrees of freedom (statement 1). The rigidity of such gyros causes them to remain aligned with a fixed point in space rather than with a fixed point on the earth. The makes the spin axis appear to change as the earth rotates (earth rate drift) and as the aircraft is moved from place to place on the earth (transport

wander). These errors mean that a directional gyro is incapable of self-orientation around an earth-tied direction (statement 4). So option only a is true.

GYRO 50 b.

Apparent wander is the sum of earth rate drift and transport wander. Earth rate drift = 15° x the Sin of the latitude per hour. The average latitude in this question is zero so the earth rate drift is zero.

Transport Wander can be calculated using the standard equation:

TW = (East/West groundspeed (in Kts) x Tan latitude) / 60) degrees per hour

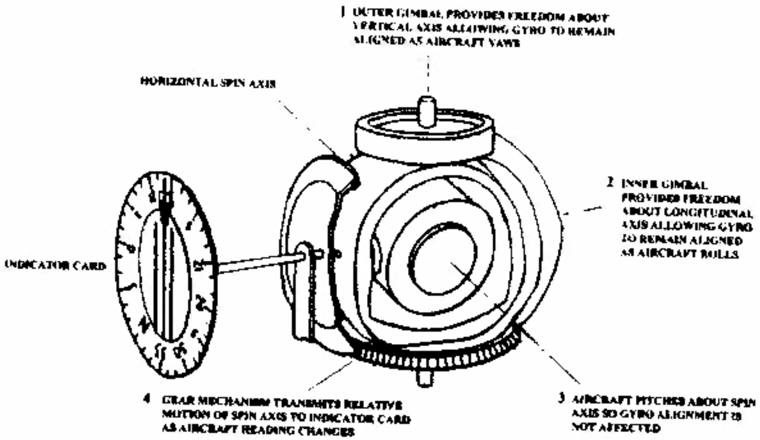
This question specifies a flight with a track of 360° between the 005° S and 005° N. This means that the East/West groundspeed is zero and the mean latitude is zero. This in turn means that the transport wander is zero. Adding together the zero earth rate drift and the zero transport wander gives a precession error of the directional gyro due to apparent drift of 0°/hour (option b).

GYRO 51. b.

Because of its property of rigidity, a spinning gyroscope remains aligned with a fixed point in space. If a gyroscope is placed upon the earth it will initially be aligned with both a point in space and a point on the earth. This might for example be the North Pole. As the earth rotates it carries the gyroscope with it. The gyroscope will remain aligned with the same point in space but this will no longer be aligned with the same point on the earth. This phenomenon is called earth rate error or apparent drift. The magnitude of earth rate drift is proportional to the latitude such that: Earth rate drift = 15° x the Sin of the latitude per hour. The greatest possible value that a Sin can take is 1, so the maximum possible magnitude of earth rate drift is 15°. this occurs at the poles.

GYRO 52. b.

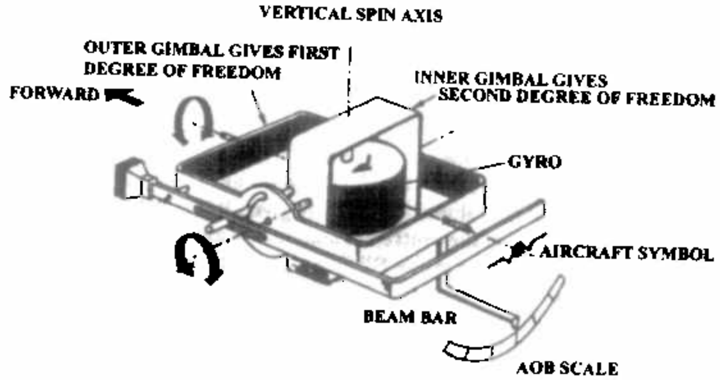
A simple Directional Gyro or DGI is illustrated below. Its purpose is to provide a heading reference. It must therefore aligned with a fixed pint in the horizontal plane relative to the ground, regardless of the pitching, rolling and yawing of the aircraft. In order to do this it must have a horizontal spin axis and two degrees of freedom (option b). It should be noted that for JAR examination purposes the number of degrees of freedom possessed by a gyro is equal to the number of gimbals. So a DGI must also have two gimbals.



SIMPLE DGI

GYRO 53. a.

A simple example of an attitude indicator is illustrated below.



A vertical gyroscope with a gravity erection device will detect motion in roll and pitch. Such a gyro is therefore employed in an Artificial Horizon.
It should be noted that a DGI and a turn indicator both employ horizontal gyros.
A rate gyro is used to detect angular acceleration rates.

GYRO 54. d.
A rate gyro senses angular acceleration rates. When angular acceleration rate is integrated the result is angular velocity. An integrating gyro is a rate gyro, which carries out these functions. It is used in inertial navigation units (2) and in inertial navigation platforms (4). Integrating gyros are not used in attitude indicators because these indicate attitude rather than rate of change of attitude. Although rate of turn indicators (3) do indicate angular velocities, current versions do not employ integrating gyros. Autopilots (5)do not usually employ gyros of any sort, but receive their signals from gyros in other flight instruments or the inertial navigation or inertial reference systems.

GYRO 55. a.
The term vertical changes might be taken to mean changes in altitude, pitch and roll. But no form of gyro is able to sense changes in altitude, so only pitch and roll need to be considered for the purposes of this question. Such changes are measured using an artificial horizon or attitude indicator. These employ a gyro with two degrees of freedom and a vertical spin axis. A simple attitude indicator is illustrated in GYRO 53.

GYRO 56. d.
In considering this question it should be noted that gyroscopes possess all four of the properties listed. But the questions ask which properties are peculiar to gyros. These are precession (2) and rigidity (3), because inertia (1) is possessed by all masses and angular momentum (4) is possessed by all rotating masses. Student feedback suggests that this type of questions is frequently badly worded in that it simply ask "what properties are possessed by gyros" In such circumstances, students should select all of the options possessed by any mass, but make a written objection stating that the question is badly worded and why this is so.

GYRO 57. b.
The rigidity of a gyro stems from its angular momentum, so anything that increases angular momentum will increase rigidity. Angular momentum is the product of mass multiplied by rotational velocity. At any given RPM, the rotational velocity increases with radius from the centre of rotation. So angular momentum and rigidity are increased by increasing RPM and concentrating the mass close to the periphery of a gyro (option b)

GYRO 58. c.
The purpose of a gravity erection device is to erect a gyro spin axis in the vertical plane. A vertical spin axis is employed in an artificial horizon. It should be noted that a DGI and turn indicator both employ a horizontal spin axis. A VSI does not employ any type of gyro.

GYRO 59. a.
The purpose of a yaw damper is to prevent Dutch Roll by enhancing the directional stability of an aircraft. It does this by providing rudder control inputs proportional to the rate and direction of yaw. In order to sense yaw rates it employs a horizontal rate gyro.

GYRO 60. a.
Gyro-stabilised platforms use three rate gyros to measure the rates of yawing pitching and rolling. Rate gyros have one degree of freedom. In order to obtain heading information it is necessary that a gyro has a horizontal spin axis. So to obtain heading information a gyro stabilised platform requires a gyro with a horizontal spin axis and one degree of freedom (option a).

GYRO 61. c.
Apparent wander is the sum of earth rate drift and transport wander. Earth rate drift = 15° x the Sin of the latitude per hour. The average latitude in this question is zero so the earth rate drift is zero.

Transport Wander can be calculated using the standard equation:

TW = (East/West groundspeed (in Kts) x Tan latitude) / 60) degrees per hour

This question specifies a flight with a track of 360° between the 005° S and 005° N. This means that the East/West groundspeed is zero and the mean latitude is zero. This in turn means that the transport wander is zero. Adding together the zero earth rate drift and the zero transport wander gives a precession error of the directional gyro due to apparent drift of 0°/hour (option c).

GYRO 62. b.
In many of the older reference books, the degrees of freedom of a gyro are assumed to include spin. This mean that the number of degrees of freedom is one more than the number of gimbals. For the purposes of the JAR examinations however the degrees of freedom do not include spin, and so the number of degrees must be taken to be equal to the number of gimbals (option b).

GYRO 63. b.
The purpose of a directional gyro is to provide a constant source of heading reference regardless of the yawing, pitching and rolling of the aircraft. To achieve this it employs a horizontal spin axis and two gimbals providing two degrees of freedom. It should be noted that if the gyro in question is mounted on a gyro-stabilised platform it would be a rate gyro with one gimbal, one degree of freedom and a horizontal spin axis (option a). The question does not however specify a gyro-stabilised platform so option b is the most appropriate.

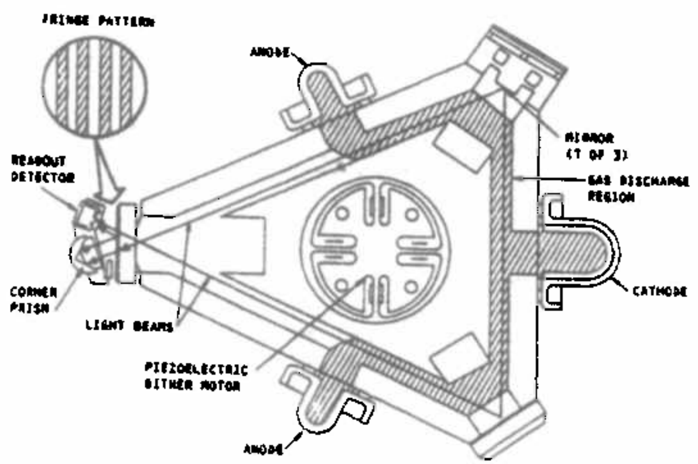
GYRO 64. a.
A gyro with a horizontal spin axis will sense rotations in yaw, plus pitch or roll depending on the spin axis orientation. A horizontal spin axis plus one degree of freedom is most commonly provided in a rate gyro.

GYRO 65. a.
Gyroscope possess all of the properties of any mass, plus some additional properties due to their rotation. Mass (1) and inertia (3) are common to all masses including gyros. Rigidity in space (2) and precession (4) are peculiar to rotating masses including gyros. But rigidity in space means that a gyro cannot possess rigidity with reference to the earth (5) because the earth moves in space.

It should be noted that if the question had asked for the properties that are unique to a gyro, then only statements 2 and 4 would be true. This is not however an option in this question. As always the key if to read the examination questions very carefully and consider all of the options before selecting one.

GYRO 66. a.
The rigidity of a gyro stems from its angular momentum, so anything that increases angular momentum will increase rigidity. Angular momentum is the product of mass multiplied by rotational velocity. At any given RPM, the rotational velocity increases with radius from the centre of rotation. So angular momentum and rigidity are increased by increasing RPM and increasing the radial displacement of its mass (option a)

GYRO 67. b
A simple ring laser gyro is illustrated below.

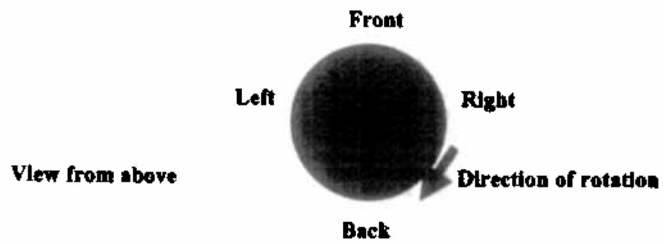


RING LASER GYROSCOPE

The ring laser gyro senses rates of rotation by measuring the difference between the resonant frequencies of two laser beams. The two beams travel in opposite directions around the triangle and are captured by a collecting mirror and detector unit. The detector unit then compares the resonant frequencies of the two beams to measure the difference between the two. These resonant frequencies are proportional to the length of the resonant structure through which they have passed. If the gyro is stationary the path taken by the two beams and hence the resonant frequencies are identical.

If however the aircraft yaws, the gyro will rotate with it. This means that the path of the beam travelling in the same direction as the gyro becomes slightly longer, whilst that of the other beam becomes slightly shorter. This difference in path length will cause a difference in resonant frequency that is proportional to the rate and direction of rotation. But when the gyro is rotating scatter from the mirrored surfaces sometimes causes the beams to lock together making the detection of small yaw rates impossible. To prevent this laser lock, a dither motor vibrates the gyro at a resonant frequency, thereby causing the beams to unlock. So the purpose of the dither motor is to prevent laser lock (option b).

GYRO 68. a.



The precession property of a rotating gyro is such that any force tending to alter the spin axis orientation, does not take effect at its point of application but at a point 90° later in the direction of gyro rotation. The above gyro is spinning clockwise, so a downward force applied to its right side will cause the back of the gyro to move downwards. This will cause the gyro to move upwards at the front.

GYRO 69. c.
A 2 axis gyro measuring vertical changes is fitted into an artificial horizon. It has two degrees of freedom and a vertical spin axis as illustrated in GYRO 53.

GYRO 70. c.
Of the properties listed in this question, mass (1) and inertia (2) are common to all bodies. Rotational velocity (5) is possessed by all rotating bodies. But rigidity (3) and precession (4) (option c) are unique to gyroscopes.

GYRO 71. d.

A simple Directional Gyro or DGI is illustrated in GYRO 52. Its purpose is to provide a heading reference. It must therefore be aligned with a fixed point in the horizontal plane relative to the ground, regardless of the pitching, rolling and yawing of the aircraft. In order to do this it must have a horizontal spin axis (4) and two degrees of freedom (2) (option d). It should be noted that for JAR examination purposes the number of degrees of freedom possessed by a gyro is equal to the number of gimbals. So a DGI must also have two gimbals.

GYRO 72. c

A vertical reference data generator is essentially the same as an artificial horizon, but produces electrical outputs rather than a visual display. It must therefore have the same two degrees of freedom (2) and vertical spin axis (3) used by an artificial horizon.

GYRO 73. c.

In a gyro stabilised magnetic compass system, The gyro and the compass magnets work in harmony to exploit the benefits of each. The gyro is largely immune to acceleration and turning errors, but suffers from drift due to earth rotation and transport wander. The compass magnets suffer from errors when accelerating or decelerating on east-west headings, and when turning on north-south headings, but is immune to earth rotation and transport wander errors. In order to improve the accuracy of the system, the datum heading of the gyro is regularly reset using signals from the magnetic compass. This is achieved by a precession coil controlled by amplified error signals from the error detector. It is also necessary to ensure that the gyro spin axis is always in the yawing plane of the aircraft. This is achieved by a torque motor which causes the directional gyro to precess (option c).

GYRO 74. c.

A rate gyro senses angular acceleration rates. When angular acceleration rate is integrated the result is angular velocity. An integrating gyro is a rate gyro, which carries out these functions. It is used in inertial navigation units (3) and in inertial attitude reference units (4). Although rate of turn indicators (1) do indicate angular velocities, current versions do not employ integrating gyros. Autopilots (2)do not usually employ gyros of any sort, but receive their signals from gyros in other flight instruments or the inertial navigation or inertial reference systems. Integrating gyros are not however used to stabilise the inertial platforms (5).

GYRO 75. b.

A simple DGI is illustrated in GYRO 52. Its purpose is to provide a heading reference. It must therefore aligned with a fixed pint in the horizontal plane relative to the ground, regardless of the pitching, rolling and yawing of the aircraft. In order to do this it must have a horizontal spin axis and two degrees of freedom).

All gyros suffer from errors due to minor mechanical imperfections (1) in the bearings and balance of their rotors. Also, because gyros remain aligned on

affixed point in space their alignment relative to any point on the earth varies due to earth rotation rate (2). Similar apparent errors also occur whenever a gyro is transported (3) to a different location on the earth. DGIs are subject to one further form of error due to the interactions of the gimbals and the rotor. Whenever an aircraft pitches, the outer gimbal of its DGI must rotate slightly about its own axis to enable the spin axis to remain aligned. This causes the inner gimbal to roll slightly (4), producing an indication of a heading change. DGIs do not employ magnetic detectors so annual migration of the pole (5) does not cause errors.

GYRO 76. b.

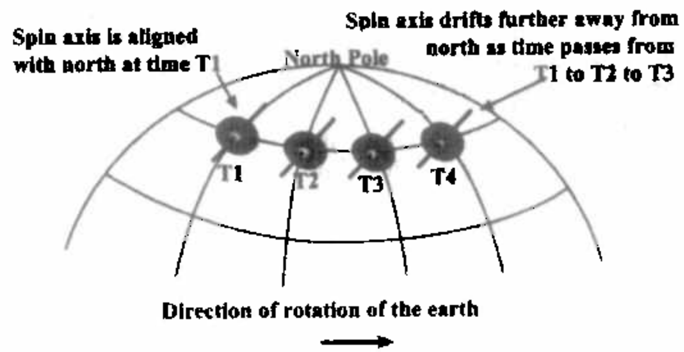
An inertial platform provides heading information by means of rate integrating gyros. This senses angular accelerations which are then integrated to give angular velocities and integrated again to give angular displacement or yaw. The heading at any point in time is calculated by adding these yaw displacements to the initial heading on which the platform was aligned before flight. In order to sense angular acceleration rates the gyros one degree of freedom (1) and a horizontal spin axis (4).

GYRO 77. c.

A simplified version of an artificial horizon is illustrated in GYRO 9. An artificial horizon uses a vertical spin axis in order to sense changes in pitch and roll. A gravity erector system is used to keep the spin axis vertical. ROT indicators (a) and DGIs (b) use horizontal spin axes so gravity erection systems are not required.

GYRO 78. a.

The term gyro wander refers to any condition in which the alignment of the spin axis changes. Real wander occurs when the alignment changes relative to space and is caused by external forces or mechanical imperfections in the gyro. Gyro drift due to earth rotation is termed apparent wander. It is caused by the fact that the gyro is carried around with the earth as it rotates, as illustrated below.



Transport wander (TW) is similar to earth rate wander, but is caused by the movement of an aircraft relative to the earth as it flies around the earth (option a).

GYRO 79. c.

A basic artificial horizon or attitude indicator is illustrated in GYRO 9. It employs an earth gyroscope, which means that the spin axis of the gyro is kept vertically aligned with the earth (3). In an air driven instrument this alignment is maintained by means of pendulous vanes controlling the escape of air from an erection chamber at the base of the gyro. In electrically driven instruments alignment is maintained by a system of mercury switches and torque motors. In order to allow the spin axis to remain vertical while the aircraft pitches and rolls, the gyro has two degrees of freedom (2). One in roll and one in pitch. So the gyro in an artificial horizon has a vertical axis and two degrees of freedom (option c).

GYRO 80. b.

The rigidity of a gyro stems from its angular momentum, so anything that increases angular momentum will increase rigidity. Angular momentum is the product of mass multiplied by rotational velocity. At any given RPM, the rotational velocity increases with radius from the centre of rotation. So angular momentum and rigidity are increased by increasing RPM and increasing the radial displacement of its mass by concentrating the mass close to its rim (option b)

GYRO 81. d.

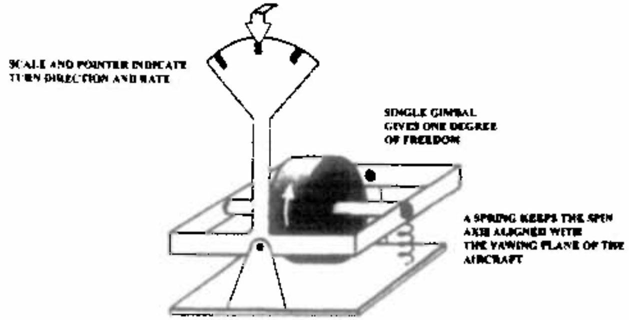
A vertical gyroscope with a gravity erection device will detect motion in roll and pitch. Such a gyro is therefore employed in an Artificial Horizon. It should be noted that a directional gyro unit (b) and a turn indicator (c) both employ horizontal gyros and hence do not use gravity erection units. An ASI (a) does not include any type of gyro or erection unit.

GYRO 82. c.

In order to sense turn direction and rate, a turn indicator (option c) must use a gyro with its spin axis aligned with the yawing plane of the aircraft. To achieve this it has one degree of freedom. (in roll).

The gyros in a slaved gyro compass (a) and a directional gyro unit (b) must remain horizontal relative to the earth as the aircraft pitches and rolls, so they employ two degrees of freedom. An artificial horizon (d) must remain vertical, so this also employs two degrees of freedom.

A typical turn indicator is illustrated below.



SIMPLE TURN INDICATOR

GYRO 83. b.

This problem can be solved using the standard equation:

TW = (E/W groundspeed (in Kts) x Tan latitude) / 60) degrees per hour

So when flying east at 400 Kts at 45° latitude:

TW = (400 x Tan 45) / 60 which = 6.67° per hour.

GYRO 84. a.

This problem can be solved using the standard equation:

TW = (E/W groundspeed (in Kts) x Tan latitude) / 60) degrees per hour

Southern latitudes are minus northern ones.

So when flying east at 300 Kts at -40° south latitude:

TW = (300 x Tan -40) / 60 which = -4.2° per hour.

GYRO 85. c.

This problem can be solved using the standard equation:

TW = (E/W groundspeed (in Kts) x Tan latitude) / 60) degrees per hour

When flying west the E/W groundspeed is minus the westerly groundspeed and southerly latitudes are minus northerly ones.

So when flying west at 300 Kts at 25° south latitude:

TW = (-300 x Tan -25) / 60 which = 2.33° per hour.

GYRO 86. c.
This problem can be solved using the standard equation:

TW = (E/W groundspeed (in Kts) x Tan latitude) / 60) degrees per hour

When flying west the E/W groundspeed is minus the westerly groundspeed .

So when flying east at 300 Kts at 25° north latitude:

TW = (-300 x Tan 25) / 60 which = -2.33° per hour.

GYRO 87. d.
This problem can be solved using the standard equation:

ER = 15° x Sin latitude degrees per hour.

Southerly latitude are minus northerly latitudes .

So at 25° south ER = 15° x Sin -25 which = -6.340 per hour.

GYRO 88. d.
This problem can be solved using the standard equation:

ER = 15° x Sin latitude degrees per hour.

So at 25° north ER = 15° x Sin 45 which = 10.61 per hour.

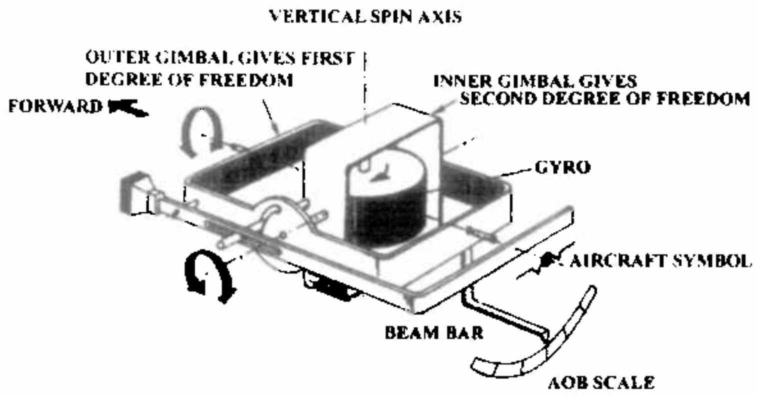
GYRO 89. a.
This problem can be solved using the standard equation:

ER = 15° x Sin latitude degrees per hour.

At the equator the latitude is 0°.

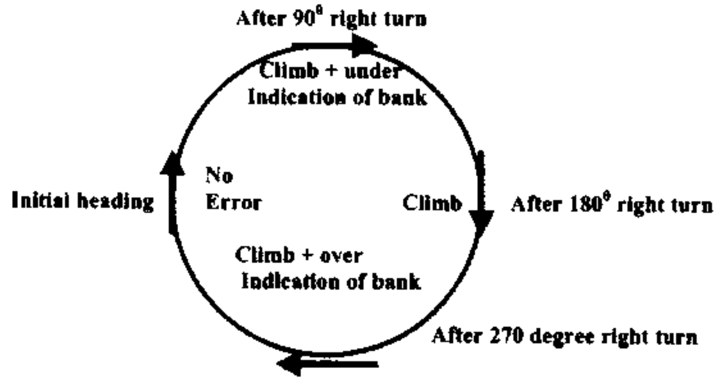
So at the equator ER = 15° x Sin 0 which = zero.

ATTITUDE 1. a.
A basic attitude indicator is illustrated below. It employs an earth gyroscope, which means that the spin axis of the gyro is kept vertically aligned with the earth. In an air driven instrument this alignment is maintained by means of pendulous vanes controlling the escape of air from an erection chamber at the base of the gyro. In electrically driven instruments alignment is maintained by a system of mercury switches and torque motors. In order to allow the spin axis to remain vertical while the aircraft pitches and rolls, the gyro has two degrees of freedom. One in roll and one in pitch.



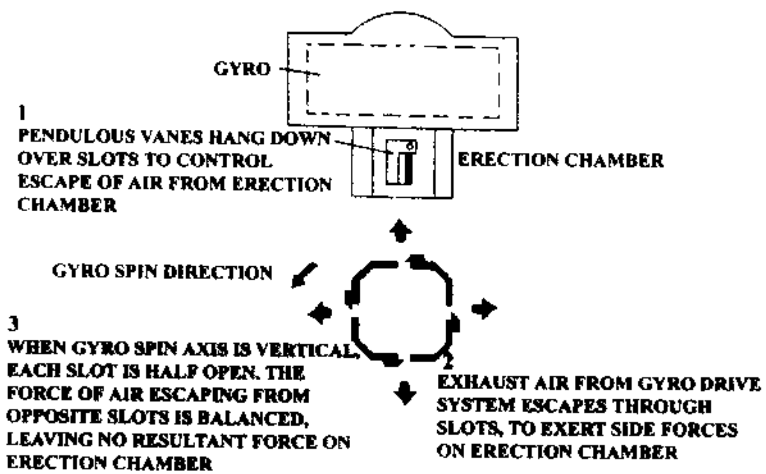
ATTITUDE 2. a.
The fact that some of the options include pendulous vanes implies that this question refers to an air driven gyroscope. These are subject to turning errors whenever the aircraft executes a turn. This problem is caused by the effects of centrifugal force on the erecting chamber and inertia on the pendulous vanes. Under normal conditions, these vanes keep the spin axis vertical, by switching on and off air jets, such that the gyro is caused to precess, whenever it departs from the vertical. But the inertia of the vanes causes them to produce inappropriate precession, whenever they are subjected to accelerations, during speed changes or turns.

The overall effect of centrifugal force on the erecting chamber and inertia on the pendulous vanes when turning right is the errors in the circle overleaf. The question does not specify the direction of turn, nor the angle through which the turn occurs. Comparing the options with the errors listed overleaf however reveals that option a, "climb due to pendulous vanes" is true throughout most of the turn.



ATTITUDE 3. d.
For the purposes of this question the term "classic artificial horizon" should be take to mean an air driven unit, as this is the most long established version. The gyroscopes in such instruments are kept vertical by means of a system of pendulous vanes and air jets as illustrated below.

PENDULOUS VANE ERECTION SYSTEM



The pressurised air used to drive the gyroscope is fed into a small erection chamber, attached to the bottom of the gyro. The air then escapes through four holes, one of which is on each of the sides of the chamber. Flow through these holes is controlled by four pendulous vanes, such that the holes are half open when the gyro is vertically aligned. Whenever the gyro tilts from the vertical, the vanes move due to gravity, such that one hole opens further and the opposite one closes. The escape of air from the wider open hole tends to push the base of the gyro

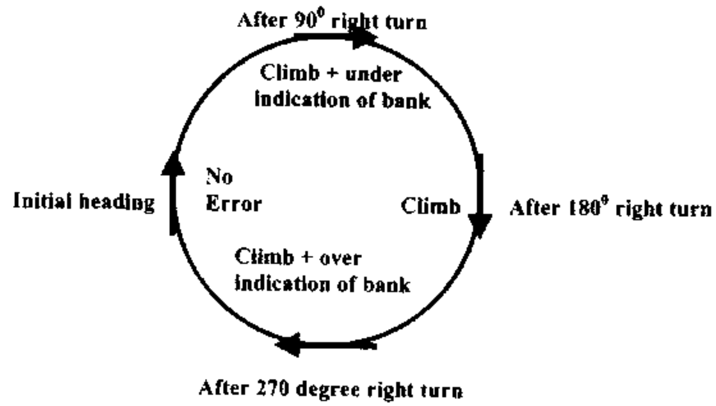
towards the opposite vane. This force is precessed through 90 degrees, such that the gyro returns to the vertical as illustrated below.

But the inertia of the vanes causes them to produce inappropriate precession, whenever they are subjected to accelerations, during speed changes or turns. The overall effect of these errors is that in a 90 degree constant attitude and bank turn, the attitude indicator will indicate too little bank and too much nose up attitude (option d), as illustrated in the diagram in ATTITUDE 2.

ATTITUDE 4. b.
A basic attitude indicator is illustrated in ATTITUDE 1 above. It employs an earth gyroscope, which means that the spin axis of the gyro is kept aligned with the local earth vertical. This is achieved by means of pendulous vanes in an air driven instrument or mercury switches and torque motors in electrically driven units. In order to keep the spin axis vertical while the aircraft pitches and rolls, the gyro has two degrees of freedom. One in roll and one in pitch.

ATTITUDE 5. a.
The term basic AI should be taken to mean an uncompensated air driven attitude indicator. These are subject to turning errors whenever the aircraft executes a turn. This problem is caused by the effects of centrifugal force on the erecting chamber and inertia on the pendulous vanes. Under normal conditions, these vanes keep the spin axis vertical, by switching on and off air jets, such that the gyro is caused to precess, whenever it departs from the vertical. But the inertia of the vanes causes them to produce inappropriate precession, whenever they are subjected to accelerations, during speed changes or turns.

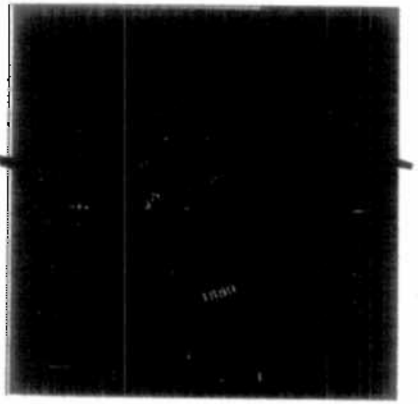
The overall effect of centrifugal force on the erecting chamber and inertia on the pendulous vanes when turning right is the errors in the circle overleaf. In a 270 degree right turn, these errors are nose up and bank (option a).



ATTITUDE 6. c.

Aircraft attitude is primary flight information. It is therefore displayed to the EFIS primary flight display (PFD) (option c) as illustrated below. Although modern ECAM and EICAS display flying control positions, they do not display attitude. It should however be noted that in the event of an EFIS screen failure, PFD data can be transferred to any of the other screens.

Pitch attitude is indicated by the position of these black bars and crosshairs representing the aircraft, relative to the white horizon line and the pitch scales.



Roll attitude is indicated by the position of this black triangular pointer relative to the other triangular pointer on the sky/earth globe.

TYPICAL EFIS PRIMARY FLIGHT DISPLAY

ATTITUDE 7. a.

The term "classic AI" should be taken to mean an uncompensated air driven attitude indicator. These are subject to turning errors whenever the aircraft executes a turn. This problem is caused by the effects of centrifugal force on the erecting chamber and inertia on the pendulous vanes. Under normal conditions, these vanes keep the spin axis vertical, by switching on and off air jets, such that the gyro is caused to precess, whenever it departs from the vertical. But the inertia of the vanes causes them to produce inappropriate precession, whenever they are subjected to accelerations, during speed changes or turns.

The overall effect of centrifugal force on the erecting chamber and inertia on the pendulous vanes when turning right is the illustrated in ATTITUDE 2 and 4. After 90 degrees of right turn the errors are too much nose up and too little bank (option a)

ATTITUDE 8. b.

The term "classic AI" should be taken to mean an uncompensated air driven attitude indicator. These are subject to turning errors whenever the aircraft executes a turn. This problem is caused by the effects of centrifugal force on the erecting chamber and inertia on the pendulous vanes. Under normal conditions, these vanes keep the spin axis vertical, by switching on and off air jets, such that the gyro is caused to precess, whenever it departs from the vertical. But the inertia

of the vanes causes them to produce inappropriate precession, whenever they are subjected to accelerations, during speed changes or turns.

The overall effect of centrifugal force on the erecting chamber and inertia on the pendulous vanes when turning right is the illustrated in ATTITUDE 2 and 4. After 270 degrees of right turn the errors are too much nose up and too much bank (option b). The errors in a left turn will also vary with turn angle but will be a combination of nose down and left bank. None of the options include nose down, so it can be assumed that the questions refers to a right turn.

ATTITUDE 9. a.

A basic artificial horizon or attitude indicator is illustrated in ATTITUDE 1 above. It employs an earth gyroscope, which means that the spin axis of the gyro is kept aligned with the local earth vertical. This is achieved by means of pendulous vanes in an air driven instrument or mercury switches and torque motors in electrically driven units. In order to keep the spin axis vertical while the aircraft pitches and rolls, the gyro has two degrees of freedom. One in roll and one in pitch.

ATTITUDE 10. b.

A latitude nut is fitted to a directional gyro to compensate for earth rate error. This applies only to gyroscopes with a horizontal spin axis. The spin axis of an AI is vertical, so it does not exhibit earth rate drift and is not fitted with a latitude nut.

ATTITUDE 11. a.

This question is somewhat dubious in that options a and c can both be said to be correct to some degree. The gravity sensing unit in a modern AI senses any departure of the gyro spin axis from the vertical. By varying the electrical supply to two a torque motors, it then causes the gyro to be re-erected. If however the question is interpreted in the strictest possible sense, the gyro is returned to vertical after tilting rather than actually being prevented from tilting and it is the torque motors rather than the gravity sensing unit that actually re-erects it. But the term erecting is normally taken to refer to initial pre-flight aligning rather than continuous correction, whereas the term "preventing tilting" subjects continuous operation throughout flight. The gravity sensing unit functions throughout flight, so option a is the most appropriate.

ATTITUDE 12. c.

The term "classic AI" should be taken to mean an uncompensated air driven attitude indicator. These are subject to turning errors whenever the aircraft executes a turn. This problem is caused by the effects of centrifugal force on the erecting chamber and inertia on the pendulous vanes. Under normal conditions, these vanes keep the spin axis vertical, by switching on and off air jets, such that the gyro is caused to precess, whenever it departs from the vertical. But the inertia of the vanes causes them to produce inappropriate precession, whenever they are subjected to accelerations, during speed changes or turns.

The overall effect of centrifugal force on the erecting chamber and inertia on the pendulous vanes when turning right is the illustrated in ATTITUDE 2 and 4. After 180 degrees of right turn the errors are too much nose up (option c). Although the question does not specify the direction of turn, the errors in left turns are a combination of dive and bank. Diving is not included in any of the options so it may be assumed that the question refers to a right turn.

ATTITUDE 13. b.

A basic artificial horizon is illustrated in ATTITUDE 1 above. It employs an earth gyroscope, which means that the spin axis of the gyro is kept aligned with the local earth vertical. This is achieved by means of pendulous vanes in an air driven instrument or mercury switches and torque motors in electrically driven units. In order to keep the spin axis vertical while the aircraft pitches and rolls, the gyro has two degrees of freedom. One in roll about the longitudinal axis and the other in pitch about the lateral axis. Both of these axes are horizontal. It should be noted that this question does not refer to the spin axis of the gyro, so option b is correct. If however the questions had required degrees of freedom and spin axis direction, option a would be correct. This question illustrates the importance of reading examination questions very carefully before selecting an option.

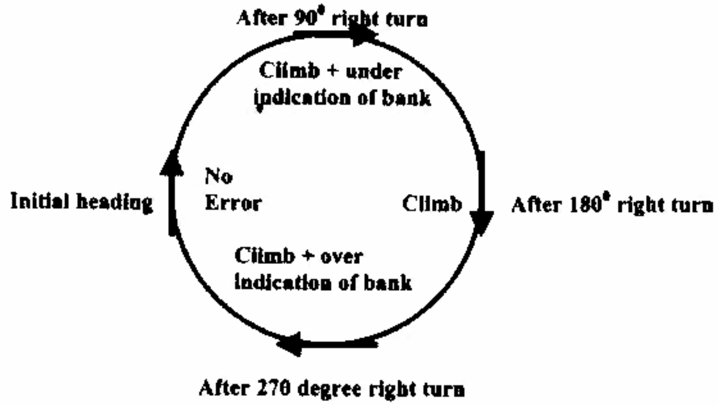
ATTITUDE 14. a.

The purpose of an emergency standby artificial horizon is to provide attitude information in the event of failure of the main attitude instruments. To achieve this it is provided with an independent power supply (1) and its own integral gyro (2). In order to ensure maximum reliability whilst minimising weight and size, standby horizons do not employ remote gyroscopes (3). Although used primarily following primary instrument failure, they are also used continuously as a confidence check for the main instruments. JAR 25 requires only one standby AI which must be visible to both pilots, rather than one per pilot (5).

ATTITUDE 15. b.

The term basic AI should be taken to mean an uncompensated air driven attitude indicator. These are subject to turning errors whenever the aircraft executes a turn. This problem is caused by the effects of centrifugal force on the erecting chamber and inertia on the pendulous vanes. Under normal conditions, these vanes keep the spin axis vertical, by switching on and off air jets, such that the gyro is caused to precess, whenever it departs from the vertical. But the inertia of the vanes causes them to produce inappropriate precession, whenever they are subjected to accelerations, during speed changes or turns.

The overall effect of centrifugal force on the erecting chamber and inertia on the pendulous vanes when turning right is the errors illustrated below.

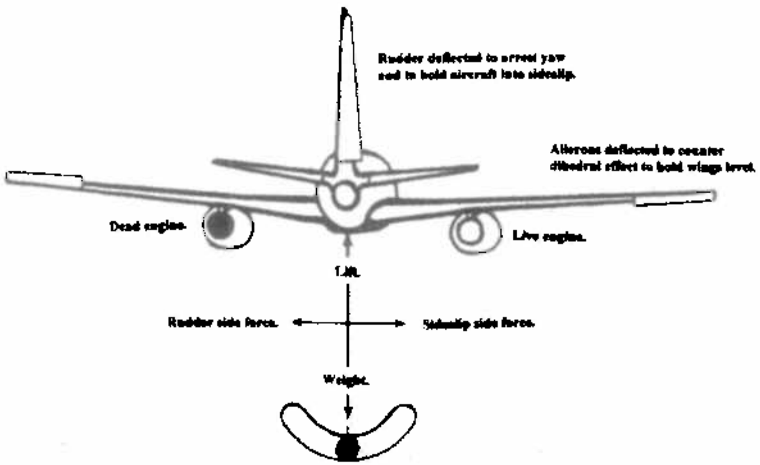


After a right turn through 270 degrees, the errors will be too much climb and too much right bank. The question does not specify the direction of the turn, but errors in a left turn are a combination of nose down and bank. None of the options include nose down, so the turn may be assumed to be to the right. So after a 270 degree turn to the right the indications will be bank right and nose up (option b).

TURN/SLIP 1. b.

The ball is positioned by the vector sum of all acceleration forces acting upon it. In straight and level constant speed flight the only acceleration is that due to gravity and as this acts vertically downwards, so the ball is held in the central position. When an aircraft is side-slipping due to bank, the gravitational acceleration still acts vertically, but because of the bank angle, does not act through the normal axis of the aircraft. This causes the ball to move out of the central position, and towards the sideslip direction.

The ball does not however always give a true indication of sideslip. For example, in the case of a single engine failure the aircraft can be made to sideslip along the desired track, whilst the wings are held level by means of the ailerons. In this situation the aircraft will be side-slipping, but the ball will be central indicating no slip. The situation in which the ball gives a false indication in wings level side slipping flight following single engine failure is illustrated below.



Ball central indicating no slip.

The left engine has failed, causing asymmetric thrust to tend to yaw the aircraft to the left. The pilot has used opposite rudder to arrest this yaw and to yaw the aircraft to the right, such that it side-slips down the intended track. The ailerons are also being used to maintain wings level. Under these circumstances the ball is central although the aircraft is side-slipping at a constant speed.

Conversely, if the pilot uses rudder to bring the aircraft heading back on track, and bank to prevent the rudder side force from causing side-slip, the ball will indicate slip although there is none. So the ball of a serviceable turn and slip indicator is positioned by accelerations, but does not always indicate the state of side-slip.

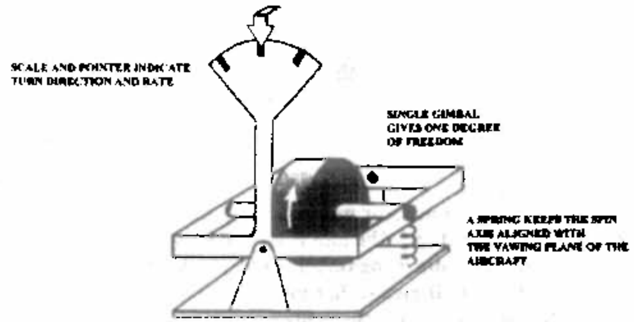
<u>TURN/SLIP 2. a.</u>
The turn indicator indicates rate of turn, usually in terms of rate 1, 2, 3 etc. Rate of turn is equal to gTan AOB / V, so the turn indicator is affected by AOB (1) and airspeed (2). But weight (3) and altitude (4) do not affect rate of turn at any given bank angle nor the turn indicator reading.

<u>TURN/SLIP 3. c.</u>
A turn indicator gives an indication of the direction of turn (1) and the rate of turn (2) of an aircraft. Rate of turn is a measure of the angular velocity of the aircraft about its vertical axis (4). It should be noted that because an aircraft banks when turning, the true vertical axis (3) differs from the aircraft normal axis (4). Although this question also specifies the use of an attitude indicator, this is not strictly required to indicate any of the above. Angular velocity about the longitudinal axis (5) is roll rate. This cannot be indicated by a turn indicator nor

an artificial horizon. Comparing the above facts with the options in this question reveals that option c (1, 2, 4) is correct.

<u>TURN/SLIP 4. a.</u>
The turn indicator indicates rate of turn, usually in terms of rate 1, 2, 3 etc. Rate of turn is equal to gTan AOB / V, where V is the TAS. So the turn indications are proportional to TAS. But the EAS and CAS at any given TAS vary with altitude and rate of turn at any given combination of TAS and AOB, is not affected by mass. So options b, c and d are all untrue.

<u>TURN/SLIP 5. c.</u>
A typical turn indicator is illustrated below.

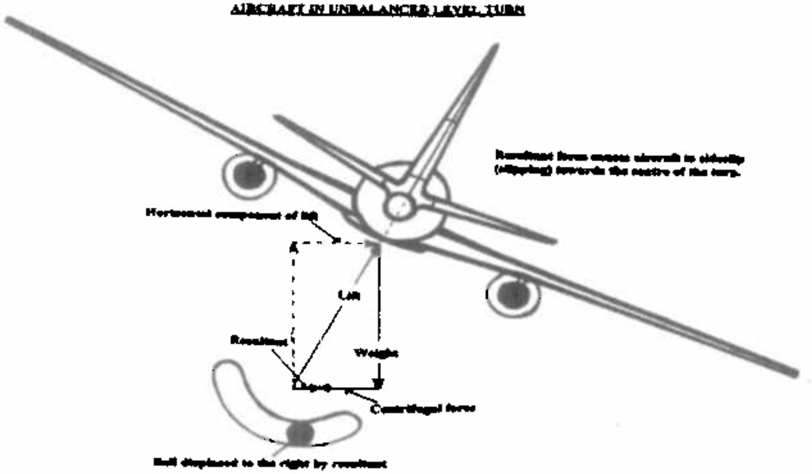


SIMPLE TURN INDICATOR

In order to sense turn rate its gyro spin axis is aligned with the yawing plane of the aircraft (5). To achieve this it has one degree of freedom (3) (in roll), but motion about this axis is limited by a calibrated spring. The yawing plane of the aircraft is not horizontal when turning so (1) is untrue. It should also be noted that a gravity erection device (6) is not used in a turn indicator but in an attitude indicator.

<u>TURN/SLIP 6. b.</u>
The needle of a turn indicator moves in the direction of the turn to indicate both direction and rate of turn. The ball is moved by gravity such that is displaced in the direction of any side slip if the turn is unbalanced. If both the needle and ball are displaced to the right it means that the aircraft is turning right and slipping into the turn. In a balanced turn the centrifugal force due to the TAS balances the horizontal component of lift caused by the bank angle. Slipping towards the centre of the turn occurs when the aircraft is banked too steeply for its TAS. This situation is illustrated below.

AIRCRAFT IN UNBALANCED LEVEL TURN



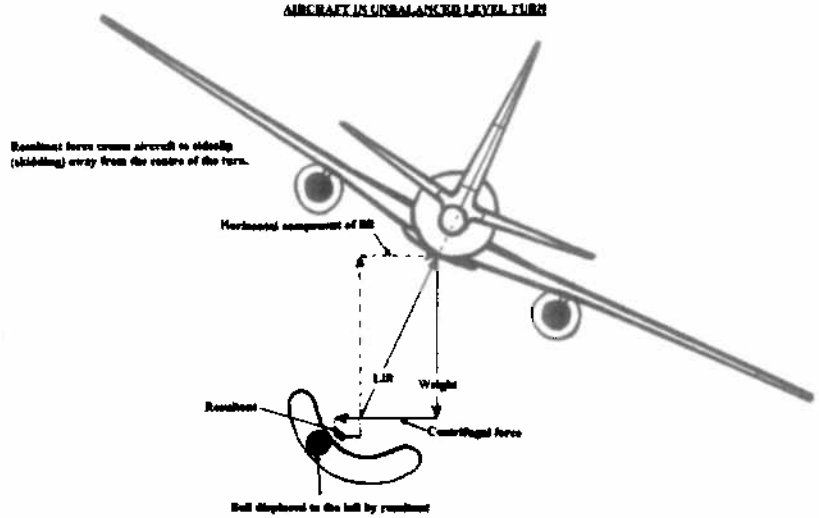
TURN/SLIP 7. b.

The needle of a turn indicator moves in the direction of the turn to indicate both direction and rate of turn. The ball is moved by gravity such that is displaced in the direction of any side slip if the turn is unbalanced. If both the needle and ball are displaced to the right it means that the aircraft is turning right and slipping into the turn. In a balanced turn the centrifugal force due to the TAS balances the horizontal component of lift caused by the bank angle. Slipping towards the centre of the turn occurs when the TAS is insufficient to balance the angle of bank. This situation is illustrated in TURN/SLIP 6.

TURN/SLIP 8. a.

The needle of a turn indicator moves in the direction of the turn to indicate both direction and rate of turn. The ball is moved by gravity such that is displaced in the direction of any side slip if the turn is unbalanced. If the needle is displaced to the right and the ball to the left, it means that the aircraft is turning right and skidding away from the turn. In a balanced turn the centrifugal force due to the TAS balances the horizontal component of lift caused by the bank angle. Skidding away from the centre of the turn occurs when the angle of bank is insufficient to balance the TAS. This situation is illustrated below.

AIRCRAFT IN UNBALANCED LEVEL TURN



TURN/SLIP 9. a.

A typical turn indicator is illustrated in TURN/SLIP 5 above. In order to sense turn rate its gyro spin axis is aligned with the yawing plane of the aircraft. To achieve this it has one degree of freedom (in roll), but motion about this axis is limited by a calibrated spring. Although the yawing plane of the aircraft is not horizontal when turning, it is approximately so in slightly banked turns. So in such turns , the turn needle indicates angular velocity about the vertical axis. Angular velocity about the later axis (option c) is pitching rate, which is not measured by a turn indicator. Yaw displacement (option c) is indicated by a compass of directional gyro.

TURN/SLIP 10. b.

The options in this questions are widely spread so the problem can be solved using the following standard approximation:

Rate 1 turn AOB = (TAS (in Kts) / 10) + 7

Inserting the given data gives AOB = (120 / 10) + 7 which is 19 degrees.

Option b, 20° is closest to this figure.

TURN/SLIP 11. c.

The turn indicator provides an indication of turn direction and rate of turn by sensing the rate at which the spin axis of its gyro is tilted as the aircraft yaws. This is precessed through 90 degrees to move the needle in the direction of the turn. The above sequence of events occurs both on the ground and in flight, so turning right on the ground will cause the needle to move to the right.

The ball is positioned by the vector sum of all acceleration forces acting upon it. In straight and level constant speed flight the only acceleration is that due to gravity and as this acts vertically downwards, so the ball is held in the central position. But when turning right on the ground the wings remain level and the aircraft is subjected to an acceleration to the right. The inertia of the ball will therefore cause it to lag behind the aircraft such that it moves to the left.

TURN/SLIP 12. c.

The turn indicator indicates rate of turn, usually in terms of rate 1, 2, 3 etc. Rate of turn is equal to gTan AOB / V, so the turn indicator is affected by airspeed (1) and AOB (3). But mass (2) has no effect on rate of turn or ROT indications.

TURN/SLIP 13. a.

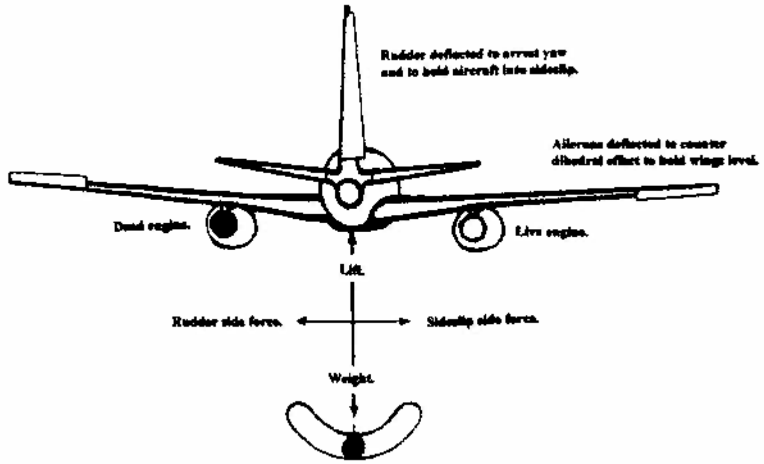
The options in this questions are widely spread so the problem can be solved using the following standard approximation:

Rate 1 turn AOB = (TAS (in Kts) / 10) + 7

Inserting the given data gives AOB = (150 / 10) + 7 which is 22 degrees.

TURN/SLIP 14. a.

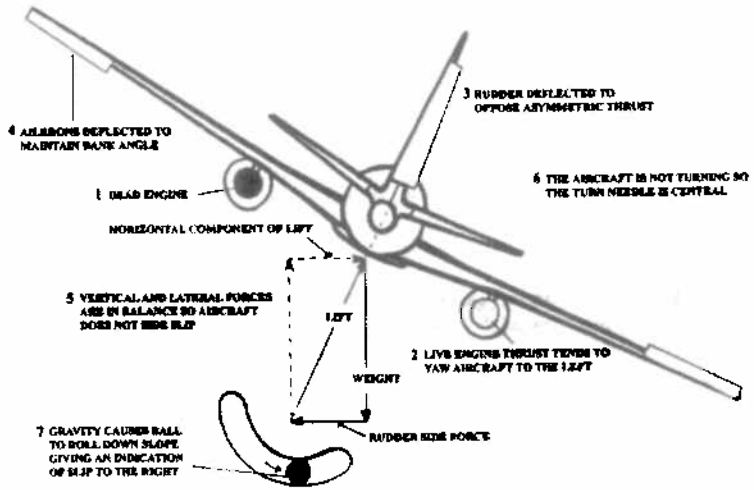
The situation is illustrated overleaf. The left engine has failed, causing asymmetric thrust to tend to yaw it to yaw to the left. The pilot has used opposite rudder to arrest this yaw and to yaw the aircraft to the right, such that it side-slips down the intended track. The ailerons are also being used to maintain wings level. Under these circumstances the ball is central although the aircraft is side-slipping at a constant speed. Because the wings are level and the sideslip rate is constant, both the needle and ball are central.



Ball central indicating no slip.

TURN/SLIP 15. d.

The situation is illustrated below.



BANKED NON-SLIPPING FLIGHT FOLLOWING LEFT ENGINE FAILURE

The left engine has failed, causing asymmetric thrust to tend to yaw it to yaw to the left. The pilot has used opposite rudder to arrest this yaw and to bring the aircraft back onto its original heading. To prevent the rudder side force from causing side slip towards the dead engine, the aircraft has been banked towards the live engine.

In this condition the fin side force is balanced by the horizontal component of lift, so the aircraft does not side slip but flies down its original track. Because the aircraft is not turning the turn needle is central. But because the aircraft is banked, the ball is out to the right. It should be noted that the ball is then indicating slip towards the live engine, although no such slip is occurring.

<u>TURN/SLIP 16. c.</u>

When an aircraft is in climbing flight the engines are usually producing a large amount of thrust. The failure of a left engine will therefore cause a large degree of asymmetric thrust, which will cause rapid yaw to the left. This yaw will be indicated by left movement of the turn needle. But the turn indicator is at the front of the aircraft, so the yawing will cause it to accelerate rapidly to the left. Because of its inertia, the ball will lag behind the rest of the instrument, giving the impression of right side slip. So the immediate effects of a left engine failure will be needle left and ball right.

<u>TURN/SLIP 17. a.</u>

The turn indicator needle moves in the direction of the turn so a needle to the right indicates aright turn. The position of the ball is determined by the vector sum of gravity and lateral acceleration. If the ball moves to the right in a right turn, it means that the aircraft is side-slipping to the left towards the centre of the turn. This occurs when the horizontal component of lift pulling it into the turn, is greater than centrifugal force pulling it outwards. This situation can be caused by either too high TAS or too little bank. So option a, turning right with too much bank is correct.

<u>TURN/SLIP 18. c.</u>

In any balanced turn the rate of turn is equal to gTan AOB / TAS. It should be noted that neither aircraft weight nor A of A appear in this equation, so option a, b, and d are incorrect. Option c, although incomplete is therefore the most accurate.

<u>TURN/SLIP 19. c.</u>

A turn indicator gives an indication of the direction of turn (2) and the rate of turn. Rate of turn is a measure of the angular velocity of the aircraft about its vertical axis (3). Although this question also specifies the use of an attitude indicator, this is not strictly required to indicate any of the above. It should be noted that because an aircraft banks when turning, the true vertical axis (4) is not the same as the aircraft vertical axis (3). TAS (1) cannot be indicated by a turn indicator nor by an artificial horizon.

<u>TURN/SLIP 20. c.</u>

In any balanced turn the rate of turn is equal to gTan AOB / TAS. It should be noted that neither aircraft weight (4) nor A of A (1) appear in this equation, so only option c is true.

<u>TURN/SLIP 21. b.</u>

A typical turn indicator is illustrated in TURN/SLIP 5. In order to sense turn rate its gyro spin axis is aligned with the yawing plane of the aircraft, which is generally horizontal (3). To achieve this it has one degree of freedom (2) (in roll), but motion about this axis is limited by a calibrated spring.

<u>TURN/SLIP 22. c.</u>

This problem can be solved using the following standard approximation:

Rate 1 turn AOB = (TAS (in Kts) / 10) + 7

Inserting the given data gives AOB = (120 / 10) + 7 which is 19 degrees. This is closest to option c, which is 18.

<u>TURN/SLIP 23. d.</u>

The turn needle moves in the direction of the turn, so needle to the left indicates a turn to the left. The position of the ball and the magnitude and direction of any sideslip is determined by the relative sizes of centrifugal force and the horizontal component of lift. In a left turn the aircraft is banked to the left in order to tilt the lift force towards the centre of the turn. If bank angle is too great the horizontal component of lift will be greater than centrifugal force, so the aircraft will slip towards the centre. This imbalance of forces will also cause the ball to move to the left. If bank angle is too small the opposite will occur, with the aircraft and the ball moving to the right. So a needle to the left and a ball to the right indicates a left turn with too little bank (option d).

<u>TURN/SLIP 24. c.</u>

The turn indicator provides an indication of turn direction and rate of turn by sensing the rate at which the spin axis of its gyro is tilted as the aircraft yaws. This is precessed through 90 degrees to move the needle in the direction of the turn. The above sequence of events occurs both on the ground and in flight, so turning right on the ground will cause the needle to move to the right.

The ball is positioned by the vector sum of all acceleration forces acting upon it. In straight and level constant speed flight the only acceleration is that due to gravity and as this acts vertically downwards, so the ball is held in the central position. But when turning right on the ground the wings remain level and the aircraft is subjected to an acceleration to the right. The inertia of the ball will therefore cause it to lag behind the aircraft such that it moves to the left.

<u>TURN/SLIP 25. a.</u>

The turn indicator indicates rate and direction of turn. In a slightly banked turn rate of turn can be said to be yaw rate. It should be noted that the turn indicator indicates turn about the normal axis of the aircraft rather than about the true vertical axis. It should however be noted that yawing occurs about the vertical axis of the aircraft. It might therefore be argued that option d is also true.

TURN/SLIP 26. d.
The turn needle moves in the direction of the turn, so needle to the left indicates a turn to the left. The position of the ball and the magnitude and direction of any sideslip is determined by the relative sizes of centrifugal force and the horizontal component of lift. In a left turn the aircraft is banked to the left in order to tilt the lift force towards the centre of the turn. If bank angle is too great to match the TAS, the horizontal component of lift will be greater than centrifugal force, so the aircraft will slip towards the centre. This imbalance of forces will also cause the ball to move to the left.

If bank angle is too small the opposite will occur, with the aircraft and the ball moving to the right. So a needle to the left and a ball to the right indicates a left turn with too little bank. This can be corrected by either reducing TAS or increasing bank angle (option d). It should be noted that the use of right rudder will cause the radius of turn to increase until the sidesilpping ceases and the ball retruns to the central position. But option a "more right rudder" is incorrect because right rudder is not normally used in a correctly executed left turn.

TURN/SLIP 27. d.
The turn needle moves in the direction of the turn, so needle to the left indicates a turn to the left. The position of the ball and the magnitude and direction of any sideslip is determined by the relative sizes of centrifugal force and the horizontal component of lift. In a left turn the aircraft is banked to the left in order to tilt the lift force towards the centre of the turn. If bank angle is too great the horizontal component of lift will be greater than centrifugal force, so the aircraft will slip towards the centre. This imbalance of forces will also cause the ball to move to the left. So both needle and ball to the left indicates a left turn with to much bank or too little TAS. This can be corrected by decreasing bank angle or increasing TAS (option d).

TURN/SLIP 28. d.
The turn indicator provides an indication of turn direction and rate of turn by sensing the rate at which the spin axis of its gyro is tilted as the aircraft yaws. This is precessed through 90 degrees to move the needle in the direction of the turn. The above sequence of events occurs both on the ground and in flight, so turning right on the ground will cause the needle to move to the right.

The ball is positioned by the vector sum of all acceleration forces acting upon it. In straight and level constant speed flight the only acceleration is that due to gravity and as this acts vertically downwards, so the ball is held in the central position. But when turning right on the ground the wings remain level and the aircraft is subjected to an acceleration to the right. The inertia of the ball will therefore cause it to lag behind the aircraft such that it moves to the left.

TURN/SLIP 29. a.
This problem can be solved using the following standard approximation:

Rate 1 turn AOB = (TAS (in Kts) / 10) + 7

Inserting the given data gives AOB = (250 / 10) + 7 which is 32 degrees.

TURN/SLIP 30. c.
This problem can be solved using the following standard approximation:

Rate 1 turn AOB = (TAS (in Kts) / 10) + 7

Inserting the given data gives AOB = (300 / 10) + 7 which is 37 degrees.

TURN/SLIP 31. a.
This problem can be solved using the following standard approximation:

Rate 1 turn AOB = (TAS (in Kts) / 10) + 7

This can be rearranged to give TAS = (AOB – 7) x 10

Inserting the given data gives TAS = (27 - 7) x 10 which is 200 Kts.

TURN/SLIP 32. a.
A typical turn indicator is illustrated in TURN/SLIP 5. In order to sense turn rate its gyro spin axis is aligned with the yawing plane of the aircraft, which is generally horizontal. To achieve this its gyro must have one gimbal providing one degree of freedom.

TURN/SLIP 33. d.
The turn needle moves in the direction of the turn, so needle to the right indicates a turn to the right. The position of the ball and the magnitude and direction of any sideslip is determined by the relative sizes of centrifugal force and the horizontal component of lift. In a right turn the aircraft is banked to the right in order to tilt the lift force towards the centre of the turn. If bank angle is too small the horizontal component of lift will be smaller than centrifugal force, so the aircraft will skid to the left, away from the centre of the turn. This imbalance of forces will also cause the ball to move to the left. So needle to the right and ball to the left, indicates a right turn with too little bank or too much TAS.

TURN/SLIP 34. c.
The first point to note is that rate of turn is related to TAS and AOB, but not to aircraft mass.

This problem can be solved using the following standard approximation:

Rate 1 turn AOB = (TAS (in Kts) / 10) + 7

Inserting the given data gives AOB = (125 / 10) + 7 which is 19.5 degrees.

TURN/SLIP 35. c.
Rate of turn is equal to (gTan AOB) / V, where V is the TAS. This means that rate of turn is proportional to AOB and TAS, but not to aircraft mass. So changing the mass of the aircraft would not affect its rate of turn at any given AOB, nor the AOB required to achieve any given rate of turn. Drag is proportional to lift, which is proportional to mass. Power required is equal to drag multiplied by TAS, so decreasing mass would decrease the drag and power required in any given flight condition. So decreasing mass to 45000 Kg would not affect the AOB required for a rate 1 turn but would decrease the power required (option c).

TURN/SLIP 36. d.
The turn indicator provides an indication of turn direction and rate of turn by sensing the rate at which the spin axis of its gyro is tilted as the aircraft yaws. This is precessed through 90 degrees to move the needle in the direction of the turn. The above sequence of events occurs both on the ground and in flight, so turning left on the ground will cause the needle to move to the left.

The ball is positioned by the vector sum of all acceleration forces acting upon it. In straight and level constant speed flight the only acceleration is that due to gravity and as this acts vertically downwards, so the ball is held in the central position. But when turning left on the ground the wings remain level and the aircraft is subjected to an acceleration to the left. The inertia of the ball will therefore cause it to lag behind the aircraft such that it moves to the right. So the correct indication in a left turn on the ground is needle left and ball right.

TURN/SLIP 37. c.
The turn needle moves in the direction of the turn, so needle to the left indicates a turn to the left. The position of the ball and the magnitude and direction of any sideslip are determined by the relative sizes of centrifugal force and the horizontal component of lift. In a left turn the aircraft is banked to the left in order to tilt the lift force towards the centre of the turn.

If bank angle is too great the horizontal component of lift will be greater than centrifugal force, so the aircraft will slip to the left, towards the centre of the turn. This imbalance of forces will also cause the ball to move to the left. So needle and ball to the left indicates a left turn with too much bank or too little TAS. If the left pedal is pushed forward the aircraft will move into a tighter turn where the forces will be balanced and sideslip will cease. The ball will then return to the centre. It should however be noted that if the original radius of turn is to be maintained, the correct action is to reduce bank angle.

TURN/SLIP 38. b.
The turn needle moves in the direction of the turn, so needle to the left indicates a turn to the left. The position of the ball and the magnitude and direction of any sideslip are determined by the relative sizes of centrifugal force and the horizontal component of lift. In a left turn the aircraft is banked to the left in order to tilt the lift force towards the centre of the turn.

If bank angle is too small the horizontal component of lift will be smaller than centrifugal force, so the aircraft will skid to the right, away from the centre of the turn. This imbalance of forces will also cause the ball to move to the right. So needle left and ball to the right indicates a left turn with too little bank or too much TAS. If the right pedal is pushed forward the aircraft will move into a wider turn where the forces will be balanced and sideslip will cease. The ball will then return to the centre. It should however be noted that if the original radius of turn is to be maintained, the correct action is to increase bank angle.

TURN/SLIP 39. d.
The turn needle moves in the direction of the turn, so needle to the right indicates a turn to the right. The position of the ball and the magnitude and direction of any sideslip are determined by the relative sizes of centrifugal force and the horizontal component of lift. In a right turn the aircraft is banked to the right in order to tilt the lift force towards the centre of the turn.

If bank angle is too great the horizontal component of lift will be greater than centrifugal force, so the aircraft will slip to the right, towards the centre of the turn. This imbalance of forces will also cause the ball to move to the right. So needle right and ball to the right indicates a right turn with too much bank or too little TAS. If the right pedal is pushed forward the aircraft will move into a tighter turn where the forces will be balanced and sideslip will cease. The ball will then return to the centre. It should however be noted that if the original radius of turn is to be maintained, the correct action is to reduce bank angle.

TURN/SLIP 40. a.
The turn needle moves in the direction of the turn, so needle to the right indicates a turn to the right. The position of the ball and the magnitude and direction of any sideslip are determined by the relative sizes of centrifugal force and the horizontal component of lift. In a right turn the aircraft is banked to the right in order to tilt the lift force towards the centre of the turn.

If bank angle is too small the horizontal component of lift will be smaller than centrifugal force, so the aircraft will skid to the left, away from the centre of the turn. This imbalance of forces will also cause the ball to move to the left. So needle right and ball to the left indicates a right turn with too little bank or too much TAS. If the left pedal is pushed forward the aircraft will move into a wider turn where the forces will be balanced and sideslip will cease. The ball will then return to the centre. It should however be noted that if the original radius of turn is to be maintained, the correct action is to increase bank angle.

INS/IRS/FMS 1. d

The period of time that is required for a pendulum to carry out one full cycle of motion is determined by the length of the pendulum. For a pendulum with a length equal to the mean radius of the earth, this period is approximately 84 minutes. The term "Schuler period" is named after the scientist who discovered the phenomenon, and refers to an oscillation cycle of 84 minutes duration (option d). INS and IRS platforms oscillate at this frequency.

INS/IRS/FMS 2. a.

INS and IRS systems obtain heading information from rate gyros. These sense the rate at which the aircraft yaws about its vertical axis. The output of a yaw rate gyro is an electrical signal that is proportional to the yaw rate. This signal is then integrated to give a second electrical signal that is proportional to the yaw displacement, which is the angle through which the aircraft has yawed. This yaw displacement is then added to the initial heading to give the new heading. So heading information is obtained from yaw rate gyros. In order to sense yaw rate, these gyros must have 1 degree of freedom and a horizontal spin axis (option a).

INS/IRS/FMS 3. a.

The period of time that is required for a pendulum to complete one full cycle of motion is proportional to its length. For a pendulum with a length equal to the mean radius of the earth, this period is approximately 84 minutes. The term "Schuler period" is named after the scientist who discovered the phenomenon, and refers to an oscillation cycle of approximately 84 minutes duration (option d).

In an INS the platform must be maintained vertical relative to the earth. In an IRS the platform is strapped down, but the system must maintain a record of the direction of vertical relative to the earth. INS platforms and IRS accelerometers exhibit oscillations about the earth vertical. In order to maintain a satisfactory level of accuracy, the errors caused by these oscillations must be minimised. This is achieved by the use of damping and Schuler tuning with a period of about 84 minutes (option a).

INS/IRS/FMS 4. b.

In order to answer this question correctly it must be noted that the term used is a "gyro platform" and not a "gyro-stabilised platform". The term "gyro platform" refers to the gryo used in a Directional Gyro Indicator or DGI and not in an INS or IRS. In a DGI the gyro spin axis must remain horizontal as the aircraft pitches, and must remain pointing north as the aircraft yaws. In order to do this it requires 2 degrees of freedom in the horizontal axis (option b).

INS/IRS/FMS 5. a.

The Alert light warns the pilot that the aircraft is approaching the next waypoint. In auto mode the Alert light will illuminate steady two minutes before the waypoint and extinguish when overhead the waypoint. In manual mode the light will illuminate 2 minutes before the next waypoint, it will then flash for 30 seconds

before the waypoint until the track is changed. Option a, is therefore the most accurate in this question.

INS/IRS/FMS 6. b.

The term "Integration" refers to a mathematical process whereby a rate of change of one variable is used to calculate the total change of that variable over a given time period. Acceleration, for example, is the rate of change of speed. When this is integrated the result is speed. But speed is rate of change of position. So when integrating speed, the result is distance moved.

In an INS or IRS system the accelerometers measure accelerations. The function of the integrator at the first stage of integration is to convert accelerations into speeds. And the function of the integrator at the second stage of integration is to convert speed into distance gone.

In the case of the E/W accelerometer and integrators the fist stage integration gives E/W speed. The second stage gives E/W distance gone or departure. To convert this into the change of longitude it is necessary to multiply departure by the secant of the latitude (option b).

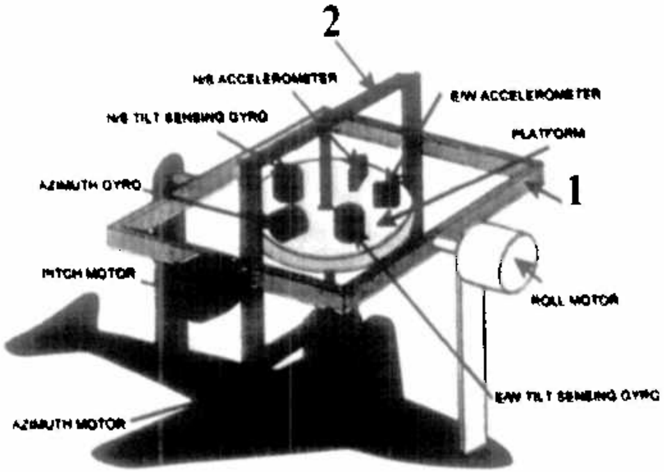
INS/IRS/FMS 7. c.

The term "Integration" refers to a mathematical process whereby a rate of change of one variable is used to calculate the total change of that variable over a given time period. Acceleration, for example, is the rate of change of speed. When this is integrated the result is speed. But speed is rate of change of position. So when integrating speed, the result is distance moved.

In an INS or IRS system the accelerometers measure accelerations. The function of the integrator at the first stage of integration is to convert accelerations into speeds. And the function of the integrator at the second stage of integration is to convert speed into distance gone.
In the case of the E/W accelerometer and integrators the fist stage integration gives E/W speed. The second stage gives E/W distance gone or departure. To convert this into the change of longitude it is necessary to multiply departure by the secant of the latitude.

But at latitudes greater than about 82°, the functions of secant latitude and tangent latitude start to approach infinity and the computer cannot handle the rapid changes involved (option c).

INS/IRS/FMS 8. a.



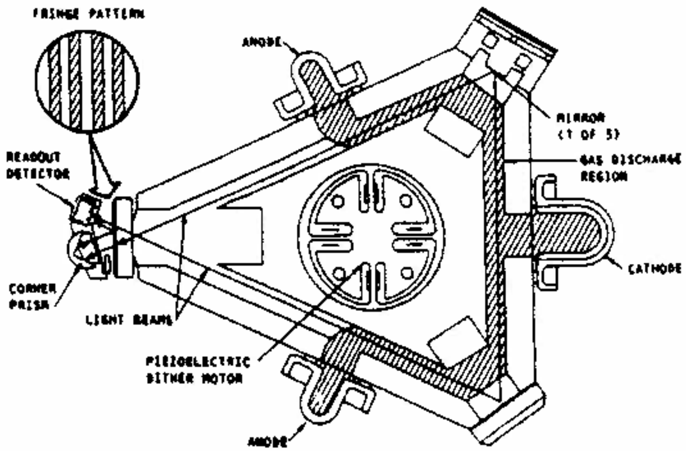
Gimbal number 1 allows the platform to remain level while the aircraft rolls, so it is the roll gimbal. Gimbal number 2 allows the platform to remain level while the aircraft pitches, so it is the pitch gimbal (option a).

INS/IRS/FMS 9. d.
The term "three axis data generator" means a gyroscopic device which is used to provide data to instruments that are fitted in a separate location. To provide three axis data the unit must be fitted with at least one vertical gyro and one horizontal gyro. The vertical reference unit in such a device will use a vertical gyro with 2 degrees of freedom to sense changes in pitch and bank angle (option d). It should be noted that such a device is not part of an INS or IRS system.

INS/IRS/FMS 10. d.
The term "Integration" refers to a mathematical process whereby a rate of change of one variable is used to calculate the total change of that variable over a given time period. Acceleration, for example, is the rate of change of speed. When this is integrated the result is speed. But speed is rate of change of position. So when integrating speed, the result is distance moved.

In an INS or IRS system the accelerometers measure accelerations. The function of the integrator at the first stage of integration is to convert accelerations into speeds (statement 2). And the function of the integrator at the second stage of integration is to convert speed into distance gone (statement 3). These are the only correct statements in this question, so option d is true.

INS/IRS/FMS 11. d.
A simple ring laser gyro is illustrated below.



RING LASER GYROSCOPE

The ring laser gyro senses rates of rotation by measuring the difference between the resonant frequencies of two laser beams. The two beams travel in opposite directions around the triangle and are captured by a collecting mirror and detector unit. The detector unit then compares the resonant frequencies of the two beams to measure the difference between the two. These resonant frequencies are proportional to the length of the resonant structure through which they have passed. If the gyro is stationary the path taken by the two beams and hence the resonant frequencies are identical.

If however the aircraft yaws, the gyro will rotate with it. This means that the path of the beam travelling in the same direction as the gyro becomes slightly longer, whilst that of the other beam becomes slightly shorter. This difference in path length will cause a difference in resonant frequency that is proportional to the rate and direction of rotation. But when the gyro is rotating scatter from the mirrored surfaces sometimes causes the beams to lock together making the detection of small yaw rates impossible. To prevent this laser lock, a dither motor vibrates the gyro at a resonant frequency, thereby causing the beams to unlock. So the purpose of the dither motor is to prevent lock in the laser beams (option d).

INS/IRS/FMS 12. b.
The term "Integration" refers to a mathematical process whereby a rate of change of one variable is used to calculate the total change of that variable over a given time period. Acceleration, for example, is the rate of change of speed. When this is integrated the result is speed. But speed is rate of change of position. So when integrating speed, the result is distance moved.

In an INS the accelerometers measure accelerations. The function of the integrator at the first stage of integration is to convert accelerations into speeds. So the product of the first stage integration of the E/W acceleration sensed by the INS system is speed along the local (E/W) parallel (option b).

INS/IRS/FMS 13. d.
The term "Integration" refers to a mathematical process whereby a rate of change of one variable is used to calculate the total change of that variable over a given time period. Acceleration, for example, is the rate of change of speed. When this is integrated the result is speed. But speed is rate of change of position. So when integrating speed, the result is distance moved.

In an INS or IRS system the accelerometers measure accelerations. The function of the integrator at the first stage of integration is to convert accelerations into speeds. And the function of the integrator at the second stage of integration is to convert speed into distance gone.

In the case of the E/W accelerometer and integrators the fist stage integration gives E/W speed. The second stage gives E/W distance gone or departure. To convert this into the change of longitude it is necessary to multiply departure by the secant of the latitude. The secant of an angle is 1/cosine of that angle. The cosine function is also used by the system to correct for earth rate gyro drift. As latitude increases towards 900, the cosine approaches zero. This makes alignment with true north virtually impossible (option d).

INS/IRS/FMS 14. b.
In order to align an INS before use it is necessary to input accurate latitude and longitude values for the position of the aircraft. If the latitude input is inaccurate the system will detect the error and provide a warning. If however the input longitude is inaccurate, the inaccuracy will not be detected. This will then result in poor alignment and inaccuracy throughout the subsequent flight (option b).

INS/IRS/FMS 15. c.
To understand the concept of coriolis it is necessary to consider the manner in which the circumference of the earth varies as latitude increase from zero at the equator towards 90° at the poles. The circumference of the earth at the equator is approximately 21600 nautical miles. The earth rotates from west to east through one full turning approximately 24 hours. So any point on the surface of the earth at the equator is moving at approximately 900 Kts. This means that an aircraft standing on the ground at the equator, on a northerly heading will have a west to east velocity of 900 Kts.

As latitude increases towards the poles, the circumference of the earth decreases, but it still takes 24 hours to complete one full revolution. This means that a point on the surface at any latitude greater than zero will be moving west to east at less than 900 Kts. As latitude increases the rotational speed of any given point decreases until it reaches zero at the poles. This means that if the aircraft takes-off

from the equator and maintains its northerly heading and 900 Kts west to east speed, it will not move due north, but also drift from west to east and an increasing rate. Very close to the North Pole this drift rate will be almost 900 Kts.

This means that in order to fly due north the aircraft must gradually reduce its west to east speed, to match the reducing rotational speed of the earth as latitude increases. But this reduction in west to east speed constitutes acceleration. This acceleration is termed coriolis acceleration and it will be detected by the accelerometers in the INS.

Whenever aircraft fly along flight paths that are referenced to the earth, they are flying along curved paths. These curved paths cause the accelerometers to detect accelerations which are called coriolis accelerations.

In order to achieve this gradual reduction in west to east speed, the heading of the aircraft relative to space, must gradually change in an anti-clockwise direction. This will have the effect of reducing the south to north speed of the aircraft. The accelerometers will detect this change of south to north speed. So coriolis errors affect both the N/S and the E/W accelerometers (option c).

INS/IRS/FMS 16. c.
INS systems exhibit a number of different errors. These include bounded errors which alternate between maximum an minimum values over a period of 84.4 minutes. The main causes of bounded errors are:

- a. Platform tilt due to initial misalignment.
- b. Inaccurate measurement of accelerations by the accelerometers.
- c. Integrator errors in the first stage of integration.

The second type of error is unbounded errors. These are either cumulative track errors or distance errors. They are caused by:

- a. Initial azimuth misalignment of the platform.
- b. Wander of the azimuth gyro.
- c. Real wander of the platform levelling gyro (option b). This causes a Schuler oscillation of the platform but the mean recorded value of distance run is increasingly divergent from the true distance run.
- d. Integrator errors in the second stage of integration.

The third type of error is inherent error. Inherent errors are caused by factors such as the irregular shape of the earth, the movement of the earth through space, and mechanical imperfections in the components of the system. These can be reduced, but this invariably makes the system more complex and hence more expensive to manufacture.

So the errors of an INS fall into three categories, bounded, unbounded and inherent (option c).

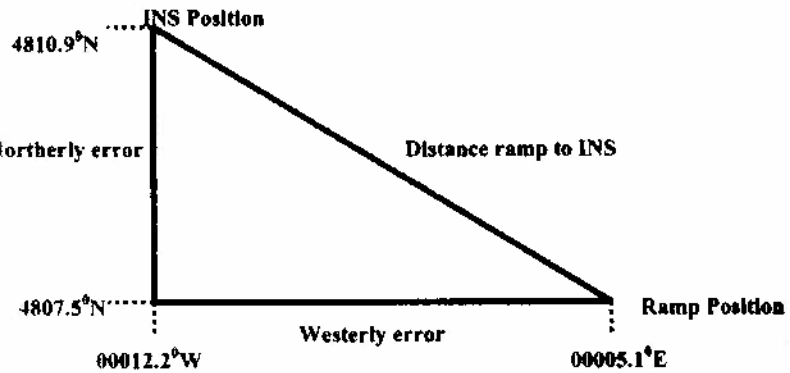
INS/IRS/FMS 17. d.
Both INS and IRS systems employ accelerometers mounted at 90° to each other to sense accelerations in three planes. The fundamental difference between INS and IRS is that the IRS is a strap down system (option d), whereas the INS uses a gyro-stabilised platform that must be kept earth horizontal at all times.

INS/IRS/FMS 18. b.
Because they do not employ any rotating parts, RLGs (Ring Laser Gyros) are extremely sensitive. This enables them to achieve accuracy levels of within 2 nautical miles per hour (option b).

INS/IRS/FMS 19. b.
This type of problem can be solved using the standard equation:

$$\text{Radial error} = \frac{\text{Distance from ramp position to INS position (in nm)}}{\text{Time in navigational mode (in hours)}}$$

The diagram below illustrates the situation described in this question:



The northerly error is:

INS latitude (4810.9°N) - ramp latitude (4807.5°N) = 3.4'

This can be converted using the standard equation that 1' of latitude = 1 nm to give a northerly error of 3.4 nm.

The westerly error can be calculated using the standard departure equation:

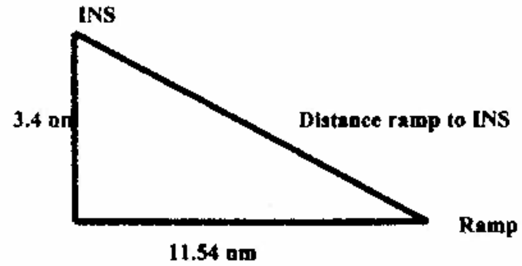
Distance (nm) = d long (in ') x Cos (mid latitude)

d long is INS longitude (00012.2°W) – Ramp longitude (00005.1°E) = 17.3'

$$\text{Mid latitude} = \frac{\text{Ins latitude } 4810.9°N) + \text{Ramp latitude } (4807.5°N)}{2} \quad 4809.2°N$$

So distance (nm) = 17.3' x cos 4809.2' = 11.54 nm

These distances can now be drawn as illustrated below:



Using pythagorus's theorem Radial error = $\sqrt{(3.4^2 + 11.54^2)}$ 12.03 nm

Dividing this distance by the time taken gives:

Radial error = 12.03nm / 8.33 hours = 1.44 nm.hour.

This is closest to option b 1.37 nm/h.

INS/IRS/FMS 20. d.
The term "Integration" refers to a mathematical process whereby a rate of change of one variable is used to calculate the total change of that variable over a given time period. Acceleration, for example, is the rate of change of speed. When this is integrated the result is speed.

An INS uses accelerometers set at 90° to each other, in order to measure accelerations in three directions. These accelerations are then integrated to give the speeds in those directions. Both the measured accelerations and resulting speeds, are values measured relative to a stationary frame of reference.
This means that they are not related to the air and therefore do not take into account any winds that may be blowing.

TAS is measured relative to the air, so the TAS at any given absolute speed depends upon wind speed and direction. So in order to calculate the TAS, the INS must take the absolute speed and direction of the aircraft and add to this the wind speed and direction. This is closest to option d.

INS/IRS/FMS 21. b.
INS systems exhibit a number of different errors. These include bounded errors which alternate between maximum an minimum values over a period of 84.4 minutes. The main causes of bounded errors are:

a. Platform tilt due to initial misalignment.
b. Inaccurate measurement of accelerations by the accelerometers.
c. Integrator errors in the first stage of integration.

The second type of error is unbounded errors. These are either cumulative track errors or distance errors. They are caused by:

a. Initial azimuth misalignment of the platform.
b. Wander of the azimuth gyro.
c. Real wander of the platform levelling gyro (option b). This causes a Schuler oscillation of the platform but the mean recorded value of distance run is increasingly divergent from the true distance run.
d. Integrator errors in the second stage of integration.

The greatest cause of unbounded errors is real wander of the platform gyroscopes (option b).

INS/IRS/FMS 22. d.

During initialisation of an INS the platform is levelled and aligned with true north. This process takes several minutes to complete and during this time the aircraft must not be moved from the ramp. Once initialisation has been completed a green NAV READY light illuminates to indicate that the system is ready to be set to NAV position. Only after these processes have been completed may the aircraft be moved. So during initialisation of the INS the aircraft must not be moved until the green READY NAV light is illuminated and the mode select switch has been set to the NAV position (option d).

INS/IRS/FMS 23. d.

In order to enable an INS to align its platform before flight, it is necessary to input accurate latitude and longitude data. The system cannot detect errors of longitude but can detect errors of latitude. If incorrect data is provided the system will accept an error of 10° longitude but not one of 10° of latitude in the inserted initial position (option d).

INS/IRS/FMS 24. a.

The period of time that is required for a pendulum to carry out one full cycle of motion is determined by the length of the pendulum. For a pendulum with a length equal to the mean radius of the earth, this period is approximately 84 minutes. The term "Schuler period" is named after the scientist who discovered the phenomenon, and refers to an oscillation cycle of approximately 84 minutes duration (option d).

In an INS the platform on which the accelerometers are mounted must be maintained vertical relative to the earth. In an IRS the platform is strapped down, but the system must maintain a record of the direction of vertical relative to the earth. INS platforms and IRS accelerometers exhibit oscillations about the earth vertical. In order to maintain a satisfactory level of accuracy, the errors caused by

these oscillations must be minimised. This is achieved by the use of damping and Schuler tuning with a period of about 84 minutes. An IRS with laser gyros should (i) always be Schuler tuned, and (ii) always be strapped down (option a)

INS/IRS/FMS 25. c.

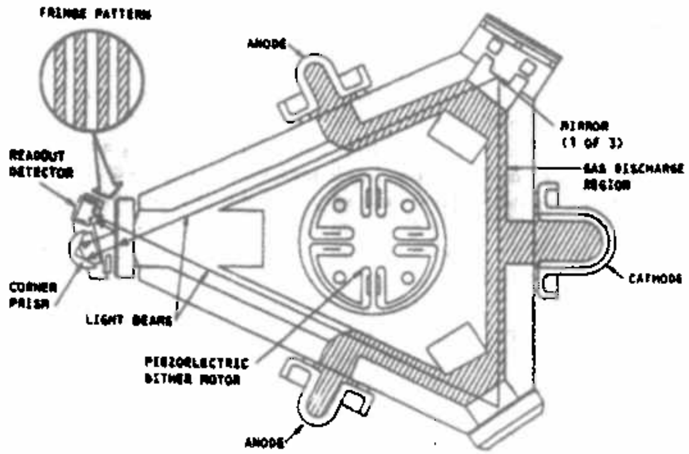
Both INS and IRS use three accelerometers set at 90° to each other to sense accelerations in three planes. This arrangement of three gyros at 90° to each other is called the trihedron.

In an INS the platform on which the accelerometers are mounted must be maintained vertical relative to the earth. In an IRS the platform is strapped down, but the system must continuously compute its position and orientation relative to the earth. In order to align an INS the platform is physically moved until it is earth vertical and aligned with true north. In an IRS the platform is not physically moved but its orientation must be calculated by a computer. In order to align a strap-down inertial unit in an IRS, it is required to insert accurate latitude and longitude data to enable the system to determine the computed trihedron before moving the aircraft from the ramp (option c).

INS/IRS/FMS 26. c.

A RLG or Ring Laser Gryo has no spinning parts but uses two laser beams to sense angular acceleration rates. In order to produce these laser beams the RLG must be filled with a suitable gas or mixture of gasses. Most RLGs are filled with a mixture of helium and neon (option b).

A simple ring laser gyro is illustrated below.



RING LASER GYROSCOPE

INS/IRS/FMS 27. a.
The principle difference between conventional gyros and RLGs (Ring Laser Gyros) is that ring laser gyros do not have any rotating parts. This means that they can be brought up to working condition more quickly than conventional gyros. It should also be noted that there is no requirement to actually align a RLG. The start-up process is a matter of bringing the RLG up to working temperature and calculating its orientation. So alignment of RLG takes less than 10 minutes (option a).

INS/IRS/FMS 28. c.
The period of time that is required for a pendulum to carry out one full cycle of motion is determined by the length of the pendulum. For a pendulum with a length equal to the mean radius of the earth, this period is approximately 84 minutes. The term "Schuler period" is named after the scientist who discovered the phenomenon, and refers to an oscillation cycle of approximately 84 minutes duration (option d).

In an INS the platform on which the accelerometers are mounted must be maintained vertical relative to the earth. In an IRS the platform is strapped down, but the system must maintain a record of the direction of vertical relative to the earth. In an INS the gyros should never be strap down. In an IRS the gyros should always be strapped down (option c).

INS/IRS/FMS 29. a.
Both INS and IRS use accelerometers sense accelerations. In the case of IRS, the system uses three gyros set at 90° to each other. This arrangement of three gyros at 90° to each other is called the trihedron.

In an INS the platform on which the accelerometers are mounted must be maintained vertical relative to the earth. In an IRS the platform is strapped down, but the system must continuously compute its position and orientation relative to the earth. In order to align an INS the platform is physically moved until it is earth vertical and aligned with true north. In an IRS the platform is not physically moved but its orientation must be continuously calculated using a computer. In order to align a strap-down inertial unit in an IRS, it is required to insert the local geographical coordinates. This is necessary to enable the computer to position the computing trihedron with reference to the earth (option a).

INS/IRS/FMS 30. c.
The accurate pre-flight alignment of an INS requires the inputting of the current longitude and latitude. If an incorrect longitude is put into the system during alignment it will be accepted. If however an incorrect latitude is put into the system, the result depends upon the magnitude of the error. The alignment process is carried out in two stages, fine levelling and gyro-compassing. The latitude put in by the pilot is used during the gyro-compassing stage. If the error is significant, the gyro-compassing process will fail and the system will invite the pilot to recheck the ramp position. If however the error is very small, the system will accept it but the gyro-compassing process will be corrupted such that it will cause a false north

alignment. This in turn will result in ever increasing (unbounded) errors as the flight progresses. Because the system will accept all longitude errors, but only very small latitude errors, option c is the most appropriate.

INS/IRS/FMS 31. c.
In considering this question it should be noted that an IRS will always use a strapped down platform and ring laser gyros, whereas an INS always uses a stabilised platform and conventional gyros. But both INS and IRS suffer Schuler errors and coriolis effects, so options a and b are both untrue. Options c and d are both dubious in that the ring laser gyros in IRS do not spin and hence do not have a spin up time. This might however be taken to mean that their spin up time is zero, in which case option c is better than option d. Option c is also correct in saying that an IRS suffers laser lock, because they employ ring laser gyros. So although none of the options are entirely true, option c is the most accurate.

INS/IRS/FMS 32. b.
FMS databases are produced by specialist agencies such as Jeppesen, usually in the form of magnetic tape. The standard validity period for an FMS database is 28 days (option b). Minor updates can be made manually to take account for changes introduced by such things as NOTAMS.

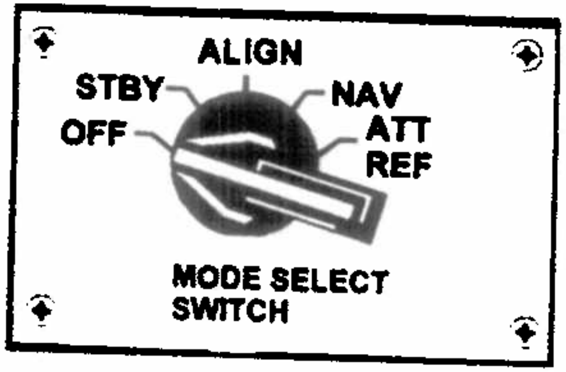
INS/IRS/FMS 33. a.
Two types of inertial system are currently in use. These are stabilised platforms and strapped down platforms. In the stabilised platform system, both the gyros and the accelerometers are stabilised. In a strapped down system, both the gyros and accelerometers are strapped down. The stabilisation processes employed in a stabilised platform are not simply a matter of using gyros, so all of the options referring to gyro-stabilisation are not entirely true. Option a is however entirely true of a strapped down system.

INS/IRS/FMS 34. b.
The JAR 25 standard colour code system for electronic display includes:

CYAN	Background shading and static information.
MAGENTA	Active routes and waypoints, command information.
RED	Warning information.
WHITE	Static information such as scales.
GREEN	Present situation and information of low priority.
YELLOW	Cautionary information.

INS/IRS/FMS 35. a.
When an INS is switched on it must go through a number of stages. The first of these is a warm up period, which must be followed by the alignment process. After alignment is complete the system can be used to navigate the aircraft. If faults develop in the navigation modes of the system, some types of system can still be

used to provide attitude information. The standard sequence for switching on INS is therefore Off, Standby, align, nav, attitude reference. These settings are illustrated below.



INS/IRS/FMS 36. c.
The accurate pre-flight alignment of an INS requires the inputting of the current longitude and latitude. If an incorrect longitude is put into the system during alignment it will be accepted. If however an incorrect latitude is put into the system, the result depends upon the magnitude of the error. The alignment process is carried out in two stages, fine levelling and gyro-compassing. The latitude put in by the pilot is used during the gyro-compassing stage. If the error is significant, the gyro-compassing process will fail and the system will invite the pilot to recheck the ramp position. If however the error is very small, the system will accept it but the gyro-compassing process will be corrupted such that it will cause a false north alignment. This in turn will result in ever increasing (unbounded) errors as the flight progresses (option c).

It should be noted that because an IRS has an inbuilt memory, it can remember the position at the time the system was last shut down. It is therefore able to inform the pilot when an incorrect position is inserted during the subsequent start up.

INS/IRS/FMS 37. c.
In both the stabilised platform and strapped down platform inertial systems, gyros and accelerometers are used to sense angular and linear accelerations. Most systems employ three accelerometers and three gyroscopes. Each accelerometer is set at 90 degrees to the others to form a trihedron. The gyros are arranged in a similar manner. In order to convert outputs from the gyros and accelerometers into meaningful information, the alignment of the three axes of the trihedron must be known. In a stabilised system the trihedron is physically aligned with true north. In a strapped down system the physical alignment is not altered but the relationship between the trihedron and true north is established (option c). This relationship is then used in the computation of all motions throughout the subsequent flight.

INS/IRS/FMS 38. c.
A stable platform which is maintained earth horizontal will behave like a very large pendulum, the length of which is equal to the radius of the earth. The time taken for a pendulum to swing through one cycles is determined by its length, so an earth horizontal stable platform oscillates at a fixed frequency equal to that of a pendulum of length of one earth radius. The period of such a pendulum is 84.4 minutes. A platform exhibiting this effect is termed a "Schuler tuned platform", and a Schuler period is approximately 84 minutes (option c).

INS/IRS/FMS 39. a.
The inputs to an FMS include:

i.	Radio information from VOR, ADF, DME, SSR, ILS, RADALT, Weather radar, GPWS (3).
ii.	Air data computer information (1).
iii.	INS (2).
iv.	Thrust management system (4).
v.	AFCS (5).
vi.	EFIS.
vii.	ECAM/EICAS (4).
viii.	Flight management computer (5).

So all of the statements in this question are true (option a).

INS/IRS/FMS 40. d.
When an INS is switched on it must go through a number of stages. The first of these is a warm up period, which must be followed by the alignment process. After alignment is complete the system can be used to navigate the aircraft. If faults develop in the navigation modes of the system, some types of system can still be used to provide attitude information. The standard sequence for switching on INS is therefore Off, Standby, align, nav, attitude reference (d). A typical switching arrangement is illustrated in question INS/IRS/FMS 6 above.

INS/IRS/FMS 41. b.
The first page in an FMS CDU database is the ident page.

INS/IRS/FMS 42. a.
Flying an aircraft incurs a wide range of costs, including such things as fuel, crew salaries, landing charges, ATC charges, aircraft leasing or depreciation costs, aircraft maintenance costs. The optimum overall cost for any given flight depends upon the relative magnitudes of these individual costs. A cost index is a measure of the relationship between the fuel costs of a flight and all of the other flight time related costs. Setting a cost index of zero on an FMS, will cause the system to assign absolute importance to fuel costs. It will therefore generate a flight profile that will produce the greatest possible range for a given quantity of fuel. This will give maximum range for a given fuel load (option a). Setting any higher cost index

will alter the profile such that fuel costs increase but other costs such as flight time decrease.

INS/IRS/FMS 43. b.
Standard FMS CDU waypoint information includes:

i. Runway number (1).
ii. Airport ICAO identifier (3).
iii. Navaid identifier (4).
iv. Waypoint name (5).

So option b is correct.

INS/IRS/FMS 44. d.
Integration is a mathematical process whereby accelerations rate are converted into velocities and velocities are converted into positions. A rate integrating senses angular acceleration rates and integrates these to provide angular velocity and displacement (heading, pitch attitude and bank angle)information. Rate integrating gyros are used in inertial attitude units (4) and inertial navigation units (5).

INS/IRS/FMS 45. b.
Integration is a mathematical process whereby accelerations rate are converted into velocities and velocities are converted into positions. Yaw rate is a measure of angular velocity, so integrating this will give yaw displacement.

INS/IRS/FMS 46. d.
A stable platform which is maintained earth horizontal will behave like a very large pendulum, the length of which is equal to the radius of the earth. The time taken for a pendulum to swing through one cycles is determined by its length, so an earth horizontal stable platform oscillates at a fixed frequency equal to that of a pendulum of length of one earth radius. The period of such a pendulum is 84.4 minutes. A platform exhibiting this effect is termed a "Schuler tuned platform", and a Schuler period is approximately 84 minutes (option d).

INS/IRS/FMS 47. b.
In both the stabilised platform and strapped down platform inertial systems, gyros and accelerometers are used to sense angular and linear accelerations. Most systems employ three accelerometers and three gyroscopes. Each accelerometer is set at 90 degrees to the others to form a trihedron. The gyros are arranged in a similar manner. In order to convert outputs from the gyros and accelerometers into meaningful information, the alignment of the three axes of the trihedron must be known. In a stabilised system the trihedron is physically aligned with true north. In a strapped down system the physical alignment is not altered but the relationship between the trihedron and true north is established (option b). This

relationship is then used in the computation of all motions throughout the subsequent flight.

INS/IRS/FMS 48. d.
Each of the gyros in a stabilised platform is used to sense acceleration rates about one axis. These acceleration rates are integrated once to calculate angular velocity and twice to calculate angular displacement. In order to sense these accelerations, the gyros must each have one degree of freedom and their spin axis in the plane in which they are to sense motion. Heading changes occur in the horizontal plane so the spin axis must be horizontal in order to detect heading changes. The heading information gyro must therefore have one freedom of motion and a horizontal spin axis.

INS/IRS/FMS 49. c.
In both the stabilised platform and strapped down platform inertial systems, gyros and accelerometers are used to sense angular and linear accelerations. Most systems employ three accelerometers and three gyroscopes. Each accelerometer is set at 90 degrees to the others to form a trihedron. The gyros are arranged in a similar manner. In order to convert outputs from the gyros and accelerometers into meaningful information, the alignment of the three axes of the trihedron must be known. In a stabilised system the trihedron is physically aligned with true north. In a strapped down system the physical alignment is not altered but the relationship between the trihedron and true north is established. This process may be termed calculating the computed trihedron (option c). This relationship is then used in the computation of all motions throughout the subsequent flight.

INS/IRS/FMS 50. d.
The inputs to an FMS include:

i. Operating data from the AFCS (1) and Flight management computer (2).
ii. Air data from the Air Data Computer information (3).
iii. Route data from the Flight management System and the INS or IRS (4).
iv. Engine data from the Thrust Management System and from
v. ECAM/EICAS (5).
vi. Radio Aids Data from from VOR, ADF, DME, SSR, ILS, RADALT, Weather radar, GPWS (6).

So all of the statements in this question are correct (option d).

INS/IRS/FMS 51. d.
A stable platform which is maintained earth horizontal will behave like a very large pendulum, the length of which is equal to the radius of the earth. The time taken for a pendulum to swing through one cycles is determined by its length, so an earth horizontal stable platform oscillates at a fixed frequency equal to that of a

pendulum of length of one earth radius. The period of such a pendulum is 84.4 minutes. A platform exhibiting this effect is termed a "Schuler tuned platform", and a Schuler period is approximately 84 minutes.

INS/IRS/FMS 52. c.

A ring laser gyro senses angular velocities by measuring the changes in the resonant frequencies of two beams of laser light. Because this employs no rotating parts or bearings, laser gyros provide much longer service lives than their mechanical equivalents (option c). It should be noted that strictly speaking ring laser gyros do not have a run up time and the system alignment time is related more to the type of platform (stabilised or strapped down) than to the type of gyros. The electrical power consumption of the two types of gyro is not significantly different.

INS/IRS/FMS 53. c.

Integration is a mathematical process whereby acceleration rate are converted into velocities and velocities are converted into positions. A rate integrating gyro senses angular acceleration rates and integrates these to provide angular velocity and displacement (heading, pitch attitude and bank angle) information. Rate integrating gyros are used in inertial navigation system (c). They are not however commonly used in artificial horizons, flight directors nor turn and slip indicators.

INS/IRS/FMS 54. b.

Two modes of guidance can be employed using the FMS. The term "managed guidance" refers to the process whereby FMS provides commands to the autopilot to manoeuvre the aircraft in order to ensure that the aircraft follows the planned track. The term "selected guidance" refers to the process whereby the FMS commands the pilot to manoeuvre the aircraft to maintain the planned track.

INS/IRS/FMS 55. c.

When an aircraft is using only multiple inertial systems, the FMC will compute the mean of the inertial positions. When using only multiple radio navigation beacon information the FMS will compute the mean of the various radio fix positions. If however it is using both multiple inertial and multiple radio information sources, the FMS will display the mean of all of the positions. That is to say it will compute both the mean inertial position and the mean radio position. It will then compute the mean of these two and display the resulting position (option c).

INS/IRS/FMS 56. a.

As the flight progresses the FMC will automatically select the appropriate DME stations. It will then decode the reply and display the identifier letters on the screen. If however the FMC autotunes to a DME station and does not receive a satisfactory decode, it will display the frequency of the station. The pilot must then identify the station.

INS/IRS/FMS 57. b.

Flying an aircraft incurs a wide range of costs, including such things as fuel, crew salaries, landing charges, ATC charges, aircraft leasing or depreciation costs, aircraft maintenance costs. The optimum overall cost for any given flight depends upon the relative magnitudes of these individual costs. A cost index is a measure of the relationship between the fuel costs of a flight and all of the other flight time related costs. Setting a cost index of zero on an FMS, will cause the system to assign absolute importance to fuel costs. It will therefore generate a flight profile that will produce the greatest possible range for a given quantity of fuel. Setting any higher cost index will alter the profile such that fuel costs increase but other costs such as flight time decreases. So a cost index is an FMS input code telling the FMS the required balance between optimising fuel costa nd sector time (option b).

INS/IRS/FMS 58. c.

When operating in VNAV and LNAV modes the FMC manages the flight of the aircraft from waypoint to waypoint. If a waypoint is reached beyond which no route is defined, the FMS will revert to heading hold mode.

INS/IRS/FMS 59. c.

An FMS is able to control flight in both the lateral navigation (LNAV) mode and vertical navigation (VNAV) modes.

INS/IRS/FMS. 60. d.

In both the stabilised platform and strapped down platform inertial systems, gyros and accelerometers are used to sense angular and linear accelerations. Most systems employ three accelerometers and three gyroscopes. Each accelerometer is set at 90 degrees to the others to form a trihedron. The gyros are arranged in a similar manner. In order to convert outputs from the gyros and accelerometers into meaningful information, the alignment of the three axes of the trihedron must be known. In a stabilised system the trihedron is physically aligned with true north (option d). In a strapped down system the physical alignment is not altered but the relationship between the trihedron and true north is established. This relationship is then used in the computation of all motions throughout the subsequent flight.

EFIS 1. c.

The EFIS system uses the following colour codes:

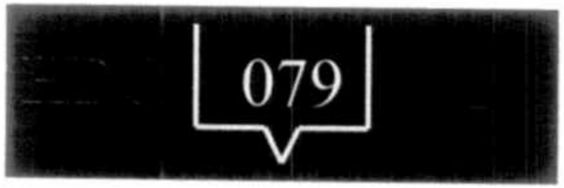
Green	Active or selected modes and/or dynamic conditions.
White	Present status, situation and scales.
Magenta	Command information, pointers, symbols, and fly-to conditions, weather radar turbulence.
Cyan	Non-active and background information.
Red	Warnings.
Yellow	Cautionary information, faults, flags.
Black	Blank areas, off codition.

So option c (yellow or amber) is the most accurate in this question.

EFIS 2. b.
The purpose of the EFIS Primary Flight Display (PFD) is to display primary flight information. Of the options listed in this question, option b, "piloting" information is the most accurate. Weather Radar information (option a) is displayed on the Navigation Display or ND. Engines and alarms (option c) and Systems (option d) are shown on the EICAS or ECAM displays.

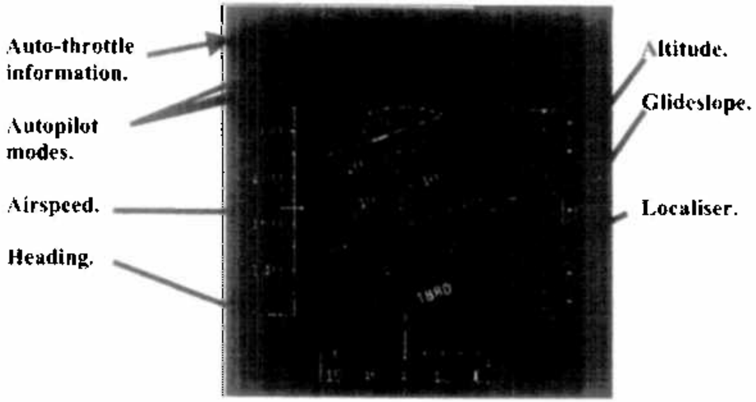
EFIS 3. b.
Decision Height is the height at which in a precision approach, a missed approach must be initiated if the required visual reference to continue the approach has not been established. This constitutes primary flight information, so it is displayed on the Electronic Attitude And Direction Indicator (EADI) in an EFIS fitted aircraft. This display is also referred to as the Primary Flight Display or PFD. The Decision Height is set by the pilot uisng the EFIS control panel prior to commencing the approach. So option b is the most accurate in this question.

EFIS 4. c.



The symbols in this question appear at the top of the Electronic Horizontal Situation Indicator or EHSI in an EFIS system. The first three digits indicate the type of information that is being displayed. In this case the green letters HDG indicate heading. The central white digits enclosed in the white box indicate the value of the information being displayed. In this case a heading of 079°. The green letter at the right indicates the reference relative to which the information is measured. In this case a green M indicates Magnetic. The white V in the centre is the pointer for the information being displayed. So the symbols provided in this question indicate the heading orientation, current heading, heading reference and heading pointer (option c).

EFIS 5. c.
The Electronic Attitude and Direction Indicator or EADI in an EFIS system displays the Primary Flight Information. This includes speed, altitude, ILS Localiser and Glide Slope information, and selected auto-throttle and autopilot modes. Depending on the selections made, the EADI can also display heading information. Option c is therefore the most accurate in this question. A typical EFIS EADI is illustrated below.



TYPICAL EFIS EADI

EFIS 6. d.
A typical EFIS suite comprises two types of instruments. The first of these is the Primary flight Display or PFD. This displays primary flight information such as altimeter setting, altitude, attitude and airspeed. The PFD is therefore the main flying instrument. The second type of instrument is the Electronic Horizontal situation Indicator or EHSI. This shows a range of navigational information. Comparing the above descriptions with the statements provided in the question reveals that option d is the most accurate.

EFIS 7. b.
Decision height is displayed in one of two formats on the EADI. When the aircraft is more than 1000 ft agl the decision height is indicated by the letters DH followed by digits to indicate the decision height. When the aircraft is at or below 1000 ft agl the display changes to a white circular scale with a magenta pointer to indicate decision height. The circumference of the scales increases or decreases to reflect the aircraft radio altitude at any given point in time. The display changes to yellow and flashes momentarily when the aeroplane descends below decision height. The most accurate option in this question is below 1000 ft (option b).

EFIS 8. b.
The BOEING 737 Operations Manual, which is used as the reference source by the JAA for EFIS questions states that the weather Radar Information is enabled using the WXR switch and can be displayed in all EHSI modes except FULL NAV, FULL VOR/ILS and PLAN modes. So in the PLAN mode the Weather Radar display data is inhibited (option b).

EFIS 9. c.

Decision height is displayed in one of two formats on the EADI. When aircraft is more than 1000 ft agl the decision height is indicated by the letters DH followed by digits to indicate the decision height. When the aircraft is at or below 1000 ft agl the display changes to a white circular scale with a magenta pointer to indicate decision height. The circumference of the scales increases or decreases to reflect the aircraft radio altitude at any given point in time. The display changes to yellow and flashes momentarily when the aeroplane descends below decision height. The most accurate option in this question is below 1000 ft AGL (option c).

EFIS 10. c.

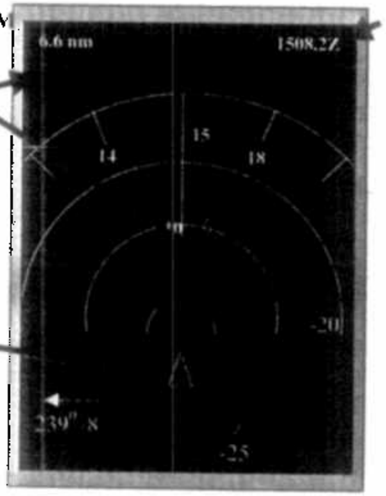
The BOEING 737 Operation Manual, which is used as the reference source for JAA EFIS questions states that the weather radar display uses the following colour codes:

Red	Intense precipitation.
Yellow	Less intense precipitation.
Green	Still less intense precipitation.
Magenta	Turbulence.

So Weather Radar returns show as areas of precipitation in green, yellow and red. The option closest to this is (option c).

EFIS 11. d.

The magenta letters VLM here indicate that the next active waypoint is VLM.



The white digits here indicate that the ETA at VLM is 1508.2Z

The white triangle here represents the aircraft current position.

So in the diagram above the next waypoint to be overflown is VLM and the estimated time of arrival at VLM is 1508.2Z. This is closest to option d.

EFIS 12. b.

The BOEING 737 Operations Manual provided which is used as the reference source for JAA EFIS questions states that the symbol below in white when shown on the EFIS EHSI indicates the aeroplane (option b).

EFIS 13. b.

The BOEING 737 Operations Manual which is used as a reference source for JAA EFIS questions states that wind velocity and direction are indicated on the EHSI in Full Nav and Expanded NAV and VOR/ILS modes, but not in Plan mode. When Plan mode is selected the EHSI displays the FMC flight plan route. This does not include wind velocity or direction. Taking these factors into account it can be seen that option b is the most accurate in this question.

EFIS 14. d.

The EFIS system uses the following colour codes:

Green	**Active or selected modes and/or dynamic conditions.**
White	**Present status, situation and scales.**
Magenta	**Command information, pointers, symbols, and fly-to conditions, weather radar turbulence,**
Cyan	**Non-active and background information.**
Red	**Warnings.**
Yellow	**Cautionary information, faults, flags.**
Black	**Blank areas, off codition.**

So option d (Magenta for command information) is the most accurate in this question.

EFIS 15. c.

The BOEING 737 Operations Manual, which is used as the reference source by the JAA for EFIS questions states that the weather Radar Information is enabled using the WXR switch and can be displayed in all EHSI modes except FULL NAV, FULL VOR/ILS and PLAN modes. So Weather Radar data is visible in the Map mode and in any expanded mode (option c).

EFIS 16. b.
Decision height is displayed in one of two formats on the EADI. When aircraft is more than 1000 ft agl the decision height is indicated by the letters DH followed by digits to indicate the decision height. When the aircraft is at or below 1000 ft agl the display changes to a white circular scale with a magenta pointer to indicate decision height. The circumference of the scales decreases as the aircraft descends. The display changes to yellow and flashes momentarily when the aeroplane descends below decision height. The most accurate option in this question is that the decision height is displayed on the "EADI and below 1000 ft is shown as a circular scale which is erased anti-clockwise as the aircraft descends"(option b).

EFIS 17. b.
The heading reference used on the EHSI may be true or Magnetic (option b). Magnetic heading is indicated by the letter M at the top of the display and can be used between latitudes 73° North and 65° South. True heading is used at latitudes beyond 73° North and 65° South and is indicated by the letter T at the top of the display.

EFIS 18. b.
The EFIS system uses the following colour codes:

Green	Active or selected modes and/or dynamic conditions.
White	Presenet status situation and scales.
Magenta	Command information, pointers, symbols, and fly-to conditions, wether radar turbulence,
Cyan	Non-active and background information.
Red	Warnings.
Yellow	Cautionary information, faults, flags.
Black	Blank areas, off codition.

So on the FMA, engaged flight automatic flight modes are displayed in green (option b).

EFIS 19. d.
The EADI has only one operating mode so option a is untrue. The EHSI has no fail operational mode, but data can be transferred to other screens if one fails. But this process is not controlled using the EFIS control panel, so option b is untrue. The autopilot modes are selected using the Autopilot Mode Control Panel (MCP), so option c is untrue. The EFIS control panel allows the pilots to select a variety of functions including the setting of decision height. So option d is true.

EFIS 20. d.
The EFIS system uses the following colour codes:

Green	Active or selected modes and/or dynamic conditions.
White	Presenet status situation and scales.
Magenta	Command information, pointers, symbols, and fly-to conditions, wether radar turbulence,
Cyan	Non-active and background information.
Red	Warnings.
Yellow	Cautionary information, faults, flags.
Black	Blank areas, off codition.

So the colours typically used on an EHSI display are white, green, magenta, cyan, yellow and red (option d).

EFIS 21. a.
The display in this question shows an expanded section of the VOR display. It is therefore the expanded VOR mode (option a). Further details of the Expanded VOR mode are provided in the key facts section off this book.

EFIS 22. b.
The BOEING 737 Operations Manual, which is used as the reference source by the JAA for EFIS questions states that the weather Radar Information is enabled using the WXR switch and can be displayed in all EHSI modes except FULL NAV, FULL VOR/ILS and PLAN modes. So in the PLAN mode the Weather Radar display data is inhibited (option b). Further details of the Plan mode are provided in the key facts section off this book.

EFIS 23. b
Decision height is displayed in one of two formats on the EADI. When the aircraft is more than 1000 ft agl the decision height is indicated by the letters DH followed by digits to indicate the decision height. When the aircraft is at or below 1000 ft agl the display changes to a white circular scale with a magenta pointer to indicate decision height. The circumference of the scales increases or decreases to reflect the aircraft radio altitude at any given point in time. The display changes to yellow and flashes momentarily when the aeroplane descends below decision height. So the most accurate option in this question is (option b).

EFIS 24. c.
The BOEING 737 Operation Manual, which is used as the reference source for JAA EFIS questions states that the weather radar display uses the following colour codes:

Red	Intense precipitation.
Yellow	Less intense precipitation.
Green	Still less intense precipitation.
Magenta	Turbulence.

So in the displayed weather modes, the intensities of the returns in ascending order of intensity are green, yellow, red and magenta (option c).

EFIS 25. d.
The BOEING 737 Operation Manual, which is used as the reference source for JAA EFIS questions states that the green symbol of a circle with T/D on the EHSI display below represents the FMC calculated top-of-descent (option d).

EFIS 26. d.
The Expanded NAV mode displays lateral and vertical navigation guidance information similar to a conventional HIS. The FMC is the source of the navigation data. Weather radar data is also displayed in this mode when the weather radar is switched on. The Expanded Nav mode does not display the whole compass rose, but only an expanded part of it. The relative bearing to the active waypoint is also shown in this mode, but the waypoints themselves are not (option d). More details of this mode are provided in the key facts section of this book.

EFIS 27. d.
The BOEING 737 Operations Manual, which is used as the reference source by the JAA for EFIS questions states that the weather Radar Information is enabled using the WXR switch. Weather Radar information can be shown on both the Captain's and the First Officer's EHSI simultaneously, but is inhibited in the FULL NAV, FULL VOR/ILS and PLAN modes. So the Weather Radar Display can be shown on the Captain's and the First Officer's EHSI simultaneously (option d).

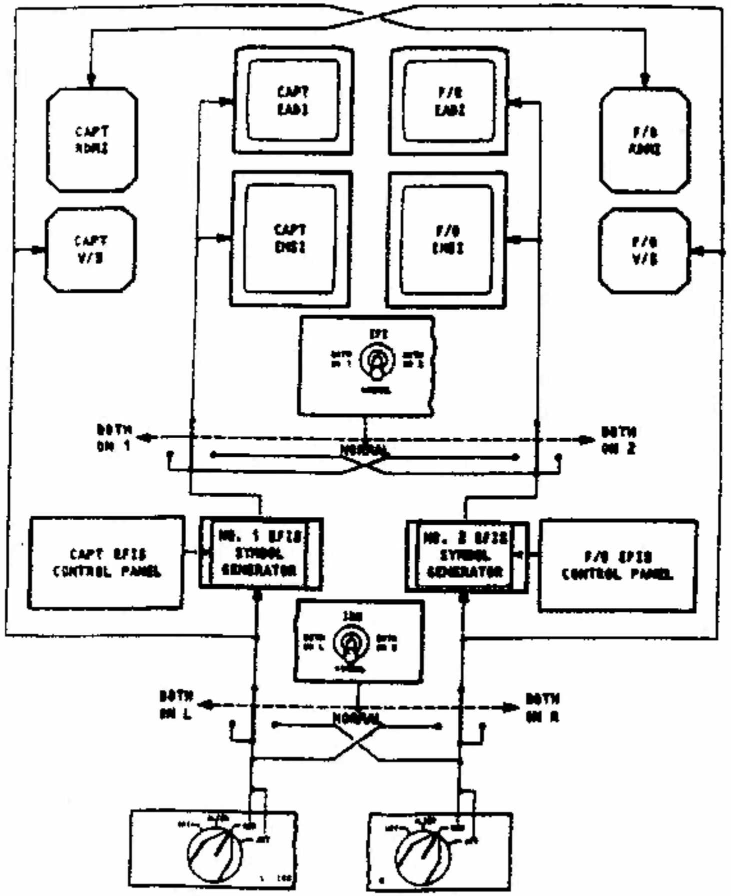
EFIS 28. c.
In order to provide adequate levels of reliability EFIS systems are typically provided with at least two symbol generators, so option a is untrue. The displays are CRT screens so option b is untrue. Each pilot typically has two CRTs one serving as the EADI and the other serving as the EHSI. In order to ensure satisfactory levels of visibility EFIS systems typically incorporate automatic CRT brightness control, which adjusts the CRT brightness for changes in ambient light levels (option c).

EFIS 29. a
As illustrated in the diagram below, the speed tape is located at the left side of the EADI (option a).

Speed tape located at the left side of the EADI.

TYPICAL EFIS EADI

EFIS 30. c.
As illustrated in the diagram of the BOEING 737 EFIS system below, the system has four screens and two symbol generators (option c).



<u>EFIS 31. d.</u>
As illustrated in the diagram in EFIS 30 above, the EFIS system include 2 Electronic Attitude Director Indicators (EADIs) and 2 Electronic Horizontal Situation indicators (EHSIs) (option d).

<u>EFIS 32. c.</u>
With its depiction of the full compass rose, VOR caption and VOR deviation command bars, the diagram in this question depicts the EHSI in the FULL VOR mode (option c). More details of this mode are provided in the key facts section of this book.

<u>EFIS 33. b.</u>
Decision height is displayed in one of two formats on the EADI. When the aircraft is more than 1000 ft agl the decision height is indicated by the letters DH followed by digits to indicate the decision height. When the aircraft is at or below 1000 ft agl the display changes to a white circular scale with a magenta pointer to indicate decision height. The circumference of the scales increases or decreases to reflect the aircraft radio altitude at any given point in time. The display changes to yellow and flashes momentarily when the aeroplane descends below decision height. In this way the scale also acts as the decision height warning light.

Because decision hight is pre-set by the pilot, the most accurate option in this question is that the decision height (DH) warning light illuminates when the aircraft descends below a pre-set altitude (option b).

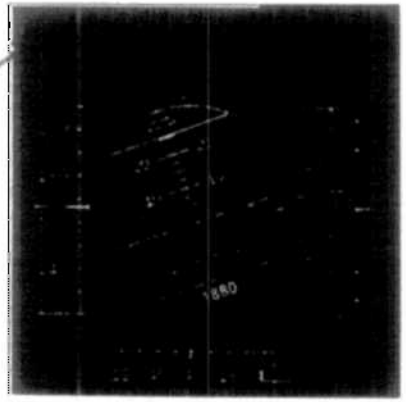
<u>EFIS 34. a.</u>
The BOEING 737 Operations Manual which is used as a reference source for JAA EFIS questions states that wind velocity and direction are indicated on the EHSI in full and expanded NAV and VOR/ILS modes, but not in plan mode. When plan mode is selected the EHSI displays the FMC flight plan route. This does not include wind velocity or direction.

The Operations Manual states that wind direction is indicated relative to the map display orientation. The Manual also states that the EHSI displays are oriented relative to the aircraft heading. This means that wind direction is displayed relative to the aircraft heading (option a).

<u>EFIS 35. c</u>
A Head Up Display or HUD is a device whereby selected elements of the instrument displays are projected onto the inside of the windscreen or onto a glass panel in the field of view of the pilots. In this way during automatic approaches and landings the HUD provides a synthetic view of the Instrument procedure (option c) superimposed on the pilots' view of the area in front of the aircraft. All of the other options in this question include some aspects of the functions of the HUD, but all are incomplete. Option a, is also untrue in that the HUD can be used in other procedures in addition to CAT II precision approaches.

<u>EFIS 36. d.</u>
Armed and engaged auto-throttle modes are displayed on the annunciator panel, which is located at the upper area of the Primary flight display (PFD) (option d) directly above the artificial horizon display. A typical PFD is illustrated below.

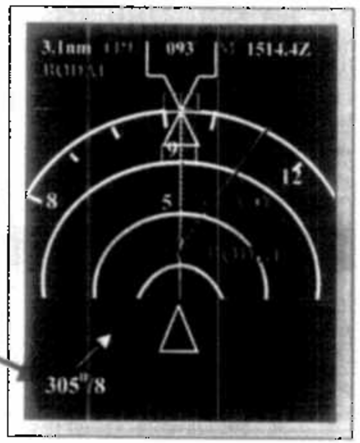
Engaged or armed auto-throttike modes are displayed here.



TYPICAL EFIS EADI

EFIS 37. b.

The BOEING 737 Operations Manual which is used as a reference source for JAA EFIS questions states that wind velocity and direction are indicated on the EHSI in full and expanded NAV and VOR/ILS modes, but not in plan mode. When plan mode is selected the EHSI displays the FMC flight plan route. Wind direction is indicated by means of a white arrow at the bottom left corner of the EHSI display. So the white arrow in the lower left corner in the diagram below indicates the current wind of 305°/8 kts is being experienced (option b).



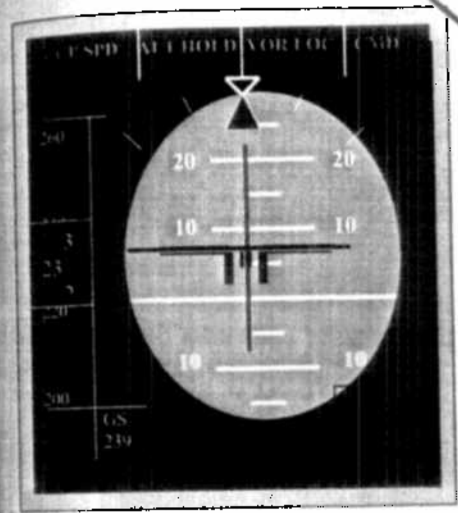
EFIS 38. c.

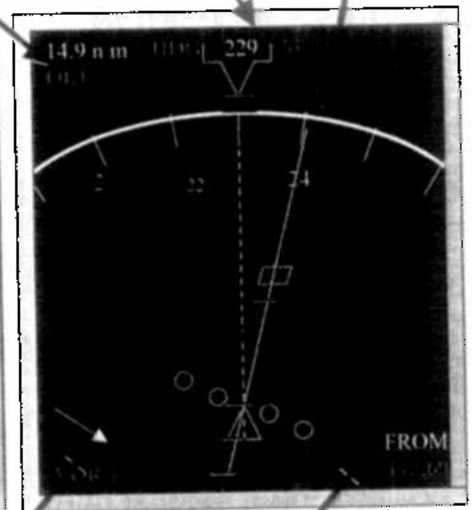
The heading pointer at the top of the display shows a heading of 229° Magnetic. But the track indicated by the magenta line is 240°. This means that the aircraft is slipping to the right. This suggests that there is a crosswind from the left (option c). This feat is also evident from the direction of the arrow at the bottom left corner of the EHSI.

Letters OKL here indiacte the active waypoint.

Heading is 229° as indiacted here.

Track is 240° as indicated here.



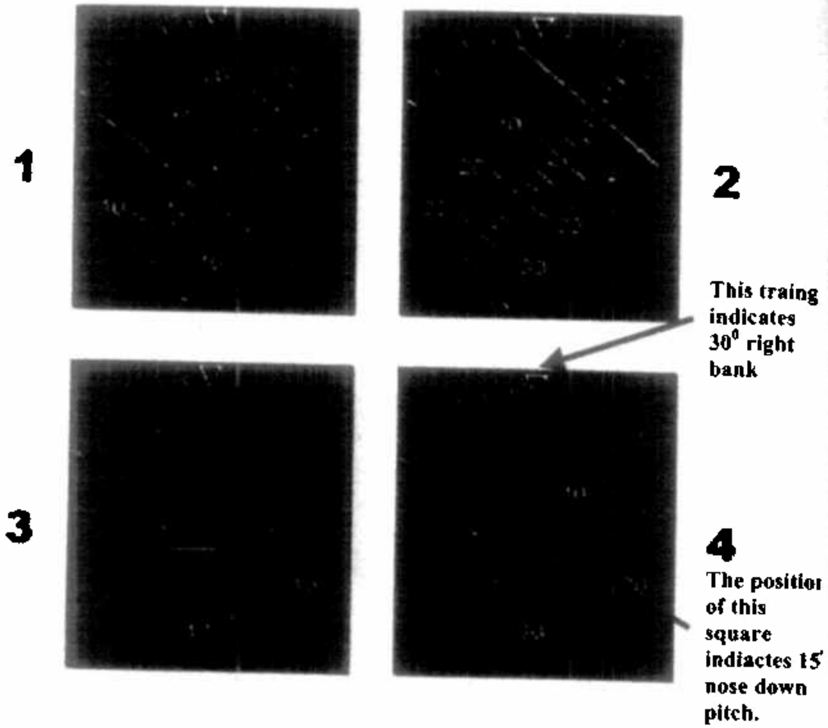


This white arrow indiactes that the wind is form the left.

The word FROM here indicates that the VOR radial is from the active waypoint

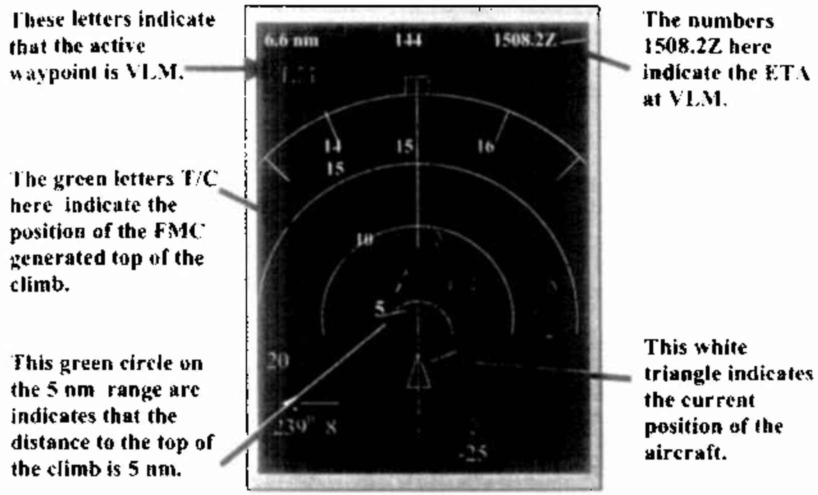
EFIS 39. d.

On an EADI the pitch attitude is indicated by the position of the black square at the centre of the aircraft symbol, relative to the scale markings on the background sky and land. A 15° nose down pitch is indicated when the black square is midway between the 10° and 20° markers on the land part of the background. This situation can be seen in figure 4. The bank angle is indicated by the white outlined black triangle at the top of the display. In figure 4 this triangle indicates approximately 30° right bank. Figure 1 indicates approximately 5° nose up and 35° left bank. Figure 2 indicates approximately 15° nose down and 35° left bank. Figure 3 indicates approximately 5° nose up and 30° right bank. So figure 4 is closest to indicating 30° right bank and 15° nose down attitude (option d).

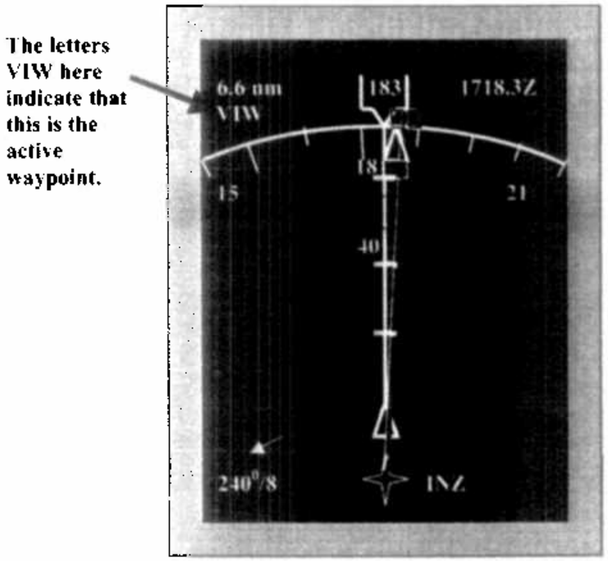


EFIS 40. a.
In the diagram in question EFIS 38 the letters OKL at the top left corner of the dispaly indicate the active waypoint VOR. The letters FROM at the bottom right corner indicate that the aircraft is flying away from OKL VOR. The magenta line from the triangular aircraft symbol to the digits 24 indicate that the radial in use is 240⁰. So the aircraft is following a radial 240⁰ from OKL VOR (option a).

EFIS 41. a.
The symbol T/C in an EFIS EHSI display indicates the position of the FMC generated top of the climb. The distance to this point is indicated by the inner range arc which is at 5 nm from the aircraft. So in the diagram below the T/C is a FMC generated top of climb and it will be reached at approximately 5 nm from the present position (option a). It should be noted that the digits VLM at the top left corner and 1508.2Z at the top right corner indicate that the ETA at VLM is 1508.2Z. So options b and c are untrue.

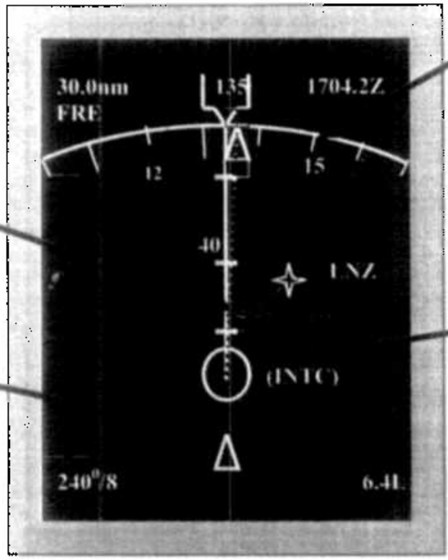


EFIS 42. b.
Although the position of the current active waypoint is not visible in this diagram, the letters VIW at the top rleft corner of the dispaly mean that this is the active waypoint (option b).



EFIS 43. b.

The green dotted line in this diagram is the 330° radial from FRE VOR. The white triangle is the current position of the aircraft. The white circle with the letters (INTC) indicates the point at which the aircraft will intercept radial 330 from FRE VOR. The magenta star at FRE VOR indicates that this is the next active waypoint. So the white circle indicates a location where you will intercept radial 330° from FRE VOR and track inbound (option b).



1. Heading 150° is here so a line from here passing through the magenta star at FRE and the white circle marked INTC is at heading 330°

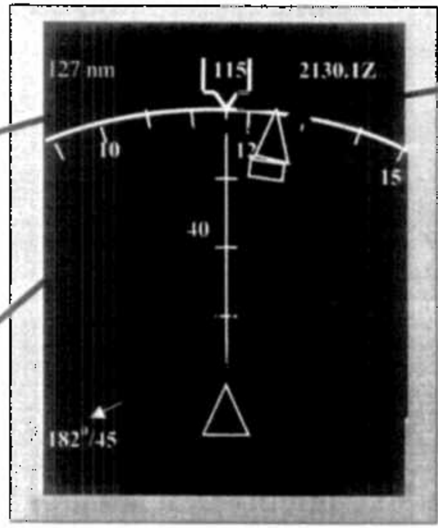
2. The magenta star and magenta letters FRE indicate that the active waypoint is FRE.

3. This green dotted line is the 330° radial from FRE.

4. This white circle and the letters INTC indicate the point at which the aircraft will intercept the green dotted line representing the 330° radial from FRE.

EFIS 44. d.

The current heading is indicated by the white oulined triangle just to the right of the track pointer. This indicates that the current heading is 125 (option d).



The letters TRK and M indicate magnetic track is selected and the figures 115 indicate that the current track is 115°.

These two magenta squares indiacte that the current heading selected is 120°.

This white triangle indicates that the current heading is 125°.

EFIS 45. c.

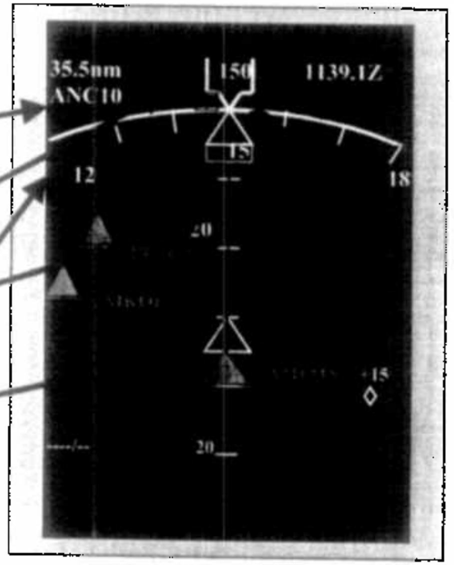
The selected heading is indicated by the magenta symbol ⊓⊓ adjacent to the outer scale. In the diagram in question EFIS 44 this is located at 120° indicating that the selected heading is 120° (option c).

EFIS 46. b.

On the EHSI display in question EFIS 44, the track is indicated by the white vertical line above the point of the triangular aircraft symbol. This is indicating a track of 115° (option b).

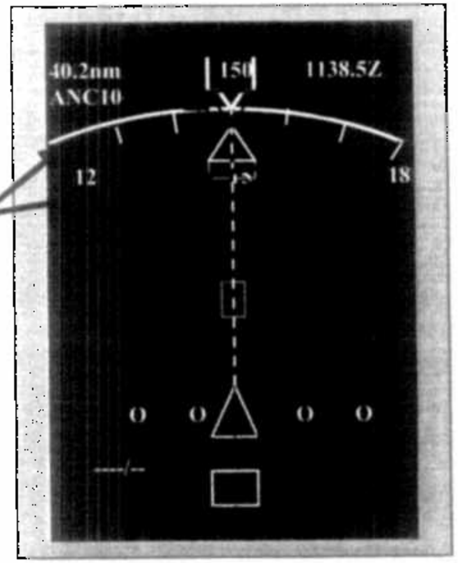
EFIS 47. b.

The display below shows the white triangular aeroplane symbol at the centre of the display and the flight plan route and navaids in use. The top part of the display shows the track, active waypoint, distance to go and ETA. This is therefore a Centre Map display (option b).



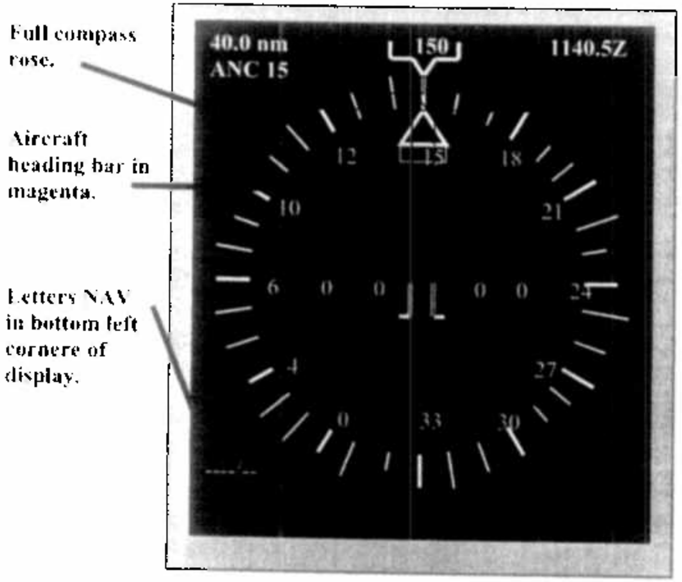
EFIS 48. d.

The Navigation Display (EHSI) in the diagram below shows the similar information to that in the Full Nav mode, but only an expanded part of the compass rose is visible. It is therefore the exanded Nav mode (option d). Further details of this mode are provided in the key facts section of this book.



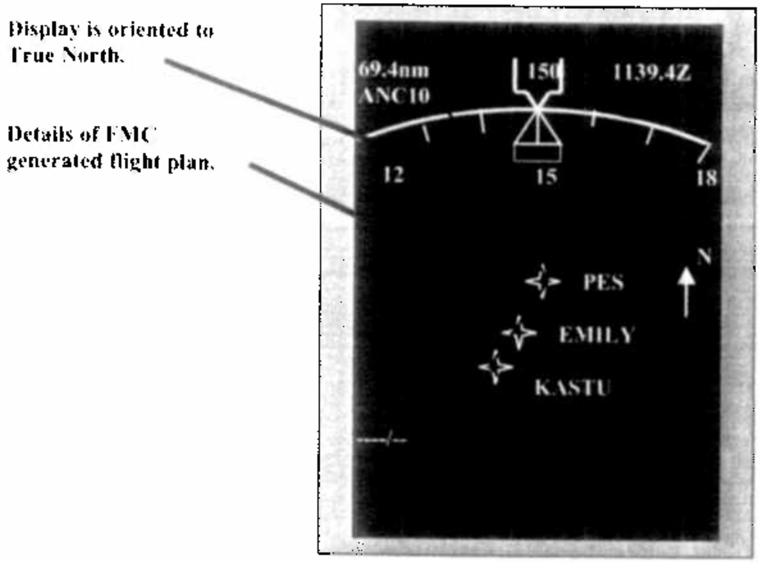
EFIS 49. c.

The Navigation Display (EHSI) in diagram below show the full compass rose plus the magnetic heading pointer and the deviation bar. This coupled with the word NAV at the bottom corner means that it is the Full Nav mode (option c).



EFIS 50. c.

The Navigatiion Display (EHSI) in the diagram below is oriented to True north and shows the FMC generated flight plan. It is therefore the Plan Mode (option c). Further details of this mode are provided in the key facts section of this book.



EFIS 51. d.

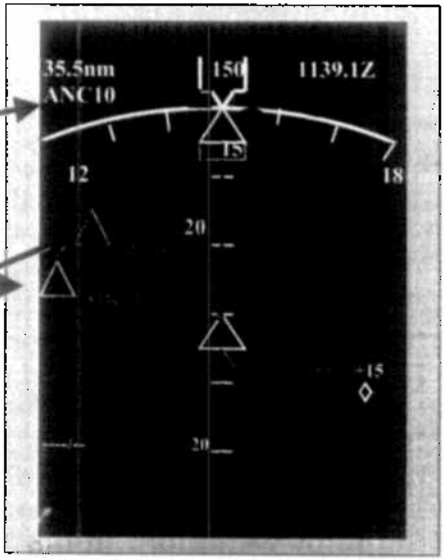
The BOEING 737 Operations Manual, which is used as the reference source by the JAA for EFIS questions states that the weather Radar Information is enabled using the WXR switch. Weather Radar information can be shown on both the Captain's and the First Officer's EHSI simultaneously, but is inhibited in the FULL NAV, FULL VOR/ILS and PLAN modes. So when using the EHSI, the weather radar may be displayed on the Map, Expanded VOR/ILS settings (option d). Further details of the various modes are provided in the key facts section of this book.

EFIS 52. b.

The title of an active waypoint is shown at the top left corner of the display. In the diagram below it is ANC10 (option b).

Magenta letters ANC10 at the top left corner of the dispaly show the active waypoint.

Triangles indicate off-route waypoints.



EFIS 53. c.

In the BOEING 737 aircraft the decision height is set using a contol knob and LED display on the ADI section of the EFIS control panel (option c). This section of the EHSI control panel is illustrated below.

Scale displays selected Height. This is also displayed on the EADI.

Decision height selector is turned to select the required decision height.

Pushing the decision height reset button resets the decision height indication on the ADI.

Turning the brightness knob adjusts the brightness of the ADI to the required level.

EFIS 54. d

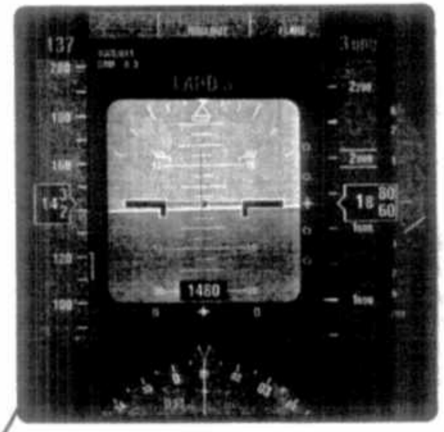
The BOEING 737 Operations Manual, which is used as the reference source by the JAA for EFIS questions states that the weather Radar Information is enabled using the WXR switches on the Captain's and First Officer's EFIS control panels. Weather Radar information can be shown on both the Captain's and the First Officer's EHSI simultaneously, but is inhibited in the FULL NAV, FULL VOR/ILS and PLAN modes. So the Weather Radar Display is controlled from both the Capatain's and the Co-pilot's ESI control panels (option d).

EFIS 55. d.

The BOEING 737 Operations Manual, which is used as the reference source by the JAA for EFIS questions states that the weather Radar Information is enabled using the WXR switch. Weather Radar information can be shown on both the Captain's and the First Officer's EHSI simultaneously, but is inhibited in the FULL NAV, FULL VOR/ILS and PLAN modes. So the WXR display is on both the Captain's and the Co-pilot's CRTs (option d).

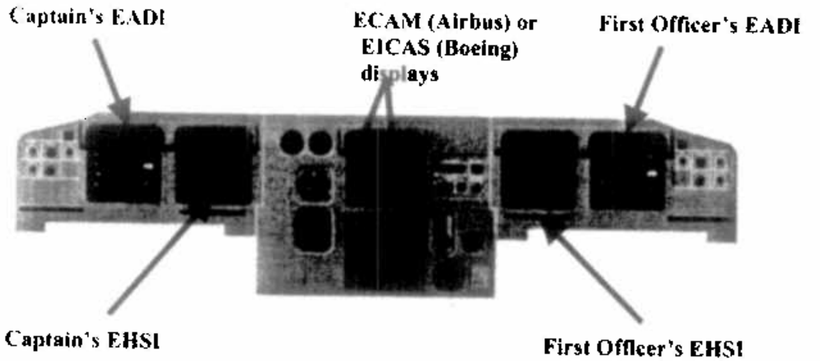
EFIS 56. b.

As illustrated below, the airspeed is shown on the speed tape at the left side of each of the ADIs (option b).



Speed tape located at the left side of the EADI.

EFIS 57. a.
In addition to the control panel, symbol generators and remote light sensors, EFIS systems employ Electronic Attitude and Direction Indicators (EADIs) and Electronic Horizontal situation Indicators (EHSIs) (option a). Altitude indications are provided on the EADI so option b is untrue. EICAS is not part of the EFIS system but is usually closely integrated with it, so option c is untrue. Weather radar (WXR) displays can be shown on the EFIS EHSI, so no separate WXRT display tubes are required in EFIS system. So option d is untrue. A typical EFIIS sisplay system is illustrated below.

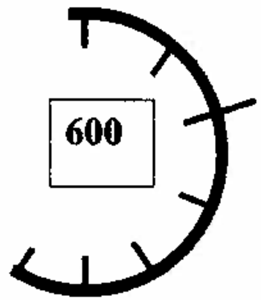


EFIS 58. b.
EFIS systems use wide a range of data inputs, including manometric, magnetic, inertial, radio, and computer generated. Option d is therefore untrue. Airspeed and Mach hold are functions of the Auto-Throttle system, so option a is untrue. EFIS display functions include VOR. ILS and MAP, but not Auto Select, so option c is untrue. This leaves only option b which is true but incomplete in that it covers only a fraction of the EFIS modes. More details of EFIS EHSI modes are provided in the key facts section of this book.

EFIS 59. b.
Magnetic compasses operate by aligning themselves with the lines of magnetic force which make up the magnetic field of the Earth. As latitude increases, the lines of magnetic force dip towards the centre of the Earth. This dipping of the lines of force reduces the strength of the horizontal component of the magnetic field. This in turn reduces the effectiveness of magnetic compasses. In order to ensure that an adequate degree of accuracy is achieved at all times, EFIS guidance, is based on Magnetic North between 73^0N and 65^0S and True North above these latitudes (option b).

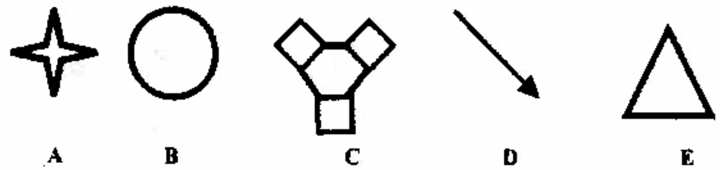
EFIS 60. c.
Decision height is displayed in one of two formats on the EADI. When aircraft is more than 1000 ft agl the decision height is indicated by the letters DH followed by

digits to indicate the decision height. When the aircraft is at or below 1000 ft agl the display changes to a white circular scale with a magenta pointer to indicate decision height. The circumference of the scales increases or decreases to reflect the aircraft radio altitude at any given point in time. The display changes to yellow and flashes momentarily when the aeroplane descends below decision height. In diagram below the data is is shown on (i) EADI, which is displaying (ii) 600 ft RA (option c).



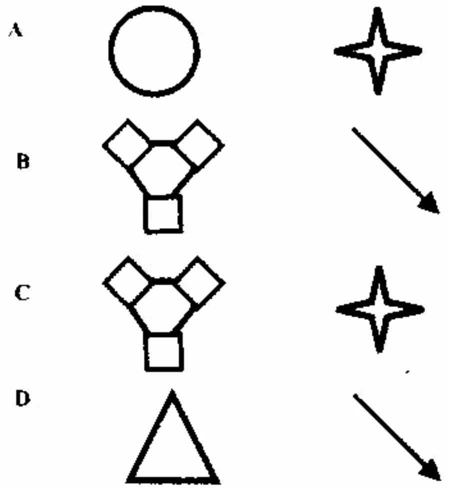
EFIS 61. c.
The BOEING 737 Opertaions Manuaul that is used by the JAA as a reference source for EFIS questions states that the symbol below appears in yellow in place of the normal radio altitude display when there is a failure of the radio altimeter (option c).

EFIS 62. d.
The BOEING 737 Opertaions Manuaul that is used by the JAA as a reference source for EFIS questions states that the symbol A is a waypoint which is active when shown in magenta, C is a navigation aid and E is an off-route waypoint. So option d is the most accurate in this question.



EFIS 63. c

The BOEING 737 Opertaions Manuaul that is used by the JAA as a refernce source for EFIS questions states that the symbols at C are a navigation aid and an enroute waypoint. So option c is the most accurate in this question.

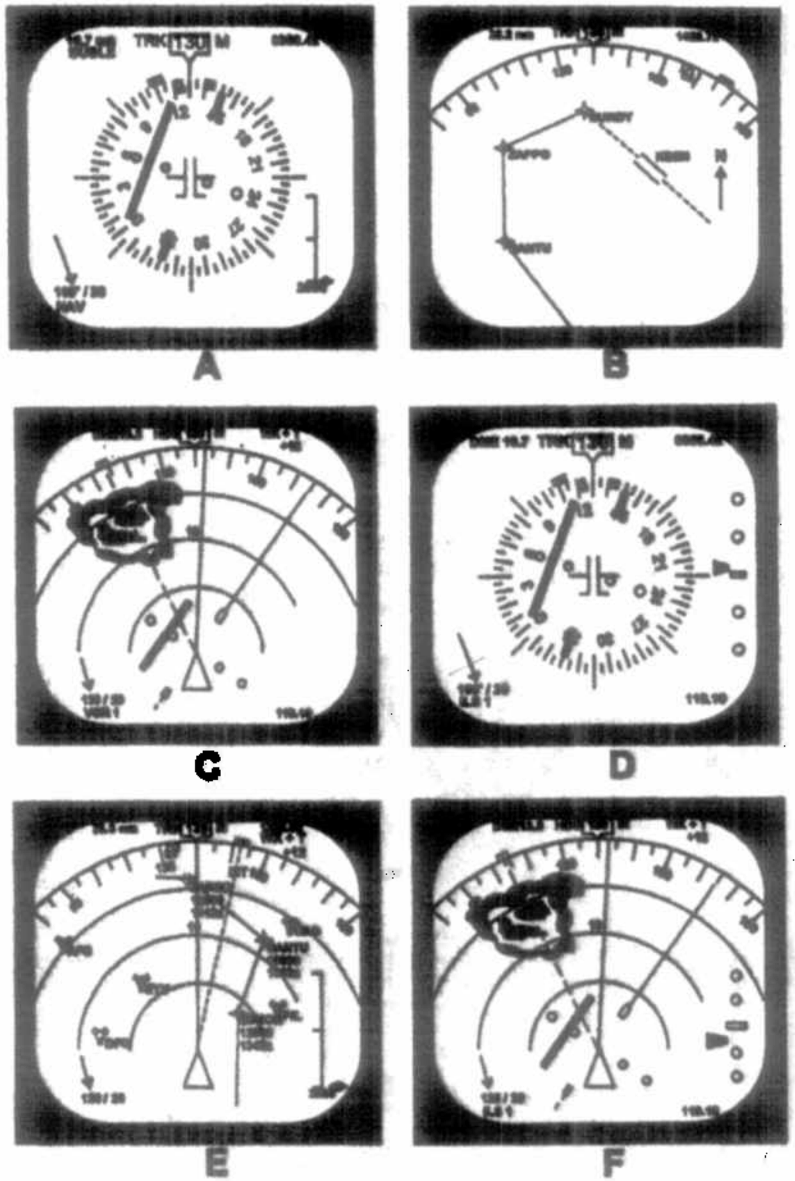


EFIS 64. a and d.

In the diagrams in question EFIS 64 which are copied on the next page, the displays are as follows:

A = FULL VOR/ILS with a VOR frequency selected.
B = PLAN.
C = Expanded VOR/ILS with a VOR frequency selected.
D = FULL VOR/ILS with an ILS/LOC frequency selected.
E = Expanded MAP.
F = Expanded VOR/ILS with an ILS/LOC frequency selected.

So full VOR display are in diagrams A and D, (options a and d). Students should lodge an appeal because there are two correct options.



EFIS 65. d.

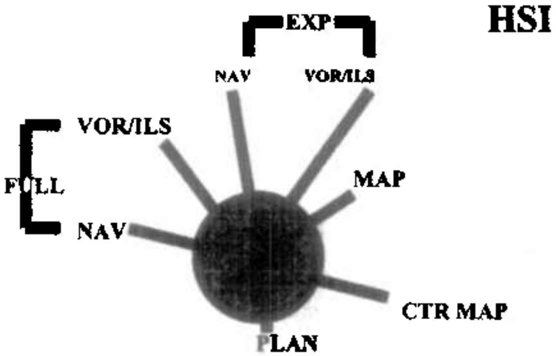
The BOEING 737 Operations Manual, which is used as the reference source by the JAA for EFIS questions states that the weather Radar Information is enabled using the WXR switch. Weather Radar information can be shown on both the Captain's and the First Officer's EHSI in all EHSI modes except the FULL NAV, FULL VOR/ILS and PLAN modes. In the diagrams in question EFIS 64, the displays are as follows:

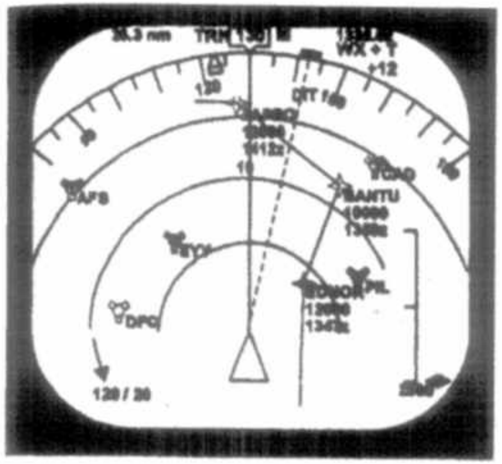
A = FULL VOR with a VOR frequency selected.
B = PLAN.
C = Expanded VOR/ILS with a VOR frequency selected.
D = FULL VOR/ILS with an ILS/LOC frequency selected.
E = Expanded MAP.
F = Expanded VOR/ILS with an ILS/LOC frequency selected.

So weather radar returns can be displayed on C (Expanded VOR/ILS), E (Expanded MAP) and F (Expanded VOR/ILS), (option d).

EFIS 66.

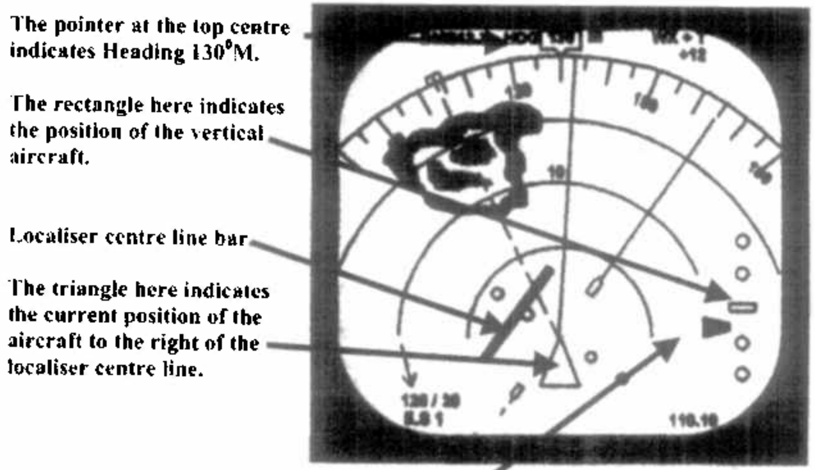
The selector knob is set to MAP, so the MAP display as illustrated below would appear on the EHSI. This is display E in the diagram (option b).





EFIS 67. a.

As illustrated in the display below, the aircraft is closing the localiser from the right, heading 130°M and is approaching the glide path from above (option a).



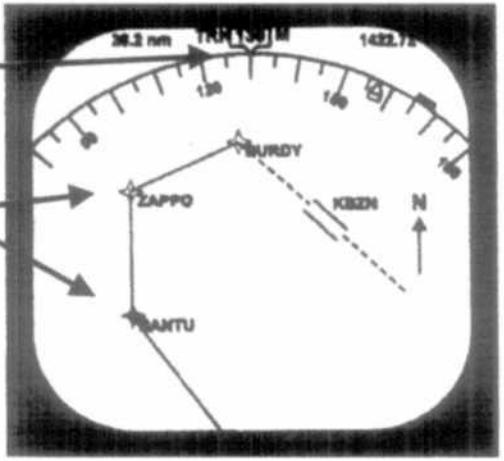
The pointer here indicates the glideslope. Comparing the positions of this pointer and the aircraft rectangle shows that the aircraft is approaching the glideslope from above.

EFIS 68. a.
As illustrated below, the track from ZAPPO to BANTU is 310°M (option a).

Track 130°M is indicated by the pointer at the top of the display.

ZAPPO is alomost directly above BANTU so the track from BANTU to ZAPPO is approximatley 130°M.

This means that the track from ZAPPO to BANU is approximately 130°M + 180° = 310°M (option a).



EFIS 69. b.
In the display below, the aircraft heading is shown to be approximately 133°M and the weather radar returns are at about 28° to the left of the aircrart heading. This means that the centre of the weather return is 360° - 28° = 332° relative. This is indicated by the thick curved arrow on the diagram below. The aircraft is represented by the triangle at the bottom of the display. The range arcs indicate that the centre of the weather returns is about 13 nm from the aircraft. So the centre of the weather return is at approximately 332° relative, 13 nm (option b).

Aircraft heading 133°M

Weather returns.

Centre of weather returns at approximately 13 nm from point of triangle.

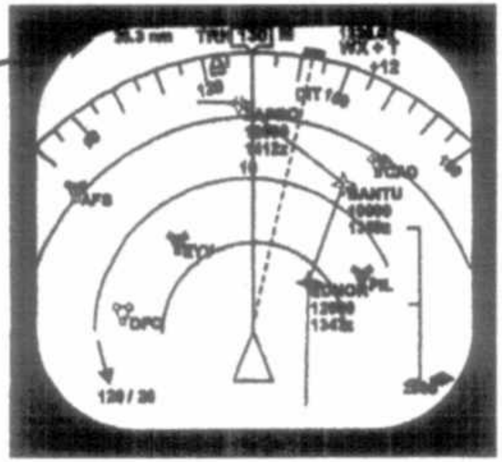
Centre of weather returns is approximatley 332° relative to the heading of the aircraft as indicated by the thick curved arrow.

EFIS 70. b.
Groundspeed is at the bottom left corner of the EADI in white digits (option b).

EFIS 71. d.
The BOEING 737 Operations manual which is used by the JAA as the reference source for EFIS questions states that "If the Captain's or F/O's LOC deviation exceeds one-half dot expanded scale (one-fourth dot standard scale), the respective LOC scale changes colour from white to yellow and the miniature runway stem flashes" and "If the Captain's or F/O's G/S deviation exceeds one dot deviation, the respective G/S scale changes colour from white to yellow and the G/S pointer flashes". Comparing these statements with the options in this question reveals that option d, "The respective localiser or glideslope scales change colour from white to amber and the pointer flashes" is the most accurate.

EFIS 72. a.
An HSI Map Mode display is illustrated below. The distance to go is shown at the top left corner of the display (option a).

Distance to go is displayed at the top left corner



EFIS 73. d.
The BOEING 737 Operations Manual, which is used as the reference source by the JAA for EFIS questions states that the weather Radar Information is enabled using the WXR switch. Weather Radar information can be shown on both the Captain's and the First Officer's EHSI simultaneously, but is inhibited in the FULL NAV, FULL VOR/ILS and PLAN modes.

Of the options listed in this question option c "MAP is incorrect. Option a "VOR" and option b (ILS" are unclear as the do not specify whether full or expanded modes are to be considered. So of the options listed in this question option d is the most accurate, because the Weather Radar data cannot be displayed on the EHSI in the PLAN mode.

AUTOFLIGHT 1 d.
During the majority of the time that an aircraft spends flying at cruising altitude it is controlled by the autopilot. This relieves the pilots of the task of constantly making minor adjustments to correct for minor deviations from the required flight path.

As a flight progresses, the burning of fuel gradually reduces the mass of the aircraft and causes its Centre of Gravity to move. This movement of the Centre of Gravity necessitates action from the autopilot to prevent changes in attitude and airspeed. If these changes were carried out by the autopilot stabilisation systems alone, it would result in a continuous command signal being sent to the elevator actuators. If the autopilot was then switched off, this would result in a loss of these signals causing the elevators to move abruptly to their neutral position. This would cause a sudden change of pitch attitude.

The Auto Trim system is part of the autopilot. Its function is to monitor the autopilot circuitry for any steady state or continuous control signals. If such signals are detected, the Auto Trim system adjusts the elevator trim tabs so that the aerodynamic forces generated by the tabs keep the elevators at the required angle. This relieves the elevator load (option d) enabling the control signals to be reduced to zero. This prevents any sudden snatching of the controls whenever the autopilot is switched off.

AUTOFLIGHT 2 d.
The Auto Throttle or automatic throttle system has a number of functions which typically include the following:

1. Maintain constant engine power during take-off and climb.
2. Maintain constant airspeed or mach number in cruise flight.
3. Adjust engine power as required to maintain or achieve selected aircraft performance in conjunction with the autopilot.

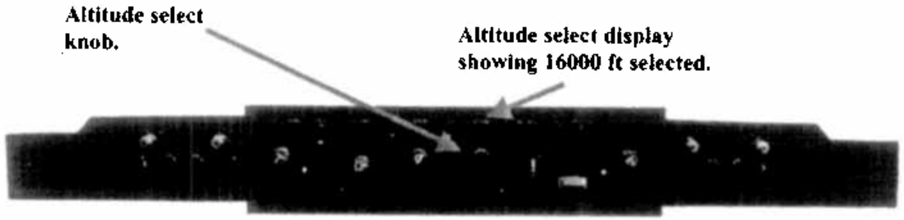
Option d is true in that it comprise functions 1 and 2 above.

AUTOFLIGHT 3 d.
Modern aircraft employ Electronic Flight Instruments Systems (EFIS). These systems consist of a pair of Primary Flight Displays (PFD), which display primary flight data such as altitude, attitude and airspeed. A second pair of displays called the Navigation Displays (ND), show navigation and flight path data. In aircraft equipped with EFIS the engaged auto throttle modes are displayed in the upper strip of the PFD (option d).

AUTOFLIGHT 4 d.
The armed and active modes of the autopilot, auto throttle and flight director are all displayed on the upper part of the EFIS primary flight display. This is able to display 2 states for the Localiser function. The first of these is "Localiser ARM" in white text. This indicates that the system is armed for a Localiser approach and

coupling will occur upon capturing the centre line of the Localiser beam (option d). The second state is "Localiser Captured" which is in green text. This means that the system has captured and locked onto the centre line of the Localiser beam.

AUTOFLIGHT 5 b.
Altitude select is one of the pitch axis command modes of the autopilot system. The pilot dials up the required altitude on the autopilot mode control panel (MCP) then presses the altitude select button. The autopilot then adjusts pitch attitude such that the aircraft climbs or descends to the selected altitude. When this altitude is reached the autopilot will automatically level the aircraft at that altitude. Engagement of the altitude select function is annunciated by lights on the upper part of the EFIS PFD and by a sound when the aircraft is approaching or departing from the selected altitude (option b). A typical autopilot mode control panel is illustrtaed below.



TYPICAL AUTOPLIOT MODE CONTROL PANEL

AUTOFLIGHT 6 a.
One of the basic functions of an autopilot system is to provide automatic stabilisation of the aircraft flight path. In order to do this, the system detects deviations from the selected path, and makes adjustments to the flying controls to correct these deviations. In order to minimise oscillations it is essential that any corrective control deflections are proportional to the difference between the reference attitude and the instantaneous attitude of the aircraft (statement 1). In order to avoid very large deviations it is necessary to adjust control deflections to match the rate of deviation from the selected attitude (statement 2). Very large rates of deviation or very large deviations will require correspondingly large control deflections. Very slow rates of deviation or very minor deviations will require correspondingly small control deflections. The temperature and pressure altitude have no direct effect on control deflections.

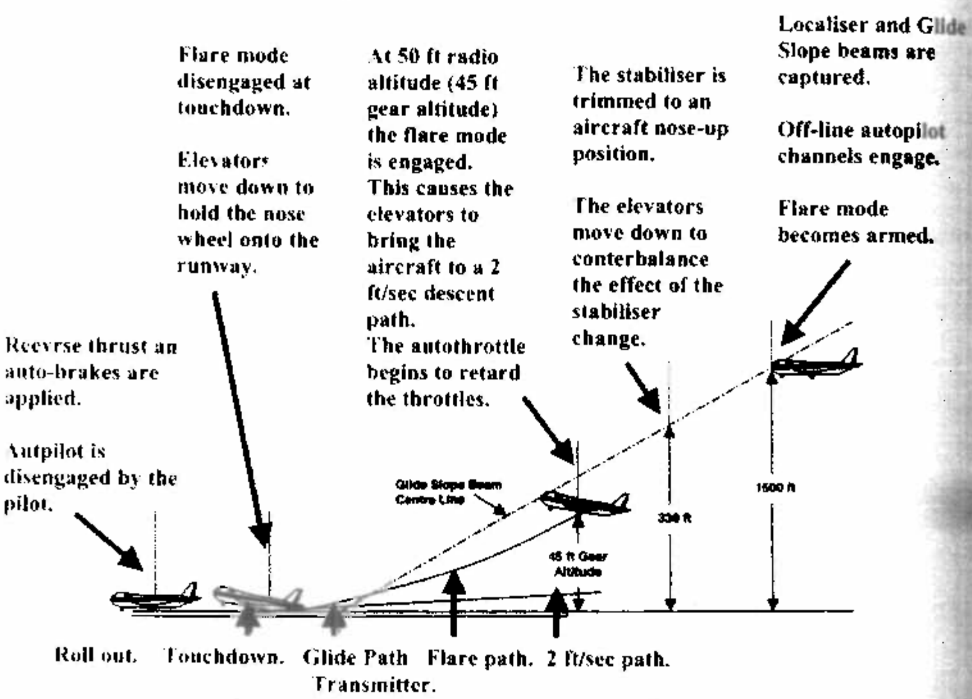
AUTOFLIGHT 7 a.
The magnitudes of the control deflections that are required to maintain a given altitude depend upon various factors. In order to minimize oscillations about the preset condition it is essential that the control deflections are proportional to the degree of deviation. This means that control deflections are greatest when the

difference between the required pitch attitude and the actual attitude is greatest (statement 1). Similarly very large rates of change of pitch attitude will require very large control deflections (statement 2)

To avoid any very large deviations from the selected altitude it is also essential that control deflections increase with increasing deviation from the selected altitude (statement 3). Similarly very large rates of change of deviation will also require very large control deflections (statement 4). So statements 1, 2, 3, and 4 are all correct (option a).

AUTOFLIGHT 8 a.

An automatic landing is one in which the entire landing process from initial approach down to the ground roll is conducted automatically. In Category 3A systems the autopilot is disengaged at the start of the ground roll. In Category 3B systems the autopilot remains in control until the end of the ground roll. So in an automatic landing the autopilot and the auto-throttle ensure a correct final approach, at least to the ground roll.

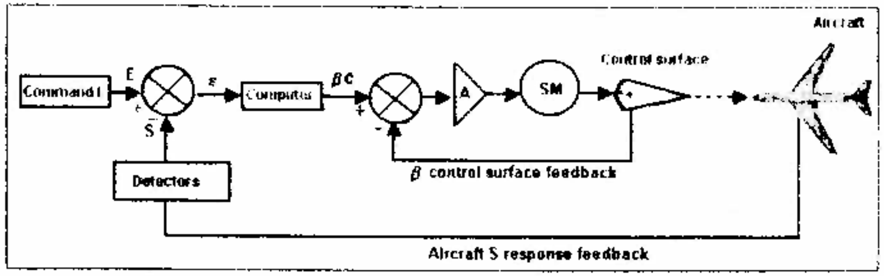


AUTOFLIGHT 9 d.

Under JAR regulations the minimum autopilot capability required for single-pilot IFR flight is heading hold and altitude hold (option d)

AUTOFLIGHT 10 b.

Autopilots provide automatic stabilization by sensing deviations from the required conditions. In the case of pitch bank and yaw angles, these deviations are detected using gyroscopes. The signals (marked Aircraft response feedback in the diagram) from these gyroscopes are compared with the pilot command inputs (marked Command E in the diagram). The crossed circle symbol in which these two signals meet represents this comparison process. The results of this comparison are sent as error signals (marked E for Epsilon) to the computer, which uses them to generate control surface commands (marked βC in the diagram). The term "offset epsilon" means the difference or offset between the actual attitude detected by the gyroscopes and the selected attitude. It can therefore be said that the piloting law is the relationship between the deflection of the control surface commanded by the computer (βC) and the offset EPSILON at the computer input (option b).



AUTOFLIGHT 11 a.

During the majority of the time that an aircraft spends flying at cruising altitude it is controlled by the autopilot. This relieves the pilots of the task of constantly making minor adjustments to correct for minor deviations from the required flight path.

As a flight progresses, the burning of fuel gradually reduces the mass of the aircraft and causes its Centre of Gravity to move. This movement of the Centre of Gravity necessitates action from the autopilot to prevent changes in attitude and airspeed. If these changes were carried out by the autopilot stabilisation systems alone, it would result in a continuous command signal being sent to the elevator actuators. When the autopilot is then switched off, this would result in a loss of these signals causing the elevators to move abruptly to their neutral position, thereby causing a sudden change of pitch attitude.

The Auto Trim system is part of the autopilot. Its function is to monitor the autopilot circuitry for any steady state or continuous control signals. If such signals are detected, the Auto Trim system adjusts the elevator trim tabs so that the aerodynamic forces generated by the tabs keeps the elevators at the required angle.

This relieves the elevator load enabling the control signals to be reduced to zero. This prevents any sudden snatching of the controls whenever the autopilot is switched off. Because the greatest changes in Centre of Gravity are along the longitudinal axis, the auto-trim operates only in the pitch axis (option a).

AUTOFLIGHT 12 d.

The term "closed loop system" means one in which the system receives feedback signals to inform it of the effects of any control inputs that it has made. This ensures the stability of the system and prevents system runaway. Such systems comprise a detector, a computer, a feedback loop and a means of converting command signals into control movements in a strictly proportional manner. The device in which small power inputs in the form of command signals control much larger power outputs is called a servomechanism (option d). In most cases such mechanisms are electrically or hydraulically powered.

AUTOFLIGHT 13 b.

As an aircraft accelerates through the transonic speed range, shockwaves begin to form on the upper surfaces of its wings. These cause separation of the boundary layer, which in turn causes an increase in drag and loss of lift. The overall effect of these processes is the rearward movement of the centre of pressure to approximately the 50% chord point. This causes the aircraft to pitch nose down in a phenomenon called Mach tuck-under.

The purpose of the mach trim system is to compensate for this rearward motion (or backing) of the centre of pressure at high mach numbers by moving the elevators to nose up (option b). It should be noted that strictly speaking the "aerodynamic centre" referred to in option b is not the same thing as the centre of pressure, but this remains the most accurate option.

AUTOFLIGHT 14 a.

As an aircraft accelerates through the transonic speed range, shockwaves begin to form on the upper surfaces of its wings. These cause separation of the boundary layer, which in turn causes an increase in drag and loss of lift. The overall effect of these processes is the rearward movement of the centre of pressure to approximately the 50% chord point. This causes the aircraft to pitch nose down in a phenomenon called Mach tuck-under.

The purpose of the mach trim system is to compensate for this rearward motion of the centre of pressure at high mach numbers by moving the elevators to the nose up position. Because mach tuck-under occurs only at high subsonic mach numbers, the mach trim system only operates above a pre-determined mach number (option a).

AUTOFLIGHT 15 d.

Strictly speaking there is no such thing as a "semi-automatic" landing. It could however be argued that this term means that the approach down to decision height

is conducted automatically then the remainder of the landing controlled manually. To achieve this the autopilot must maintain the airplane on the ILS beam until the decision height is reached it is then disengaged (statement 1). In addition to this, the auto-throttle maintains a constant speed until the decision height is reached and is then disengaged (statement 2). So option d is the most accurate in this question.

AUTOFLIGHT 16 b.

During the majority of the time that an aircraft spends flying at cruising altitude it is controlled by the autopilot. This relieves the pilots of the task of constantly making minor adjustments to correct for minor deviations from the required flight path.

As a flight progresses, the burning of fuel gradually reduces the mass of the aircraft and causes its Centre of Gravity to move. This movement of the Centre of Gravity necessitates action from the autopilot to prevent changes in attitude and airspeed. If these changes were carried out by the autopilot stabilisation systems alone, it would result in a continuous command signal being sent to the elevator actuators. If the autopilot is then switched off, this will result in a loss of these signals causing the elevators to move abruptly to their neutral position. This will cause a sudden change of pitch attitude.

The Auto Trim system is part of the autopilot. Its function is to monitor the autopilot circuitry for any steady state or continuous control signals. If such signals are detected, the Auto Trim system adjusts the elevator trim tabs so that the aerodynamic forces generated by the tabs keep the elevators at the required angle. This cancels the elevator hinge moments (statement 1), thereby easing or reducing the loads on the servo-actuators (statement 2). This in turn will ensure that the aircraft is always returned to the pilot in a trimmed condition upon disengagement of the autopilot (statement 3). So option b is true.

AUTOFLIGHT 17 b.

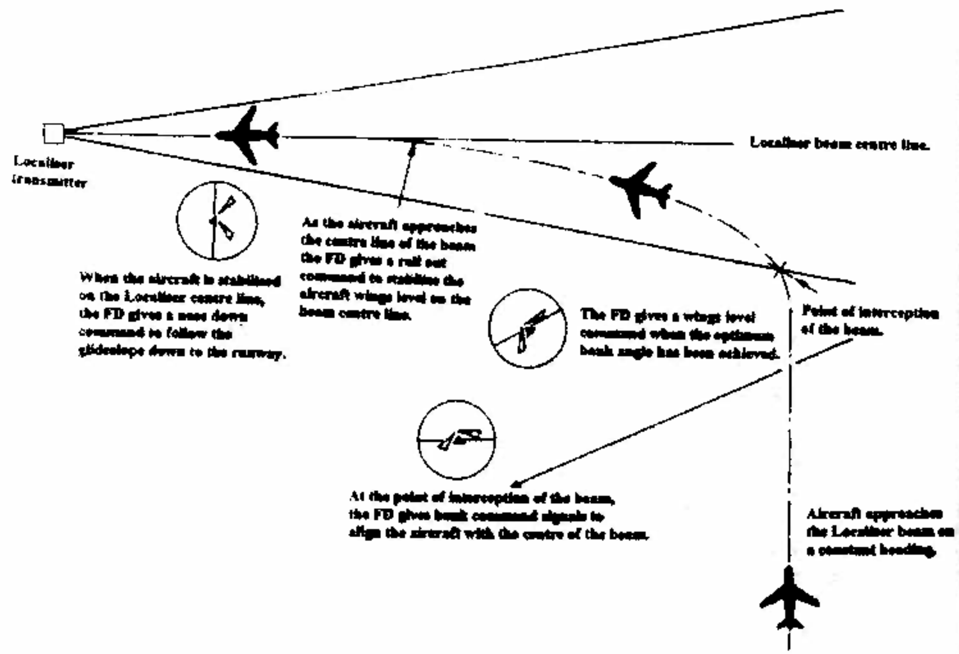
The functions of an autopilot can be broadly divided into two types. The first of these is automatic stabilisation, which includes pitch attitude holding (1), horizontal wing holding (2), and yaw damping (6). The second type might be termed guidance functions which include indicated airspeed or mach number holding (3), altitude holding (4) and VOR axis holding (5). So option b is true.

AUTOFLIGHT 18 b.

The functions of an autopilot can be broadly divided into two types. The first of these is automatic stabilisation, which includes pitch attitude holding (1), horizontal wing holding (2), and yaw damping (5). The second type might be termed guidance functions which include displayed heading or inertial track holding (3), indicated airspeed or mach number holding (4), VOR axis holding (6). So option b is true.

AUTOFLIGHT 19 c.

In order to intercept the Localiser, the aircraft flies on a constant heading until it enters the beam. The aircraft system then captures the beam using what might be described as a radio deviation law. Although this option has been recommended by many ground schools over many years, it is now known that the JAA answer is option c. A typical Localiser interception is illustrated below.



INTERCEPTION OF THE ILS LOCALISER BEAM

AUTOFLIGHT 20 b.

Dutch roll is a cyclic rolling and yawing motion that occurs when the lateral stability of an aircraft is too strong in comparison to its directional stability. When such an aircraft is disturbed in yaw, it immediately rolls away from the resulting sideslip. This causes sideslip in the opposite direction which causes the aircraft to roll in the opposite direction. The overall result of this process is repeated rolling and yawing motion which can become unstable and violent.

The purpose of the Yaw damper is to prevent Dutch Roll. To do this is uses a rate gyro to detect yaw rates. This gyro senses the angular rate of motion about the vertical axis of the aircraft. The signals from this gyro are filtered to eliminate rates that are not associated with Dutch Roll. The Yaw Damper controls the rudder, with the angular rate about the vertical axis as the input signal (option b).

AUTOFLIGHT 21 b.

An automatic landing is one in which the entire landing process from initial approach down to the ground roll is conducted automatically. In Category 3A systems the autopilot is disengaged at the start of the ground roll. In Category 3B systems the autopilot remains in control until the end of the ground roll. So in an automatic landing the autopilot and the auto-throttle of an aircraft are disengaged by the flight crew during or at the end of the ground roll (option b).

AUTOFLIGHT 22 a.

The purpose of the Yaw damper is to prevent Dutch Roll. To do this is uses a rate gyro to detect yaw rates. This gyro senses the angular rate of motion about the vertical axis of the aircraft. The signals from this gyro are filtered to eliminate rates that are not associated with Dutch Roll.

In order to enable the pilot to monitor the operation of the system, the Yaw Damper Indicator supplies the pilot with information regarding the yaw damper action on the rudder (option a). It should be noted that this indicator shows only the rudder deflection produced by the damper and not the total rudder deflection.

AUTOFLIGHT 23 c.

Mach number is equal to TAS/LSS, where TAS is the true airspeed and LSS is the local speed of sound. So if the auto-throttle system is holding a constant mach number it is holding a constant value of TAS/LSS.

LSS is proportional to temperature, so any increase in temperature will cause a corresponding increase the TAS equating to any given mach number. This means that an increase in temperature at constant mach number will cause TAS to increase.

Dynamic pressure is equal to $1/2\rho V^2$

Where ρ is the air density.
V is the true airspeed or TAS.

An increase in air temperature will cause the air to expand, thereby causing its density to decrease. So the combined effects of increasing temperature at constant mach number will be to increase V and decrease the ρ in the dynamic pressure equation $1/2\rho V^2$. The ratio of these changes is such that the overall value of $1/2\rho V^2$ remains unchanged.

Calibrated airspeed CAS is proportional to $1/2\rho V^2$, so if $1/2\rho V^2$ does not change then CAS will not change. So for an aircraft that is steady cruise at flight level 290 with the auto-throttle maintaining a constant Mach number, if the total temperature increases, the calibrated airspeed will remain constant (option c).

AUTOFLIGHT 24 d.
The Mach number or calibrated airspeed can be held constant automatically by two different systems. The first of these is the auto-throttle system, which is able to vary the thrust in order to maintain constant Mach or CAS.

The second system is the autopilot, which is able to vary pitch attitude in order to maintain constant Mach or CAS. The autopilot can also use this method to control to hold constant altitude, or a constant glide path.

Any change in pitch attitude will affect both the airspeed (mach and CAS) and the flight path. So the autopilot cannot be used to maintain constant altitude or constant glide path, and hold constant airspeed simultaneously. So when the autopilot is using pitch changes to hold constant altitude or a constant glide path, the auto-throttle must be used to maintain Mach or CAS. The autopilot can however hold constant Mach or CAS while climbing, provided a constant climb gradient is not also required.

So the calibrated airspeed (CAS) or Mach holding mode is carried out by the autopilot pitch channel in the climb mode at a constant calibrated airspeed (CAS) or Mach number (statement 1) and by the auto-throttles in the altitude or glide path holding mode (statement 4). So option d is correct.

AUTOFLIGHT 25 c.
An automatic landing can be interrupted by the pilot by pushing any one of the two TOGA buttons on the throttle quadrant. When this is done:

a. The auto-throttle reacts immediately upon the pilot action on the TO/GA (Takeoff/Go-around) switch in order to recover the maximum go-around thrust (statement 1).
b. Autopilot monitors the climb and the rotation of the airplane (statement 2).
c. The pilot retracts the landing gear and reduces the flap deflection in order to reduce the drag (statement 5).

So option c is correct.

AUTOFLIGHT 26 d.
Modern autopilot systems provide a range of automatic flight control functions. Using the Localiser and ILS beams for example the autopilot can provide automatic approaches down to any decision height or any other height selected by the pilot. An automatic landing is considered to be one in which:

a. The autopilot maintains the airplane on the ILS beam until the flare (statement 3).
b. The auto-throttle decreases the thrust when the height is approximately 30 ft (statement 4).
c. The flare and the ground roll are performed automatically (statement 5).

So option d is correct.

AUTOFLIGHT 27 a.
Under JAR Regulations An autopilot capable of holding at least altitude and heading mode is compulsory for IFR or night flights with only one pilot (option a).

AUTOFLIGHT 28 a.
Modern auto-throttle systems are able to perform a wide range of functions. These typically include the following:

a. Capture and holding of speeds (statement 1).
b. Capture and holding of Mach number (statement 2).
c. Capture and holding of N1 or EPR (Engine Power Ratio) (statement 4).

It should be noted that the functions below are carried out by the autopilot.

a. Capture and holding of flight angle of attack (statement 3).
b. Capture and holding of flight paths (statement 5).

So option a, is correct.

AUTOFLIGHT 29 b.
The "flight guidance" functions of an autopilot are those relating to vertical, lateral and longitudinal motions of the aircraft. The "basic stabilizing or stability functions" are those relating to the rotations of the aircraft in pitch, roll and yaw. So from a flight mechanics point of view, the "guidance" functions of a transport airplane autopilot consist in monitoring the movements of the centre of gravity in the three dimensions of space (path) (option b).

AUTOFLIGHT 30 c.
The "flight guidance" functions of an autopilot are those relating to vertical, lateral and longitudinal motions of the aircraft. The "basic stabilizing or stability functions" are those relating to the rotations of the aircraft in pitch, roll and yaw. So the functions of an autopilot (basic modes) consist of stabilizing and monitoring the movement around the airplane centre of gravity.

AUTOFLIGHT 31 b.
The term "control wheel steering" refers to the method by which the pilot is able to temporarily takeover control of an aircraft in automatic flight without disengaging the autopilot. This is done by applying pressure to the control yoke. This pressure is converted into error signals, which are then fed into the autopilot in order to change the attitude of the aircraft. When the pressure is released, the response of the autopilot depends upon how the actual conditions compare with those that have previously been selected on the autopilot mode control panel (MCP).

In the Boeing 737 aircraft if the bank angle is within 3 degrees of wings level then the aircraft will roll level. If the bank angle is greater than 3 degrees then the existing bank angle will be maintained and the aircraft will be held in a steady turn. If altitude is within 250 feet of the pre-selected altitude then the aircraft will return to that altitude. If the altitude is more than 250 feet away from the pre-selected altitude then the current altitude will be maintained.

Taking the above facts into account it can be seen that none of the options in this question are truly correct. Students must therefore select the option that appears to be closest to the truth. The JAR answer to this question is option b, but option c is equally true.

AUTOFLIGHT 32 b.
All modern automatic landing systems use the Radio Altimeter to provide height information. So option b is true in this question.

AUTOFLIGHT 33 d.
During the majority of the time that an aircraft spends flying at cruising altitude it is controlled by the autopilot. This relieves the pilots of the task of constantly making minor adjustments to correct for minor deviations from the required flight path.

As a flight progresses, the burning of fuel gradually reduces the mass of the aircraft and causes its Centre of Gravity to move. This movement of the Centre of Gravity necessitates action from the autopilot to prevent changes in attitude and airspeed. If these changes were carried out by the autopilot stabilisation systems alone, it would result in a continuous command signal being sent to the elevator actuators. If the autopilot is then switched off, this will result in a loss of these signals causing the elevators to move abruptly to their neutral position, thereby causing a sudden change of pitch attitude.

The Auto Trim system is part of the autopilot. Its function is to monitor the autopilot circuitry for any steady state or continuous control signals. If such signals are detected, the Auto Trim system adjusts the elevator trim tabs so that the aerodynamic forces generated by the tabs keeps the elevators at the required angle. This relieves the elevator control hinge moments (option d) enabling the control signals to be reduced to zero. This prevents any sudden snatching of the controls whenever the autopilot is switched off.

AUTOFLIGHT 34 b.
The function of an automatic pilot is to reduce pilot workload by providing automatic piloting and guidance when selected by the pilot so options c and d are untrue. The pilot has the ability to switch the autopilot on or off in flight so option a, is not true. The most accurate option in this question is that the autopilot provides piloting and guidance in both the vertical and horizontal planes (option b).

AUTOFLIGHT 35 c.
The purpose of an autopilot is to reduce pilot workload by providing automatic stabilisation and in some cases automatic guidance when selected by the pilot. When a modern autopilot is engaged without selecting any of the command modes, a modern autopilot typically provides automatic stabilization with attitude hold and possibly automatic trim. It should be noted that option a, b and d all include some of the command modes. Although the vertical speed hold part of option c is in fact a command mode, this option remains the closest to the truth (option c).

AUTOFLIGHT 36 a.
If the situation becomes dangerous during an automatic landing the pilot is able to interrupt the process by selecting go-around mode. This is done by pushing one of the Take-Off / Go Around (TOGA) buttons on the throttles (option a)

AUTOFLIGHT 37 c.
The purpose of an autopilot is to detect changes in the flight path of the aircraft and make corrective actions to maintain or achieve a selected condition. To do this it employs various components including the following:

a. Sensors (statement 2).
b. Comparators (statement 3).
c. Computers (statement 4).
d. Amplifiers (statement 5).
e. Servo-actuators (statement 6).

Statement 1, "The airflow valve" is not part of a typical autopilot. So the most accurate option in this question is option c.

AUTOFLIGHT 38 d.
In order to prevent the system from producing dangerous deviations in flight path, autopilot systems include a number of safety interlocks. These prevent the autopilot from becoming engaged when essential services or conditions are not met. These safety interlocks typically include the following:

a. Required DC electrical supplies available.
b. Required AC electrical supplies available.
c. Turn control knob in the central position.
d. Automatic synchronization system is serviceable.
e. Attitude reference units are serviceable.
f. Automatic trim system is serviceable.

Comparing this list with the options in this question shows that option d is the most accurate.

AUTOFLIGHT 39 c.
During the majority of the time that an aircraft spends flying at cruising altitude it is controlled by the autopilot. This relieves the pilots of the task of constantly making minor adjustments to correct for minor deviations from the required flight path.

As a flight progresses, the burning of fuel gradually reduces the mass of the aircraft and causes its Centre of Gravity to move. This movement of the Centre of Gravity necessitates action from the autopilot to prevent changes in attitude and airspeed. If these changes were carried out by the autopilot stabilisation systems alone, it would result in a continuous command signal being sent to the elevator actuators. If the autopilot is then switched off, this will result in a loss of these signals causing the elevators to move abruptly to their neutral position, thereby causing a sudden change of pitch attitude.

The Auto Trim system is part of the autopilot. Its function is to monitor the autopilot circuitry for any steady state or continuous control signals. If such signals are detected, the Auto Trim system adjusts the elevator trim tabs so that the aerodynamic forces generated by the tabs keeps the elevators at the required angle. This relieves the elevator control hinge moments tom zero thereby reducing the loads on the autopilot servo-actuators (statement 1)

This ensures that the aircraft is properly trimmed to prevent any sudden snatching of the controls whenever the autopilot is disengaged (statement 2). By constantly re-trimming the aircraft this system maintains the same stability/manoeuverablity trade-off within the whole flight envelope (statement 3). So option c is correct in this question.

AUTOFLIGHT 40 b.
In order to ensure adequate levels of safety during automatic landings, aircraft must have more than one serviceable autopilot. The level of redundancy available is indicated by specific terms. When an aircraft has two serviceable autopilots each of which is capable of conducting an automatic landing, it is said to be a "Fail Passive" aircraft. This means that if one autopilot fails it will be automatically disconnected and the aircraft will not make dangerous deviations from its flight path. Under these circumstance the automatic landing must be aborted and a manual landing carried out. The term "Fail Soft" is not a standard term but is sometimes used in place of the correct term "Fail Passive".

If an aircraft has three or more serviceable autopilots it is said to be "Fail Operational". The terms "Fail Safe" and "Fail Hard" are not standard autopilot terminology. Option b is therefore the most accurate in this question.

AUTOFLIGHT 41 c.
In order to ensure adequate levels of safety during automatic landings, aircraft must have more than one serviceable autopilot. The level of redundancy available is indicated by specific terms. When an aircraft has two serviceable autopilots each of which is capable of conducting an automatic landing, it is said to be a "Fail

Passive" aircraft. This means that if one autopilot fails it will be automatically disconnected and the aircraft will not make dangerous deviations from its flight path. Under these circumstance the automatic landing must be aborted and a manual landing carried out. The term "Fail Soft" is not a standard term but is sometimes used in place of the correct term "Fail Passive".

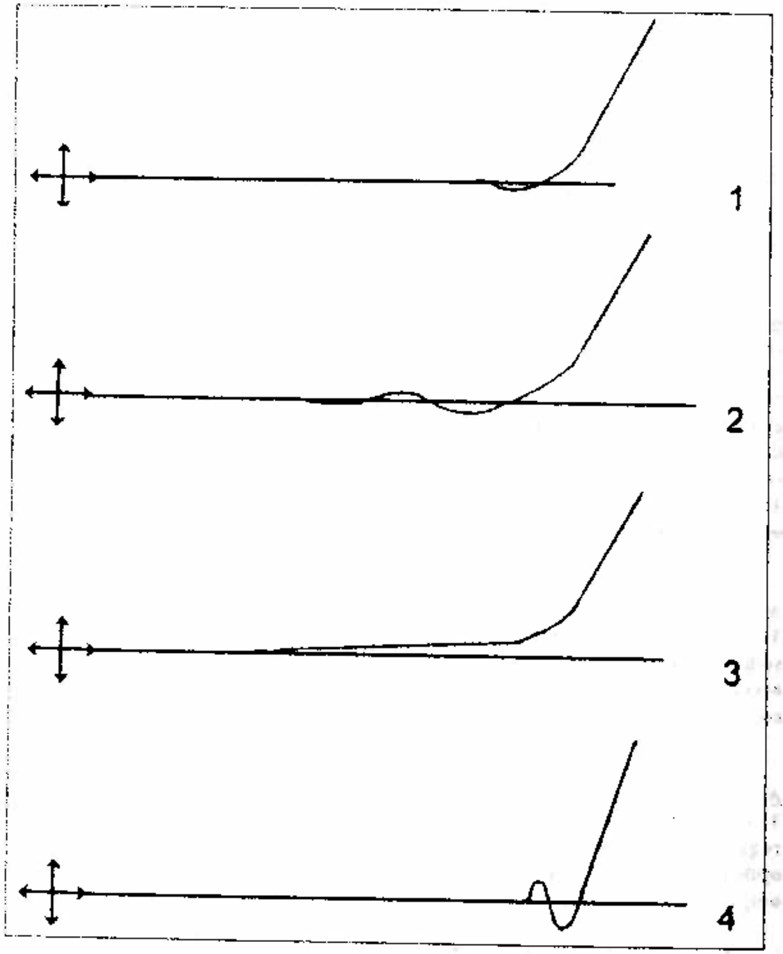
If an aircraft has three or more serviceable autopilots it is said to be "Fail Operational". The terms "Fail Safe" and "Fail Hard" are not standard autopilot terminology. Option c is therefore the most accurate in this question.

AUTOFLIGHT 42 c.
JAR regulations require that all autopilot systems be designed such that their failure cannot endanger the aircraft or its occupants. To achieve this condition, an aircraft with only one autopilot must be designed such that an autopilot failure will cause it to be automatically disconnected without causing dangerous deviates from the flight path. The terms " Fail Survival", "Fail Safe" and " Fail Soft" are not standard autopilot terms so none of the options in this question are strictly correct. The term "Fail Passive" applies only to aircraft with two autopilots, so its use in option d is incorrect. Option c is however the most accurate.

AUTOFLIGHT 43 b.
The most basic functions of an autopilot are those relating to automatic stabilization. Of those listed inn this question statements 1 and 3 are the most accurate. Pressure altitude hold (statement 2) and heading hold "statement 4) are command modes.

AUTOFLIGHT 44 d.
The term "control law" relates to the algorithms used to define the permitted and required relationships between inputs and outputs of the autopilot system. Of the options listed in this question option d, "Computer input deviation data and the output control deflection signals" is the most accurate.

AUTOFLIGHT 45 b.
The optimal path is that which produces oscillations, which are initially small and subside quickly. In figure 1 the very rapid damping would result in large flight loads being imposed on the aircraft and its occupants. In figure 3 there are no oscillations at all. In figure 4 the oscillations are very large, resulting in excessive flight loads. The optimal situation is best illustrated by figure 2 (option b).



AUTOFLIGHT 46 c.
VOR operates by producing radially transmitted radio signals indicating each degree of heading. The term "Cone of confusion" refers to the area directly above a VOR station in which no intelligible signals can be received. When an aircraft operating in VOR coupled mode flies directly over the station it is using, it temporarily loses meaningful heading signals. To overcome this problem the autopilot system will hold its existing heading until intelligible signals are again received (option c).

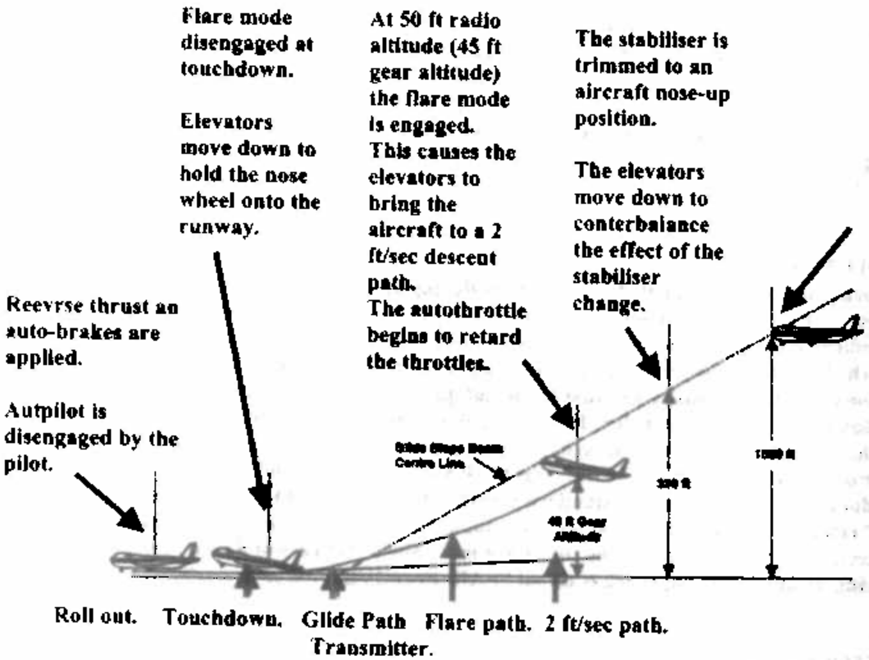
AUTOFLIGHT 47 c.
The point at which a fully automatic landing is completed depends upon the category of landing. Category 3A automatic landings are complete at the start of the ground roll. Category 3B automatic landings are complete at the end of the ground roll. Category 3C automatic landings are complete at the ramp. Of the options listed in this question option c. "During the landing roll and sometimes until the aircraft comes to a complete stop" is the most accurate.

AUTOFLIGHT 48 c.
Strictly speaking the term "Semi automatic landing system" has no official definition or use. The use of the prefix "Semi-automatic" suggests a system that is incapable of carrying out a full automatic landing all the way to touch-down. This eliminates option a. Option b is also improbable in that certain aspects of the go-around are usually executed automatically. Although options c and d could be considered to be equally accurate, it is known that the JAR answer to this question is option c. Option d is probably considered to be inappropriate in that if decision height is greater than 100 ft the system usually needs to be disconnected manually.

AUTOFLIGHT 49 d.
In order to ensure adequate levels of safety during automatic landings, aircraft must have more than one serviceable autopilot. The level of redundancy available is indicated by specific terms. When an aircraft has two serviceable autopilots each of which is capable of conducting an automatic landing, it is said to be a "Fail Passive" aircraft. This means that if one autopilot fails it will be automatically disconnected and the aircraft will not make dangerous deviations from its flight path. Under these circumstance the automatic landing must be aborted and a manual landing carried out. The terms "Fail Safe (option b)" and " Fail Redundant (option c) are not standard terms. The term "Fail Operational (option a) " refers to an aircraft with at least 3 autopilots. So an automatic landing system necessitating that the landing be continued manually in the case of a system failure during an automatic approach is called "FAIL PASSIVE (option d).

AUTOFLIGHT 50 b.
In order to ensure adequate levels of safety during automatic landings, aircraft must have more than one serviceable autopilot. The level of redundancy available is indicated by specific terms. When an aircraft has two serviceable autopilots each of which is capable of conducting an automatic landing, it is said to be a "Fail Passive (option c)" aircraft. This means that if one autopilot fails it will be automatically disconnected and the aircraft will not make dangerous deviations from its flight path. Under these circumstance the automatic landing must be aborted and a manual landing carried out. The terms "Fail Safe (option d)" and " Fail Redundant (option a) are not standard terms. The term "Fail Operational (option b) " refers to an aircraft with at least 3 autopilots. If one autopilot fails the automatic landing can continue under the control of the 2 remaining autopilots. So an automatic landing system which can keep on operating without deterioration of its performances following the failure of one of the autopilots is called "FAIL OPERATIONAL" (option b).

AUTOFLIGHT 51 a.
A typical automatic landing profile is illustrated below. This shows that at approximately 50 ft the flare mode is initiated. During the flare manoeuvre, the autopilot changes pitch attitude to gradually reduce the rate of descent such that the aircraft contacts the ground gently. The autopilot uses radio altimeter height information to enable it to carry out the flare manoeuvre. This means that during an automatic landing, from a height of about 50 ft the autopilot maintains a vertical speed depending on the radio altimeter height (option a).



AUTOFLIGHT 52 d.
During the majority of the time that an aircraft spends flying at cruising altitude it is controlled by the autopilot. This relieves the pilots of the task of constantly making minor adjustments to correct for minor deviations from the required flight path.

As a flight progresses, the burning of fuel gradually reduces the mass of the aircraft and causes its Centre of Gravity to move. This movement of the Centre of Gravity necessitates action from the autopilot to prevent changes in attitude and airspeed. If these changes were carried out by the autopilot stabilisation systems alone, it would result in a continuous command signal being sent to the elevator actuators. When the autopilot is then switched off, this will result in a loss of these signals. This will cause the elevators to move abruptly to their neutral position, thereby causing a sudden change of pitch attitude.

The Auto Trim system is part of the autopilot. Its function is to monitor the autopilot circuitry for any steady state or continuous control signals. If such signals are detected, the Auto Trim system adjusts the elevator trim tabs so that the aerodynamic forces generated by the tabs keeps the elevators at the required angle. This relieves the elevator load enabling the control signals to be reduced to zero. This enables the autopilot to transfer a stabilized aeroplane to the pilot during autopilot disengagement (option d).

AUTOFLIGHT 53 a.
Modern auto-throttle systems carry out a number of functions. These typically include maintaining constant power setting by controlling the low-pressure spool speed N1 (statement 1) or the engine pressure ratio (EPR). Other functions include the holding of constant Indicated Airspeed (IAS) (statement 3) or Mach number. The high-pressure spool speed N2 (statement 2) is not directly related to thrust so it is not controlled by the auto-throttle. Although the auto-throttle is usually used in conjunction with the autopilot, they are in fact separate systems, which can be used independently of each other. Statement 4 is therefore untrue. So statements 1 and 3 are correct (option a).

AUTOFLIGHT 54 b.
Adjusting the elevator positions will vary both the altitude and airspeed. It is therefore possible to control either of these variables using the autopilot to vary elevator position. If for example the elevators are raised to increase altitude, the airspeed will decrease. If the elevators are lowered to restore speed, the altitude will decrease. This means that it is not possible to use the elevator to hold both altitude and speed simultaneously.

When it is necessary to provide automatic simultaneous control of both altitude and airspeed modern aircraft use a combination of autopilot and auto-throttle. When the altitude acquisition mode is engaged on a jet transport airplane equipped with autopilot (AP) and auto-throttle (ATS) systems the Indicated airspeed (IAS) is maintained constant by the auto-throttle system (option b).

AUTOFLIGHT 55 a.
Whenever the autopilot engagement is selected, the autopilot servomotors take control of the flying control surfaces. Whenever autopilot disengagement is selected, the autopilot servomotors release their control of the flying control surfaces. Unless the autopilot servomotors and control surfaces are at the same setting when engagement occurs the control surfaces will be snatched to a position that matches the servomotor positions. This snatching of the controls will cause sudden and potentially violent changes in the aircraft flight path.

Modern autopilot systems include a synchronization system whereby the servomotors and control surfaces are constantly matched and synchronized.

During periods of flight when the autopilot is in the disengaged condition the servomotors follow the actions of the flying control surfaces. In this way the autopilot synchronization system prevents jerks during engagement of the autopilot (statement 3). In order to ensure maximum effectiveness the synchronization system functions in all modes including the heading, navigation, and approach modes (statement 4). It should be noted that jerks on disengagement are prevented by the atuo-trim system. So statements 3 and 4 are correct (option a).

AUTOFLIGHT 56 a.

Although the wording of this question is rather ambiguous, the options imply that it is concerned with the heading select autopilot mode. When this mode is used to select a new heading, the autopilot banks the aircraft such that it turns onto the newly selected heading. The bank angle used is proportional to the difference between the existing heading and the newly selected heading. In order to avoid the use of excessively large bank angles, the pilot first selects the maximum bank angle that he or she wishes the autopilot to use. So in a selected axis capture mode, the autopilot gives a bank attitude input proportional to the deviation between the selected heading and the current heading but not exceeding a given value (option a).

AUTOFLIGHT 57 b.

The term "control laws" refers to the algorithms that the autopilot uses when converting input error signals into output control signals to fly the aircraft. On the longitudinal axis, the control laws may combine the load factor and the changes in the pitch rate as control data sources (statement 1) in order to ensure that the aircraft is not subjected to excessive stresses. The trimming is automatic and ensures stability (statement 2) by preventing snatching of the controls on disengagement of the autopilot. In order to prevent stalling and over-stressing of the aircraft the protections apply to pitch and bank attitudes depending on the speed (statement 3). In order to ensure safety at all times these laws apply to the whole flight envelope, so statement 4 is untrue. The correct option in this question is therefore option b.

AUTOFLIGHT 58 d.

This is a curious question in that the functions of an autopilot system vary with aircraft type. In the case of the Boeing 737 aircraft, adjustment of the altimeter subscale will not cause a change of altitude until the next occasion on which a new altitude is selected. This is to enable the pilot to select the new pressure setting prior to the start of the descent to land, without causing immediate changes in the aircraft flight level.

None of the options match this situation exactly, but it is known that the JAA answer to this question is option d. It should however be noted that this option is not entirely accurate because autopilots do not "take their pressure information from the static source". If this were the case, then the altitude actually held would not match that indicated on the altimeters except in ISA conditions.

AUTOFLIGHT 59 c.

Whenever the autopilot engagement is selected, the autopilot servomotors take control of the flying control surfaces. Whenever autopilot disengagement is selected, the autopilot servomotors release their control of the flying control surfaces. Unless the autopilot servomotors and control surfaces are at the same setting when engagement occurs the control surfaces will be snatched to a position that matches the servomotor positions. This snatching of the controls will cause sudden and potentially violent changes in the aircraft flight path.

Modern autopilot systems include a synchronization system whereby the servomotors and control surfaces are constantly matched and synchronized. During periods of flight when the autopilot is in the disengaged condition the servomotors follow the actions of the flying control surfaces. In this way the autopilot synchronization system prevents jerks during engagement of the autopilot. In order to ensure maximum safety, modern autopilots include a system of safety interlocks, which prevent engagement when essential inputs and functions are not available. These safety interlocks usually include a test of the synchronisation system. So in an autopilot slaved powered control circuit, the system that ensures synchronization can itself, when it fails, prevent the automatic pilot from being engaged (option c).

AUTOFLIGHT 60 b.

The range of functions provided by an autopilot varies with aircraft type. But most modern autopilot systems inn large transport aircraft provide at least the following:

a. Vertical speed (statement 1).
b. Altitude (statement 2).
c. Heading (statement 5)

The holding of Attitude (statement 3) and bank angle (statement 4) are part of the stabilisation functions. So option b is the most accurate in this question.

AUTOFLIGHT 61 d.

During the majority of the time that an aircraft spends flying at cruising altitude it is controlled by the autopilot. This relieves the pilots of the task of constantly making minor adjustments to correct for minor deviations from the required flight path.

As a flight progresses, the burning of fuel gradually reduces the mass of the aircraft and causes its Centre of Gravity to move. This movement of the Centre of Gravity necessitates action from the autopilot to prevent changes in attitude and airspeed. If these changes were carried out by the autopilot stabilisation systems alone, it would result in a continuous command signal being sent to the elevator actuators. When the autopilot is then switched off, this will result in a loss of these signals. This will cause the elevators to move abruptly to their neutral position, thereby causing a sudden change of pitch attitude.

The Auto Trim system is part of the autopilot. Its function is to monitor the autopilot circuitry for any steady state or continuous control signals. If such signals are detected, the Auto Trim system adjusts the elevator trim tabs so that the aerodynamic forces generated by the tabs keeps the elevators at the required angle. This relieves the elevator load enabling the control signals to be reduced to zero. This in turn ensures that the aircraft is in a trimmed condition when passed handed over to the pilot at autopilot disconnection (option d). It should be noted that option a, is untrue because there are no forces on the control column in atomatic flight.

AUTOFLIGHT 62. b.
A typical automatic landing sequence using a triple redundant autopilot system is as follows:

a. RADALT becomes operational at 2500 ft.
b. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).
c. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.
d. At 330 ft radio height the horizontal stabiliser is automatically set to an aircraft nose-up trim position to prepare the aircraft for the flare. This action is counterbalanced by a downward deflection of the elevators, so that the aircraft attitude remains unchanged.
e. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, increasing nose up pitch attitude thereby bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles.
f. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.
g. At about 1 ft the pitch attitude is reduced to 2 degrees.
h. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.
i. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.

So the glideslope signal is automatically disconnecetd at 50 ft agl (option b).

AUTOFLIGHT 63. b.
A typical autoland sequence is described in AUTOFLIGHT 62. The autoland is considered to have been completed and the autopilot disconnected at the roll-out.

AUTOFLIGHT 64. d.
In order to achieve the required levels of safety, autopilot systems employ extensive self test systems. These prevent engagement when various components and systems are defective.

1. Attitude reference unit failure, because attitude information is essential for all autopilot functions.
2. Synchronisation error, because engagement of the autopilot without ensuring that it synchronised with the current flying control positions, will cause violent attitude changes, due to snatching of the controls.
3. Electrical supply failure, because the autopilot cannot function without an appropriate electrical supply.
4. Turn control knob not at centre off position, because engagement in this condition would cause a violent yawing motion.

Although the autopilot employs barometric altitude signals, engagement with incorrect QFE set (5) would not cause any sudden attitude or altitude changes, so this condition would not prevent engagement.

AUTOFLIGHT 65. b.
The principal differences between Cat 2 and Cat 3 autoland are the minimum authorised decision heights and the level of capability of the equipment required. In both cases, height information is provided by the radio altimeter.

AUTOFLIGHT 66. d.
The standard autopilot failure conditions are as follows:

FAIL PASSIVE
There is no significant out of trim condition or deviation of flight path or altitude following failure, but the landing is not completed automatically. The pilot must therefore be made aware of a fail passive situation so that he can take manual control of the aircraft. A fail passive system requires two independent autopilot channels and a monitoring system to ensure that any discrepancies between the two remain within acceptable limits.

FAIL OPERATIONAL
In the event of a failure below alert height during an automatic landing, the approach, flare and landing can be completed automatically by the remaining part of the system. This requires at least three independent channels, all of which are engaged during automatic landings. The number of channels engaged is indicated on the EFIS display as a caption. "LAND 3" indicates three channels operating, "LAND 2" indicates two channels operating, and "LAND 1" indicates only one channel operating.

AUTOFLIGHT 67. b.
The standard autopilot failure conditions are as follows:

FAIL PASSIVE
There is no significant out of trim condition or deviation of flight path or altitude following failure, but the landing is not completed automatically. The pilot must therefore be made aware of a fail passive situation so that he can take manual

control of the aircraft. A fail passive system requires two independent autopilot channels and a monitoring system to ensure that any discrepancies between the two remain within acceptable limits.

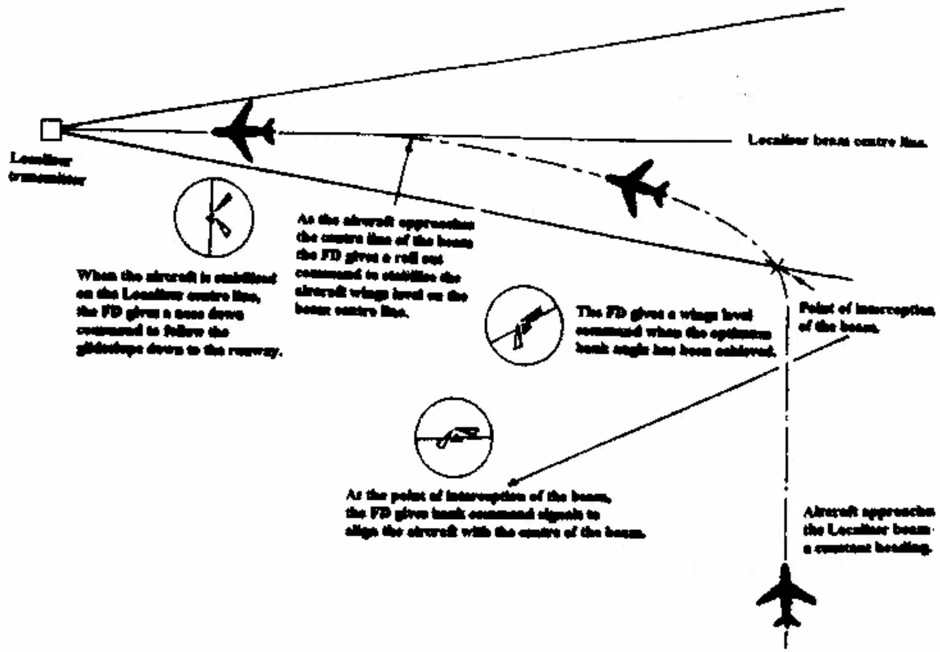
FAIL OPERATIONAL
In the event of a failure below alert height during an automatic landing, the approach, flare and landing can be completed automatically by the remaining part of the system. This requires at least three independent channels, all of which are engaged during automatic landings. The number of channels engaged is indicated on the EFIS display as a caption. "LAND 3" indicates three channels operating, "LAND 2" indicates two channels operating, and "LAND 1" indicates only one channel operating.

AUTOFLIGHT 68. c.
JAR OPS 1.655 specifies that the minimum standard of autopilot required for IFR or night operations by a single pilot are a system providing heading hold and altitude hold.

AUTOFLIGHT 69. a.
The cone of confusion is the area immediately above a VOR beacon, in which it is not possible to obtain an unambiguous signal. To overcome this problem autopilot VOR tracking systems hold a constant heading until intelligible signals are regained (option a).

AUTOFLIGHT 70. b.
The purpose of the yaw damper system is to prevent Dutch roll by enhancing the directional stability of an aircraft. It does this by moving the rudder in proportional to signals from a yaw rate gyro which senses yaw rate. Most yaw damper systems include an indicator showing the degree to which the rudder has been moved by the damper (option b), and a failure warning light.

AUTOFLIGHT 71. c.
In order to intercept the Localiser, the aircraft flies on a constant heading until it enters the beam. The aircraft system then captures the beam using what might be described as a radio deviation law. Although this option has been recommended by many ground schools over many years, it is now known that the JAA answer is option c. A typical Localiser interception is illustrated below.



INTERCEPTION OF THE ILS LOCALISER BEAM

AUTOFLIGHT 72. c.
The purpose of the yaw damper system is to prevent Dutch roll by enhancing the directional stability of an aircraft. It does this by moving the rudder in proportional to signals from a yaw rate gyro which senses yaw rate (option c).

AUTOFLIGHT 73. c.
A typical automatic landing sequence using a triple redundant autopilot system is as follows:

I. RADALT becomes operational at 2500 ft.
II. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).
III. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.
IV At 330 ft radio height the horizontal stabiliser is automatically set to an aircraft nose-up trim position to prepare the aircraft for the flare. This

the aircraft attitude remains unchanged.

V. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles to match reduced thrust requirement in the flare.

VI. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.

VII. At about 1 ft the pitch attitude is reduced to 2 degrees.

VIII. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.

IX. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.

So in an automatic landing the autopilot and the auto-throttle together control the aircraft until at least the roll out (option c).

AUTOFLIGHT 74. c.

Whenever an aircraft flying on autopilot deviates from its selected condition, the autopilot must provide corrective control inputs to return it to that condition. If the magnitudes of these control inputs were constant, the aircraft would tend to overshoot beyond the desired condition, thereby requiring the autopilot inputs to be reversed. This would lead to a constant oscillation about the selected condition.

To overcome this problem it is necessary that the autopilot control inputs be proportional to the degree of deviation. When the aircraft condition is very different from that required, the control inputs must be quite large. But as the aircraft approaches the desired condition, the control inputs must be gradually reduced to prevent overshooting and oscillation. So in the case of heading hold, the aileron control inputs provided by the autopilot must be proportional to the difference between the selected heading and the actual heading (option c). In some system the magnitude of the control inputs is also proportional to IAS but this is to prevent overstressing of the structure rather than to avoid overshooting the desired condition.

AUTOFLIGHT 75. b.

In order to achieve the required levels of safety, autopilot systems employ extensive self test systems. These prevent engagement when various components and systems are defective. Typical examples of faults that would prevent engagement are listed below.

i. Attitude reference unit failure, because attitude information is essential for all autopilot functions.

ii. Synchronisation error, because engagement of the autopilot without ensuring that it synchronised with the current flying control positions, will cause violent attitude changes, due to snatching of the controls.

iii. Electrical supply failure, because the autopilot cannot function without an appropriate electrical supply.

iv. Turn control knob not at centre off position, because engagement in this condition would cause a violent yawing motion.

So statements 1 and 3 are correct (option b).

AUTOFLIGHT 76. a.

In conventional flying control systems, the control inputs from the pilots control levers are transmitted through a system of push-pull rods and steel cables to the flying control surfaces. In powered flying control systems the same processes are used, but the control inputs are fed to the selector valves of hydraulic actuators attached to the control surfaces.

In fly-by-wire systems, the pilots control levers produce digital or analogue electrical signals that are proportional to the degree of lever deflection. These electrical signals are then fed to computers, which determine how the pilot input demands are translated into control surface movement (option a). Electrical outputs from the computers are then fed to the hydraulic actuators.

AUTOFLIGHT 77. c.

In conventional powered flying control systems the inputs from the pilots control levers are transmitted through push-pull rods and steel cables, to the selector valves of hydraulic servomechanisms, attached to the flying control surfaces. In fly-by-wire systems, the pilots control levers produce digital or analogue electrical signals that are proportional to the degree of lever deflection. These signals are then fed via computers, to the servomechanism selector valves.

These input signals are typically quite small. The purpose of the servomechanisms is to vary the force applied and range of movement, in proportion to the magnitude of the input signal (option c). Autostab modules (a), amplifiers (b) and negative feedback loops (d) are all component parts of the systems by which the control signals are processed before being passed to the servomechanism. This question is however somewhat ambiguous in that all amplifiers, regardless of the type of system in which they are fitted, take in small input signals and produce larger outputs in a proportionate manner.

AUTOFLIGHT 78. d.

As a flight progresses, the consumption of fuel gradually causes the C of G of an aircraft to move. This in turn alters the flying control positions necessary to maintain the aircraft trimmed in any given flight condition. Changes in airspeed also alter the control positions required to trim the aircraft. In manually controlled flight the pilot adjusts the trim tabs or horizontal stabiliser so that the loads on the control levers are reduced to zero.

Modern autopilots employ a system of automatic trim or auto-trim, whereby the trimming process is carried out without the need for pilot intervention. The system continuously monitors the flying control positions necessary to maintain the selected flight condition. Whenever a continuous control deflection is detected, the autopilot adjusts the trim of the aircraft, thereby reduicng control hinge moments to zero (statement 5). If the auto-trim system becomes defective the flying controls will remain deflected to maintain the desired flight condition. If the autopilot is then disengaged the flying controls will suddenly return to neutral. In extreme cases this snatching of the controls will cause the aircraft to manoeuvre violently. The auto-trim system therefore prevents snatching of the flying controls when the autopilot is disengaged (2). Modern autopilot systems often include safety interlocks, which prevent engagement of the autopilot if the auto-trim system is defective (3). So statemens 2, 3, and 5 are correct (option d).

AUTOFLIGHT 79. b.

A typical automatic landing sequence using a triple redundant autopilot system is as follows:

a. RADALT becomes operational at 2500 ft.
b. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).
c. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.
d. At 330 ft radio height the horizontal stabiliser is automatically set for to a nose up trim position with elevators providing pitch control.
e. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles to match reduced thrust requirement in the flare.
f. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.
g. At about 1 ft the pitch attitude is reduced to 2 degrees.
h. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.
i. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.

Although "semi-automatic landing" is not a standard term, it is frequently used in JAR examinations. It should be taken to mean is taken to mean one in which the autopilot controls the aircraft down to decision height (option b).

AUTOFLIGHT 80. b.

A typical automatic landing sequence using a triple redundant autopilot system is as follows:

a. RADALT becomes operational at 2500 ft.
b. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).

c. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.
d. At 330 ft radio height the horizontal stabiliser is automatically set for to a nose up trim position with elevators providing pitch control.
e. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles to match reduced thrust requirement in the flare.
f. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.
g. At about 1 ft the pitch attitude is reduced to 2 degrees.
h. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.
i. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.

So at 50 ft agl the glideslope disconnects and the airraft falres (option b).

AUTOFLIGHT 81. c.

The sequence of events in a typical autoland procedure is detailed in AUTOFLT 62. The autoland is complete when the roll out starts for Category 3A systems (option c) and when the ground roll ends for Category 3B systems.

AUTOFLIGHT 82. b.

When a subsonic aircraft exceeds its critical mach number M_{CRIT}, the sudden rearward movement of its C of P causes it to enter an unstable violent dive, termed mach tuck under. The purpose of the mach trim system is to prevent mach tuck under by automatically adjusting the trim of the aircraft. M_{CRIT} is typically just less than mach 1, which for subsonic aircraft constitutes a high mach number. So the mach trim system prevents tuck under at high mach numbers (option b).

AUTOLFLIGHT 83. c.

Deflection of an aircraft's flying control surfaces in flight, whether manually or by the autopilot, causes the aircraft to rotate about its centre of gravity (option c).

AUTOFLIGHT 84. a.

Although it would be most unusual to operate an autopilot in this condition, it would provide automatic stabilisation and in some cases autotrim (a). It would not however provide constant altitude, VNAV, LNAV or height hold, because these are selectable modes.

AUTOFLIGHT 85. c.
Pushing of the take-off and go-around (TOGA) button initiates the following sequence:

- I. The auto-throttle increases power to go-around setting (2).
- II. The autopilot pitches the aircraft into a 15° nose up attitude.
- III. The autopilot climbs the aircraft at a preset rate of climb, whilst maintaining existing heading (5).
- IV. Other autopilot modes may then be selected when above 400 ft agl.

So statements 2 and 5 are correct (option c).

AUTOFLIGHT 86. b.
A typical automatic landing sequence using a triple redundant autopilot system is as follows:

- i. RADALT becomes operational at 2500 ft.
- ii. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).
- iii. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.
- iv. At 330 ft radio height the horizontal stabiliser is automatically set for to a nose up trim position with elevators providing pitch control.
- v. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles to match reduced thrust requirement in the flare.
- vi. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.
- vii. At about 1 ft the pitch attitude is reduced to 2 degrees.
- viii. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.
- ix. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.
- x. For Category 3A systems the autoland is complete at the start of the ground roll. For Category 3B systems the autoland is complete at the end of the ground roll.

So option b, (1, 2) is correct.

AUTOFLIGHT 87. c.
A typical autoland procedure is detailed in AUTOFLIGHT 86. For Category 3A systems the autoland is complete at the start of the groound roll (option c). For Category 3B systems the autoland is complete at the end of the ground roll (option b).

AUTOFLIGHT 88. c.
Pushing of the take-off and go-around (TOGA) button initiates the following sequence:

- I. Auto-throttle increase power to go-around setting (2).
- II. Autopilot pitches aircraft into a 15° nose up attitude.
- III. Autopilot climbs the aircraft at a preset rate of climb, whilst maintaining existing heading (5).
- IV. Other autopilot modes may then be selected when above 400 ft agl.

So statements 2 and 5 are true (option c).

AUTOFLIGHT 89. b.
The parameters controlled by the auto-throttle and those controlled by the autopilot depend upon flight condition. In straight and level cruise flight, the auto-throttle holds the speed, while the autopilot holds the height.

AUTOFLIGHT 90. b.
The standard autopilot failure conditions are as follows:

FAIL PASSIVE
There is no significant out of trim condition or deviation of flight path or altitude following failure, but the landing is not completed automatically (option b). The pilot must therefore be made aware of a fail passive situation so that he can take manual control of the aircraft. A fail passive system requires two independent autopilot channels and a monitoring system to ensure that any discrepancies between the two remain within acceptable limits.

FAIL OPERATIONAL
In the event of a failure below alert height during an automatic landing, the approach, flare and landing can be completed automatically by the remaining part of the system. This requires at least three independent channels, all of which are engaged during automatic landings. The number of channels engaged is indicated on the EFIS display as a caption. "LAND 3" indicates three channels operating, "LAND 2" indicates two channels operating, and "LAND 1" indicates only one channel operating.

AUTOFLIGHT 91. b.
JAR OPS 1.655 specifies that the minimum standard of autopilot required for IFR or night operations by a single pilot are a system providing heading hold and altitude hold.

AUTOFLIGHT 92. c.
Auto-throttle modes constitute primary flight information, they are therefore displayed on the EFIS primary flight display PFD.

AUTOFLIGHT 93. a.
When in altitude hold mode, in the Boeing 737 (one of the aircraft on which the JAR syllabus is based) the left autopilot system uses the captain's altimeter and the right autopilot uses the first officer's altimeter, to provide the necessary altitude signals. But regardless of which altimeter is being used, adjustment of the sub-scale after the altitude hold has been engaged will not affect the operation of the system. The new sub-scale setting will however take effect the next time a new altitude is selected.

AUTOFLIGHT 94. c.
In order to stabilise the aircraft in any given flight condition, the autopilot must respond to deviations by returning the aircraft to its original condition, without causing it to overshoot and oscillate about the desired condition. To achieve this the control inputs at any point in time, must be proportional to the degree of deviation at that time (statement 2). But inertia of the aircraft is proportional to its rate of motion, so if for example the aircraft is yawing at a high rate, a large aileron deflection will be required to arrest this yaw rate before the deviation becomes very large. The autopilot must therefore provide control inputs that are proportional to both the rate of deviation (3) and the degree of deviation from the desired attitude.

So statements 2 and 3 are true (option c).

AUTOFLIGHT 95. b.
The purpose of the yaw damper is to prevent Dutch role by artificially enhancing the directional stability of the aircraft. To do this it employs a yaw rate gyro, and moves the rudder in proportion to yaw rate (option b).

AUTOFLIGHT 96. a.
JAR OPS 25.1329 requires that all autopilots:

a. Can be quickly and positively disengaged by the pilots to prevent it interfering with their control of the aircraft.
b. Provide quick release (emergency) controls on both control wheels, on the side of each wheel opposite to the throttles.
c. Must be designed such that it cannot produce hazardous loads on the aircraft, or create hazardous deviations in flight path.
d. Provide protection against adverse interactions between the autopilot and any system integrated with it, resulting from a malfunction.

The above regulations do not explicitly state that the autopilot must disengage automatically in the event of its failure, so option a is not entirely true. The above requirements do however mean that the system cannot run away upon failure, so option b is untrue. The question specifies only a single autopilot, so the redundancy referred to in option c is also untrue. The term "fail operational"(d), refers only to an auotland system, which employs at least three autopilot. The term "fail soft" (b) is only applicable to automatic landing systems with at least 2 autopilots. The term "fail safe"(a) might reasonably be taken to mean compliance with III above, and although not strictly necessary to satisfy regulations, most autopilots do disengage automatically in most failure situations. Option a is therefore the most appropriate, for this question.

AUTOFLIGHT 97. d
Auto-throttle mode selected constitute primary flight information. They are therefore usually displayed on the EFIS primary flight display (EFIS PFD) (option d).

AUTOFLIGHT 98. d.
A typical automatic landing sequence using a triple redundant autopilot system is as follows:

a. RADALT becomes operational at 2500 ft.
b. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).
c. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.
d. At 330 ft radio height the horizontal stabiliser is automatically set for to a nose up trim position with elevators providing pitch control.
e. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles to match reduced thrust requirement in the flare.
f. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.
g. At about 1 ft the pitch attitude is reduced to 2 degrees.
h. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.
i. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.

So the flare is initiated at 50 ft agl (option d).

AUTOFLIGHT 99. b.
Auto-throttle modes selected constitute primary flight information. They are therefore usually displayed on the EFIS primary flight display (EFIS PFD).

AUTOFLIGHT 100. d.
A typical automatic landing sequence using a triple redundant autopilot system is as follows:

a. RADALT becomes operational at 2500 ft.

b. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).

c. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.

d. At 330 ft radio height the horizontal stabiliser is automatically set for to a nose up trim position with elevators providing pitch control.

e. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles to match reduced thrust requirement in the flare.

f. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.

g. At about 1 ft the pitch attitude is reduced to 2 degrees.

h. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.

i. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.

Although "semi-automatic landing" is not a standard term, it is frequently used in JAR examinations. It should be taken to mean one in which the autopilot controls the aircraft down to decision height (option d).

AUTOFLIGHT 101. b.

JAR OPS 1.655 specifies that the minimum standard of autopilot facility for single pilot flight at night of in IFR conditions is a two axis system providing both altitude hold and heading hold.

AUTOFLIGHT 102. c

JAR OPS 1.655 specifies that the minimum acceptable standard of autopilot facility for single pilot flight at night or in IFR conditions is a two axis system capable of holding both heading and altitude.

AUTOFLIGHT 103. b.

The caption "LOC ARMED" means that the localiser is armed and ready for capture of the localiser beam. The arming of the localiser is typically achieved by pushing the "APR" switch on the flight control panel at a specified stage of the approach.

AUTOFLIGHT 104. b.

A typical automatic landing sequence using a triple redundant autopilot system is as follows:

I. RADALT becomes operational at 2500 ft.

II. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).

III. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.

IV. At 330 ft radio height the horizontal stabiliser is automatically set for to a nose up trim position with elevators providing pitch control.

V. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles to match reduced thrust requirement in the flare.

VI. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.

VII. At about 1 ft the pitch attitude is reduced to 2 degrees.

VIII. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.

IX. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.

So stateemnts 1 and 3 are true (option b).

AUTOFLIGHT 105. b.

As a flight progresses, the consumption of fuel gradually causes the C of G of an aircraft to move. This in turn alters the flying control positions necessary to maintain the aircraft trimmed in any given flight condition. Changes in airspeed also alter the control positions required to trim the aircraft. In manually controlled flight the pilot adjusts the trim tabs or horizontal stabiliser so that the loads on the control levers are reduced to zero.

Modern autopilots employ a system of automatic trim or auto-trim, whereby the trimming process is carried out without the need for pilot intervention. The system continuously monitors the flying control positions necessary to maintain the selected flight condition. Whenever a continuous control deflection is detected, the autopilot adjusts the trim tabs, thereby reducing the loads on the autopilot actuators to zero. If the auto-trim system becomes defective the autopilot actuators will be subjected to a continuous load to maintain the desired flight condition. If the autopilot is then disengaged the flying controls will suddenly return to neutral. In extreme cases this snatching of the controls will cause the aircraft to manoeuvre violently. The auto-trim system therefore prevents snatching of the flying controls when the autopilot is disengaged (b). Modern autopilot systems often include safety interlocks, which prevent engagement of the autopilot if the auto-trim system is defective.

A similar process termed synchronisation, prevents snatching on engagement of the autopilot (a) by ensuring that the autopilot and control surfaces are synchronised in non-automatic flight. System runaway (c) is prevented by feedback loops and slipping clutches. Mach tuck under (d) is prevented by the mach trim system.

AUTOFLIGHT 106. a.
JAR OPS 25.1329 requires that all autopilots:

I. Can be quickly and positively disengaged by the pilots to prevent it interfering with their control of the aircraft.
II. Provide quick release (emergency) controls on both control wheels, on the side of each wheel opposite to the throttles.
III. Must be designed such that it cannot produce hazardous loads on the aircraft, or create hazardous deviations in flight path.
IV. Provide protection against adverse interactions between the autopilot and any system integrated with it, resulting from a malfunction.

The above requirements mean that the system cannot run away upon failure, so option b is untrue. The questions specifies only a single autopilot, so the redundancy referred to in option c is also untrue. The term "fail soft" (d) is only applicable to automatic landing systems with 2 autopilots. The term "fail safe" (a) might reasonably be taken to mean compliance with requirements III and IV above, and the majority of autopilot systems will disconnect automatically in most failure situations. So option a is the most appropriate in this question.

AUTOFLIGHT 107. c.
The auto-throttle system in most large aircraft is capable of holding mach number (1), IAS (2), and N1 or EPR (4). But altitude hold (3), VOR tracking (5) and vertical speed hold (6) are all autopilot functions. It should however be noted that the auto-throttle and autopilot frequently operate in unison. When in the vertical speed hold mode for example, the autopilot maintains constant vertical speed (rate of climb or descent) by varying pitch attitude, while the auto-throttle maintains constant IAS by varying thrust.

AUTOFLIGHT 108. b.
As a flight progresses, the consumption of fuel gradually causes the C of G of an aircraft to move. This in turn alters the flying control positions necessary to maintain the aircraft trimmed in any given flight condition. Changes in airspeed also alter the control positions required to trim the aircraft. In manually controlled flight the pilot adjusts the trim tabs or horizontal stabiliser so that the loads on the control levers are reduced to zero.

Modern autopilots employ a system of automatic trim or auto-trim, whereby the trimming process is carried out without the need for pilot intervention. The system continuously monitors the flying control positions necessary to maintain the selected flight condition. Whenever a continuous control deflection is detected, the autopilot adjusts the trim tabs, thereby reducing the control hinge moments to zero (option b). This in turn reduces the loads on the autopilot servos to zero (option c). This means that two of the options in this question appear to be true. It should however be noted that the auto-trim operates continuously so the option c is incorrect in that it implis that the load reduction occurs only prior to handover to the pilot.

AUTOFLIGHT 109. a.
In order to ensure that the aircraft settles quickly in any given flight condition without excessive oscillations about it, the autopilot control inputs must be proportional to the magnitude of the error between the actual conditions and the selected conditions (1). But it is also necessary to ensure that the autopilot does not cause excessive bank angles. So the autopilot control signals are also limited such that bank angles remain within preset limits (2). In the case of the Boeing 737 aircraft, these limits are selected by the pilot using the autopilot mode control panel. So statements 1 and 2 are true (option a).

AUTOFLIGHT 110. a.
The most basic functions are those of the inner loop automatic stabilisation. These include pitch hold, yaw hold and wings level hold. The most basic of these is to keep the wings level.

AUTOFLIGHT 111. d.
As a flight progresses, the consumption of fuel gradually causes the C of G of an aircraft to move. This in turn alters the flying control positions necessary to maintain the aircraft trimmed in any given flight condition. Changes in airspeed also alter the control positions required to trim the aircraft. In manually controlled flight the pilot adjusts the trim tabs or horizontal stabiliser so that the loads on the control levers are reduced to zero.

Modern autopilots employ a system of automatic trim or auto-trim, whereby the trimming process is carried out without the need for pilot intervention. The system continuously monitors the flying control positions necessary to maintain the selected flight condition. Whenever a continuous control deflection is detected, the autopilot adjusts the trim tabs, thereby reducing the loads on the autopilot actuatots to zero. If the auto-trim system becomes defective the autopilot actuators will remain loaded to keep the controls deflected and maintain the desired flight condition. If the autopilot is then disengaged the forces necessary to maintain the controls in their deflected positions will suddenly be transferred to the pilots control levers. This is likely to cause the controls to suddenly return to neutral before the pilot can take the load. In extreme cases this snatching of the controls will cause the aircraft to manoeuvre violently.

The auto-trim system prevents snatching of the flying controls when the autopilot is disengaged, by reducing the control forces on the autopilot actuators, so that these forces are not transferred to the pilots control levers on disengagement (3). Modern systems include safety interlocks which prevent autopilot engagement if when auto-trim is defective (4). So statements 3 and 4 are true (option d).

AUTOFLIGHT 112. a.
The take-off and go-around (TOGA) are located on or close to the throttle levers Option a). The TOGA buttons may be pushed at any time during an automatic landing to initiate the following sequence:

a. Auto-throttle increase power to go-around setting.
b. Autopilot pitches aircraft into a 15° nose up attitude.
c. Autopilot climbs the aircraft at a preset rate of climb, whilst maintaining existing heading.
d. Other autopilot modes may then be selected when above 400 ft agl.

AUTOFLIGHT 113. b.

An automatic go-around is initiated by pushing one of the take-off and go-around (TOGA) buttons. This selects the following sequence:

i. Auto-throttle increase power to go-around setting (4).
ii. Autopilot pitches aircraft into a 15° nose up attitude causing it to climb away from the ground (2).
iii. Autopilot climbs the aircraft at a preset rate of climb, whilst maintaining existing heading (5).
iv. Other autopilot modes may then be selected when above 400 ft agl.
v. Retraction of landing gear and flaps must be selected manually.

So statements 2, 4 and 5 are true (option b).

AUTOFLIGHT 114. a.

A typical automatic landing sequence using a triple redundant autopilot system is as follows:

I. RADALT becomes operational at 2500 ft.
II. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).
III. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.
IV. At 330 ft radio height the horizontal stabiliser is automatically set for to a nose up trim position with elevators providing pitch control.
V. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles to match reduced thrust requirement in the flare.
VI. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.
VII. At about 1 ft the pitch attitude is reduced to 2 degrees.
VIII. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.
IX. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.

This means that the autopilot and auto-throttle control the aircraft until the roll out (option a).

AUTOFLIGHT 115. b.

The standard autopilot failure conditions are as follows:

FAIL PASSIVE

There is no significant out of trim condition or deviation of flight path or altitude following failure, but the landing is not completed automatically (option b). The pilot must therefore be made aware of a fail passive situation so that he can take manual control of the aircraft. A fail passive system requires two independent autopilot channels and a monitoring system to ensure that any discrepancies between the two remain within acceptable limits.

FAIL OPERATIONAL

In the event of a failure below alert height during an automatic landing, the approach, flare and landing can be completed automatically by the remaining part of the system. This requires at least three independent channels, all of which are engaged during automatic landings. The number of channels engaged is indicated on the EFIS display as a caption. "LAND 3" indicates three channels operating, "LAND 2" indicates two channels operating, and "LAND 1" indicates only one channel operating.

AUTOFLIGHT 116. a.

When in altitude mode, in the Boeing 737 (one of the aircraft on which the JAR syllabus is based) the left autopilot system uses the captain's altimeter and the right autopilot uses the first officer's altimeter, to provide the necessary altitude signals. But regardless of which altimeter is being used, adjustment of the sub-scale after the altitude hold has been engaged will not affect the operation of the system. The new sub-scale setting will however take effect the next time the selected altitude is changed.

AUTOFLIGHT 117. b.

Whenever the flying controls of an aircraft are deflected, whether by the pilot or autopilot, the aircraft rotates about its C of G.

AUTOFLIGHT 118. c

JAR OPS 1.655 specifies that the minimum standard of autopilot for single pilot flight in IFR is a two axis system providing altitude hold and heading hold.

AUTOFLIGHT 119. c.

A servomechanism (c) is a closed loop system in which a small input signal is converted into a larger output according to some preset law of proportionality. They are frequently employed as component parts of autopilot systems (a). Although an amplifier (b) also produces a large output in response to a small input, amplifiers are not necessarily close loop systems. A positive feedback loop (d) is employed in many types of system to provide a self-exciting feedback signal. The feedback loop is simply an information path and hence does not itself increase the ratio of output to input.

AUTOFLIGHT 120. a.
Automatic flight control systems usually employ both autopilot and auto-throttle sub-systems. The relationship between autopilot functions and auto-throttle functions varies depending upon the mode selected. In most aircraft the auto-throttle can be used to control IAS, mach number, EPR and N1. Autopilots commonly use the elevators to control IAS (a) but never use the elevators to control heading (b). So option a is correct.

AUTOFLIGHT 121. d.
A typical automatic landing sequence using a triple redundant autopilot system is as follows:

I. RADALT becomes operational at 2500 ft.
II. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).
III. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.
IV. At 330 ft radio height the horizontal stabiliser is automatically set for to a nose up trim position with elevators providing pitch control.
V. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles to match reduced thrust requirement in the flare.
VI. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.
VII. At about 1 ft the pitch attitude is reduced to 2 degrees.
VIII. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.
IX. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.

So at 50 ft agl the glideslope disengages as the flare manoeuvre commences (option d).

AUTOFLIGHT 122. b.
The go-around mode is selected by pushing one of the take-off and go-around (TOGA) buttons on the throttle quadrant (option b), to initiate the following sequence:

a. Auto-throttle increase power to go-around setting.
b. Autopilot pitches aircraft into a 15° nose up attitude.
c. Autopilot climbs the aircraft at a preset rate of climb, whilst maintaining existing heading.
d. Other autopilot modes may then be selected when above 400 ft agl.

AUTOFLIGHT 123. d.
A typical automatic landing sequence using a triple redundant autopilot system is as follows:

I. RADALT becomes operational at 2500 ft.
II. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).
III. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.
IV. At 330 ft radio height the horizontal stabiliser is automatically set for to a nose up trim position with elevators providing pitch control.
V. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles to match reduced thrust requirement in the flare.
VI. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.
VII. At about 1 ft the pitch attitude is reduced to 2 degrees.
VIII. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.
IX. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.

So at 50 ft agl the autpilot flare mode takes over picth control from the glideslope (option d).

AUTOFLIGHT 124. d.
The purpose of the yaw damper is to prevent Dutch Roll by artificially enhancing the directional stability of the aircraft. It does this be moving the rudder in proportion to the yaw rate. In some systems an indicator is provided to show the degree to which the rudder has been moved by the yaw damper.

AUTOFLIGHT 125. b.
The most basic functions of an autopilot are the inner loop stabilisation modes. These include pitch hold and wings level hold. Heading hold, airspeed hold, and altitude or height hold are all examples of higher level, pilot selectable outer loop modes. If the autopilot is engaged with no modes selected, it will provide only the inner loop modes and in some cases automatic trim.

AUTOFLIGHT 126. c.
The "LOC ARMED" caption indicates that the system is armed and ready to capture the localiser beam. The system is armed by pushing the "APR" button at some specific point in the approach.

AUTOFLIGHT 127. b.
The relationship between the roles of the autopilot and auto-throttle vary with both aircraft type and mode selected. In the case of the Boeing 737 when in the LVL CHG (level change) mode, the autopilot controls the airspeed while the throttle controls the thrust (N1 or EPR). When climbing in LVL CHG, the auto-throttle maintains maximum climb power, while the autopilot maintains the selected airspeed by varying pitch attitude. When descending, the auto-throttle maintains idle power and the autopilot maintains the selected airspeed by varying pitch attitude. It should be noted that all of the other options are untrue for the 737 aircraft, and probably most other types. So option b is correct.

AUTOFLIGHT 128. b.
A typical automatic landing sequence using a triple redundant autopilot system is as follows:

I. RADALT becomes operational at 2500 ft.
II. Localiser and glideslope beams are captured before 1500 ft and the armed off-line channels of the autopilot engage to provide triple channel operation. The Autoland status annunciator indicates LAND 3 (or LAND 2 if one cannel fails to engage).
III. Flare mode is armed and pitch and roll are controlled by the localiser and glideslope beams.
IV. At 330 ft radio height the horizontal stabiliser is automatically set for to a nose up trim position with elevators providing pitch control.
V. At 50 ft the glideslope signal is disconnected and the flare mode takes over pitch control, bringing the aircraft into a 2 ft per second descent path. Auto-throttle begins to retard the throttles to match reduced thrust requirement in the flare.
VI. Just prior to touchdown (at about 5 ft), the flare mode disengages, and the touchdown and roll-out mode engages.
VII. At about 1 ft the pitch attitude is reduced to 2 degrees.
VIII. On touchdown the elevators are brought down to hold the nose wheels in contact with the ground.
IX. Auto-throttle disengages when reverse thrust is selected. The automatic flight control system remains on until disengaged by the pilot.

So at 50 ft agl the glideslope signal is automatically disengaged (option b).

AUTOFLIGHT 129. b.
Mach number is the TAS expressed as a fraction of the local speed of sound (LSS), such that mach number = TAS / LSS. But LSS is proportional to temperature, so as altitude increases in a constant mach climb, the decreasing air temperature causes the LSS and TAS to decrease. CAS at any given TAS is proportional to air density, which also decreases as altitude increases. So in a constant mach climb, the temperature, density, LSS, TAS and CAS all decrease (option b). The relationships between EAS, CAS, TAS and Mach number in various atmospheric conditions are illustrated in the key facts section of this book.

FLIGHT DIRECTOR 1 b.
A typical EFIS PFD is illustrated below.

Flight Director command bar are displayed in magenta.

The green FD caption indicates that the Flight Director mode is active.

TYPICAL EFIS PRIMARY FLIGHT DISPLAY

Modern aircraft employ Electronic Flight Instruments Systems (EFIS). These systems consist of a pair of Primary Flight Displays (PFD), which display primary flight data such as altitude, attitude and airspeed. A second pair of displays called the Electronic Horizontal Situation Indicators (EHSI), show navigation and flight path data. In aircraft equipped with EFIS the flight director modes are displayed in the upper strip of the PFD (option b).

FLIGHT DIRECTOR 2 c.
The purpose of the Flight Director system is to reduce pilot workload by providing easily interpreted command signals to enable the pilot to maintain preset flight conditions. The specific components which make up the flight director system vary with aircraft type but typically include at least a computer (1) and command bars (4). The autopilot and auto throttle systems are not part of the flight director system but often operate in conjunction with it. Option c is therefore correct.

FLIGHT DIRECTOR 3 c.
The purpose of the Flight Director system is to reduce pilot workload by providing easily interpreted command signals to assist the pilot to return to a desired path in an optimal way (option c).

FLIGHT DIRECTOR 4 a.
The location of the flight director command bars depends upon the type of aircraft. In non-EFIS aircraft they will be on the ADI, Attitude Display Indicator (option a). In EFIS equipped aircraft they will be on the EFIS Primary Display (PD).

FLIGHT DIRECTOR 5 b.

The function of the Flight Director (FD) command bars is to give command signals to the pilot to indicate the correct manoeuvres to achieve the desired flight path in the most efficient manner. If a new heading of 180° is selected when the aircraft is established in heading hold on 160° the aircraft must roll right to intercept the new heading. This command will be indicated by the vertical command bar moving to the right. As the aircraft rolls towards the required bank angle the command bars will gradually move back to the central position. So the vertical command bar will be centred if the aircraft is on optimum path to join heading 180° (option b).

FLIGHT DIRECTOR 6 c.

The flight director bars may be visible in manual flight and in some modes of automatic flight.

In manual flight with the flight director switched on, the bars give the pilot indications of the bank and pitch attitudes required to achieve the selected heading airspeed or altitude. The bars are not visible when the flight director is switched off.

In automatic flight the command bars indicate to the pilot what actions the autopilot is taking. But when the autopilot is engaged without any command modes selected, there are no commands to be shown on the FD bars. So the FD bars are not visible in this condition. The command bars also disappear from view when the flare mode of an automatic landing is initiated. So the Flight Director command bars are sometimes visible in automatic flight (option c).

FLIGHT DIRECTOR 7 a.

The diagram illustrates the typical layout of the flight director bars on an attitude and direction indicator.

The W symbol represents the aircraft.
The thin horizontal line represents the horizon.
The thick horizontal line represents the pitch attitude command bar. If it is above the aircraft then a nose up pitch change is required.
The thick vertical line represents the bank command bar. If it is to the left of the aircraft then a bank to the left is required.

Each of the command bars will centralize on the aircraft symbol when the command has been satisfied. In this question the pitch command bar is above the aircraft so must roll left and increase the flight attitude until the command bars re-centre on the symbolic airplane. This is closest to option option a.

FLIGHT DIRECTOR 8 d.

The Flight Director can be displayed on various instruments. In the case of EFIS equipped aircraft they will be on the Primary Flight Display or PD. In less sophisticated aircraft they are typically displayed on the Attitude and Direction Indicator ADI (option d).

FLIGHT DIRECTOR 9 b.

The purpose of the flight director is to provide command indications to enable the pilot to take up the pitch and bank attitudes to achieve or maintain the selected flight path in the most efficient manner. In this question the newly selected heading is to the right of the current heading. The vertical command bar will therefore move to the right. As the pilot banks the aircraft towards the required bank angle the displacement of the bar will gradually decrease to zero when at the correct bank angle. The bar will then move to the left to command the roll out manoeuvre when appropriate.

The most accurate option in this question is option b, "The vertical bar deviates to the right and will be centred as soon as you roll the aircraft to the bank angle calculated by the flight director" (option b).

FLIGHT DIRECTOR 10 d.

The flight director bars may be visible in manual flight and in some modes of automatic flight. In manual flight with the flight director switched on, the bars give the pilot indications of the bank and pitch attitudes required to achieve the selected heading airspeed or altitude in the most efficient manner. So when VOR hold is selected the flight director bars indicate the optimum instantaneous path to reach the selected VOR radial (option d).

FLIGHT DIRECTOR 11 a.

The flight director bars may be visible in manual flight and in some modes of automatic flight.

In manual flight with the flight director switched on, the bars give the pilot indications of the bank and pitch attitudes required to achieve or hold the selected heading airspeed or altitude. So the position of the flight director command bars indicates the manoeuvres to execute, to achieve or maintain a flight situation (option a).

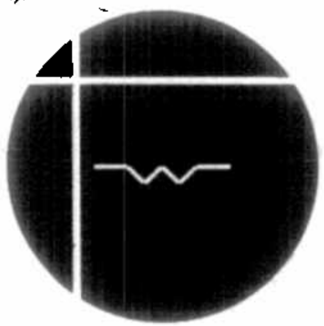
FLIGHT DIRECTOR 12 a.

The diagram illustrates the typical layout of the flight director bars on an attitude and direction indicator.

The W symbol represents the aircraft.
The thin horizontal line represents the horizon.
The thick horizontal line represents the pitch attitude command bar. If it is above the aircraft then a nose up pitch change is required.
The thick vertical line represents the bank command bar. If it is to the left of the aircraft then a bank to the left is required.

Each of the command bars will centralize on the aircraft symbol when the command has been satisfied. In this question the pitch command bar is above the aircraft you so must increase the flight attitude until the command bars re-centre on the symbolic airplane.

So After having programmed your flight director, if you see that the indications of your ADI (Attitude Director Indicator) are as represented in diagram below. On this instrument, the command bars indicate that you must increase the flight attitude and bank your airplane to the left until the command bars re-centre on the symbolic aeroplane (option a).



FLIGHT DIRECTOR 13. b
The command bars of a flight director indicate commands as follows:

a. Upward displacement of the horizontal bar indicates a pitch up command.
b. Left displacement of the vertical command bar indicates a turn left command.

So the flight director in this question is indicating commands to go up and left.

FLIGHT DIRECTOR 14. c.
The command bars of a flight director indicate commands as follows:

a. Downward displacement of the horizontal bar indicates a pitch down command.
b. Left displacement of the vertical command bar indicates a turn left command.

So the flight director in this question is indicating commands to go down and left.

FLIGHT DIRECTOR 15. a.
The command bars of a flight director indicate commands as follows:

I. Downward displacement of the horizontal bar indicates a pitch down command.
II. Left displacement of the vertical command bar indicates a turn left command.

So the flight director in this question is indicating commands to go down and right.

FLIGHT DIRECTOR 16. a.
The command bars of the flight director indicate the commands that are being sent to the autopilot, to achieve the selected flight condition. Selecting a heading of 350° when on 275°, would require a right turn. The command roll bar would therefore move to the right until the AFDS angle of bank required to intercept the 350° heading is achieved. The roll bar would then centralise (option a). It should be noted that the bar would then move to the left when the aircraft is within about 10° of the selected he heading, to level the aircraft on the required heading.

FLIGHT DIRECTOR 17. a.
Flight director modes constitute primary flight information, so they are typically displayed on the EFIS Primary flight Display (PFD).

FLIGHT DIRECTOR 18. a.
The command bars of a flight director indicate commands as follows:

I. Upward displacement of the horizontal bar indicates a pitch up command.
II. Left displacement of the vertical command bar indicates a turn left command.

So the flight director in this question is indicating commands to go up and right.

FLIGHT DIRECTOR 19. b.
The flight director bars constitute primary flight information. They are therefore displayed on the EFIS primary flight display (EFIS PFD). In non-EFIS aircraft they are usually displayed on a separate attitude and direction indicator or ADI.

FLIGHT DIRECTOR 20. a.
The command bars on an attitude and direction indicator (ADI), show the changes in attitude necessary to achieve the desired flight path. In the case of a turn the bars indicate the bank angle required to intercept the selected heading. When that bank angle is achieved, the bars return to neutral. As the aircraft gets within about 10 degrees of the desired heading the bars move to indicate the bank required to level the aircraft on the correct heading.

FLIGHT DIRECTOR 21. a.
The flight director bars on the ADI indicate the manoeuvres that are required to achieve the selected flight condition. In this case the bars have moved left and up, so the pilot must bank left and increase the nose up attitude until the bars centralise.

FLIGHT DIRECTOR 22. b.
The flight director bars move vertically and laterally to indicate the manoeuvre required to achieve the selected flight condition. If 180 degrees is selected when

flying on a heading of 160 then the aircraft must bank to the right. The flight director bars will therefore move right.

FLIGHT DIRECTOR 23. b.
Flight director modes selected constitute primary flight information. They are therefore displayed on the EFIS primary flight display (EFIS PFD).

FLIGHT DIRECTOR 24. a.
The flight director bars move to indicate the manoeuvres required to attain the selected flight condition. If a heading of 350 is selected when on 270 degrees, the aircraft must bank right. The FD bars will therefore move right to indicate the angle of bank required to intercept the 350 heading. The bars will gradually centralise as bank angle approaches that required. As the heading approaches 340 the bars will move left to indicate the bank angle required to level to achieve a roll out on a heading of 350. It should be noted that this is not a magnetic compass question, so compass errors need not be considered.

EICAS/ECAM 1. a.
This question refers to the basic version of ECAM, in which the screens were displaced laterally. In this system the left screen displays information in the form of checklists or memos, while the right screen displays supporting diagrams (option a). In more modern versions of ECAM the screens are displaced vertically with the upper screen displaying engine primary data and warnings while the lower screen displaying secondary information.

EICAS/ECAM 2. a.
This question refers to the basic version of ECAM, which has four modes of operation. Three of these are automatic and the other manual. The modes are as follows:

NORMAL. The normal flight mode automatically provides information related to the stage of flight. This includes such things as pre-start check lists, post-start check lists, and pre-take-off check list.

ADVISORY. This mode automatically displays any non-emergency change in the status of the aircraft or its systems. This might include events such as switching from APU to main generators.

FAILURE. This takes precedence over all other modes automatically indicating when pre-set parameters have been exceeded. A warning message and list of required corrective actions is provided in the left screen, and a supporting diagram in the right screen. Examples might include engine over-heat, fire warning or generator failure.

MANUAL. This mode may be selected manually by the pilots in order to call up diagrams and messages indicating the current status of various aircraft systems.

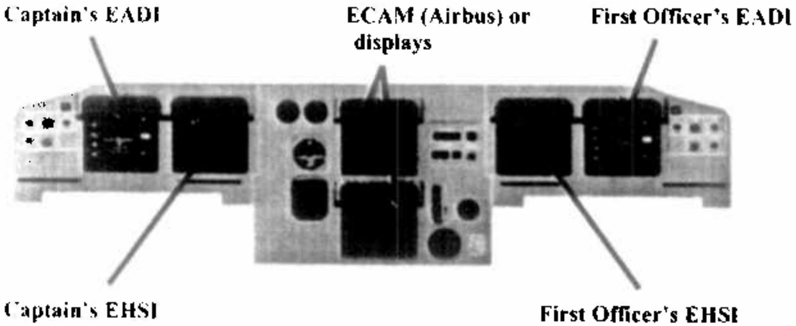
EICAS/ECAM 3. d.
In certain circumstances a system or item of equipment, although serviceable in itself, may become non-operational due to the failure of some other system or component. A left generator failure for example may disable a number of electrical bus bars and the non-essential systems fed from them. ECAM indicates such serviceable but non-operational systems or components by enclosing them in boxes on the display screens (option d). This method is not employed in the EICAS system.

EICAS/ECAM 4. a and c.
If this question refers to the basic version of ECAM, in which the screens are displaced laterally then engine information is not included (option c). In this system the left screen displays information in the form of checklists or memos, while the right screen displays supporting synoptic diagrams (option a). If however the question relates to the advanced vesions of ECAM, then the screens are displaced vertically with the upper screen displaying engine primary data and warnings while the lower screen displays secondary information. Option a and c are therefore both true of the basic system but no options are true of the advanced system. Students should appeal if this question appears in their JAR examination.

EICAS/ECAM 5. c.
This question refers to the basic version of ECAM, in which the screens were displaced laterally. In this system the left screen displays information in the form of checklists or memos, while the right screen displays supporting synoptic diagrams. This version of ECAM was fitted in aircraft which did not employ EFIS, so no alternative CRT screens were available in the event of a single ECAM screen failure. Failure of a single screen therefore caused the loss of the data that would normally be displayed on that screen (option c). So a right screen failure would cause the loss of the diagram, leaving the written information available on the left screen. It should be noted that this early version of ECAM did not display any engine data, so screen failure did not affect the operation of the engines.

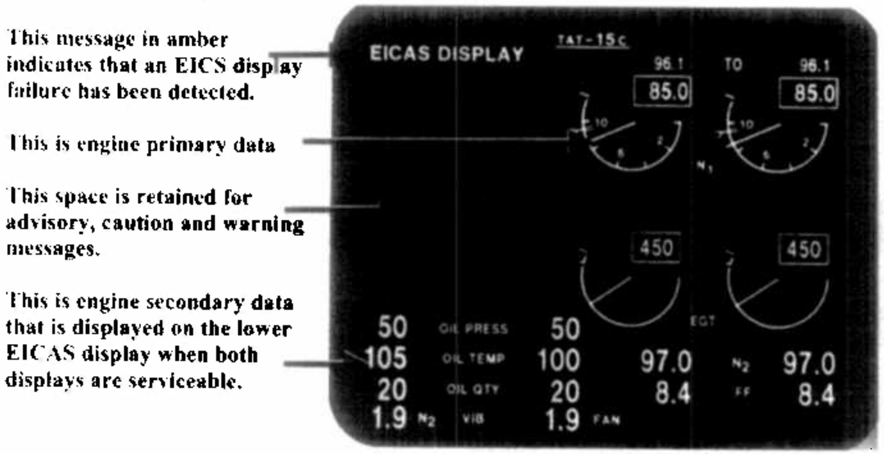
EICAS/ECAM 6. b.
This question refers to aircraft which possess both ECAM and EFIS. In such aircraft a total of six CRT screens (2 ECAM, 2 EFIS PFD and 2 EFIS ND) are available. The ECAM system in such aircraft is also of a more advanced version in which the displays are vertically displaced and indicate different data. The upper screen displays engine primary information and warnings and advisory messages, while the lower screen displays secondary information. Because the screens display different data, the loss of data from any one screen is unacceptable. So when a single ECAM screen fails in such aircraft, the data from that screen is automatically transferred to one of the EFIS screens. It should be noted that the

compacted display referred to in option a is employed only in EICAS. A typical modern ECAS/EFIS display panel is illustrated below.



EICAS/ECAM 7. a.

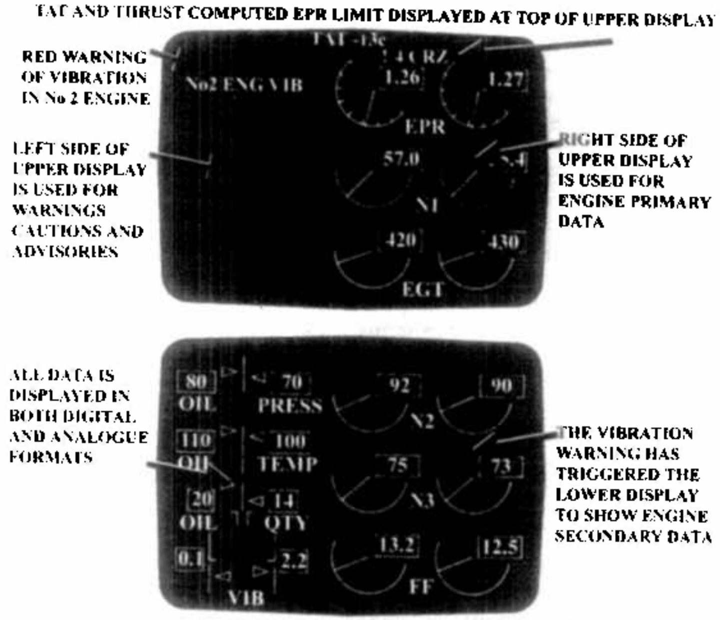
All versions of the EICAS system employ two vertically displaced screens. The upper screen displays engine primary data, warnings, cautions and advisory messages, while the lower screen displays secondary data. Because each screen displays different data, the loss of data from any one screen is unacceptable. In non-EFIS equipped aircraft there are normally only the two EICAS CRT displays available. In the event of a single EICAS screen failure, the data from both screens is displayed on the remaining serviceable screen in a compacted version (option a). The emergency engine primary data LCD display referred to in option d is used in the event of both EICAS screens failing. A typical compacted EICAS display is illustrated below.



TYPICAL EICAS COMPACTED DISPLAY

EICAS/ECAM 8. b.

This question refers to aircraft which possess both EICAS and EFIS. In such aircraft a total of six CRT screens (2 EICAS, 2 EFIS PFD and 2 EFIS EHSI) are available. All versions of the EICAS system employ two vertically displaced screens. The upper screen displays engine primary data, warnings, cautions and advisory messages, while the lower screen displays secondary data. Because each screen displays different data, the loss of data from any one screen is unacceptable. So in the event of a single EICAS screen failure in EFIS equipped aircraft, the data that would normally be displayed on the failed screen is automatically transferred to one of the EFIS screens. A typical EICAS display is illustrated below.



TYPICAL EICAS DISPLAY

EICAS/ECAM 9. a.

In advanced ECAM the upper display is divided laterally. The upper portion shows engine primary data, while the lower portions shows warnings and advisory messages. Warnings are provided as red messages at the bottom left corner of the upper display. These are accompanied by list of the corrective actions to be taken, shown in blue. The amber messages referred to in option b, are used for lower priority, advisory massages indicating non-emergency changes in status. Whenever a warning or advisory massage appears in the upper display, a supporting diagram appears in the lower display.

EICAS/ECAM 10. c.

All versions of the EICAS system employ two vertically displaced screens. The upper screen displays engine primary data, warnings, cautions and advisory messages, while the lower screen displays secondary data. The upper, primary display is divided vertically, with engine primary data on the right side. If an emergency occurs, its nature is shown as a red message in the left side of the upper display. This area is also used to display lower priority cautionary and advisory massages in amber. Whenever a mix of warnings, cautions and advisories is being shown, the warnings appear at the top of the list, followed by cautions and then advisories. So emergencies will be indicated in red at the top left side of the upper display (option c). It should however be noted that in some aircraft such messages appear at the right side of the upper display with engine primary data on the left side.

EICAS/ECAM 11. d.

All versions of the EICAS system employ two vertically displaced screens. The upper screen displays engine primary data, warnings, cautions and advisory messages, while the lower screen displays secondary data. The upper, primary display is divided vertically, with engine primary data on one side. If an emergency occurs, its nature is shown as a red message in the other side of the upper display. This area is also used to display lower priority cautionary and advisory massages in amber. The lower display is used to show secondary data relating to the engines or systems. In normal flight the Engine primary data such as N1, EGT and EPR are displayed constantly on the upper screen, while lower screen remains blank.

EICAS/ECAM 12. a.

Various reference books contain slightly different versions of the number of modes provided by the EICAS system. The following modes are however included in all such references:

OPERATIONAL.

This is the normal flight mode. The upper screen displays engine primary data, while the lower screen remains blank. In the event of a change in status, the upper screen displays a warning, cautionary or advisory message and the lower screen displays a supporting diagram and secondary data.

STATUS.

This mode may be selected by the pilot in order to interrogate various systems. In the status mode the upper screen continues to display engine primary data, while the lower screen shows the status of whatever system the pilot has selected.

MAINTENANCE.

This mode is not available in flight. The maintenance mode shows condition and usage information for various systems and components within the aircraft. This information is used to determine what servicing is required between flights.

Some references also refer to the displaying of warnings, cautions and advisory messages as a fourth EMERGENCY mode. The MANUAL mode referred to in options b, c and d, is the ECAM equivalent of the EICAS status mode. So option a is the most appropriate.

EICAS/ECAM 13. b.

Messages provided by the EICAS system are divided into the following three categories:

WARNINGS.	These are displayed in red, together with an aural message. They indicate situations which require immediate corrective action (option b in this question).
CAUTIONS.	These are displayed in amber and may or may not be accompanied by an aural message, depending on their nature. They indicate situations of which the pilot must be made aware, which do not require immediate corrective action, but might do so in the near future.
ADVISORIES.	These are displayed in amber, indented to the right by a distance of one digit on the EICAS display. They are not accompanied by any aural message. They indicate system status changes not requiring corrective action.

EICAS.ECAM 14. d.

Messages provided by EICAS are divided into the following three categories:

WARNINGS.	These are displayed in red, together with an aural message. They indicate situations which require immediate corrective action.
CAUTIONS.	These are displayed in amber and may or may not be accompanied by an aural message, depending on their nature. They indicate situations of which the pilot must be made aware, which do not require immediate corrective action, but might do so in the near future.
ADVISORIES.	These are displayed in amber, indented to the right by a distance of one digit on the EICAS display. They are not accompanied by any aural message. They indicate system status changes not requiring corrective action.

So an amber message may be a caution or an advisory (option d).

EICAS/ECAM 15. c.

In both ECAM and EICAS, green bugs are used to indicate target values. In the case on the EPR gauge, the green bug is set by the Flight Management Computer or the Thrust Computation system to indicate target EPR for the flight condition selected (option c).

EICAS/ECAM 16. c.
The advantages provided by modern systems such as ECAM and EICAS are reduced cockpit clutter and improved information management. Cockpit clutter is reduced by replacing a large number of conventional instruments with two display screens. Information management is improved by displaying information only when it is required by the crew. Although the benefits listed in options a, b, and d are also provided, these are of a secondary nature.

EICAS/ECAM 17. d.
The EICAS system includes extensive built in test facilities, which are designed to detect and respond to system failures. Responses available include all of those listed in this question.

EICAS/ECAM 18. c.
All versions of the EICAS system employ two vertically displaced screens. The upper screen displays engine primary data, warnings, cautions and advisory messages, while the lower screen displays secondary data. Because each screen displays different data, the loss of data from any one screen is unacceptable.

The basic EICAS system was fitted to non-EFIS aircraft. In such aircraft there are normally only the two EICAS CRT displays available. In the event of a single EICAS screen failure, the data from both screens is displayed on the remaining serviceable screen in a compacted format. If both screens fail, a limited range of engine primary data is provided on an emergency engine data LED display (option c). Because of the small size of this display the data provided is typically restricted to actual and limiting values of N1, N2 and EGT. A typical standby engine LED display is illustrated below.

EICAS/ECAM 19. d.
EICAS advisory messages relate to non-emergency changes in status. They are are displayed in amber, indented to the right by a distance of one digit on the left side of the EICAS upper display. They are not accompanied by any aural message.

EICAS/ECAM 20. c.
In order to ensure a common standard, JAR regulations specify the functions for which various colours are to be used in aircraft information display and management systems including EICAS , ECAM and EFIS. Red is used to display warnings and limits.

EICAS/ECAM 21. c.
In order to ensure a common standard, JAR regulations specify the functions for which various colours are to be used in aircraft information display and management systems including EICAS , ECAM and EFIS. Amber is used to display cautionary and advisory message and time limited or cautionary data values. These do not require immediate corrective actions, but the pilot must be aware of them in order to assess their potential effects in the event of other failures.

EICAS/ECAM 22. d.
In the event of a failure of any single component in an ECAM system, the system will provide an amber advisory message, and automatically take corrective action. Because no action is required by the pilot, no other aural or visual warning will be provided. In the event of a total ECAM system failure (including the built-in test and fault diagnosis facilities) the system would be unable to provide any indications or warnings. So option d, amber message is the most appropriate.

EICAS/ECAM 23. b.
Both ECAM and EICAS systems include "cancel" and recall" buttons. In situations where a large number of warnings , cautions and advisory messages are displayed, the cancel button enable the pilot to scroll down this list. The recall button can then be use to scroll back to the top of the list. It should be noted that pressing cancel removes only the cautions and advisory messages from the screen. Warnings cannot be deleted without the appropriate corrective actions being taken, so option a and c are untrue. Messages are always displayed in order of priority, so option d is also untrue.

EICAS/ECAM 24. d.
ECAM warnings are displayed in red at the bottom left corner of the upper or left display. These are accompanied by a list of required corrective actions displayed in cyan. When the corrective actions have been taken, the cyan instructions turn into a statement of the new configuration displayed in green.

EICAS/ECAM 25. b.
JAR regulations require that all newly certificated class A passenger aircraft be equipped with an automatic means of indicating whether or not the aircraft is in the correct configuration prior to take-off. In the ECAM system this facility is provided by means of a take-off button on the ECAM control panel. When the T/O button is pressed the system checks that the aircraft is in the appropriate configuration (option b) and lists any discrepancies.

EICAS/ECAM 26. c.
JAR regulations require that all newly certificated class A passenger aircraft be equipped with an automatic means of indicating whether or not the aircraft is in the correct configuration prior to take-off. In the ECAM system this facility is provided by means of a take-off button on the ECAM control panel. When the take-off button is pushed, the system checks the configuration of the aircraft and indicates any discrepancies. Items checked include trailing and leading edge flaps, horizontal stabiliser setting, brakes, power lever positions, spoilers, side stick, and flex temperature setting.

EICAS/ECAM 27. d.
The basic ECAM system does not provide any form of engine indications so options a and b are untrue. This version of ECAM provides both primary and secondary data for a range of aircraft systems (option d). In more advanced versions engine primary and secondary information is also included.

EICAS/ECAM 28. c.
It should be noted that because all of the options include engine data, the question must be referring to the advanced version of ECAM, because the basic ECAM did not provide any form of engine data. It is a JAR requirement that all such systems display information in both digital and analogue format.

EICAS/ECAM 29. c.
The basic ECAM employs a left and right display, whereas the advanced version employs upper and lower displays. Warnings and cautions are provided at the bottom of the left or upper display depending on which version of the system is being used. The right and lower displays show secondary data and diagrams.

EICAS/ECAM 30. a.
In both the ECAM and EICAS systems, red messages are used for warnings. These are situations which require immediate corrective action (option a). It is unnecessary to press the status button (option b) because the lower screen will automatically display relevant secondary data whenever a warning message appears on the upper screen. A number of warnings can be displayed simultaneously and the cancel button will not affect warning messages, so option c is also untrue. Lists of corrective actions (option d) are provided by ECAM but not by EICAS.

EICAS/ECAM 31. b.
In the EICAS system amber messages accompanied by aural alerts indicate cautionary situations. Cautionary messages do not require any immediate corrective action, but the pilots must be aware of them.

EICAS/ECAM 32. b.
In the EICAS system amber messages not accompanied by aural alerts indicate advisory situations. Advisory messages do not require any immediate corrective action, but the pilots must be aware of them.

EICAS/ECAM 33. a.
In both the ECAM and EICAS systems, red messages are used for warnings. These are situations which require immediate corrective action (option a). In the case of ECAM these corrective actions are listed in cyan at the bottom of the left or upper display (option a).

EICAS/ECAM 34. d.
In the advanced ECAM system, the primary flying control positions are displayed on the left side of the lower display. It should be noted that flap positions are displayed on the right side of the upper display.

EICAS/ECAM 35. a.
In the advanced ECAM system, the flap positions are displayed on the right side of the upper display. It should be noted that primary flying control positions are displayed on the left side of the lower display.

EICAS/ECAM 36. a.
Two versions of ECAM, are currently in use. In the basic system the left screen displays information in the form of checklists or memos, while the right screen displays supporting diagrams. In more modern versions of ECAM the screens are displaced vertically with the upper screen displaying engine primary data and warnings while the lower screen displays secondary information.

When an aircraft system failure occurs, the left display will indicate the situation in red or amber, together with the required corrective actions in cyan. The right display will show a diagram of the faulty system (option a). In an advanced system the same information is provided but on the upper and lower displays respectively.

EICAS/ECAM 37. b.
When an aircraft system failure occurs, the left display will indicate the situation in red or amber, together with the required corrective actions in blue. The right display will show a diagram of the faulty system. In an advanced system the same information is provided but on the upper and lower displays respectively.
When the required corrective action has been take, the upper (or left) screen will briefly continue to display the original fault statement, but the list of corrective actions will become green. Both screens will then revert to normal.

EICAS/ECAM 38. c.
Two versions of ECAM, are currently in use. In the basic system the left screen displays information in the form of checklists or memos, while the right screen displays supporting diagrams. In more modern versions of ECAM the screens are displaced vertically with the upper screen displaying engine primary data and warnings while the lower screen displayed secondary information. In normal flight conditions, the lower (or right) screen is blank and the upper (or left) screen indicates primary engine data.

EICAS/ECAM 39. b
In both the ECAM and EICAS systems, red messages are used for warnings. These are situations which require immediate corrective action. Such situations include engine fires. In the case of EICAS this would be indicated by a red warning caption on the upper display, an aural warning, and engine secondary data on the lower display.

EICAS/ECAM 40. b.
In both ECAM and EICAS engine data is provided in both digital and analogue forms. The limiting value of EGT is shown by a red bug on the analogue display. If this limiting value is exceeded, both the digital and analogue displays turn red to draw attention to the matter.

EICAS/ECAM 41. a.
Both ECAM and EICAS systems employ extensive built-in test and fault diagnostic circuits to detect and respond to internal faults. If a fault is detected the system will indicate this by an amber advisory message and take corrective action. If however the fault is not detected the system can neither provide a caption, nor take corrective action.

Because the lower EICAS display is normally blank, it is possible that its failure could go undetected by both the system and the pilot. To overcome this problem the upper screen gives an indication whenever any data should be visible on the lower display. This indication takes the form of a line of ✓ at the lower left corner of the upper display. So if the lower screen fails and the system does not detect it, the lower display will remain blank, but the upper will show a series of ✓ signs whenever data should be on the lower display.

EICAS/ECAM 42. c.
In certain circumstances, a system, although serviceable in itself, can be rendered non-operational because of the failure of another supporting system. In ECAM equipped aircraft, such non-operational, but serviceable systems are indicated by a boxed caption. So a RADALT message would indicate that the RADALT is not itself defective, but has been rendered unavailable due to the failure of another systems which is also identified by another message.

EICAS/ECAM 43. c.
Pressing of the EICAS status button (option b) causes the lower display to show the first page in the status menu. Repeatedly pressing the status button (option c) then causes the system to scroll down through the full range of status pages. If the button is pushed when the display is on the last page, the screen will be cleared. It should be noted that pressing the clear (CLR) button (option a) scrolls down through the warnings, cautions and advisory messages on the upper screen. Pressing the recall (RCL) (option d) button scrolls up through this list.

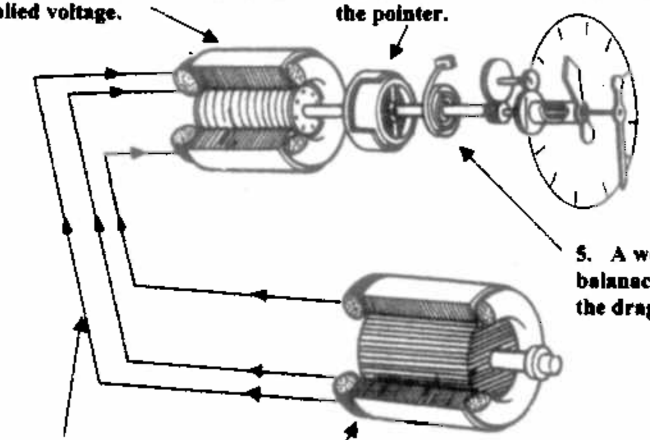
EICAS/ECAM 44. c.
All modern commercial transport aircraft employ both EFIS and either ECAM or EICAS. It should be noted that ECAM and EICAS are never used in the same aircraft, and an ECAM or EICAS type system is now a mandatory JAR requirement for such aircraft.

EICAS/ECAM 45. d.
The principal reasons for the development of the ECAM and EICAS systems was to reduce cockpit clutter (1) and to reduce pilot workload (2) by making it easier to interpret information in difficult circumstance (4) and hence make faults easier to identify (3). The use of modern electronics in these systems also makes them lighter (5) and facilitates better integration of information (6). So all of the benefits listed in this question are achieved.

ENGINE 1 a.
In a multi-cylinder piston engines it is never possible to provide every cylinder with the exactly the same amount of cooling airflow. This means that each of the cylinders will run at a different temperature, with the hottest cylinder being that which receives the least effective cooling. In order to minimize the cost and complexity of the temperature measurement system, a temperature sensor is usually fitted to only one of the cylinders. The greatest of risk of damage to the engine lies in excessively high cylinder temperatures, so the single temperature sensor is usually fitted to the hottest cylinder. The position of this hottest cylinder will depend upon its position in the engine block (option a).

ENGINES 2 d.
This question refers to a DC tacho-generator system as illustrated below.

This type of system employs a small DC generator driven by the engine. The volatge output from this generator is proportionl to the RPM. This voltage is fed to a small DC motor which drives a tachmeter through a magnetic drag cup. This could be described a s a magnetic tachometer (option d).



THREE PHASE TACHO GENERATOR

ENGINES 3 d.
This question refers to the magnetic or inductive RPM measurement system commonly called a speed probe or inductive probe. The detector or speed probe itself, is simply an inductive coil and magnet fixed adjacent to the tips of the rotating notched wheel or the fan or compressor blades. As the notches on the wheel or the fan/compressor blades pass by the magnet the strength of the magnetic field fluctuates. This causes a varying DC signal to be generated in the inductive coil. The frequency of the variations in this DC signal is proportional to the RPM. In some such systems the varying DC signal is converted into a square wave pulses which are then counted to give an indication of RPM (option d).

ENGINES 4 b.
Vibration monitoring systems in aircraft commonly employ accelerometers to measure both the frequency and amplitude of the vibration. The accelerometers measure the radial movement of the engines. But the signals from the accelerometers are a combination of all of the vibration frequencies present, plus electrical noise. The frequency of an engine vibration is proportional to the RPM. Frequency filters are therefore used to filter out all of the unwanted frequencies, so

that only those of interest to the pilot remain. The amplitude of the vibration is proportional to the degree of damage of imbalance of the object producing it. A vibration indicator therefore receives signals from different sensors (accelerometers) and then indicates the vibration amplitude at a given frequency (option b).

ENGINES 5 b.
A wide variety of RPM measuring systems have been employed in aircraft as technology has developed. Tacho-generator systems for example have evolved from using DC generators (2), through the widely used three-phase generators (4) to 12 pole single-phase generators (3) used in the most modern computerized systems. A commonly used modern alternative system is the inductive speed probe which uses a magnetic sensor to produce an AC or pulsed DC signal (1). Option b is therefore the most accurate in this question.

ENGINES 6 a.
Engine Pressure Ratio is a measure of the degree by which the engine has increased the pressure of the air passing through it. EPR is the Low pressure turbine outlet or discharge pressure divided by the low pressure compressor inlet pressure (option a).

ENGINES 7 a.
Vibration metering systems in aircraft commonly employ accelerometers to measure both the frequency and amplitude of the vibration. The commonly use 2 accelerometers mounted at right angle to each other and at right angles to the engine drive shaft, to measure the radial movement of the engine spools (option a).

The signals from the accelerometers are a combination of all of the vibration frequencies present, plus electrical noise. Frequency filters are therefore used to filter out all of the noise and unwanted frequencies, so that only those of interest to the pilot remain. These signals are very weak so they are then amplified before being used to trigger indication systems. Options b, c, and d are not accurate however because the number of filters and amplifiers varies from system to system.

ENGINES 8 d.
Different coloured arcs are commonly used on gauges to provide easily recognised indications of the significance of various ranges. In most such gauges, the greeen arc indicates the normal operating range (option d).

ENGINES 9 d.
In multi-propeller aircraft a considerable amount of noise and vibration can be caused by the interaction between adjacent propellers. In order to minimise these effects it is necessary to ensure that all of the propellers operate at the same RPM. In some aircraft this is achieved by manually adjusting the speed select levers for each engine. The purpose of synchroscopes is to assist the pilot in this task of

setting all engine sat the same speed (option d), by indicating the RPM differences between the various engines. In one such system each synchroscope comprises of a small dial with a propeller symbol within it. If all engines are at the same RPM, all of the synchroscopes will be stationary. Any engines not at the same RPM will be indicated by the rotation rate of their synchroscopes.

ENGINES 10 b.
Thermocouple systems measure temperature using the Seebeck effect. If two dissimilar metals are connected together, a voltage will be generated whenever the junction between the two metals is heated. The magnitude of the voltage is proportional to the temperature of the junction. If this voltage is used to drive an electrical current the current can then be measured to give an indication of the temperature at the junction of the two metals.

In order to provide a continuous circuit the other ends of the two metals must be also be joined together. This may be by a direct connection or by means of some other type of metal. But for the system to function, the two dissimilar metals must be directly joined to each other at least one point (option b). Options a and c are untrue because the system requires two dissimilar metals. Option d is untrue because wheatstone bridges measure resistance and are not used in thermocouple systems.

ENGINES 11 c.
In order to give an easily interpreted reminder of the significance of various operating temperatures, the scales of temperature gauges are often marked with arcs of different colours. In such gauges the yellow or amber arc indicates the temperature range that may be used only in exceptional circumstances (option c). An example of this is the temperature range that may be used for a limited time , usually of a maximum of five minutes during take-off.

ENGINES 12 c.
Vibration monitoring systems in aircraft commonly employ accelerometers to measure both the frequency and amplitude of the vibration. They commonly use 2 accelerometers mounted at right angle to each other and at right angles to the engine drive shaft, to measure the radial movement of the engine spools. The signals from the accelerometers are a combination of all of the vibration frequencies present, plus electrical noise. Frequency filters are therefore used to filter out all of the noise and unwanted frequencies, so that only those of interest to the pilot remain. These signals are very weak so they are then amplified before being used to trigger indication systems. Option c is therefore the most accurate in this question.

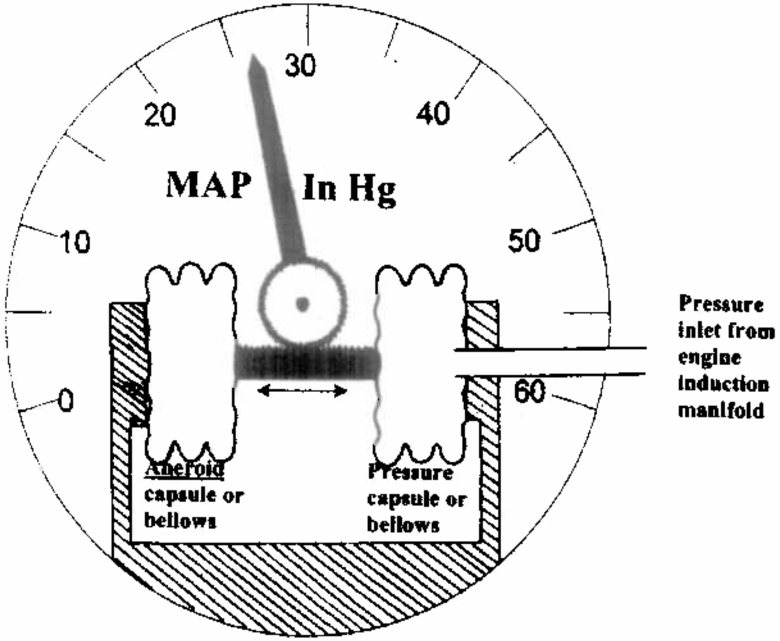
ENGINES 13 b.
The type of sensor that must be used in a pressure gauge is determined by the magnitude of the pressure that is to be sensed. Thin brass or bronze capsules are used for very low pressure. More substantial bellows are used for medium

pressures, while much stiffer bourdon tubes are used for high pressures. The correct sequence in order of increasing pressure is therefore 3 aneroid capsules, 1 Bellows, and 2 Bourdon tubes (option b).

ENGINES 14 c.
In order to give an easily interpreted reminder of the significance of various operating conditions, the scales of cockpit gauges are often marked with arcs of different colours. In some RPM gauges a narrow red arc appears within the wider green arc. The green arc indicates the allowable RPM range for normal operations. The narrow red arc indicates the RPM range within which there is a risk of the propeller generating vibration within its resonant frequency. Such vibration can quickly become destructive, so continuous operation within the narrow red arc is forbidden (option c).

ENGINES 15 a.
Cylinder Head Temperature (CHT) is normally measured using a thermocouple. Such systems measure temperature using the Seebeck effect. If two dissimilar metals are connected together, a voltage will be generated whenever the junction between the two metals is heated (option a). The magnitude of the voltage is proportional to the temperature of the junction. If this voltage is used to drive an electrical current the current can then be measured to give an indication of the temperature at the junction of the two metals. Options b and c are untrue because they are not commonly used on cylinder heads. Option d is untrue because Bourdon tubes measure high pressure.

ENGINES 16 c.
The most common type pf manifold pressure gauge is the Manifold Absolute Pressure or MAP gauge. The term absolute pressure means the pressure relative to absolute zero pressure. Any restrictions in the manifold such as the air filter, carburetor and throttle valve will reduce the air pressure in the manifold. The manifold pressure must therefore be measured downstream of all such restrictions. The MAP gauge therefore measures absolute pressure in the intake system near to the inlet valve (option c). A typical MAP gauge is illustrated below.



TYPICAL MAP GAUGE

ENGINES 17 a.

The most common type of manifold pressure gauge is the Manifold Absolute Pressure or MAP gauge. The term "absolute pressure" means the pressure relative to absolute zero. Any restrictions in the manifold such as the air filter, carburetor icing and the throttle valve will reduce the air pressure in the manifold. The manifold pressure must therefore be measured downstream of all such restrictions. To overcome this problem the MAP gauge measures absolute pressure in the intake system near to the inlet valve.

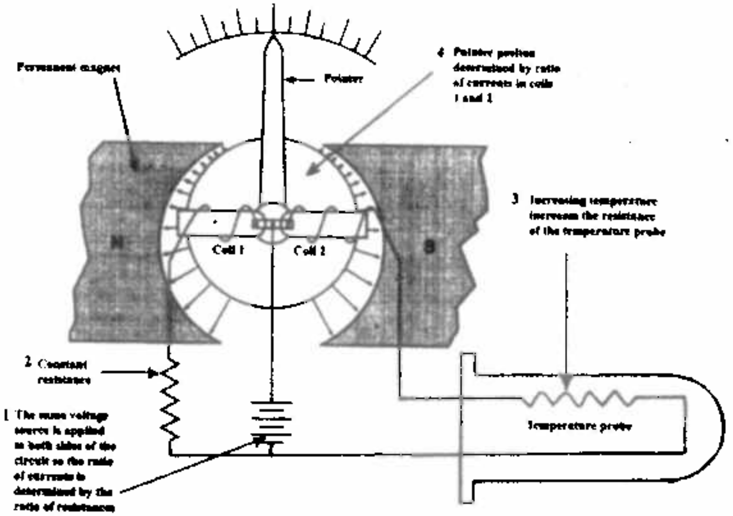
In a normally aspirated engine the engine must suck air into the manifold, so the MAP will always be less than local atmospheric pressure whenever the engine is running. In a supercharged engine a compressor forces air into the manifold at increased pressure. So the MAP in such an engine will always be greater than local atmospheric pressure. This means that if a manifold pressure gauge consistently registers atmospheric pressure, the cause is probably a leak in the pressure line from the manifold to the gauge (option a).

ENGINES 18 a.

Thermocouple systems measure temperature using the Seebeck effect. If two dissimilar metals are connected together, a voltage will be generated whenever the junction between the two metals is heated. If this voltage is used to drive an electrical current the current can then be measured to give an indication of the temperature at the junction of the two metals. In order to provide a continuous circuit the other ends of the two metals must be also be joined together. With such a circuit the voltage and current produced are proportional to the temperature difference between the hot and cold junctions. This means that to provide an accurate indication of the temperature of the hot junction it is necessary to keep the cold junction at a constant temperature (option a).

ENGINES 19 d.

A typical ratiometer is illustrated below.



RATIOMETER TEMPERATURE MEASUREMENT SYSTEM

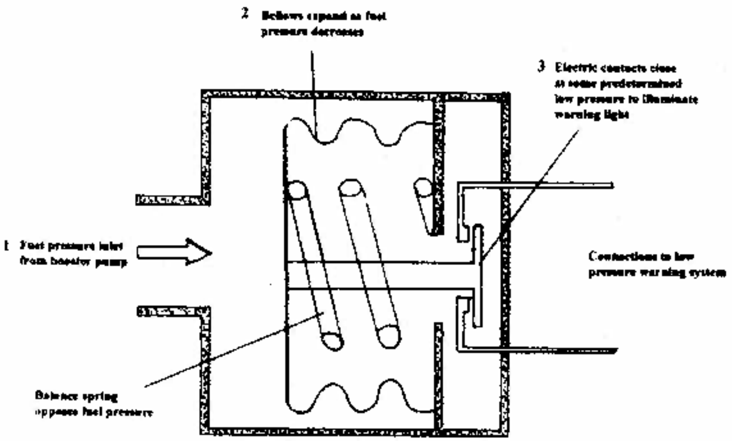
In order to measure temperature very accurately it is necessary to ensure that variations in indication caused by such things as line resistances and supply voltage fluctuations are minimised. The ratiometer operates by applying the same supply voltage to two resistive circuits. The resistance of one circuit is constant, whilst that of the other increases with temperature. The current flow through each circuit is therefore proportional to the supply voltage and the resistance of each circuit. But both circuits share the same power supply, so the ratio of the two currents will vary only with variations in temperature. This means that the ratiometer carries out an independent test of the supply current (option d). A ratiometer is therefore largely immune to variations in power supply and is therefore ideal for the accurate measurement of temperatures.

ENGINES 20 c and d.

This question is problematic in that different engines have used different types of sensor as the technology has developed. If the requirement is for an indication of absolute pressure then an aneroid capsule will be used (option d). But if the measurement is to be used to vary fuel flow in a hydro-mechanical fuel system then a bellows is more likely (option c). Differential capsules and Borden tubes (options a and b) are unlikely to be used. Options c and d are therefore both potentially correct answers to this question. Students should therefore appeal if this question appears in their examination. It should also be noted that very modern systems use electronic transducers.

ENGINES 21 a and b.

This question is dubious in that the sensor may be an aneroid capsule or bellows. In most aircraft the LP fuel system pressure is not indicated, but its pressure is monitored to operate a low pressure warning or booster pump failure light. In such circumstances, it is the absolute pressure (relative to zero) that is important. So a differential capsule (option d), subtracting one pressure from another, is unsuitable. Bourdon tubes (option c) are used to measure very high pressure so they are totally unsuitable for use in measuring the low pressure produced by LP fuel pumps. Then most commonly used sensor is a micro-switch activated by the deformation of a thin capsule or bellows as illustrated below.



BELLOWS TYPE LP FUEL PRESSURE SENSOR

It should however be noted that whether a capsule or bellows, it must be an aneroid in order so give an indication of absolute pressure (relative to zero). So although options a and b are both true, option a is the most accurate.

ENGINES 22 a.

The question is rather dubious in that none of the options represent serious disadvantages in single phase AC generator tachometers. It is therefore necessary to select the best option through a process of elimination. Statement 1 is totally untrue because such systems do not have commutators. So any option which includes statement 1 is untrue. This eliminates options b, c and d, leaving option a as the best answer. It should however be noted that even this option is dubious because such system transmit information in the form of the frequency of an AC current. Line resistance losses will not alter this frequency, but will reduce current strength.

ENGINES 23 a.

Single phase AC generator tachometers do not have commutators so statement 1 is true. This fact eliminates option c and d because they do not include statement 1. All AC tachometers transmit the information in the form of the frequency of the AC current produced. Although line resistance losses will reduce the strength of the signal, they will not alter the frequency. This means that line resistance losses are not of great importance in terms of the information transmitted, so statement 2 is untrue. This fact eliminates options b, c and d. Because they generate their own AC current such systems are independent of the aircraft power supplies, so statement 3 is true. So option a is the only correct answer to this question.

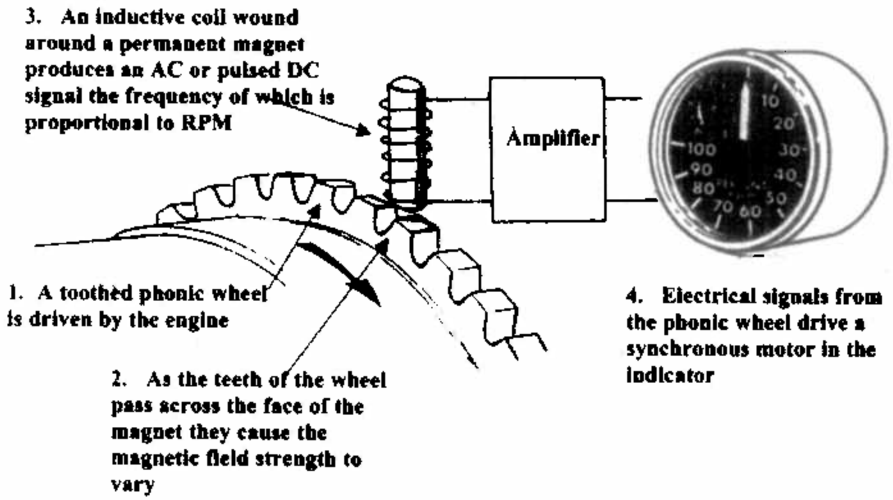
ENGINES 24 c.

Some early types of aircraft employed DC generator tachometers to measure engine RPM. These consisted of a miniature DC generator driven by the engine and a simple DC motor driving the indicator. The voltage produced by the generator was directly proportional to the engine RPM. The motor drove a magnetic drag cup consisting of a small magnet rotating within a metal cup. Although there was no direct connection between the magnet and the cup, the magnetic field of the rotating magnet applied a torque to the cup. The cup was connected directly to the spindle of the indicator needle.

The torque craeted by the darg cup was opposed by a weak hair spring. The faster the motor turned the greater would be the torque applied to the cup and the greater would be the deflection of the hairspring and needle. In this way the rotation of the motor was converted into angular deflection of the indicator needle. The motor RPM, was proportional to the DC voltage produced by the generator. Because this DC voltage was proportional to the generator RPM, the needle position gave an indication of the engine RPM.

Because the system used a DC current, only two wires were required to transmit the information. This made the transmission of data very simple, so statement 1 is true. Also because the system generated its own current it was independent of the aircraft power supplies, so statement 2 is also true. One of the disadvantages of this system was that arcing at the commutators of the generator and motor produced spurious signals that could affect other equipment, so statement 3 is untrue. The only correct answer to this question is therefore option c.

ENGINES 25 c.
The question is ambiguous in that the term "electronic tachometer sensor" may be taken to mean a number of different things. One such system uses a toothed wheel rotating in front of an electro-magnet (option c). Whenever one of the teeth is aligned with the magnet, the magnetic field is very strong. Whenever a gap between the teeth is aligned with the magnet, the field strength is reduced. The frequency of the variation if field strength is proportional to the RPM of the toothed wheel. A typical system is illustrated below.



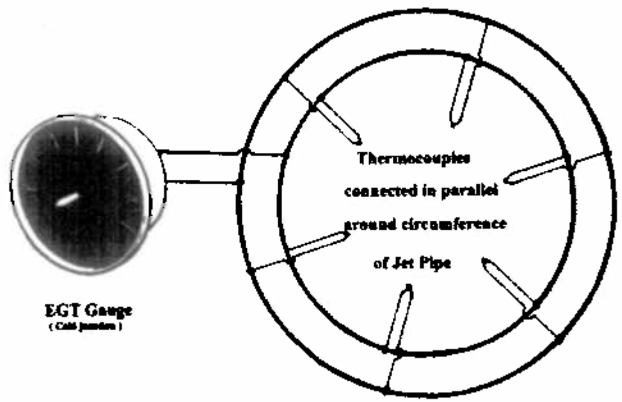
ENGINES 26 d.
This question is ambiguous in that the term "electrical induction tachometer" may be taken to mean a number of different things. One such system uses a toothed wheel rotating in front of an electro-magnet. Whenever one of the teeth is aligned with the magnet, the magnetic field is very strong. Whenever a gap between the teeth is aligned with the magnet, the field strength is reduced. The frequency of the variation if field strength is proportional to the RPM of the toothed wheel.

Because the information is in the form of frequency it is not very sensitive to errors due to variations in line resistances, so 1 is true. The system generates its own electrical power making it independent of the aircraft power supplies, so 2 is also true. Although temperature variations will not affect the frequency of the signal, any very large changes in temperature will alter the amplitude of the signal and can in extreme cases affect the indications. Statement 3 is not therefore entirely

true. The system can however be used to drive several different indicators provided they are connected in parallel. Statements 1, 2 and 4 are therefore true (option d). It should however be noted that the difference between options b and d are marginal. Students should therefore appeal if this question appears in their examination.

ENGINES 27 d.
The hot gasses passing through a gas turbine engine become exhaust gas only after they have passed through the final turbine. In a multi-turbine engine this would be the lowest pressure turbine. This is not provided as an option in this question, so option d, "the high pressure turbine outlet" is the best answer. Options a, b and c are all untrue because they are all upstream of the turbines.

ENGINES 28 a.
The hot gasses passing through a gas turbine engine become exhaust gas only after they have passed through the final turbine. In a multi-turbine engine this would be the lowest pressure turbine. Temperatures in this location are extremely high so the most commonly used type of sensor is the thermocouple (option a). A number of thermocouples connected in parallel are typically used as illustrated below.



Typical Thermocouple Temperature Gauging System

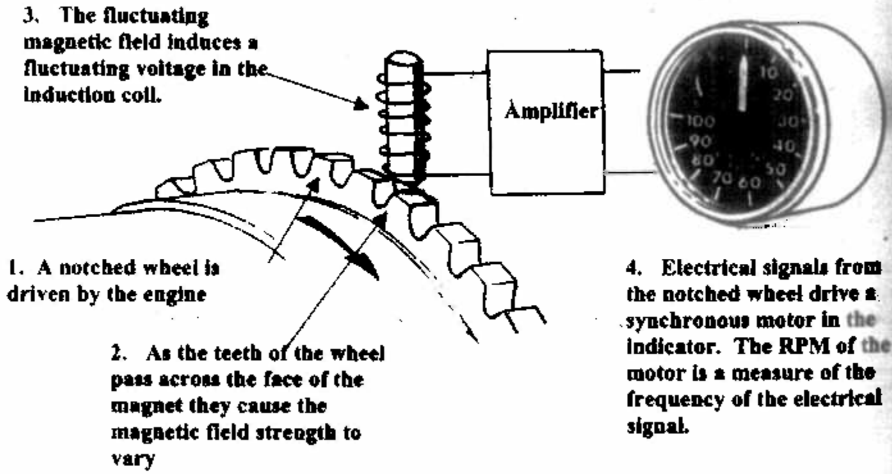
ENGINES 29 c.
This question refers to a component called a dead needle, which is used in some temperature gauges. The dead needle is not directly connected to the gauge indicating needle, but is mounted on an independent coaxial spindle. The dead needle is manually set at the maximum allowable temperature prior to engine start up. As the engine is started up, its exhaust gas temperature increases and the indicator needle rotates towards the dead needle. If the EGT reaches the limit, the

indicator needle will come into contact with the dead needle. If EGT continues to rise the indicator needle will drive the dead needle around with it.

When EGT starts to fall the indicator needle will move back, leaving the dead needle at the point indicating the highest temperature reached. In this way the dead needle moves when the corresponding value is exceeded and remains positioned at the maximum value that has been reached (option c)

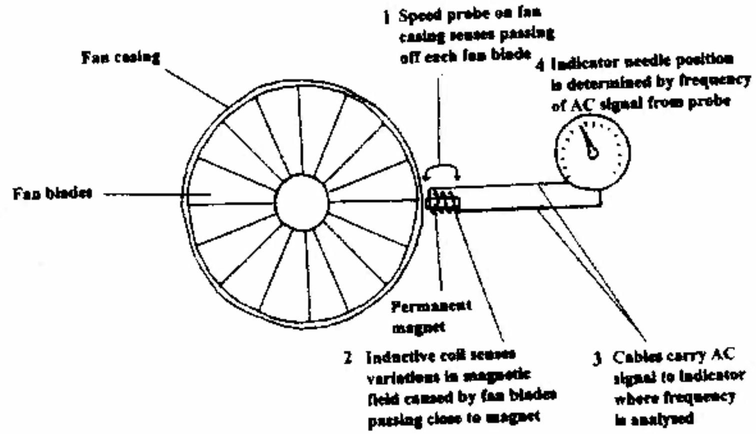
ENGINES 30 b.
As technology has developed over the years engine fuel control systems have evolved from simple mechanical devices, through hydro-mechanical system to the modern computer controlled electronic systems. The current state of technology is the Full Authority Digital Engine Control system or FADEC. As its name suggests, FADEC has full authority over all of the functions of the engine. These functions include all of those listed in this question, so option b is correct.

ENGINES 31 b.
As illustrated below an inductive tachometer system employs an electro-magnetic induction coil placed close to a notched wheel. The wheel is driven by the engine at a speed that is proportioanl to engine RPM. Whenever one of the teeth is aligned with the magnet, the magnetic field is very strong. Whenever a gap between the teeth is aligned with the magnet, the field strength is reduced. The frequency of the variation if field strength is proportional to the RPM of the notched wheel. This fructuating magnetic field induces a fluctuating voltage in the induction coil. The frequency of the electrical output signal is therefore a measure of the RPM of the engine. So the operating principle of an inductive tachometer is to measure the frequency of electrical impulses created by a notched wheel rotating in a magnetic field (option b).

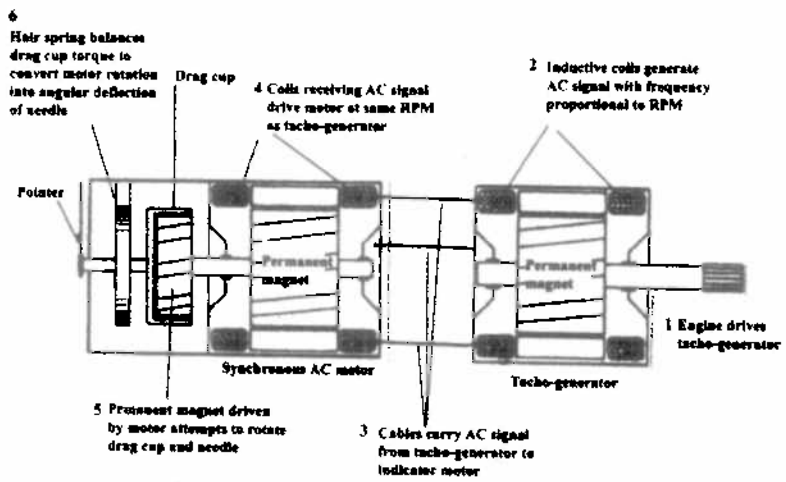


ENGINES 32 c.
This question is dubious in that it does not specify what is meant by the term "electronic" tachometer". If this is interpreted to mean a modern digital system used for example with ECAM or EICAS, then the sensor is most likely to be an inductive speed probe. This consists of an inductive coil wrapped around a small magnet. The magnet is placed close to either a toothed phonic wheel or the fan or compressor blades of the engine. As the engine rotates the teeth of the wheel or the fan or compressor blades pass in front of the magnet. This causes the magnetic field strength to fluctuate, being strongest when a tooth or blade aligns with the magnet and weakest when a gap does so. This fluctuating magnetic field induces a pulsed DC or AC voltage in the inductive coil. The frequency of this voltage is proportional to the engine RPM.

So the operating principle of an "electronic" tachometer is to measure the frequency of the electric impulse created by a notched wheel rotating in a magnetic field (option c).



ENGINES 33 a.
As illustrated below this type of system employs an AC generator or alternator driven by the engine. This is usually a three phase device, but can be single phase. The frequency of the alternator output varies with engine RPM. The AC signal is fed to a synchronous motor within the magnetic tachometer. Because of its synchronous nature, the motor runs at an RPM equal to the signal frequency. This continuous rotation is then converted into angular deflection of a pointer by means of magnetic a drag cup. So only statements 3 and 5 are true (option a).

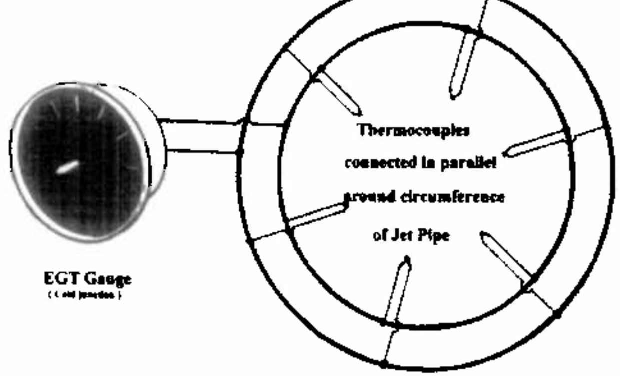


AC TACHO-GENERATOR SYSTEM

ENGINES 34 b.
Turbojet engines produce thrust by accelerating air rearwards. The amount of thrust produced is equal to the mass flow of air passing through the engine multiplied by the acceleration given to that air. This means that an indication of thrust can be provided by measuring either the mass flow of air or the acceleration given to that air.

The mass flow of air at any given altitude is proportional to the engine low pressure spool or Fan RPM. One type of thrust indication system is based upon the fan RPM, which is termed N1. The acceleration given to the airflow is proportional to the amount by which its pressure is increased as it passes through the engine. This is called the engine pressure ratio or EPR, which is equal to the low pressure turbine outlet pressure divided by the low pressure compressor inlet pressure. It is important to note that EPR is the ratio of the pressures at two different locations within the engine, and is not simply the pressure at any one point. So the two main sources of information used to calculate turbojet thrust are the Fan rotation speed (or N1) or the EPR (Engine Pressure Ratio).

ENGINES 35 b.
The hot gasses passing through a gas turbine engine become exhaust gas only after they have passed through the final turbine. In a multi-turbine engine this would be the lowest pressure turbine. Temperatures in this location are extremely high so methods such as bi-metallic strips and liquid expansion thermometers are unsuitable. The most commonly used type of sensor is the thermocouple (option b). A number of thermocouples connected in parallel are typically used as illustrated below.



Typical Thermocouple Temperature Gauging System

ENGINES 36 d.
Engines fitted with constant speed propellers have three main controls. These are:

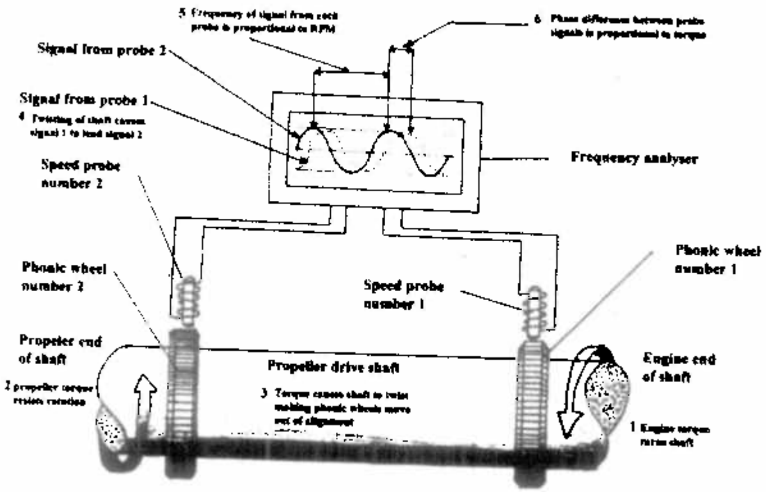
1. **The RPM lever which controls propeller/engine RPM.**
2. **The throttle or power lever which controls engine power output.**
3. **The mixture control lever which controls the fuel:air ratio.**

It should be noted that because they run at constant RPM, the power output of such engines is not directly related to RPM. The indicators used with such engines are typically:

1. **The RPM indicator which is used to indicate propeller RPM and to enable the pilot to control the propeller RPM regulator (option d).**
2. **The MAP or Boost gauge which is used in conjunction with the throttle or power lever to control power output.**
3. **The temperature indicator which is used in conjunction with the mixture lever.**

ENGINES 37 b.
One commonly used type of torque meter measures the oil pressure required to prevent rotation of the annular gear of a epicyclic reduction gearbox as illustrated below. Although option a appears to describe this system, closer inspection of the wording of the is option reveals that it does not in fact do so. The option uses the term "fixed crown gear". This is not the correct name for the "Annular gear" used in this type of system. The use of the term "epicycloidal" is also incorrect as the type of gearbox is in fact an "epicyclic gearbox". Option a is therefore incorrect.

Option c is incorrect because the frequency of the output of a single impulse tachometer will indicate RPM but not torque. Option b is correct in that one type of torque metering system uses this method as illustrated below. Option d appears to describe the type of system used in the Gazelle helicopter. But this system measure the frequency of pulses of light rather than the quantity of light.



TWIN PHONIC WHEEL RPM AND TORQUE MEASURING SYSTEM

ENG 38. a.
Engine air inlet temperatures are typically in the low to medium temperature range. They are usually measured using a resistive temperature probe (option a) or thermocouple (not an option). Mercury (option b) and alcohol (option c) are rarely used for this purpose in modern aircraft because of the hazardous nature of these materials and their need for relatively heavy capillary tubes. Optical pyrometry is an advanced temperature sensing method and is currently only in use for the measurement of turbine temperatures in prototype engine testing.

ENG 39. d.
Thermocouple temperature measurement systems operate on the basis of the Seebeck effect. Two dissimilar metal electrical conductors are joined at each end. Whenever one of these junctions is hotter than the other, a voltage is created in the conductor. The magnitude of this voltage is proportional to the difference in temperature between the two junctions. If the cold junction is kept a constant temperature, the voltage will be proportional to the temperature of the hot junction. So if the cold junction is kept at constant temperature, a millimetric voltmeter can be calibrated to indicate the temperature of the hot junction (option d).

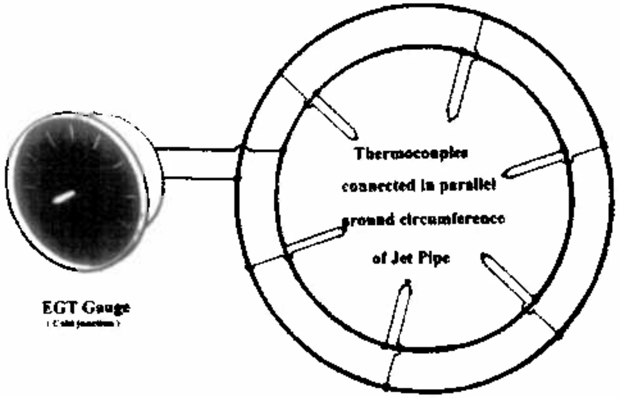
Although options a and b are also true, keeping the junction at absolute zero would be an unnecessary complication, because any constant temperature will suffice. Option c is also true but omits the need for the selected temperature to remain constant. Option d is therefore the most appropriate in this question.

ENG 40. c.
Thermocouple temperature measurement systems operate on the basis of the Seebeck effect (option c). Two dissimilar metal electrical conductors are joined at each end. Whenever one of these junctions is hotter than the other, a voltage is created in the conductor. The magnitude of this voltage is proportional to the difference in temperature between the two junctions. So basic thermocouple systems do not require any form of external power supply (options a and b). It should be noted that option d is incorrect in that inductive reactance plays no part in the Seebeck effect.

ENG 41. d.
The most commonly used method of measuring cylinder head temperature is by means of a thermocouple (options a and d). Resistive probes (options b and c) are not in general use because of their need for an external power supply.
Aircraft piston engines usually possess a considerable number of cylinders, so the use of a thermocouple on each would be expensive and complex. In order to overcome this problem, most light aircraft piston engines employ a single thermocouple fixed to the hottest cylinder(option d). This is because the danger of detonation and engine damage is greatest where temperature is highest

ENG 42. d.
Engine turbine and exhaust gas temperatures are usually measured using thermocouples (1). Resistive temperature probes (3) are commonly used for engine oil temperature measurement and sometimes air inlet temperature. Mercury is rarely used in modern engines because of the hazardous and corrosive nature of the material and the need for relatively heavy capillary tubes. Capacitive temperature sensing elements (4) are possible, but are never used in current aircraft engines. So option d, thermocouples and resistive probes, is the most appropriate for this question.

ENG 43. c.
Engine turbine and exhaust gas temperatures are usually measured using thermocouples. In order to maintain system effectiveness in the event of a probe failure, a large number of probes are usually employed. These are connected in parallel as illustrated below, so that failure of a single probe will have a minimal effect on the accuracy of the system (option c).



Typical Thermocouple Temperature Gauging System

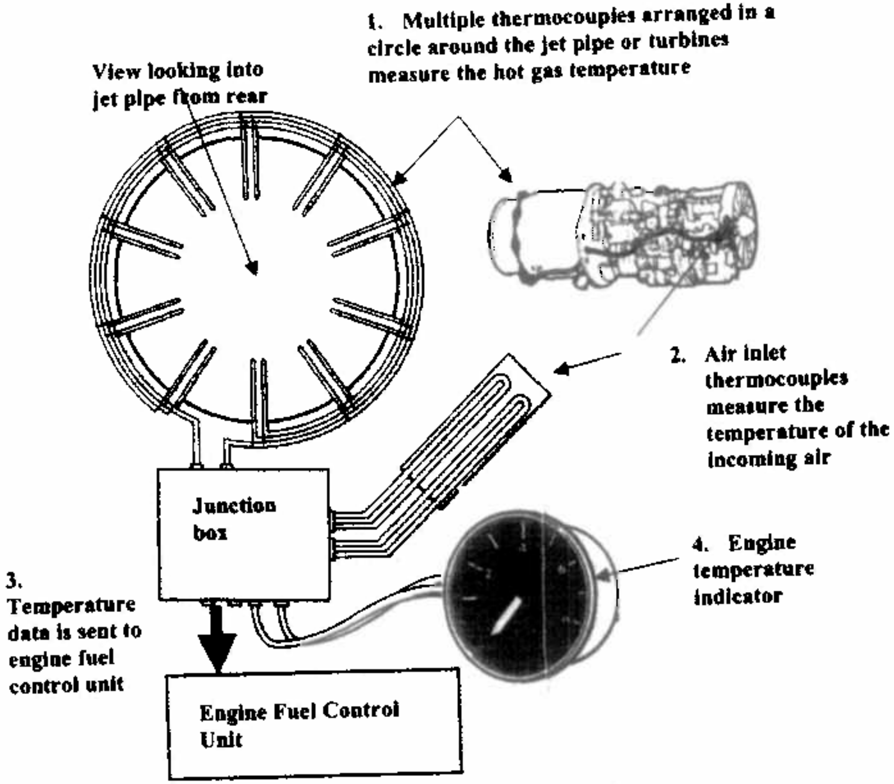
ENG 44. a.
The most commonly used method of measuring cylinder head temperature is by means of a thermocouple (option a). Resistive probes (options b) are not in general use because of their need for an external power supply. Although the design of a capacitive temperature (option c) sensing system is possible, such systems are not in use in any current aircraft. Bi-metal strips (option d) are generally used only in such things as thermostatic valves.

ENG 45. b.
Thermocouple temperature measurement systems operate on the basis of the Seebeck effect. Two dissimilar metal electrical conductors are joined at each end (option b). Whenever one of these junctions is hotter than the other, a voltage is created in the conductor. The magnitude of this voltage is proportional to the difference in temperature between the two junctions. If the cold junction is kept a constant temperature, the voltage will be proportional to the temperature of the hot junction.

If the metals were connected at only one point (option a) no current could flow. Option c appears to refer to some type of capacitive system. Such systems are not related to thermocouples and are not currently used in aircraft. The Seebeck effect is caused by the dissimilar nature of the two metals so using two similar metals (option d), would be ineffective.

ENG 46. c.
Engine turbine and exhaust gas temperatures are usually measured using thermocouples. In order to maintain system effectiveness in the event of a probe failure, a large number of probes are usually employed. These are connected in

parallel (option c) as illustrated below, so that failure of a single thermocouple will have a minimal effect on the accuracy of the system. A single thermocouple (option a) or a number connected in series (option b) are not used because this would cause all indications to be lost if one thermocouple failed. A thermistor (option d) is a transistor, the resistance of which varies with temperature. They are often used as thermostatic switches but are not used to measure jet engine exhaust temperatures.



TYPICAL THERMOCOUPLE SYSTEM

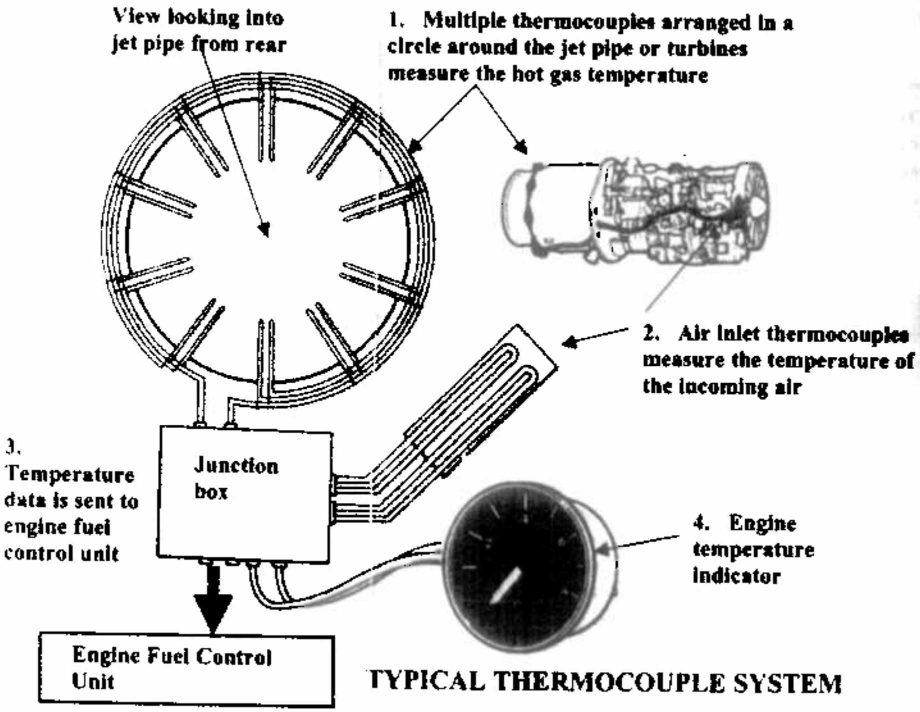
ENG 47. b.
This question refers to the dead needle system employed in some aircraft types. A movable red pointer can be rotated to position it over the red line that indicates the maximum permissible temperature. As engine temperature increases during start up and operation, the indicator pointer moves up towards the movable red pointer. If the maximum permissible temperature is exceeded, the needle pushes the red line up to whatever maximum is reached, then leaves it there as temperatures subsequently decline. So the red pointer position remains as a record of the maximum temperature that was attained in excess of the red line limit.

ENG 48. c.

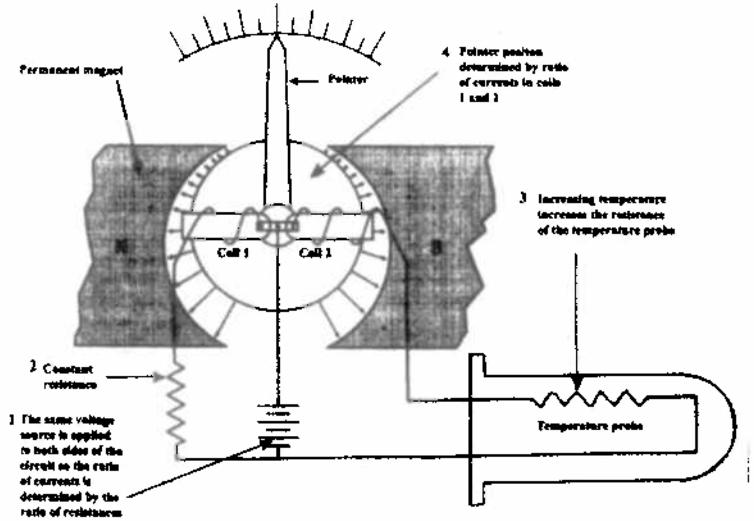
Thermocouple temperature measurement systems operate on the basis of the Seebeck effect. Two dissimilar metal electrical conductors are joined at each end. Whenever one of these junctions is hotter than the other, a voltage is created in the conductor. The magnitude of this voltage is proportional to the difference in temperature between the two junctions. If the cold junction is kept a constant temperature, the voltage will be proportional to the temperature of the hot junction. So if the cold junction is kept at constant temperature, a millimetric voltmeter can be calibrated to indicate the temperature of the hot junction (option c). The temperatures specified in options a and b, have no special significance in this matter. Option d is incorrect because the hot junction must be exposed to the hot gasses in order to measure their temperature.

ENG 49. d.

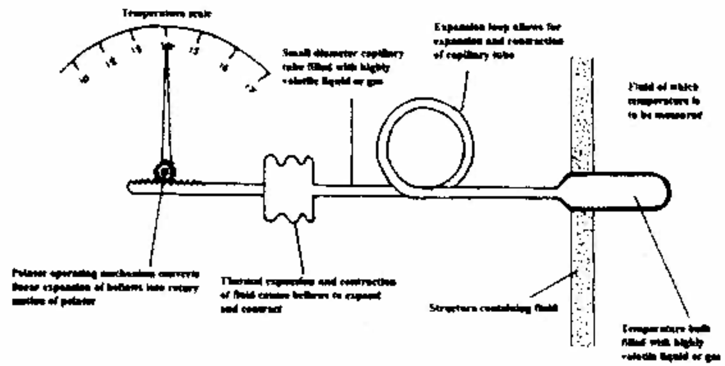
Thermocouple temperature measurement systems operate on the basis of the Seebeck effect (1). Two dissimilar metal electrical conductors are joined at each end. Whenever one of these junctions is hotter than the other, a voltage is created in the conductor. Resistive temperature probes as illustrated below, operate on the basis that the probe resistance increases as temperature increases (2). Although it might be possible to design and construct a temperature measurement system based on capacitance (3), such systems are not currently in use in aircraft. Thermal expansion and contraction (4) are sometimes used to measure temperatures in aircraft. Such systems are illustrated below.



TYPICAL THERMOCOUPLE SYSTEM



RATIOMETER TEMPERATURE MEASUREMENT SYSTEM



Typical Thermal Expansion Type Temperature Measuring System

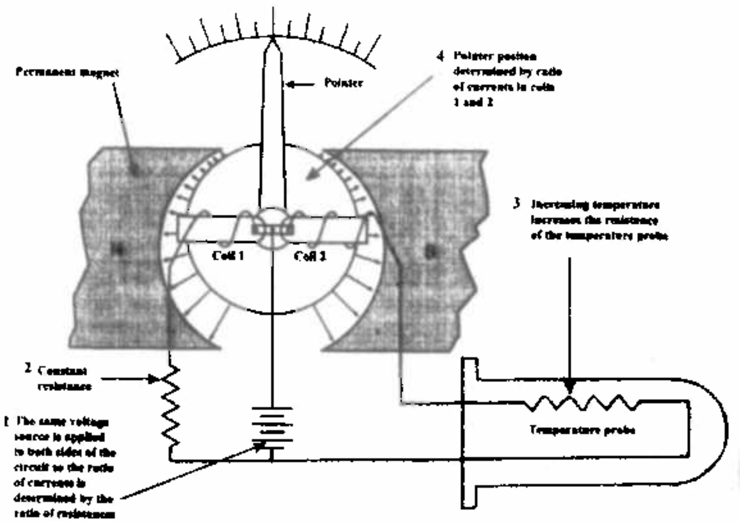
ENG 50. d.
The most commonly used method of measuring cylinder head temperature is by means of a thermocouple. Aircraft piston engines usually possess a considerable number of cylinders, so the use of a thermocouple on each would be expensive and complex. In order to overcome this problem, most light aircraft piston engines employ a single thermocouple fixed to the hottest cylinder(option d). This is because the danger of detonation and engine damage is greatest where temperature is highest

ENG 51. b.
Various terms are used to describe the temperatures at different points within gas turbine engines. Examples are compressor inlet temperature, compressor outlet temperature, turbine inlet temperature, turbine outlet temperature, jet pipe temperature and exhaust gas temperature. The term exhaust gas temperature (EGT) refers to the temperature of the gas as it exits from the last or low pressure turbine. So option b is the most appropriate in this question. It should be noted that where an engine has more than one turbine, the high pressure (HP) turbine is upstream of the LP turbine. Gas flowing into and out of the HP turbine (options a and d) is therefore hotter than the EGT of the gas flowing out of the LP turbine.

ENG 52. a.
Various terms are used to describe the temperatures at different points within gas turbine engines. Examples are compressor inlet temperature, compressor outlet temperature, turbine inlet temperature, turbine outlet temperature, jet pipe temperature and exhaust gas temperature. The term exhaust gas temperature (EGT) refers to the temperature of the gas as it exits from the last or low pressure turbine. So option a is the most appropriate in this question.

Options b and c are incorrect because they refer to turbine inlet temperature (TIT) and jet pipe temperature (JPT) respectively. Combustion chamber temperature (option d) is much higher than EGT and is in fact rarely measured except in prototype and development engines. It should be noted that few if any aircraft provide indications of both EGT and JPT simultaneously.

ENG 53. a.
A ratiometer system is illustrated below. It works by comparing the ratio of currents passing through two resisters. One resistor is kept constant, whilst the other varies with changes in temperature. But both resistors are fed from the same voltage supply, so the ratio of the currents flowing through each is determined only by the temperature-induced variations in resistance in the temperature probe. The lengths and hence line resistances of the two sides of the circuit are approximately equal. A ratiometer is therefore largely insensitive to line resistance losses, option a is true and options b and c are untrue. It should however be noted that damage to any single side of the circuit will degrade its accuracy so option d is untrue.



RATIOMETER TEMPERATURE MEASUREMENT SYSTEM

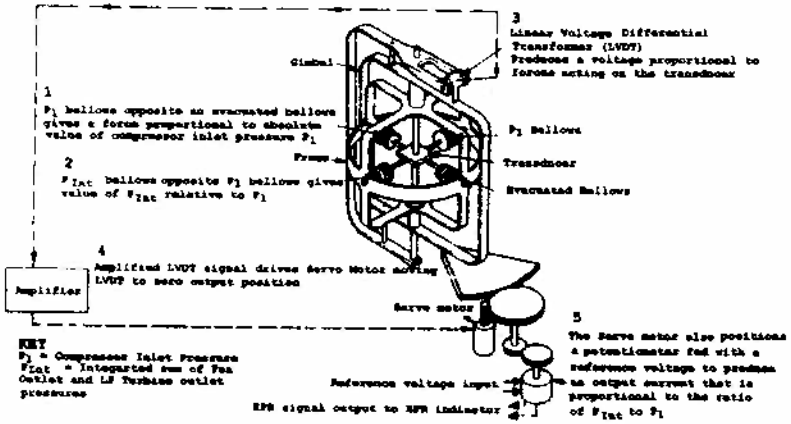
ENG 54. a.
Resistive temperature probes as illustrated in the previous question, operate on the basis that the electrical resistance of the probe increases as temperature increases. They are not suitable for the sensing of extremely high temperatures, but are commonly used for such things as engine lubricating oil temperature measurement systems.

Although it might be possible to design a capacitive temperature measurement system (option b), such systems are not commonly used in aircraft. Thermocouples (option c) are commonly used for exhaust gas and turbine temperature measurement but rarely for lubricating oil. Bi-metalic strips are most commonly used in thermostatic switches and light aircraft air temperature gauges.

ENG 55. b and c.
EPR is the ratio of LP Turbine outlet pressure to LP compressor inlet pressure. It is therefore calculated by dividing the first of these pressures by the second. None of the options listed will achieve such a division, so none are strictly correct. This question has however been reported by a number of students, so it is probably an accurate representation of a real question. It is therefore necessary to gauge which of the options the examiners most probably believe to be correct.

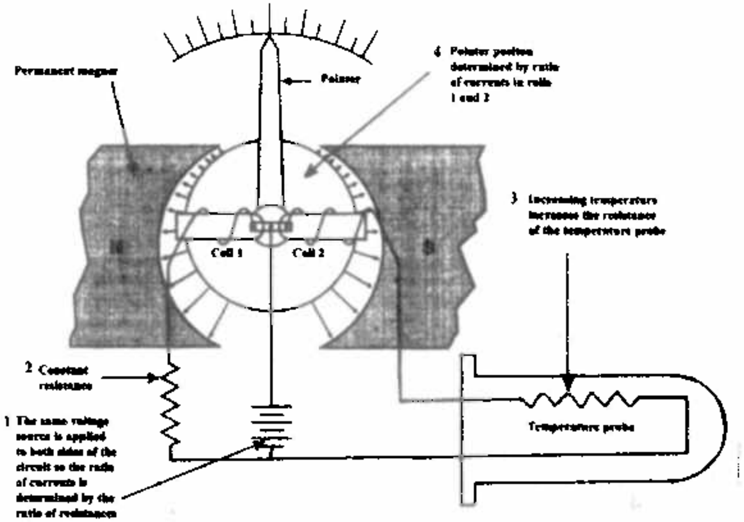
Bourden tubes measure high pressures and capsules produce very small mechanical outputs, neither of which are required in an EPR gauge. So option a can be discarded. A differential capsule subtracts one pressure from another to leave the difference between the two. In an ASI for example this method is used to extract dynamic pressure from pitot pressure by subtracting static pressure. But the EPR gauge must divide one pressure by another to give the ratio of the two pressures so option b is untrue. Capacitive probes (option d) are used in fuel tank contents measuring systems.

The diagram below shows how a typical EPR gauge is constructed. LP compressor (or Fan) inlet pressure (P_1) is fed into a bellows opposite an aneroid capsule(option c) or bellows (option b). This arrangement gives an absolute value of P_1. The integrated sum of Fan outlet and LP turbine outlet pressures (P_{Int}) is fed into a bellows opposite a P_1 bellows. This gives a value of P_{Int} minus P_1. The forces generated by the bellows act upon a transducer and Linear Voltage Transformer to generate an electrical signal. This is amplified and fed to a servo motor to position a potentiometer to produce a signal relative to the ratio $P_{Int} : P_1$ which is EPR. This signal is fed to the EPR indicator in the cockpit. Option b, bellows and option c aneroid capsule, are therefore both correct.



TYPICAL ELECTRO-MECHANICAL EPR SENSOR

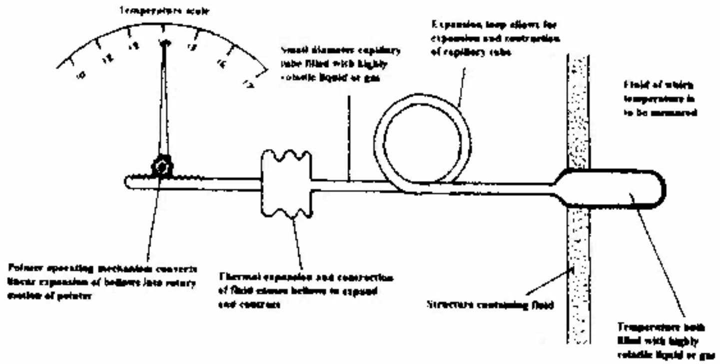
ENG 56. b.
The range of temperatures to be measured in a carburettor inlet temperature system is relatively low and great accuracy is not required. The most commonly used method is therefore the resistive probe as illustrated below. It should be noted that reactive and capacitive probes, option c and d are not in common use in any aircraft systems.



RATIOMETER TEMPERATURE MEASUREMENT SYSTEM

ENG 57. b.
The range of temperatures to be measured in an engine oil system is relatively low and great accuracy is not required. The most commonly used method is therefore the resistive probe as illustrated in the previous question. It should be noted that reactive and capacitive probes, option c and d are not in common use in any aircraft systems.

ENG 58. a.
The range of temperatures to be measured in an engine fuel system to compensate for altitude changes, is relatively low. In non FADEC systems there is no specific requirement for an electrical output, so the most commonly used method is therefore the liquid expansion probe (option a) as illustrated below.



Typical Thermal Expansion Type Temperature Measuring System

It should be noted that reactive and capacitive probes, option b and d are not in common use in any aircraft systems. Bi-metalic strips (option c) are most commonly used in thermostatic switches and light aircraft air temperature gauges.

ENG 59. b.

The circumferences of the dials of EGT gauges are commonly marked with colour coded arc to indicate various temperature ranges. The usual coding system is as follows:

White, green or uncoloured.	Normal range for unrestricted use (option a).
Amber.	Cautionary range available for limited time. This might include maximum EGT for take-off or climb power (option b).
Red.	Maximum allowable temperature, available for momentary use only.

It should be noted that options c and d are not commonly used terms.

ENG 60. b.

The ratiometer operates by applying the same supply voltage to two resistive circuits, as illustrated in ENG 19. The resistance of one circuit is constant, whilst that of the other increases with temperature. The current flow through each circuit is therefore proportional to the supply voltage and the resistance of each circuit. Both circuits are of the same length and share the same power supply, so the ratio of the two currents will vary only with variations in temperature. A ratiometer is therefore largely insensitive to variations in line resistances (option b)

or power supply. So options a and d are untrue. Option c is strictly true only if the line resistance of both circuits vary to the same degree.

ENG 61. b and d.

Turbine engine air inlet pressures are typically quite low, so a bourdon tube (option a), which measures high pressures, would be ineffective. A differential capsule (option c) is also inappropriate in that it is the absolute pressure above zero that is of interest. Bellows (option b) and aneroid capsules (option d) are both suitable in that they are both capable of measuring low pressures.

ENG 62. a.

Capsules (1) are very thin metal envelopes which expand and contract in response to changing pressures. They are typically used in pitot static instruments where they measure small changes in very low static and dynamic pressures. Bellows (2) also measure low pressures. They are commonly used in hydro-mechanical fuel systems, where the pressures are in the low to medium range. Bourden tubes are flattened metal tubes formed into a curve. They gradually straighten out when the internal pressure increases. Bourden tubes are used to measure high pressures. The correct sequence is therefore 1,2, 3, as indicated in option a.

ENG 63. c.

A capsule stack is simply a number of capsules stuck together, so that their individual movements are added together to give a larger overall response. They are used to measure low pressures when a large mechanical output for a given pressure change is required (option c).

ENG 64. a.

Bellows are used to measure presure. They are commonly used in hydro-mechanical fuel systems, where the pressures are in the low to medium range.

ENG 65. b.

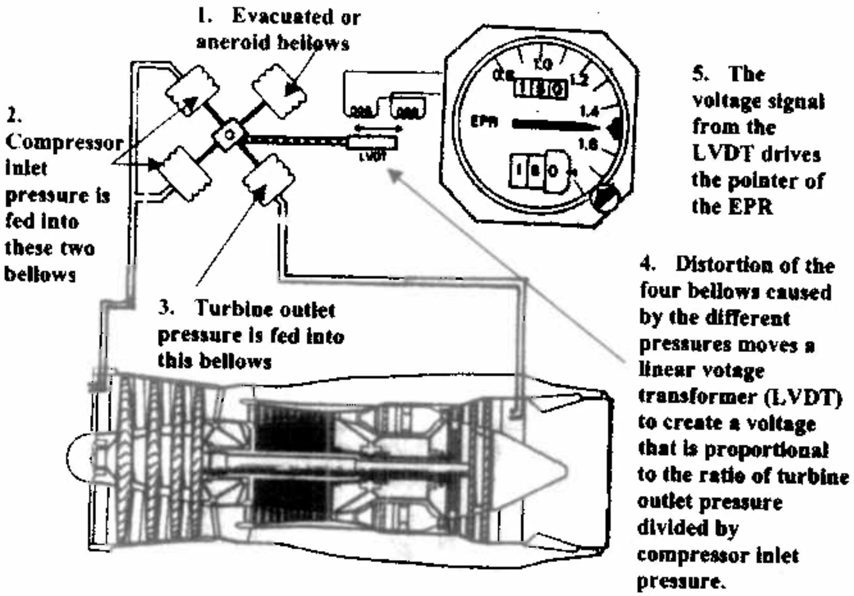
Turbine outlet pressures are measured for a variety of reasons. When measured as part of an EPR gauging system, they are measured using capsules or bellows (option b). In older hydro-mechanical engine fuel systems they are also measured using bellows (option b) to operate engine pressure ratio limiting systems. Differential capsules (option c) are not used because they subtract one pressure from another and bourdon tubes (option d) are not used because they measure high pressures. So options a and b are both correct. Option b is however the most widely used method, so this is probably the one that the examiners require.

ENG 66. b.

Remote pressure sensing systems work by producing an electrical resistance that is proportional to the pressure. This is then transmitted to the cockpit where it is measured using a wheatstone bridge or ratiometer gauge (option b). Options a, c and d are all incorrect because capacitance is not used to measure pressures in current aircraft.

ENG 67. c.

The EPR gauge indicates the ratio of LP turbine outlet pressure to compressor inlet pressure. To do this it divides turbine outlet pressure by compressor inlet pressure (option c) as illustrated in the diagram below.



ENG 68. a.

The critical altitude is the maximum altitude at which a turbocharged engine can maintain its rated boost when climbing at rated power setting. At all lower altitudes the system will automatically maintain rated boost. In this case the critical altitude is 15000 ft, so the boost at 10000 ft will be 10 PSI. But the questions asks what MAP will be at this point. MAP is the absolute pressure in the manifold and can be calculated by adding ISA msl pressure of 15 PSI to the boost pressure. So in this case the MAP will be 25 PSI. This can be converted into inches of mercury by multiplying by 2. So the MAP of 25 PSI is equal to 50 inches of mercury. So option a is correct.

ENG 69. c.

All rotating bodies produce vibration due to minor imbalances and roughness in the bearing surfaces. In the case of aircraft engines, sudden increases in vibration are a sign of damage and can potentially indicate impending failure. It is therefore important that engines be shut down if such increases go beyond specified limits.

Vibration monitoring systems measure both the frequency of the vibration and the amplitude. The frequency indicates the RPM of the damaged component whilst the amplitude indicates the degree of damage. But a pilot in flight has little interest in which specific component in an engine is causing vibration. What he or she needs to know is whether or the not it is safe to continue running the engine. So aircraft vibration monitoring systems indicate the amplitude of the vibration, relative to some specified shut-down threshold (option c).

ENG 70. b.

All rotating bodies produce vibration due to minor imbalances and roughness in the bearing surfaces. In the case of aircraft engines, sudden increases in vibration are a sign of damage and can potentially indicate impending failure. It is therefore important that engines be shut down if such increases go beyond specified limits. Vibration monitoring systems measure both the frequency of the vibration and the amplitude. The frequency indicates the RPM of the damaged component whilst the amplitude indicates the degree of damage. But a pilot in flight has little interest in which specific component in an engine is causing vibration. What he or she needs to know is whether or the not it is safe to continue running the engine. So aircraft vibration monitoring systems indicate the amplitude of the vibration, relative to some specified shut-down threshold (option b).

ENG 71. b.

Vibration in aircraft is commonly measured by accelerometers (1) based on two principles. The inductive (3) method uses a small permanent magnet suspended on weak springs. As the aircraft vibrates, the magnet oscillates on the springs. The magnet is surrounded by an inductive coil, so this oscillation induces an alternating voltage in the coil. The second method is the piezoelectric crystal (2), which creates a small voltage whenever pressure is applied to it. The crystal with a small weight attached to it, is fixed to the structure. As the aircraft vibrates the weight alternately presses on and releases the crystal. This creates an alternating voltage similar to that in the inductive method. In both cases the frequency of the voltage is proportional to the RPM of the vibrating component and the amplitude of the voltage is proportional to the vibration amplitude. So option b is correct. Capacitive systems (4) and strain gauges (5) are not used to measure vibration in current aircraft.

ENG 72. b.

Vibration metering systems in aircraft commonly employ accelerometers to measure both the frequency and amplitude of the vibration. But the signals from the accelerometers are a combination of all of the vibration frequencies present, plus electrical noise. Frequency filters are therefore used to filter out all of the noise and unwanted frequencies, so that only those of interest to the pilot remain. These signals are very weak so they are then amplified before being used to trigger indication systems. So option b is correct.

ENG 73. d.
All rotating bodies produce vibration due to minor imbalances and roughness in the bearing surfaces. In the case of aircraft engines, sudden increases in vibration are a sign of damage and can potentially indicate impending failure. It is therefore important that engines be shut down if such increases go beyond specified limits. Vibration monitoring systems measure both the frequency of the vibration and the amplitude. The frequency indicates the RPM of the damaged component whilst the amplitude indicates the degree of damage. But a pilot in flight has little interest in which specific component in an engine is causing vibration. What he or she needs to know is whether or the not it is safe to continue running the engine. So aircraft vibration monitoring systems indicate the amplitude of the vibration, relative to some specified shut-down threshold (option d).

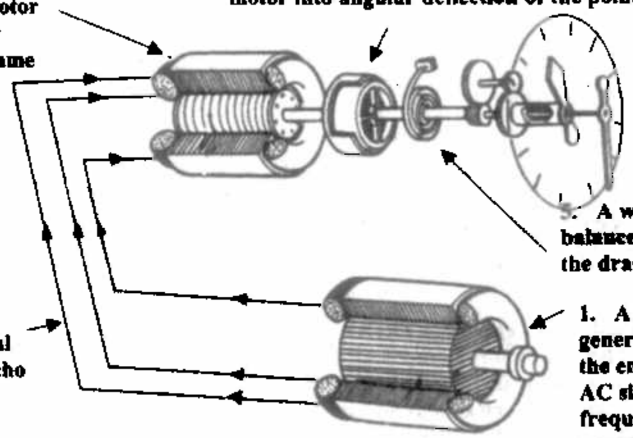
ENG 74. a.
All rotating bodies produce vibration due to minor imbalances and roughness in the bearing surfaces. In the case of aircraft engines, sudden increases in vibration are a sign of damage and can potentially indicate impending failure. It is therefore important that engines be shut down if such increases go beyond specified limits. The components most likely to sustain damage in turbofan engines are the fans and the turbines. The main direction of vibration from rotating bodies is radial, so turbofan vibration sensors are normally radially aligned on the fan and turbine casings (option a).

ENG 75. c.
In multi-propeller aircraft a considerable amount of noise and vibration can be caused by the interaction between adjacent propellers. In order to minimise these effects it is necessary to ensure that all of the propellers operate at the same RPM. In some aircraft this is achieved by manually adjusting the speed select levers for each engine. The purpose of synchroscopes is to assist the pilot in this task, by indicating the RPM differences between the various engines (option c). Each synchroscope typically comprises of a small dial with a propeller symbol within it. If all engines are at the same RPM, all of the synchroscopes will be stationary. Any engines not at the same RPM will be indicated by the rotation rate of their synchroscopes.

ENG 76. d.
Vibration metering systems in aircraft commonly employ accelerometers to measure both the frequency and amplitude of the vibration. The accelerometers measure the radial movement of the engines. But the signals from the accelerometers is a combination of all of the vibration frequencies present, plus electrical noise. Frequency filters are therefore used to filter out all of the noise and unwanted frequencies, so that only those of interest to the pilot remain. These signals are very weak so they are then amplified before being used to trigger indication systems. So option d is correct.

ENG 77. b.
Vibration in aircraft is commonly measured by accelerometers based on two principles. The inductive (1) method uses a small permanent magnet suspended on weak springs. As the aircraft vibrates, the magnet oscillates on the springs. The magnet is surrounded by an inductive coil, so this oscillation induces an alternating voltage in the coil. The second method is the piezoelectric crystal (4), which creates a small voltage whenever pressure is applied to it. The crystal with a small weight attached to it, is fixed to the structure. As the aircraft vibrates the weight alternately presses on and releases the crystal. This creates an alternating voltage similar to that in the inductive method. In both cases the frequency of the voltage is proportional to the RPM of the vibrating component and the amplitude of the voltage is proportional to the vibration amplitude. So option b is correct. Phonic wheels (2) are used to measure RPM and torque. Magnetometers (3) are not used in current aircraft.

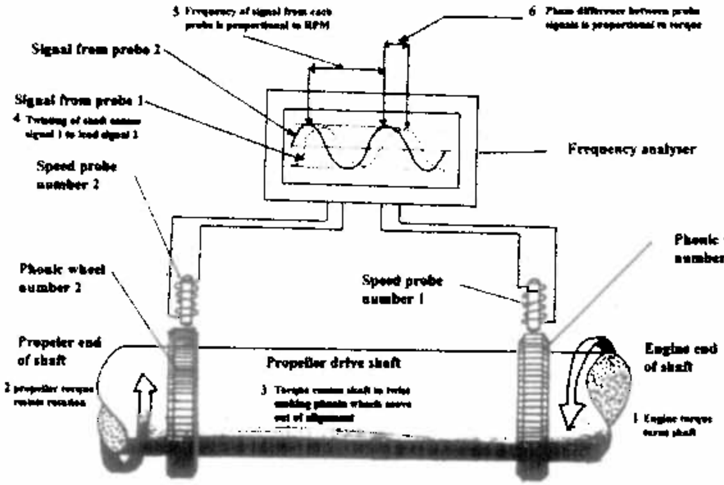
ENG 78. d.
A tacho-generator engine RPM measuring system employs an AC generator driven by the engine. This is usually a three phase device, but can be single phase or even DC in older system. In the AC systems, the frequency of the generator output varies with engine RPM. The AC signal is fed to a synchronous motor within the indicator. Because of its synchronous nature, the motor runs at an RPM equal to the signal frequency. This continuous rotation is then converted into angular deflection of a pointer by means of magnetic a drag cup. Most modern systems are 3 phase AC, so option d is the most appropriate in this question.



THREE PHASE TACHO GENERATOR

ENG 79. a.

Both torque and engine RPM can be measured simultaneously using a system of two phonic wheels. Wheels are fixed to each end of the engine output shaft, such that their teeth are aligned when no torque is applied. Adjacent to each wheel is a speed probe comprising of an inductive coil wrapped around a magnet. As the shaft rotates, the teeth of each wheel pass close to the adjacent magnets. The passing of the teeth causes the magnetic fields to fluctuate, thereby inducing a currents in the coils. The frequency of each current is proportional to RPM of the wheel. The signals from both wheels are in phase when no torque is applied to the shaft. But as torque increases, the shaft is twisted, causing the phonic wheels to rotate out of alignment. This in turn causes the signals from the two wheels to move out of phase. The phase difference between the wheels is proportional to torque. So option a is the most appropriate in this question. This system is illustrated below.



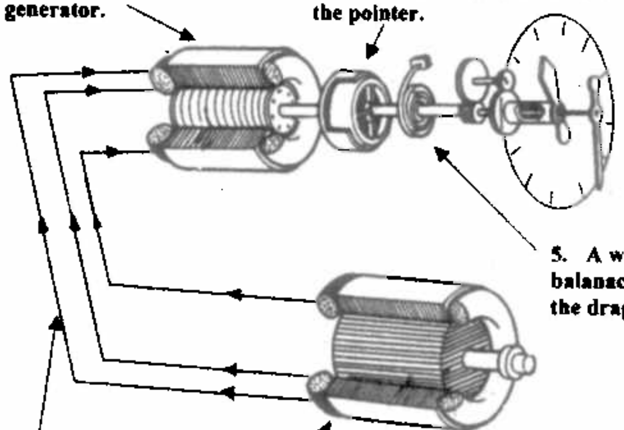
TWIN PHONIC WHEEL RPM AND TORQUE MEASURING SYSTEM

ENG 80. b.

A tacho-indicator receives an electrical signal that is in some way proportional to the RPM being measured. In an AC system it is the signal frequency that represents RPM, whilst in a DC system it is the amplitude. In both cases this signal is fed to a motor which rotates at a speed proportional to the RPM being measured. This continuous rotation must then be converted into a limited degree of angular deflection of a pointer in the indicator. This is achieved by a magnet rotating within a metal drag cup (option b). As the magnet is rotated by the motor it attempts to turn the cup with it. But cup rotation is limited by a weak spring. At any given RPM, the turning effect of the magnet balances the spring such that the pointer angle indicates RPM.

ENG 81. c.

AC tachometer systems employ an AC generator driven by the engine, to produce a signal the frequency of which is proportional to measured RPM. This signal is fed to a squirrel cage synchronous AC motor. Because of its synchronous nature, the motor runs at a speed that is proportional to the frequency of the signal. Most modern systems employ 3 phase generators and motors to improve accuracy. This system is illustrated below.



THREE PHASE TACHO GENERATOR

ENG 82. d.

Tacho-generator systems employ an AC generator driven by the engine, to produce a signal the frequency of which is proportional to measured RPM. This signal is fed to a squirrel cage synchronous AC motor. Because of its synchronous nature, the motor runs at a speed that is proportional to the frequency of the signal (option d). Most modern systems employ 3 phase generators and motors to improve accuracy. This system is illustrated in the previous question above.

ENG 83. c.

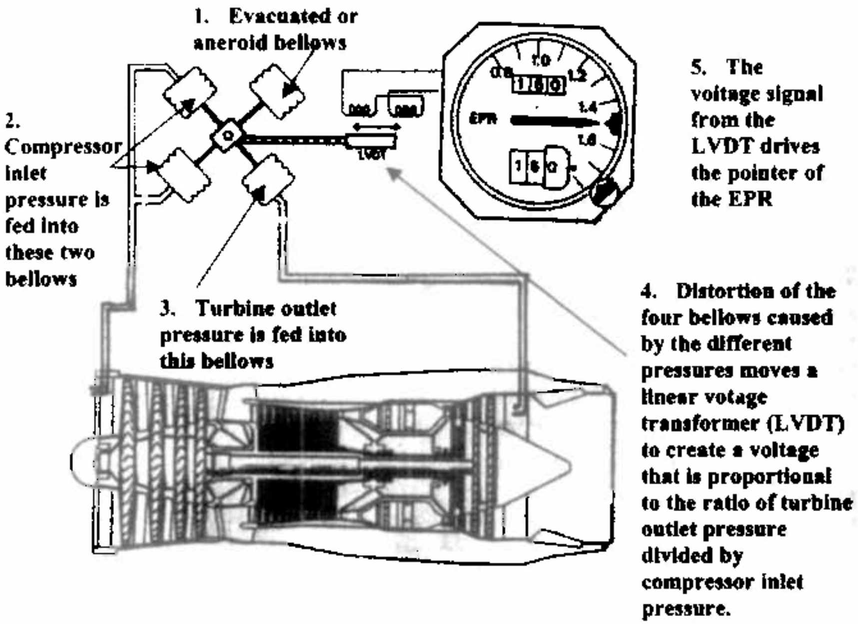
In a non bypass turbojet engine EPR is the ratio of the LP turbine outlet pressure to the LP compressor inlet pressure. It is therefore a measure of the proportion by which the pressure of the air has been increased. But in a high bypass turbofan engine the situation is more complicated because the majority of the thrust is produced by the cold stream, or bypass flow. This does not pass through the turbines, so turbine outlet pressure is less relevant to thrust output. EPR in such turbofans must therefore take into the pressure rises in both the hot and cold gas streams. So EPR in a modern turbofan is the ratio of the integrated mean of LP turbine outlet pressure plus fan outlet pressure to the fan inlet pressure.

Option a is incorrect because it not sufficiently precise. Option b is untrue because it refers to the HP compressor. Option d is incorrect because it refers to combustion chamber pressure.

ENG 84. a.

The EPR gauge indicates the ratio of LP turbine outlet pressure to compressor inlet pressure. To do this it divides turbine outlet pressure by compressor inlet pressure as illustrated in the diagram below.

When the engine are spooled up to take-off power, prior to brake release, the air pressure in the air intake becomes very low. Dividing turbine outlet pressure by this very low inlet pressure gives a very high initial EPR. But as the aircraft accelerates down the runway, ram effect increases the inlet pressure to a value greater than ambient. Dividing turbine outlet pressure by this increased inlet pressure gives a lower value of EPR. So as the aircraft accelerates during its take-off run, the EPR decreases. But if the compressor inlet air tapping was blocked the system would continue to sense the lower pressure that existed at the time of blockage. Dividing turbine outlet pressure by this lower trapped pressure would cause the EPR gauge to over indicate during the take-off run (option a).



ENG 85. a.

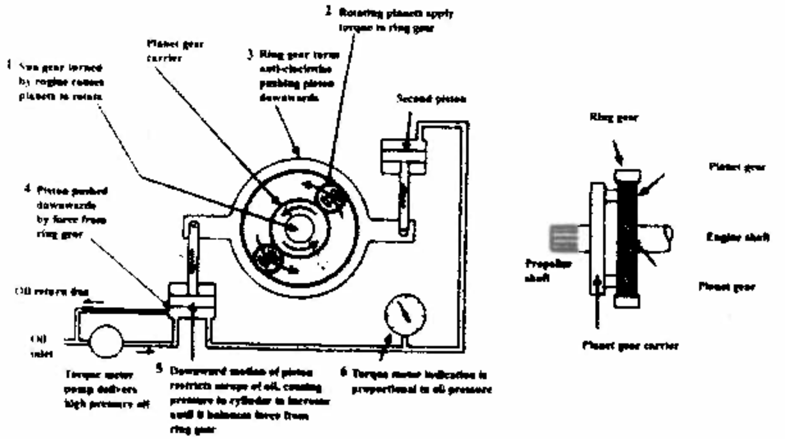
In many modern aircraft the indicated EPR is used when setting the power levers at the start of the take-off. So if the EPR gauge is over reading by a wide margin, there is danger that an unacceptably low thrust will be available during the take-off. In the worst case this will prevent the take-off from being completed within the distances (TORA and TODA) available. Option a is therefore true and the other options are untrue.

ENG 86. b.

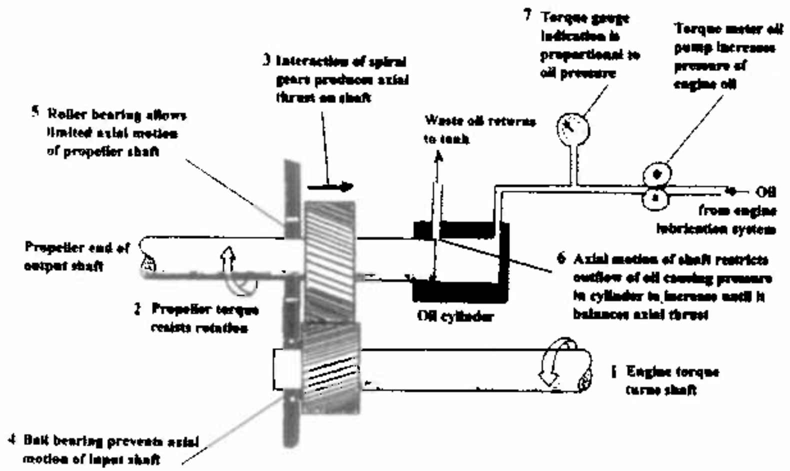
The torque output of a turbo-prop engine is the turning force applied to the propeller drive shaft. In the SI system it is measured in Newton meters (1) and in the Imperial system it is measured in Lbf ft (5). But the method by which it is actually measured varies from aircraft type to type. One such method involves the creation of a hydraulic pressure that is proportional to the applied torque. In some aircraft employing this technique the torque is indicated as a pressure in PSI (3). In more modern aircraft types, torque is usually measured using phonic wheels or strain gauges, and indicated in % (2). EPR is never used as an indication of torque in any aircraft types. So option b is true and the others untrue.

ENG 87. d.

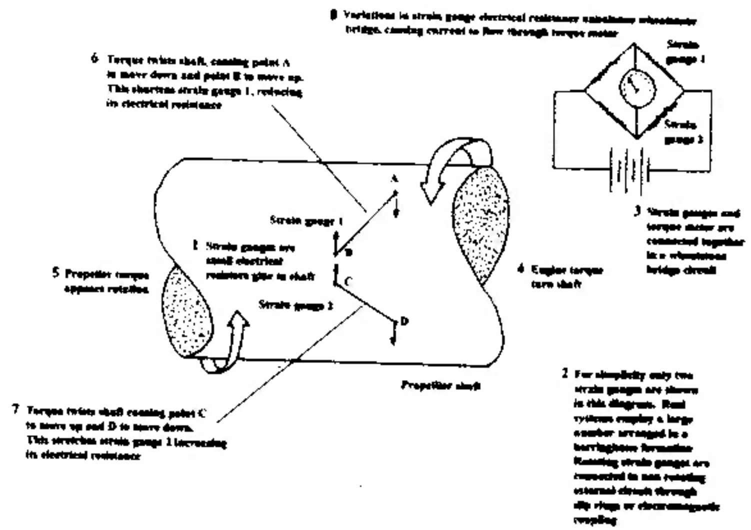
The torque output of a turbo-prop engine is the turning force applied to the propeller drive shaft. The method by which it is actually measured varies from aircraft type to type. One such method involves the creation of a hydraulic pressure that is proportional to the applied torque. This may be in the form of either a rotary (1) or axial (2) hydraulic system. These are illustrated below. In more modern aircraft types, torque is usually measured using phase shift between two phonic wheels (4), as illustrated in ENG 79, or strain gauges (3) as illustrated below. So option d is the most appropriate in this question.



ROTARY TYPE HYDRAULIC TORQUE METER



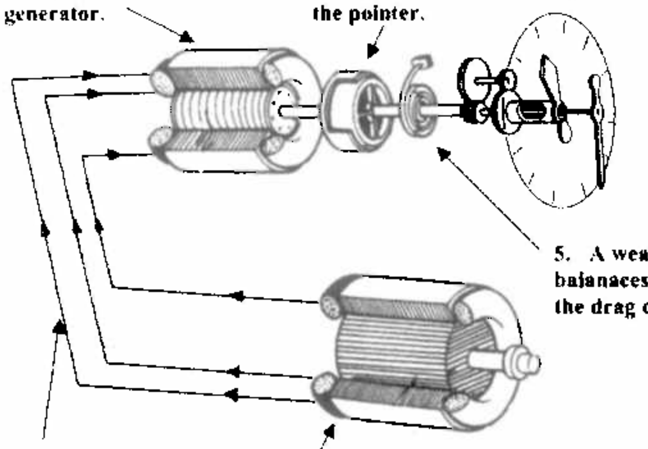
AXIAL TYPE HYDRAULIC TORQUE METERING SYSTEM



STRAIN GAUGE TYPE TORQUE METER

ENG 88. c.

The type of tacho-generator system that employs a squirrel cage synchronous motor is illustrated below. The frequency of the three phase signal produced by the tacho-generator is proportional to engine RPM (option c). The AC signal is fed to a synchronous squirrel cage motor within the indicator. Because of its synchronous nature, the motor runs at an RPM equal to the signal frequency. This continuous rotation is then converted into angular deflection of a pointer by means of magnetic a drag cup.



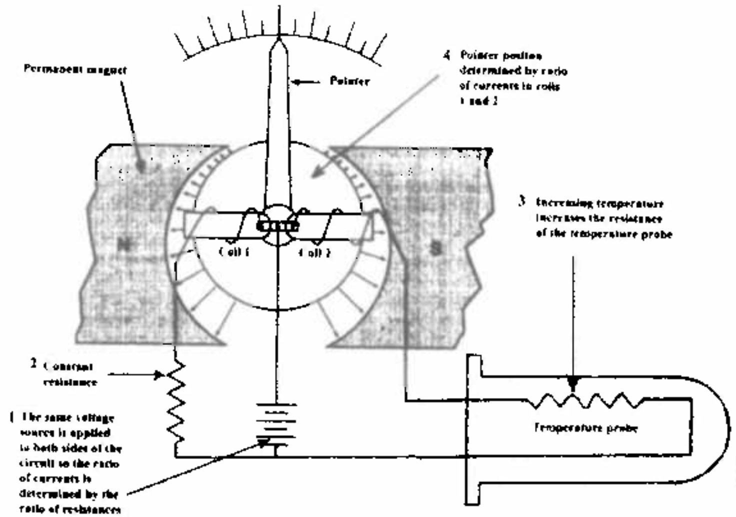
THREE PHASE TACHO GENERATOR

ENG 89. c.

Vibration metering systems in aircraft commonly employ accelerometers to measure both the frequency and amplitude of the vibration. The accelerometers measure the radial movement of the engines. But the signals from the accelerometers are a combination of all of the vibration frequencies present, plus electrical noise. Frequency filters are therefore used to filter out all of the noise and unwanted frequencies, so that only those of interest to the pilot remain. These signals are very weak so they are then amplified before being used to trigger indication systems. So option c is correct.

ENG 90. c.

In order to measure any variable very accurately it is necessary to ensure that variations in indication caused by such things as line resistances and supply voltage fluctuations are minimised. The ratiometer as illustrated below, operates by applying the same supply voltage to two resistive circuits. The resistance of one circuit is constant, whilst that of the other increases with temperature. The current flow through each circuit is therefore proportional to the supply voltage and the resistance of each circuit. But both circuits share the same power supply, so the ratio of the two currents will vary only with variations in temperature. A ratiometer is therefore largely immune to variations in power supply voltage (option c). Variometers (option a) and galvanometers (option b) are simply moving coil instruments and are not in themselves particularly immune to line resistance losses. Rheostats (option d) are variable resistors and are usually used as the sensor in ratiometer systems.



RATIOMETER TEMPERATURE MEASUREMENT SYSTEM

TEMP 1. b.

Total Air Temperature (TAT) is the Static Air Temperature (SAT), plus the temperature changes caused by the following:

a. Heating due to kinetic energy being converted into heat as airflow is brought to rest whe it strikes the surface of an aircraft.
b. Heating due to adiabatic compression of the air due to pressure changes caused by the motion of the aircraft through it.
c. Heating due to friction.

So TAT is greater than SAT. The difference between the two depends upon the mach number of the aircraft, and is described by the standard equation:

$$TAT = SAT \times (1 + (0.2 \times K \times M^2))$$

Where K is a measure of the accuracy of the temperature sensing probe.
M is the mach number of the aircraft.

But mach number is TAS/LSS, so TAT is more proportional to TAS than to any of the other options offered in this question. So Total Air Temperature is higher than Static Air Temperature, by an amount which is proportional to TAS (option b).

TEMP 2. a.
Total Air Temperature (TAT) is the Static Air Temperature (SAT), plus the temperature changes caused by the following:

a. Heating due to kinetic energy being converted inot heat as airflow is brought to rest when it strikes the surface of an aircraft.
b. Heating due to adiabatic compression of the air due to pressure changes caused by the motion of the aircraft through it.
c. Heating due to friction.

But all of the above can be said to be kinetic heating effects, so option a is the most accurate.

TEMP 3. b.
Ram Recovery Factor is a maesure of the accuracy with which a temperature porbe is able to measure the full heating effects of ram compression of the air at high speeds.

$TAT = SAT \times (1 + (0.2 \times K \times M^2))$

Where TAT is total air temperature after ram heating has taken place.
SAT is the static air temperature before any ram heating takes place.
K is the RAM recovery factor, which is a measure of the accuracy of the temperature sensing probe.
M is the mach number of the aircraft.

For a Rosemount probe the ram recovery factor is normally assumed to be 1.0.

TEMP 4. a.
$TAT = SAT \times (1 + (0.2 \times K \times M^2))$

Where K is the RAM recovery factor, which is a measure of the accuracy of the temperature sensing probe.
M is the mach number of the aircraft.

TEMP. 5. b.
In some aircraft the EGT gauge is fitted with a red line, which is not connected to the temperature sensing system, but which can be moved manually. It is positioned over the maximum allowable (red line) EGT prior to engine start-up. If this temperature is exceeded during the start or subsequent flight, the pointer will contact the red line and push it around the dial to the maximum value attained by the gauge pointer. The red line will then remain in this position to give a record of the maximum temperature achieved.

TEMP 6. d.
This is a badly worded question, but is included in this book because it has been reported to have been in examinations taken by a large number of students.
Of the five thermometers suggested in this question, only two are regularly used in modern aircraft. Resistive temperature coils (1) are used to measure temperature in a number of systems such as engine lubricating oil and hydraulic fluid. Thermocouples (5) are used in a wide range of systems including EGT and cylinder head temperature. But each option includes three methods, so another must be selected. Although Mercury is used to measure temperature in non-aviation situations, it is rarely used in modern aircraft. It is however a more likely option than Capacitive (3) or Inductive (4) methods, in that can be said to be used in aircraft first aid kits. Option d is therefore the most accurate in this question.

TEMP 7. b.
Total Air Temperature (TAT) is the Static Air Temperature (SAT), plus the temperature changes caused by the following:

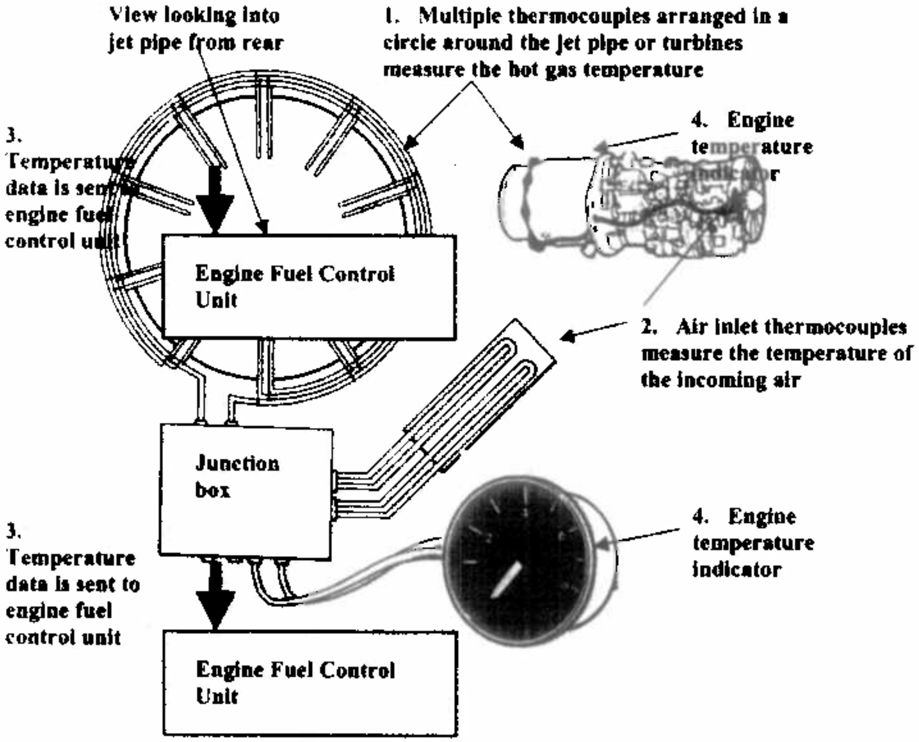
a. Heating due to kinetic energy being convereted into heat as airflow is brought to rest when it strikes the surface of an aircraft.
b. Heating due to adiabatic compression of the air due to pressure changes caused by the motion of the aircraft through it.
c. Heating due to friction.

Options a and b, are therefore each partly correct. It is however true that adiabatic heating makes a greater contribution to the temperature rise than does friction heating. So option b is the most appropriate. Options c, heating due to shock waves, and d, gauge errors are both untrue.

TEMP 8. b.
Thermocouples operate on the basis of the Seebeck effect whereby two dissimilar metals are joined together at two junctions. If one of these junctions are heated, a voltage is generated across the two metals. The magnitude of this voltage is increased by heating one junction (in the temperature probe), whilst keeping the other junction (in the gauge) at a lower temperature. In this way thermocouple systems generate their own electrical power supply (1). Because the temperature sensors are simply metal junctions, they have no moving parts to wear out (2). The voltages produced are typically very low and are measured in millivolts (3). Provided suitable metals are used, thermocouples can be employed in high or low temperature areas (5).

Thermocouple systems are however susceptible to line resistance losses (4). If for example, electrical connectors at the back of the gauge or probes become corroded, the voltages and currents sensed by the gauge will be reduced. So statemenst 1,2,3 and 5 are true (option b).

TEMP 9. b.
Thermocouples operate on the basis of the Seebeck effect whereby two dissimilar metals are joined together at two junctions. If one of these junctions are heated, a voltage is generated across the two metals. The magnitude of this voltage is increased by heating one junction (in the temperature probe), whilst keeping the other junction (in the gauge) at a lower temperature. If the cold junction is kept at a constant temperature, any change in voltage will be entirely due to changes in the temperature of the hot junction. The gauge can then be calibrated in degrees of temperature. A typical jet engine thermocouple temperature measurement system is illustrated overleaf.

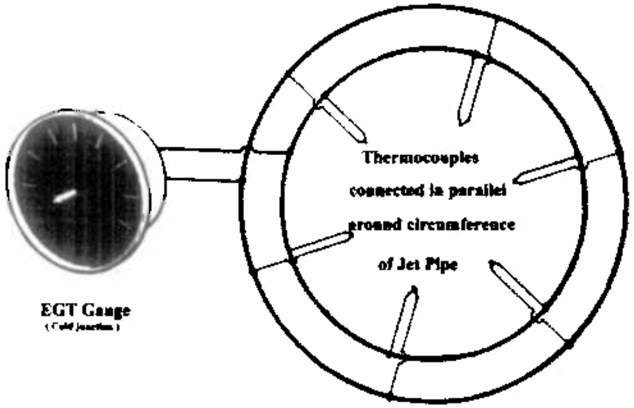


TYPICAL THERMOCOUPLE SYSTEM

TEMP 10. b.
The temperature of hot gasses in jet engines is normally measured using thermocouples. These operate on the basis of the Seebeck effect whereby two dissimilar metals are joined together at two junctions. If these junctions are heated, a voltage is generated across the two metals. The magnitude of this voltage is

increased by heating one junction (in the temperature probe), whilst keeping the other junction (in the gauge) at a lower temperature. If the cold junction is kept at a constant temperature, any change in voltage will be entirely due to changes in the temperature of the hot junction. The gauge can then be calibrated in degrees of temperature.

But if only one hot junction is used, the entire system will be rendered unserviceable if this junction becomes damaged. To overcome this problem, operational thermocouple systems typically employ a large number of hot junctions, connected in parallel. If one or more junctions become damaged this has a minimal effect on the overall voltage. The system then continues to operate, albeit with slightly reduced accuracy. A typical thermocouple EGT gauging system is illustrated below. So EGT is measured using thermocouples connected in paraliell (option b).



Typical Thermocouple Temperature Gauging System

TEMP 11. a.
This problem must be solved in two stages. Firstly the SAT at 36000 ft must be calculated. As altitude increases up to 36000 ft in the ISA, SAT decreases at a rate of 1.98° C per 1000 ft. ISA means sea level SAT is 15° C, so the SAT at 36000 ft can be calculated using the standard equation:

SAT at altitude in the ISA = 15° C – (1.98° C x altitude in 1000s of ft)

Which for 36000 ft gives SAT = 15° C – (1.98° C x 36) which = -56.28° C.

This is converted into absolute temperature by adding 273 to give 216.72° K

This can then be used to calculated TAT using the standard equation:

$$TAT = SAT \times (1 + (0.2 \times K \times M^2))$$

Where K is the RAM recovery factor, which is a measure of the accuracy of the temperature sensing probe.
M is the mach number of the aircraft.

K for a Rosemount probe is normally assumed to be 1, so using this and the data provided in the question gives:

$TAT = 216.72^\circ K \times (1 + (0.2 \times 1 \times 1^2))$ which $= 260.64^\circ K$.

Subtracting 273 converts this to TAT = -12.936° C

This is approximately –13° C (option a).

TEMP 12. b.

The standard equation for TAT is:

$$TAT = SAT \times (1 + (0.2 \times Kr \times M^2))$$

Where Kr is the RAM recovery factor, which is a measure of the accuracy of the temperature sensing probe.
M is the mach number of the aircraft.

Comparing this with the options offered in this question reveals that option b is the most appropriate on the basis indicated below:

$$TAT = SAT(1 + 0.2Kr\ M^2).$$

Where Kr is the RAM recovery factor.
M is the mach number of the aircraft.

TEMP 13. A.

Total Air Temperature (TAT) is the Static Air Temperature (SAT), plus the temperature changes caused by the following:

a. Heating due to kinetic energy being released by the as it is brought to rest upon the surface of an aircraft.
b. Heating due to adiabatic compression of the air due to pressure changes caused by the motion of the aircraft through it.
c. Heating due to friction.

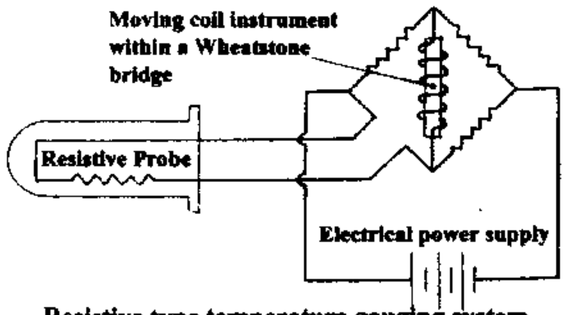
Options a, b and c, are therefore each partly correct, but incomplete. It is however true that adiabatic heating makes a greater contribution to the temperature rise than does kinetic heating or friction. So option a is the most appropriate.

TEMP 14. c.

The temperature of hot gasses in jet engines is normally measured using thermocouples. These operate on the basis of the Seebeck effect whereby two dissimilar metals are joined together at two junctions. If these junctions are heated, a voltage is generated across the two metals. The magnitude of this voltage is increased by heating one junction (in the temperature probe), whilst keeping the other junction (in the gauge) at a lower temperature. If the cold junction is kept at a constant temperature, any change in voltage will be entirely due to change sin the temperature of the hot junction. The gauge, which comprises of a moving coil instrument, can then be callibrated in degrees of temperature.

TEMP 15. b.

A resistive temperature probe contains a small metallic resistive element. This forms part of an electrical circuit. Increasing temperature increases the electrical resistance of the coil. By sensing these variations in the electrical resistance, the changes in temperature of the coil are sensed. A typical resistive gauging system is illustrated below.



Resistive type temperature gauging system

TEMP 16. c.

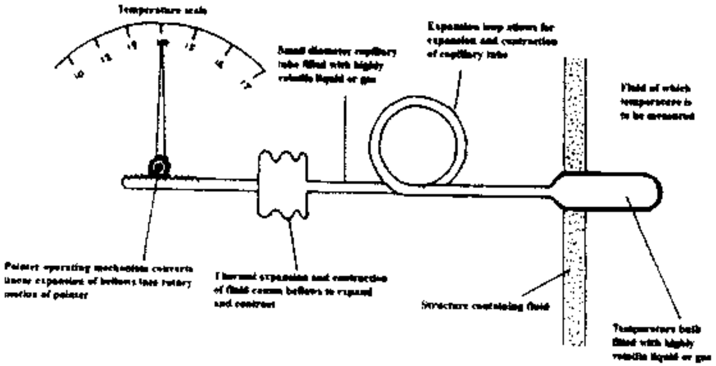
A bi-metallic strip temperature sensor is made up of two parallel strips of dissimilar metals, joined at each end. As the temperature increases or decreases, both strips expand or contract. But because the metals are dissimilar, their thermal expansion rates are also dissimilar. So one strip expands and contracts at a greater rate than the other. This causes the strips to bend in a manner that is proportional to the temperature.

This bending motion is commonly used to open and close electrical thermostatic switches (option c) in order to control indicators or cooling/heating systems. Although bi-metallic strips can be used over a wide temperature range, they are not used to measure jet pipe temperatures, because they do not produce an electrical signal that is proportional to temperature. A thermistor is a semi-conductor or transistor the output of which varies with temperature.

TEMP 17. d.

Resistive temperature probes (1) are commonly used to measure fluid temperatures in aircraft lubricating oil and hydraulic systems. They contain a small metallic resistive element. This forms part of an electrical circuit. Increasing temperature increases the electrical resistance of the coil. By sensing these variations in the electrical resistance, the changes in temperature of the coil are sensed.

Expansive sensing elements (4) are often used in jet engine fuel control systems, and in some piston engine fuel injection systems. The system comprises of small sphere or cylinder at one end of a capillary tube, and a bellows or capsule at the other end. The entire assembly is filled with a highly volatile fluid. Changes in temperature cause this fluid to expand or contract. This in turn causes the bellows or capsule to expand or contract, operating a gauge or providing a mechanical output proportional to temperature. A typical expansive type temperature measuring system is illustrated below.



Typical Thermal Expansion Type Temperature Measuring System

The temperature of hot gasses in jet engines is normally measured using thermocouples. These operate on the basis of the Seebeck effect (5) whereby two cables made of dissimilar metals are joined together at two junctions. If one of these junctions is heated, a voltage is generated across the two wires. The magnitude of this voltage is increased by heating one junction (in the temperature probe), whilst keeping the other junction (in the gauge) at a lower temperature. If the cold junction is kept at a constant temperature, any change in voltage will be entirely due to change sin the temperature of the hot junction. The gauge, which comprises of a moving coil instrument, can then be calibrated in degrees of temperature.

Although it is possible to construct inductive (2) and capacitive (3) temperature sensing systems, these are not commonly used in aircraft.

TEMP 18. b.

TAT probes indicate total air temperature. The standard equation for TAT is:

TAT = SAT x (1 + (0.2 x K x M^2))

Where SAT is the static (ambient) air temperature
Kr is the RAM recovery factor, which is a measure of the accuracy of the temperature sensing probe.
M is the mach number of the aircraft.

This can be rearranged to give:

SAT = TAT / (1 + (0.2 x K x M^2))

Inputting the data provided in the question gives:

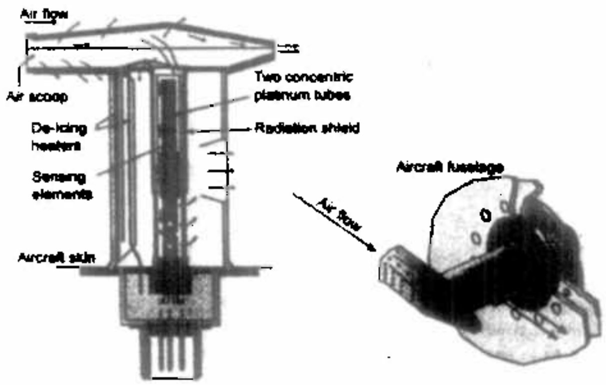
SAT = 45 / (1 + (0.2 x 0.85 x 2^2)) which is SAT = 26.78^0 K

TEMP 19. b.

The electrical cables and connections between the temperature sensing elements and the gauges and indicators in the cockpit can be quite long, particularly in large aircraft. The electrical resistance of these cables and connectors depends upon the material from which they are made, the quality of manufacture, their temperature and physical condition. During the life of and aircraft, these components sustain damage due to corrosion and fatigue. This increases their electrical resistance. This in turn decreases the current that will flow for any given applied voltage. So systems which use electrical current as a measure of temperature, will be made less accurate due to these line resistance losses. But resistance losses occur only when a current is flowing. This means that systems based on varying voltages, are less affected by line resistance losses. So temperature sensing systems based on varying currents are less accurate than those employing varying voltages (option b). It is however important to note that this is true only when the system is designed to allow no significant current flow. This would be the case for example ina digital system.

TEMP 20. c.

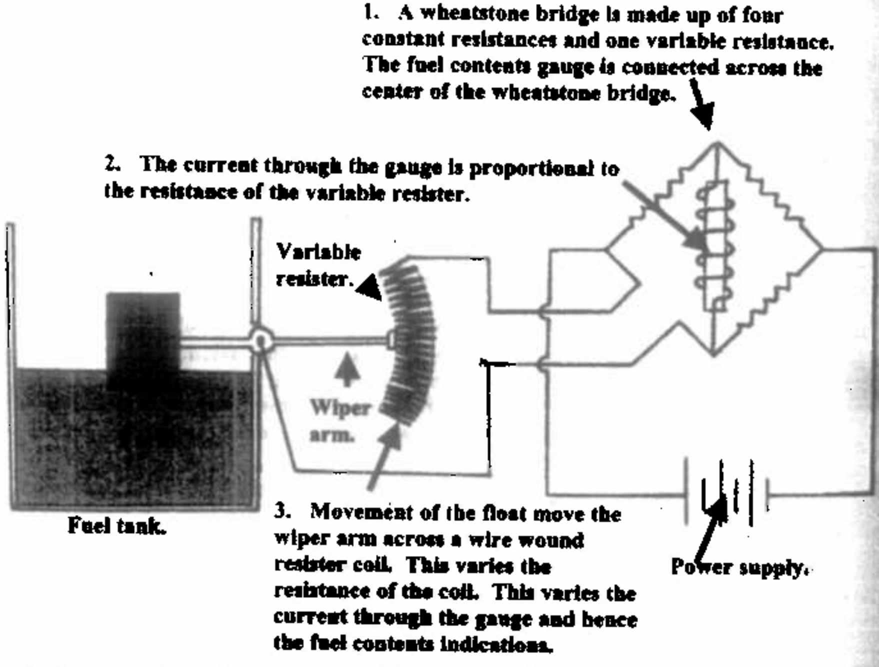
Rosemount probes are used in modern aircraft to measure the total air temperature or TAT. They do this by passing a small amount of the airflow over a sensing element within the probe. But if the probe freezes up, this flow of air through the probe will stop. In order to overcome this problem, the probes are fitted with electrical heating coils to prevent icing. A typical Rosemount Probe is illustrated below.



ROSEMOUNT TOTAL AIR TEMPERATURE PROBE

FUEL 1. b.

A typical float type fuel gauging system is illustrated below.



TYPICAL FLOAT TYPE FUEL CONTENTS SYSTEM

The sensors in float-type fuel gauging systems are simply small cork floats, connected to the wiper arms of variable resistors. As the fuel level rises or falls, the floats move up or down, decreasing or increasing the resistance of the variable resistors. These changes are measured, usually by means of a wheatstone bridge, to give an indication of fuel level. But changes in aircraft attitude also cause the fuel level in each part of the tank to change, making the system inaccurate (1).

Accelerations and decelerations cause the fuel to surge backwards and forwards in the tanks, thereby changing the indications and making the system inaccurate (2). As altitude increases the decreasing temperature causes the fuel to contract. Although this does not affect the mass or chemical energy content of the fuel, it does reduce the fuel level and hence the system indications. So the system accuracy is reduced by variations in ambient temperature (4). But ambient pressure variations (3) have no significant effect on the accuracy of the system provided the pressure does not become low enough for the fuel to boil away. So option b, (1, 2, 4) is the only one that is entirely true.

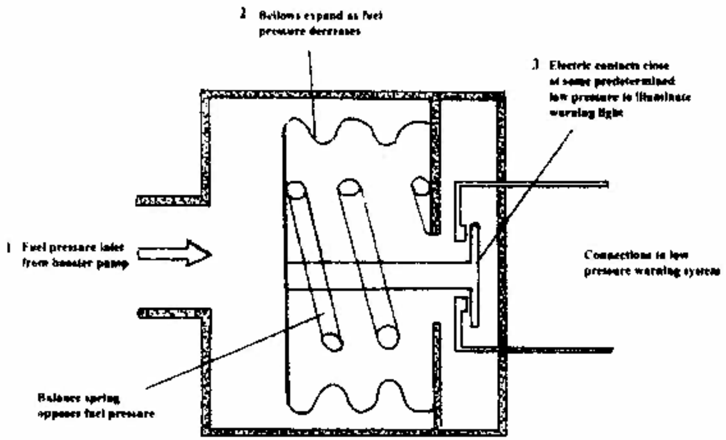
FUEL 2. b.

The sensors in capacitive fuel gauging systems take the form of large capacitors each of which is made up of two concentric tubes. These tubes are vertically oriented reaching from the top of the fuel tank to the bottom. The dielectric material in these capacitors consists of the fuel for that part of the tubes that is below the surface of the fuel, and air for that part of the tubes that is above the surface of the fuel.

The capacitance or charge storing capacity of the sensors is proportional to the average dielectric strength of the material between the two tubes. The dielectric constant of jet fuel is approximately twice that of air, so the overall capacitance of each sensor is proportional to the amount of the sensor that is immersed in fuel. As the fuel level rises and falls, the capacitance of the sensors increases and decreases in response to variations in the proportion of the sensors that are immersed in the fuel (option b). Although these systems do not operate by sensing changes in the capacitance or dielectric constant of the fuel (Options a, c, and d) they do automatically compensate for such changes.

FUEL 3. c and d.

In LP fuel systems it is the absolute pressure that is important, so an aneroid capsule (option c) or evacuated bellows (option d) would be suitable pressure sensors. But in most aircraft the LP fuel pressure is not indicated to the crew, but is monitored in order to operate a low pressure warning or booster pump failure light. Most systems employ a bellows (option d), enclosing an electrical switch as illustrated below. Bourden tubes (option a) measure only high pressures, so they are unsuitable for this use. It should also be noted that capacitors (option b) are not used to measure pressure in any current aircraft systems. So option d, bellows is the most probable method, but opion c, an aneroid capsule can also be used. A typical fuel pressure sensor is illustrated below.



BELLOWS TYPE LP FUEL PRESSURE SENSOR

FUEL 4. a.

The sensors in capacitive fuel gauging systems take the form of large capacitors each of which is made up of two concentric aluminium tubes. These tubes are vertically oriented, reaching from the bottom of the fuel tank to the top. The space between the inner and outer tubes is not sealed, so fuel and air are able to flow into and out of the space as the fuel level in the tank changes. The dielectric material in these capacitors consists of the fuel for that part of the tubes that is below the surface of the fuel, and air for that part of the tubes that is above the surface of the fuel.

The capacitance or charge storing capacity of the sensors is proportional to the average dielectric constant of the material between the two tubes. The dielectric constant, which is proportional to the density (ρ) of the fuel, is approximately twice that of air (option a), so the overall capacitance of each sensor is proportional to the amount of the sensor that is immersed in fuel.

FUEL 5. a.

The sensors in capacitive fuel gauging systems take the form of large capacitors each of which is made up of two concentric tubes. These tubes are vertically oriented reaching from the top of the fuel tank to the bottom. The dielectric material in these capacitors consists of the fuel for that part of the tubes that is below the surface of the fuel, and air for that part of the tubes that is above the surface of the fuel.

The capacitance or charge storing capacity of the sensors is proportional to the average dielectric strength of the material between the two tubes. The dielectric constant of fuel is approximately twice that of air, so the overall capacitance of each sensor is proportional to the amount of the sensor that is immersed in fuel. As the fuel level rises and falls, the capacitance of the sensors increases and decreases. The term capacitive reactance refers to the manner in which a capacitor affects the flow of AC currents. By applying an AC current to the sensors, an indication of fuel contents is derived on the basis of changes in capacitive reactance of the circuit (option a). It should be noted that the term "reactive capacitance" in options b and c has no recognised meaning. Variations in the dielectric constant of fuel (option d) occur only with changes in fuel type.

FUEL 6. a.

Fuel flow meters can be divided into two general types. These are volumetric flow meters and mass flow meters. A very basic volumetric flow meter consists of an internal flap placed across the fuel pipe. When no fuel is flowing, the flap is held closed by a weak spring. Whenever fuel is flowing the flap is pushed back to make a passage through which the fuel flows. The size of the orifice created by the deflection of the flap, is just sufficient to accommodate the volume of the fuel flowing through. So the orifice size and hence flap angle is determined by the volume flow rate of the fuel. The flap is connected to the wiper of a variable resistor. The resistance of this variable resistor is therefore proportional to volumetric fuel flow rate.

But the energy being supplied to the engine is proportional to the mass flow of fuel. Most modern flow meters are therefore of the mass flow type. One such meter consists of a small turbine through which the fuel flow on its way to the engine. The RPM of any turbine is not proportional to the volume flow through it, but to the mass flow. This is because the turbine extracts kinetic energy from the material passing through it, by changing the momentum of that material. Momentum is proportional not to volume but to mass. So the RPM of a turbine-type flow meter is proportional to the mass flow of fuel through it. Mass flow at any given volumetric flow rate is proportional to density, so any changes in fuel density caused by variations in temperature or fuel type, are automatically compensated for by a mass flow meter (option a).

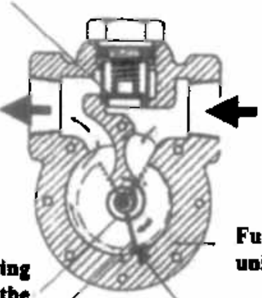
FUEL 7. a.

The sensors in capacitive fuel gauging systems take the form of large capacitors each of which is made up of two concentric tubes. These tubes are vertically oriented reaching from the top of the fuel tank to the bottom. The dielectric material in these capacitors consists of the fuel for that part of the tubes that is below the surface of the fuel, and air for that part of the tubes that is above the surface of the fuel.

The capacitance or charge storing capacity of the sensors is proportional to the average dielectric strength of the material between the two tubes. The dielectric constant of fuel is approximately twice that of air, so the overall capacitance of each sensor is proportional to the amount of the sensor that is immersed in fuel. As the fuel level rises and falls, the capacitance of the sensors increases and decreases in response to variations in the proportion of the sensors that are immersed in the fuel.

The dielectric constant of fuel is proportional to its density. As fuel temperature decreases, the fuel contracts, causing its density and dielectric constant to increase. But this contraction also reduces the proportion of the sensor that is immersed in the fuel. So as fuel temperature decreases, the increasing sensor capacitance caused by increasing fuel dielectric constant is negated by the decreasing capacitance due to the decreasing fuel level. The effects of temperature variations are therefore effectively self cancelling. So fuel temperature changes have no effect on indications in a capacitive fuel gauging system (option a).

<u>FUEL 8. d.</u>
Fuel flow meters can be divided into two general types. These are volumetric flow meters and mass flow meters (option d). A very basic volumetric flow meter consists of a spring loaded vane placed across the fuel flow passage. This system is illustrtaed below.

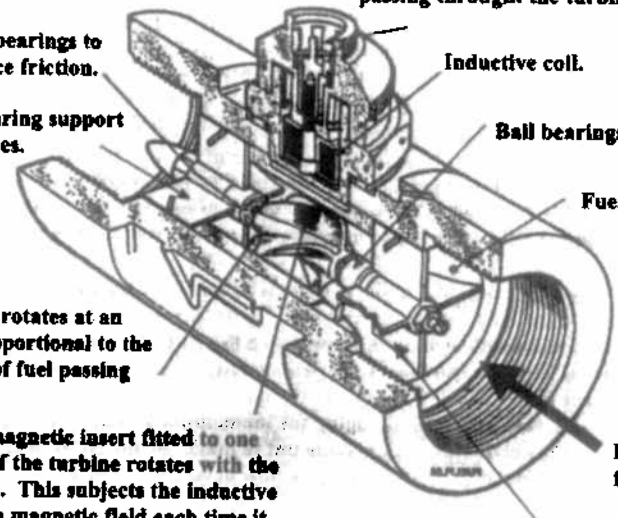


VOLUMETRIC TYPE FUEL FLOW METER

When no fuel is flowing, the vane is held closed by a weak spring. Whenever fuel is flowing the flap is pushed back to make a passage through which the fuel flows. The size of the orifice created by the deflection of the flap, is just sufficient to accommodate the volume of the fuel flowing through. So the orifice size and hence flap angle is determined by the volume flow rate of the fuel. The flap is connected

to the wiper of a variable resistor. The resistance of this variable resistor is therefore proportional to volumetric fuel flow rate.

But the energy being supplied to the engine is proportional to the mass flow of fuel. Most modern flow meters are therefore of the mass flow type. One such meter consists of a small turbine through which the fuel flow on its way to the engine. The RPM of any turbine is not proportional to the volume flow through it, but to the mass flow. This is because the turbine extracts kinetic energy from the material passing through it, by changing the momentum of that material. Momentum is proportional not to volume but to mass. So the RPM of a turbine-type flow meter is proportional to the mass flow of fuel through it. This type of fule flow meter is illustrated below.



SIMPLE MASS FLOW TYPE FUEL FLOW METER

<u>FUEL 9. b.</u>
The sensors in float-type fuel gauging systems are simply small cork floats, connected to the wiper arms of variable resistors. As the fuel level rises or falls, the

floats move up or down, decreasing or increasing the resistance of the variable resistors. These changes are measured, usually by means of a wheatstone bridge, to give an indication of fuel level. But changes in aircraft attitude also cause the fuel level in each part of the tank to change, making the system inaccurate (2).

Accelerations and decelerations cause the fuel to surge backwards and forwards in the tanks, thereby changing the indications and making the system inaccurate (1). Changes in temperature cause the fuel to expand and contract. So an aircraft that is refuelled with cold fuel will receive a greater mass of fuel than one receiving warm fuel. But the pilot must know the mass of fuel on board rather than the volume, because it is the mass of fuel that determines aircraft performance. So fuel gauging systems indicate units of mass. The accuracy of a float type fuel gauging system is therefore reduced by variations in ambient temperature (5).

Different grades of fuel have different densities, so this will also reduce the accuracy of the system (6). Float type systems can be powered by AC or DC so (3) and (4) are untrue.

<u>FUEL 10. a.</u>
Fuel flow meters can be divided into two general types. These are volumetric flow meters and mass flow meters. A very basic volumetric flow meter consists of a vane placed across the fuel pipe. When no fuel is flowing, the vane is held closed by a weak spring. Whenever fuel is flowing the flap is pushed back to make a passage through which the fuel flows. The size of the orifice created by the deflection of the flap, is just sufficient to accommodate the volume of the fuel flowing through. So the orifice size and hence flap angle is determined by the volume flow rate of the fuel. The flap is connected to the wiper of a variable resistor. The resistance of this variable resistor is therefore proportional to volumetric fuel flow rate.

But the energy being supplied to the engines is proportional to the mass flow of fuel. Most modern flow meters are therefore of the mass flow type. One such meter consists of a small turbine through which the fuel flow on its way to the engine. The RPM of any turbine is not proportional to the volume flow through it, but to the mass flow. This is because the turbine extracts kinetic energy from the material passing through it, by changing the momentum of that material. Momentum is proportional not to volume but to mass. So the RPM of a turbine-type flow meter is proportional to the mass flow of fuel through it.

Mass flow at any given volumetric flow rate is proportional to density, so any changes in fuel density caused by variations in temperature or fuel type, are automatically compensated for by a mass flow meter (option a). Although the system is not capable of detecting variations in pressure (option a), calorific value (option c) nor viscosity (option d), these have no effect on the accuracy of its mass flow indications.

<u>FUEL 11. b.</u>
The combustion of fuel converts complex hydrocarbon materials into much simpler carbon dioxide, carbon monoxide and water. The effect of this is to break the high

energy chemical bonds within the fuel and replace them with much lower energy bonds. The energy released in the form of heat represents the difference between the high energy content of the initial high energy bonds and that of the new lower energy bonds. The calorific value of a fuel is a measure of the energy available in each unit of fuel. Both the chemical energy content and the mass of fuel are proportional to the number of chemical bonds. This in turn is proportional to the number of molecules.

As fuel temperature increases and decreases it expands and contracts. This means that the same number of molecules take up a different volume. This in turn means that temperature changes will alter the amount of chemical energy in any given volume of fuel, but will not alter the amount of energy in any given mass. So calorific value of fuel is proportional to mass rather than to volume.
The rate at which energy is provided to the engines is equal to the calorific value of the fuel multiplied by the mass fuel flow. Fuel mass flow rate is therefore more important than fuel volumetric flow rate because calorific value is proportional to mass (option b).

It should be noted that although options a and d are true, they are not the most significant factors in determining the relative importance of mass flow and volume flow.

<u>FUEL 12. b.</u>
The combustion of fuel converts complex hydrocarbon materials into much simpler carbon dioxide, carbon monoxide and water. The effect of this is to break the high energy chemical bonds within the fuel and replace them with much lower energy bonds. The energy released in the form of heat represents the difference between the high energy content of the initial high energy bonds and that of the new lower energy bonds. The calorific value of a fuel is a measure of the energy available in each unit of fuel. Both the chemical energy content and the mass of fuel are proportional to the number of chemical bonds. This in turn is proportional to the number of molecules.

As fuel temperature increases and decreases it expands and contracts. This means that the same number of molecules take up a different volume. This in turn means that temperature changes will alter the amount of chemical energy in any given volume of fuel, but will not alter the amount of energy in any given mass. So calorific value of fuel is proportional to mass rather than to volume.

The rate at which energy is provided to the engines is equal to the calorific value of the fuel multiplied by the mass fuel flow. Fuel mass flow rate is therefore more important than fuel volumetric flow rate because calorific value is proportional to mass. So most modern turbofan engines employ mass fuel flow meters (option b).

<u>FUEL 13. d.</u>
Fuel flow meters can be divided into two general types. These are volumetric flow meters and mass flow meters. A very basic volumetric flow meter consists of an internal vane placed across the fuel pipe. When no fuel is flowing, the vane is held

closed by a weak spring. Whenever fuel is flowing the flap is pushed back to make a passage through which the fuel flows. The size of the orifice created by the deflection of the flap, is just sufficient to accommodate the volume of the fuel flowing through. So the orifice size and hence flap angle is determined by the volume flow rate of the fuel. The flap is connected to the wiper of a variable resistor. The resistance of this variable resistor is therefore proportional to volumetric fuel flow rate.

But the energy being supplied to the engines is proportional to the mass flow of fuel. Most modern flow meters are therefore of the mass flow type. One such meter consists of a small turbine through which the fuel flow on its way to the engine. The RPM of any turbine is not proportional to the volume flow through it, but to the mass flow. This is because the turbine extracts kinetic energy from the material passing through it, by changing the momentum of that material. Momentum is proportional not to volume but to mass. So the RPM of a turbine-type flow meter is proportional to the mass flow of fuel through it. So modern turboprop aircraft are likely to use turbine impeller type fuel flow meters (option d).

FUEL 14. d.

The sensors in capacitive fuel gauging systems take the form of large capacitors each of which is made up of two concentric tubes. These tubes are vertically oriented reaching from the top of the fuel tank to the bottom. The dielectric material in these capacitors consists of the fuel for that part of the tubes that is below the surface of the fuel, and air for that part of the tubes that is above the surface of the fuel.

The capacitance or charge storing capacity of the sensors is proportional to the average dielectric strength of the material between the two tubes. The dielectric costant of fuel is approximately twice that of air, so the overall capacitance of each sensor is proportional to the amount of the sensor that is immersed in fuel. As the fuel level rises and falls, the capacitance of the sensors increases and decreases in response to variations in the proportion of the sensors that are immersed in the fuel.

The dielectric constant of fuel is proportional to its density. As fuel temperature decreases, the fuel contracts, causing its density and dielectric constant to increase. But this contraction also reduces the proportion of the sensor that is immersed in the fuel. So as fuel temperature decreases, the increasing sensor capacitance caused by increasing fuel dielectric constant is negated by the decreasing capacitance due to the decreasing fuel level. The effects of temperature variations are therefore effectively self cancelling. So fuel temperature changes have no effect on indications in a capacitive fuel gauging system. But if fuel of a different grade is put into the tank, this fuel will have a differenet dielectric constant. This means that contents indications will be inaccurate.

One method of overcoming this problem is to use a compensated capacitive fuel gauging system. This system gives an indication of tank contents in the manner described above, but in doing so compares the capacitance of the main sensors with

that of a small reference capacity. This reference capacitor is fixed in a horizontal position at the bottom of the tank. This means that the reference capacitor is completely immersed in whatever liquid is in the bottom of the tank. The system measures the capaciatnce of the reference capacitor and uses this value to calculate the dielectric constant of the liquid surrounding the reference capacitor. It then calculates the mass of fuel in the tank based upon the assumption that all of the liquid is of the same dielectric constant. In this way the system automatically compensates for changes in fuel grade.

The dielectric constant of air is 1, that of jet fuel is about 2 and that of pure water is about 80. If the fuel tank holds a very small amount of water and a larger amount of fuel, this water will be at the bottom where it will immerse the reference capacitor. The system will then compare the more-or-less normal capacitance of the main capacitors with the greatly increased capacitance of the reference capacitor. This will cause it to read almost (but not quite) empty. If however then tank holds only water this will greaetly increase the capacitance of the main capacitors. The system will therefore calulate that the tank holds an exceptionally large mass of fuel (about 40 times its normally full mass). Because of the limitations of the indication system it is highly unlikely that it will be capable of indicating this mass accuartely. The system will therefore give an indication that is more than zero, but inaccurate (option d).

FUEL 15. b.

The sensors in float-type fuel gauging systems are simply small cork floats, connected to the wiper arms of variable resistors. As the fuel level rises or falls, the floats move up or down, decreasing or increasing the resistance of the variable resistors. These changes are measured, usually by means of a wheatstone bridge, to give an indication of fuel level. The principal advantage of this system is that it is simple and cheap (2).

But changes in aircraft attitude also cause the fuel level in each part of the tank to change, making the system inaccurate, so (4) is untrue. By sensing the fuel level this system actually measure volume rather than mass, so it is unable to compensate for changes in density due to thermal expansion and contraction or differing fuel grades. So (1) and (4) are untrue.

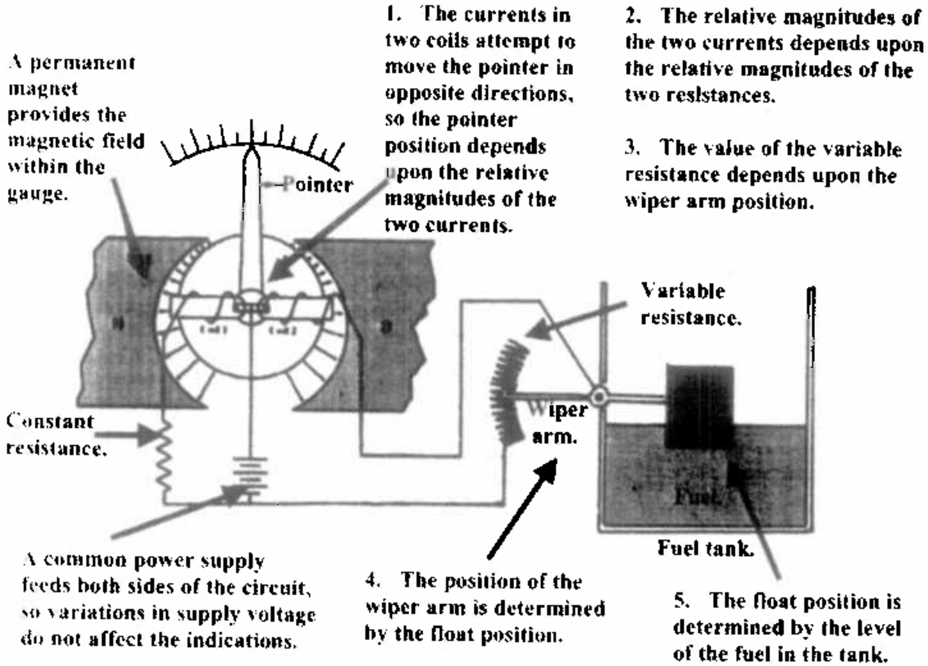
FUEL 16. a.

The sensors in float-type fuel gauging systems are simply small cork floats, connected to the wiper arms of variable resistors. As the fuel level rises or falls, the floats move up or down, decreasing or increasing the resistance of the variable resistors. These changes are measured, usually by means of a ratiometer, to give an indication of fuel level.

A ratiometer operates by applying the same supply voltage to two resistive circuits. The resistance of one circuit is constant, whilst that of the other increases with fuel level. The current flow through each circuit is therefore proportional to the supply voltage and the resistance of each circuit. But both circuits share the same power supply, so the ratio of the two currents will vary only with variations in fuel level.

A ratiometer is therefore largely immune to variations in power supply voltage, so option b is untrue. It should however be noted that if the supply voltage becomes extremely low, the current will be insufficient to power the gauge, so option d is not entirely true.

A galvanometer is simply an ammeter and is therefore unable to compensate for variations in power supply or line resistances. So if the system uses a galvanometer as its indicator, its readings will also be sensitive to changes in supply voltage (option a). A float type fuel gauging system using a ratiometer is illsutrated below.

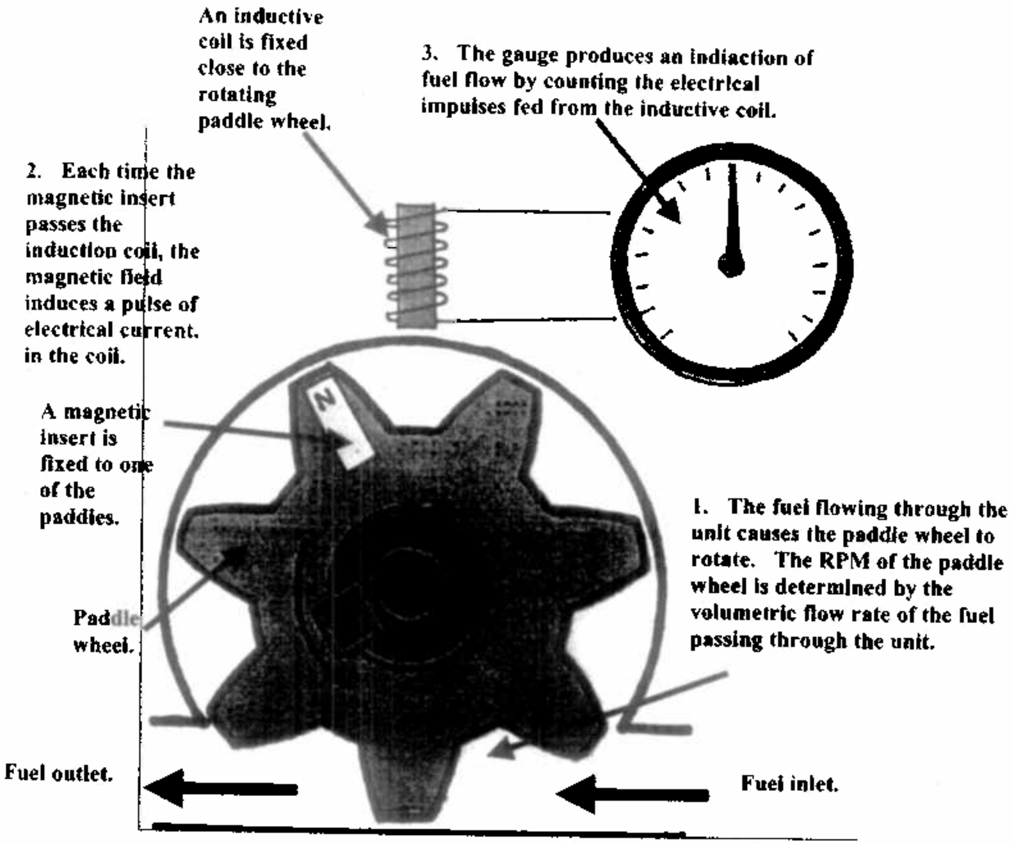


FLOAT TYPE FUEL GAUGING SYSTEM WITH RATIOMETER

FUEL 17. b.

A paddle wheel type fuel flow meter is illustrated below. It consists of a paddle wheel enclosed within a cylindrical casing. When a fuel passes through the unit, it causes the wheel to rotate. The volume of fuel that passes through the unit during each turn of the wheel, is equal to the sum of the volumes of the spaces between the daddles of the wheel. This means that the indication form this type of unit is a measure of volumetric flow rate.

Each time the paddle wheel rotates, a small magnet attached to one of the paddles passes close to an inductive coil. When it does so the magnetic field induces a small pulse of electrical current in the coil. One of these pulses is produced for each turn of the wheel, so the number of pulses over any given time period is proportional to the RPM of the wheel. But this RPM is proportional to the valumetric fuel flow rate. So this type of gauge measures volumetric flow rate by counting the impulses (option b).



SIMPLE PADDLE WHEEL TYPE FUEL FLOW METER

COMPASS 1. d.

The sensing element in a direct reading magnetic compass is a small bar magnet. By aligning itself with the lines of magnetic force produced by the magnet field of the earth, it continuously points towards the magnetic north. But because the sensor is simply a magnet, its alignment can be affected by any other source of magnetic field. The degree to which compass alignment is affected depends upon the strength of the magnetic fields produced by these sources. This in turn is proportional to the proximity of the source to the compass. Even a relatively weak magnet close to the compass can seriously degrade its accuracy.

The main sources of magnetic fields in aircraft are electrical currents and magnetically hard iron. The term magnetically hard iron refers to the phenomenon whereby some ferrous materials are difficult to magnetise, but retain there magnetism for long periods. So any magnetised hard iron (option b) materials located close to the compass within an aircraft, will affect the compass readings. Soft iron (option a) loses its magnetism very quickly and aluminium (option c) cannot be magnetised, so neither of these will affect compass readings.

The term "soft iron effect hard iron" refers to the effect on a compass as hard iron close to it gradually loses its magnetism. When a compass swing is carried out, adjustments are made to compensate for any hard iron close to it. But as this hard iron loses its magnetism, the compensating adjustments remain in place, causing the compass to become over compensated. This will cause errors in the opposite sense to those of the origin hard iron. So soft iron effect hard iron, and hard iron will affect compass readings (option d).

COMPASS 2. a.

In a gyro stabilised magnetic compass system, The gyro and the compass magnets work in harmony to exploit the benefits of each. The gyro is largely immune to acceleration and turning errors, but suffers from drift due to earth rotation and transport wander. The compass magnets suffer from errors when accelerating or decelerating on east-west headings, and when turning on north-south headings, but is immune to earth rotation and transport wander errors. In order to improve the accuracy of the system, the datum heading of the gyro is regularly reset using signals from the magnetic compass. This is achieved by a precession coil controlled by amplified error signals from the error detector. It is also necessary to ensure that the gyro spin axis is always in the yawing plane of the aircraft. This is achieved by a torque motor which causes the directional gyro to precess (option a).

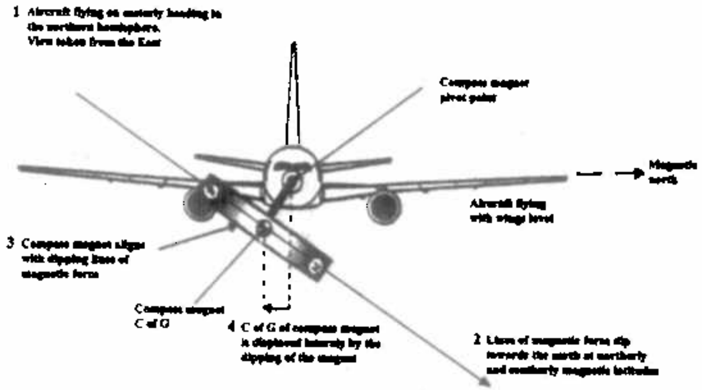
The selsyn stator (option b) cannot be rotated or adjusted by compass signals. It is the selsyn rotor that is adjusted by the gyro and precession coil. Calibration of the pointer (option c) and pointer movement (option d) are functions of the gyro more than they are functions of the compass signals.

COMPASS 3. c.

This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate.

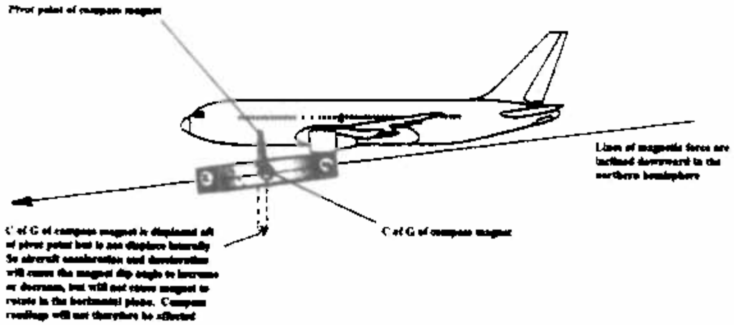
The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic south pole and vertically into the ground at the magnetic north pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy.

In order to minimise this problem, compasses are typically suspended such that their C of G is lower than their pivot. In this way the weight of the magnet is made to oppose the dipping caused by the lines of magnetic force. This is termed pendulous suspension. Although this reduces compass dip, it does not entirely eliminate it. This means that whenever an aircraft heading is anything other than magnetic north or south, the C of G of the compass magnet will be off-set to one side of the pivot, as illustrated below.



EFFECT OF DIPPING MAGNETIC LINES OF FORCE ACTING ON PENDULOUSLY SUSPENDED COMPASS MAGNET

Whenever an aircraft accelerates or decelerates on such a heading, the lateral displacement of the C of G and the inertia of its compass magnet, causes the magnet to rotate. The magnitude and direction of this rotation is determined by the aircraft heading, the hemisphere and the acceleration or deceleration rate. This question specifies a northerly heading, so there will be no rotation of the compass magnet. The effect of flight on a northerly heading is illustrated below.



EFFECT OF DIP WHEN FLYING NORTH

COMPASS 4. a.
In order to calculate magnetic heading from true heading it is necessary to apply a correction for variations in the direction of the magnetic field of the earth. This variation differs at all points on the earth, and is indicated in the form of a map of isogonal lines. So to find magnetic heading from true heading requires a compass and a map indicating isogonal lines.

A compass calibration card (option b) and a deviation card (option c), are the same thing. They indicate the deviation between an aircraft compass north and magnetic north. They cannot however show the relationship between true heading and magnetic heading because this differs at all points on the earth.

COMPASS 5. d.
The sensing element in a direct reading magnetic compass is a small bar magnet. By aligning itself with the lines of magnetic force produced by the magnet field of the earth, it continuously points towards the magnetic north. But because the sensor is simply a magnet, its alignment can be affected by any other source of magnet field. The degree to which compass alignment is affected depends upon the strength of the magnetic fields produced by these sources. This in turn is proportional to the proximity of the source to the compass. Even a relatively weak magnet close to the compass can seriously degrade its accuracy.

The main sources of magnetic fields in aircraft are ferrous materials (option a), and electrically induced magnetic fields (option c). Such fields are created by the operation of many types of electrical equipment, including transformers (option b). Non-ferrous metals (option d) cannot be magnetised so they will not affect compass readings.

COMPASS 6. c.
The sensing element in a direct reading magnetic compass is a small bar magnet. By aligning itself with the lines of magnetic force produced by the magnet field of the earth, it continuously points towards the magnetic north. But because the sensor is simply a magnet, its alignment can be affected by any other source of magnet field. The degree to which compass alignment is affected depends upon the strength of the magnetic fields produced by these sources. This in turn is proportional to the proximity of the source to the compass. Even a relatively weak magnet close to the compass can seriously degrade its accuracy.

All aircraft contain a number of sources of magnetic fields, so all aircraft compasses will be affected by them. The purpose of a compass swing is to maximise compass accuracy by making adjustments for the effects of these magnetic fields. In this way the compass north is aligned more accurately with magnetic north (option c). The lubber line (option a) is a mark on the outside of the compass. Its relationship with true north changes whenever aircraft heading changes. The term "schuler tuning" (option b) is related to the stabilisation of INS systems and not direct reading magnetic compasses. The relationship between compass north and true north (option d) varies with longitude and latitude, so the two cannot be aligned during compass swings.

COMPASS 7. c.
This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate. The general effects are illustrated in the diagrams in the answers to questions 3 and 13.

This type of question can be answered by visualising the general effects or more simply, by noting that decelerations on easterly or westerly headings always cause an apparent turn away from the nearest magnetic pole. But in accelerations or decelerations on southerly or northerly headings, or constant speed on any heading, no apparent turn occurs.

This question specifies a southerly heading, so there will be no rotation of the compass magnet and no false indication of a turn (option c).

COMPASS 8. a and d.
The sensing element in a direct reading magnetic compass is a small bar magnet. By aligning itself with the lines of magnetic force produced by the magnet field of the earth, it continuously points towards the magnetic north. But because the sensor is simply a magnet, its alignment can be affected by any other source of magnet field. The degree to which compass alignment is affected depends upon the strength of the magnetic fields produced by these sources. This in turn is proportional to the proximity of the source to the compass. Even a relatively weak magnet close to the compass can seriously degrade its accuracy.

The main sources permanent magnetism in aircraft is hard iron. This term refers to the phenomenon whereby some ferrous materials are difficult to magnetise, but retain there magnetism for long periods. The initial magnetisation of such materials requires the application of very strong magnetic fields. These are typically induced by strong electrical fields or lightening strikes (option d). Although changes in longitude (option c) and latitude (option b) affect compass accuracy, these effects become permanent only after very long periods in the new longitude or latitude.

One explanation of permanent magnetism is the idea that a material is made up of am enormous number of microscopic magents. When a material is in a demagnetised condition, these tiny magnets are aligned in random directions so that there is no overall magnetism. The material exhibits permanent magnetism when the majority of these tiny magnets are aligned in any one direction.

One effect of the hammering of rivets (option a) is to shake up these tiny magnets, causing them to lose their mutually aligned state. This returns them to a randomly aligned condition, thereby reducing any permanent magnetism within the aircraft. But if the aircraft remains on any one heading during the hammering process, the shaking process tends to align the tiny magnets with the local magnetic field of the earth. This means that hammering of rivets during manufacture can also cause permanent magnetism (option a). Students should lodge an appeal if this question appears in their examination, because the question has two correct options.

COMPASS 9. a.

The magnets of a compass point towards compass north. This is determined by the combined effects of the magnetic field of the earth and the magnetic fields generated by components within each aircraft. The direction to the magnetic north pole is termed magnetic north. Because the magnetic fields within each individual aircraft are slightly different from those in all other aircraft, it is unlikely that compass north and magnetic north with be identical. The term compass deviation refers to the difference between magnetic north and compass north for a given compass. The purpose of compass swinging is to reduce compass deviation to the minimum possible value. Compass swings must therefore be carried out after any event that is likely to have significantly altered compass deviation.

Such events include:

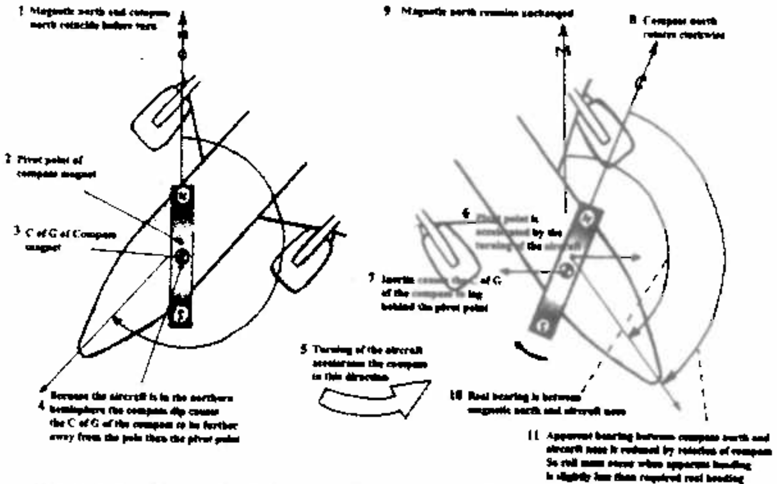
- Lightening strikes.
- Large changes in magnetic latitude.
- Long periods of storage on any one heading.
- Replacement of certain major components.

Only option a, long term changes in latitude, is the only one that meets these criteria. It should be noted that although short term changes in latitude also alter deviation, it would be impracticable to carry out a compass swing after such changes, because for long north-south routes, this would require a compass swing after every flight. Changes in longitude and base changes not involving large changes in latitude, have much smaller effects on deviation, so they do not require compass swinging.

COMPASS 10. a.

Whenever an aircraft turns, the compass is accelerated in the direction of the turn. If the aircraft is not over the magnetic equator. Its compass magnet will be dipped, due to the dip of the lines of magnetic force around the earth. This will cause the C of G of the magnet to be displaced as illustrated in the diagrams in the answer to question compass 3.

Because the C of G of the compass magnet is no longer directly below its pivot point, acceleration of the compass during turns about the north and south magnetic poles, will cause the magnet to rotate. This will cause the compass indications to alter as illustrated below.



SITUATION BEFORE TURN SITUATION DURING TURN

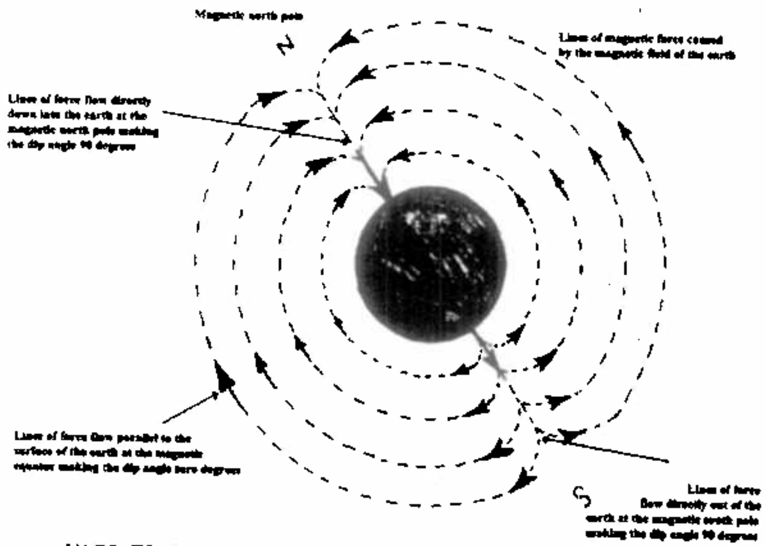
COMPASS ERROR WHEN TURNING SW TO SE IN NORTHERN HEMISPHERE

This is the greatest cause of compass errors, except when landing or taking-off. It should be noted that changes in latitude (option b) affect the degree of dip and hence the degree of turning error. But changes in latitude do not actually cause errors. Parallax errors and changes in magnetic deviation are generally quite small.

COMPASS 11. c.

The sensing element in a direct reading magnetic compass is a small bar magnet. By aligning itself with the lines of magnetic force produced by the magnet field of the earth, it continuously points towards the magnetic north. But the lines of magnetic force that make up the magnetic field of the earth are not horizontal at all points. As illustrated in the diagram below, the lines are vertical at the magnetic poles and horizontal only at the magnetic equator. At all other latitude the lines dip to varying degrees.

The direction of these lines at any point on the surface of the earth is therefore made up of a horizontal (H) component and a vertical (Z) component. As illustrated in the answer to question Compass 30, the Z component causes the compass magnet to dip. This reduces its effectiveness in aligning with magnetic north. So increasing Z component decreases compass sensitivity. It is the H component which aligns the compass with magnetic north, so increasing H component increases compass sensitivity. So both the Z and H components affect compass sensitivity (option c).



VARIATION OF DIP ANGLE WITH MAGNETIC LATITUDE

COMPASS 12. c.

This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate. The general effects are illustrated in the diagrams in the answers to questions Compass 3 and 13.

This type of question can be answered by visualising the general effects or more simply, by noting that decelerations on easterly or westerly headings always cause an apparent turn away from the nearest magnetic pole. But in accelerations on southerly or northerly headings, or constant speed on any heading, no apparent turn occurs. This question specifies cruising flight, so it can be assumed that airspeed will be constant. So although the heading is westerly, the constant speed means that there will be no rotation of the compass magnet, and hence no apparent turn (option c).

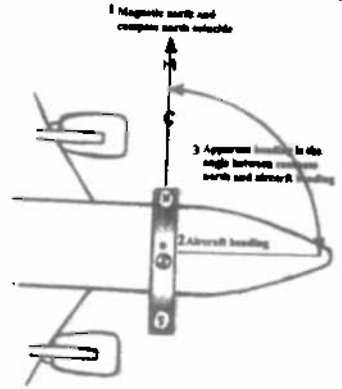
COMPASS 13. c.

This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate.

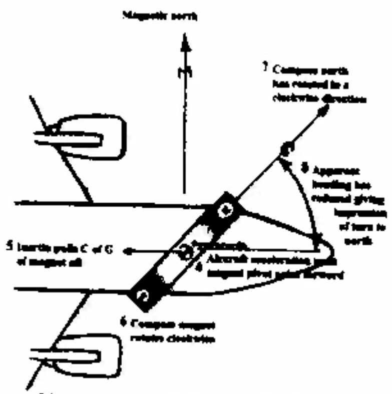
The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic north pole and vertically into the ground at the magnetic south pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy.

In order to minimise this problem, compasses are typically suspended such that their C of G is lower than their pivot. In this way the weight of the magnet is made to oppose the dipping caused by the lines of magnetic force. This is termed pendulous suspension. Although this reduces compass dip, it does not entirely eliminate it. This means that whenever an aircraft heading is anything other than magnetic north or south, the C of G of the compass magnet will be off-set to one side of the pivot.

Whenever an aircraft accelerates or decelerates on such a heading, the lateral displacement of the C of G and the inertia its compass magnet, causes the magnet to rotate. The magnitude and direction of this rotation is determined by the aircraft heading, the hemisphere and the acceleration or deceleration rate. This question specifies acceleration on a north westerly heading, so the compass magnet will rotate clockwise as illustrated below. The compass will therefore indicate less than 45°. This illustrates the more general result that accelerations produce an apparent turn towards the nearest pole.



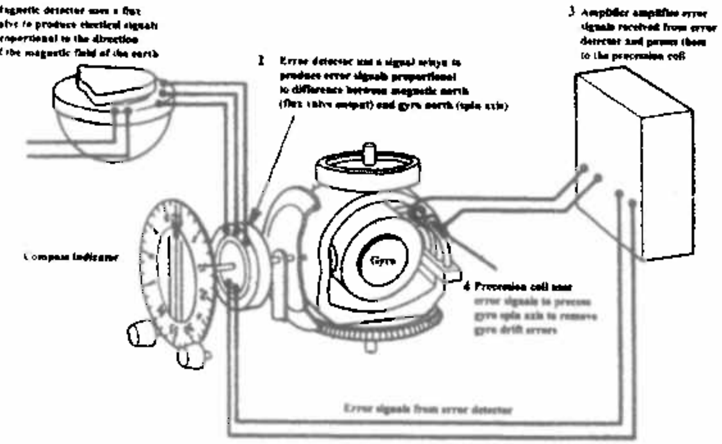
SITUATION BEFORE ACCELERATION IN EASTERLY DIRECTION



SITUATION DURING ACCELERATION IN EASTERLY DIRECTION

COMPASS 14. a.

A typical gyro magnetic compass system is illustrated below.



TYPICAL GYRO STABILISED COMPASS SYSTEM

This illustrates the fact that the flux valve or flux gate is part of the magnetic detector unit. Upon leaving the detector unit the signals pass to the signal selsyn in the error detector unit (option a), where it is compared with the gyro direction. Error signals are then sent to the amplifier and ultimately to the precession coil. The do not pass to the erecting system (option c). The annunciator (option d) monitors these signals to indicate when the gyro is correctly synchronised with the compass.

COMPASS 15. b.

In order to calculate magnetic heading from true heading it is necessary to apply a correction for variations in the direction of the magnetic field of the earth. These variations differ at all points on the earth, and are indicated in the form of a map of isogonal lines. So to find magnetic heading from true heading requires a compass and a map indicating isogonal lines (option b).

Isoclinal lines (option a) indicate the points where the degree of dip or Z component in the magnetic field of the earth are equal. These cannot be used to calculate magnetic heading. A compass calibration card (option c) and a deviation card (option d), are the same thing. They indicate the deviation between an aircraft compass and magnetic north. They cannot however show the relationship between true

COMPASS 16. b.

The detector unit in a remote indicating magnetic compass employs a flux valve to produce an electrical signal, representing the direction of the magnetic field of the earth. To do this it employs AC current (option b) to generate an alternating magnetic field. This alternating magnetic field interacts with the non-alternating magnetic field of the earth to produce an electrical signal representing heading. If a DC current (option a) were to be used the flux valve would immediately become magnetically saturated and remain so. It is essential that the magnetism of the flux valve is easily reversible, so they are made of magnetically soft materials such a perm-alloy steel (option d). But is cannot be said that all flux valves are made of perm-alloy steel, so option d is not entirely true. Option b is therefore the most appropriate in this question.

COMPASS 17. d.

A typical gyro magnetic compass system is illustrated in the answer to question COMPASS 14. This illustrates the fact that the flux valve or flux gate is part of the magnetic detector unit. Upon leaving the detector unit the signals pass to the signal selsyn, in the error detector (option d), then on to the amplifier (option c). The amplifier and the precession coils are both part of the feedback loop (option a). Flux valve output does not pass directly to the compass card (option b)

COMPASS 18. a.

The magnetic field of the earth is made up of a vertical component (Z) and a horizontal (H) component. The direction of the lines of forces at any point above the earth's surface, is the vector sum of these two components. At the poles, the lines of force flow vertically out of the earth at the magnetcic South Pole and into the earth at the magnetci North Pole, so their vertical component is maximum and their horizontal component is zero.

COMPASS 19. a.

The sensing element in a direct reading magnetic compass is a small bar magnet. By aligning itself with the lines of magnetic force produced by the magnet field of the earth, it continuously points towards the magnetic north. But because the sensor is simply a magnet, its alignment can be affected by any other source of magnet field. The degree to which compass alignment is affected depends upon the strength of the magnetic fields produced by these sources. This in turn is proportional to the proximity of the source to the compass. Even a relatively weak magnet close to the compass can seriously degrade its accuracy.

The main sources of magnetic fields in aircraft are ferrous materials (2), and electrically induced magnetic fields (1). Such fields are created by the operation of many types of electrical equipment, including transformers. Non-ferrous metals (3) cannot be magnetised so they will not affect compass readings. So option a is the most accurate.

COMPASS 20. c.
This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate. The general effects are illustrated in the diagrams in the answers to questions Compass 3 and 13.

This type of question can be answered by visualising the general effects or more simply, by noting that decelerations on easterly or westerly headings always cause an apparent turn away from the nearest magnetic pole. But in accelerations or decelerations on southerly or northerly headings, or constant speed on any heading, no apparent turn occurs. This question specifies a northerly heading, so there will be no rotation of the compass magnet.

COMPASS 21. d.
Whenever an aircraft turns, the compass is accelerated in the direction of the turn. If the aircraft is not over the magnetic equator. Its compass magnet will be dipped, due to the dip of the lines of magnetic force around the earth. This will cause the C of G of the magnet to be displaced as illustrated in the diagrams in the answer to question compass 3.

Because the C of G of the compass magnet is no longer directly below its pivot point, acceleration of the compass during turns about the north and south magnetic poles, will cause the magnet to rotate. This will cause the compass indications to alter as illustrated in the answer to question Compass 10.

COMPASS 22. c.
In a gyro stabilised magnetic compass system, the gyro and the compass magnets work in harmony to exploit the benefits of each. The gyro is largely immune to acceleration and turning errors, but suffers from drift due to earth rotation and transport wander. The compass magnets suffer from errors when accelerating or decelerating on east-west headings, and when turning on north-south headings, but are immune to earth rotation and transport wander errors. In order to improve the accuracy of the system, the datum heading of the gyro is regularly reset using signals from the magnetic compass and error detector. These signals are fed to a precession coil that keeps the gyro synchronised to magnetic north. It is also necessary to ensure that the spin axis of the gyro is always within the yawing plane of the aircraft. This is achieved by a torque motor which precesses the directional gyro whenever it moves out of the yawing plane.(option c).

The selsyn stator (option a) is used in older type systems, but cannot be rotated or adjusted by compass signals. Heading pointer movement (option b) is functions of the gyro more than they are functions of the compass signals. The inputs from the flux valve (option d) are received by the error detector.

COMPASS 23. b.
This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate.

The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic South Pole and vertically into the ground at the magnetic North Pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy.

In order to minimise this problem, compasses are typically suspended such that their C of G is lower than their pivot. In this way the weight of the magnet is made to oppose the dipping caused by the lines of magnetic force. This is termed pendulous suspension. Although this reduces compass dip, it does not entirely eliminate it. This means that whenever an aircraft heading is anything other than magnetic north or south, the C of G of the compass magnet will be off-set to one side of the pivot.

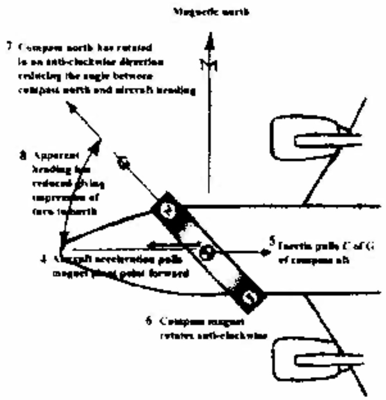
Whenever an aircraft accelerates or decelerates on such a heading, the lateral displacement of the C of G and the inertia its compass magnet, causes the magnet to rotate. The magnitude and direction of this rotation is determined by the aircraft heading, the hemisphere and the acceleration or deceleration rate. These effects are illustrated in the diagrams in answers to questions Compass 3 and 13.

COMPASS 24. b.
This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate.

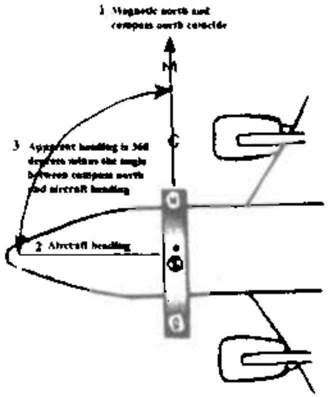
The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic south pole and vertically into the ground at the magnetic north pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy.

In order to minimise this problem, compasses are typically suspended such that their C of G is lower than their pivot. In this way the weight of the magnet is made to oppose the dipping caused by the lines of magnetic force. This is termed pendulous suspension. Although this reduces compass dip, it does not entirely eliminate it. This means that whenever an aircraft heading is anything other than magnetic north or south, the C of G of the compass magnet will be off-set to one side of the pivot.

Whenever an aircraft accelerates or decelerates on such a heading, the lateral displacement of the C of G and the inertia its compass magnet, causes the magnet to rotate. The magnitude and direction of this rotation is determined by the aircraft heading, the hemisphere and the acceleration or deceleration rate. This question specifies acceleration on a westerly heading in the northern hemisphere. This will cause the compass magnet to rotate anti-clockwise as illustrated below. So the compass will indicate a turn to the north as illustrated below. This answer illustrates the more general result that accelerations cause an apparent turn towards the nearest pole.



SITUATION DURING ACCELERATION
IN WESTERLY DIRECTION



SITUATION BEFORE ACCELERATION
IN WESTERLY DIRECTION

COMPASS 25. b.

A typical gyro magnetic compass system is illustrated in the answer to question Compass 14. This illustrates the fact that the flux valve or flux gate is part of the magnetic detector. Upon leaving the detector unit the signals pass to the signal selsyn, in the error detector (option b), then on to the amplifier (option c) and ultimately to the precession coil. The do not pass directly to the erecting system (option a) nor to the heading indicator card (option d).

COMPASS 26. b.

Magnetic north is the direction to the magnetic north pole of the earth. Compass north is the direction to the magentic north pole as indicated by the compass needle. True north is the direction to the geographic north pole of the earth.

The sensing element in a direct reading magnetic compass is a small bar magnet. By aligning itself with the lines of magnetic force produced by the magnet field of the earth, it continuously points towards the magnetic north. But because the

sensor is simply a magnet, its alignment can be affected by any other source of magnet fields. The degree to which compass alignment is affected depends upon the strength of the magnetic fields produced by these sources. This in turn is proportional to the proximity of the source to the compass. Even a relatively weak magnet close to the compass can seriously degrade its accuracy.

All aircraft contain a number of sources of magnetic fields, so all aircraft compasses will be affected by them. The purpose of a compass swing is to maximise compass accuracy by making adjustments for the effects of these magnetic fields. In this way the compass north is aligned more accurately with magnetic north (option b). The lubber line (option c) is a mark on the outside of the compass. Its relationship with true north changes whenever aircraft heading changes. The relationship between compass north and true north (option a)varies with longitude and latitude, so the two cannot be aligned during compass swings. A compass correction card (option d) is drawn up during a compass swing but this is not the primary purpose of the swing. So the purpose of a compass swing is to align compass north with magnetic north (option b).

COMPASS 27. b.

The detector unit in a RIMC (Remote Indicating Magnetic Compass) employs a flux valve to produce an electrical signal, representing the direction of the magnetic field of the earth. To do this it employs AC current (option b) to generate an alternating magnetic field. This alternating magnetic field interacts with the non-alternating magnetic field of the earth to produce an electrical signal representing heading. If a DC current (option a) were to be used the flux valve would immediately become magnetically saturated and remain so. It is essential that the magnetism of the flux valve is easily reversible, so they are made of magnetically soft materials such a perm-alloy steel (option d). But even those that are made from this material require an AC current to function. Option b is therefore the most appropriate in this question.

COMPASS 28. b.

This question is concerned with the effects of acceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate.

The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic south pole and vertically into the ground at the magnetic north pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy.

In order to minimise this problem, compasses are typically suspended such that their C of G is lower than their pivot. In this way the weight of the magnet is made to oppose the dipping caused by the lines of magnetic force. This is termed pendulous suspension. Although this reduces compass dip, it does not entirely eliminate it. This means that whenever an aircraft heading is anything other than magnetic north or south, the C of G of the compass magnet will be off-set to one side of the pivot.

Whenever an aircraft accelerates or decelerates on such a heading, the lateral displacement of the C of G and the inertia its compass magnet, causes the magnet to rotate. The magnitude and direction of this rotation is determined by the aircraft heading, the hemisphere and the acceleration or deceleration rate. This question specifies acceleration on a westerly heading, so the compass magnet will rotate clockwise as illustrated in the diagram in the answer to question Compass 13. The compass will therefore indicate less than 45° (option b). This answer illustrates the more general result that accelerations cause an apparent turn towards the nearest pole.

COMPASS 29. c.

Magnetic north is the direction to the magnetic north pole of the earth. Compass north is the direction to the magentic north pole as indicated by the compass needle. True north is the direction to the geographic north pole of the earth.

In order to calculate magnetic heading from true heading it is necessary to apply a correction for the variation in the direction of the magnetic field of the earth. This variation differs at all points on the earth, and is indicated in the form of a map of isogonal lines. So to find magnetic heading from true heading requires a compass and a map indicating isogonal lines (option c).

Isoclinal lines (option d) indicate the points where the degree of dip or Z component in the magnetic field of the earth are equal. These cannot be used to calculate magnetic heading. A compass deviation card (option a), indicates the deviation between an aircraft compass and magnetic north. They cannot however show the relationship between true heading. The term "error card" (option b) has no recognised meaning in relation to aircraft compasses.

COMPASS 30. c.

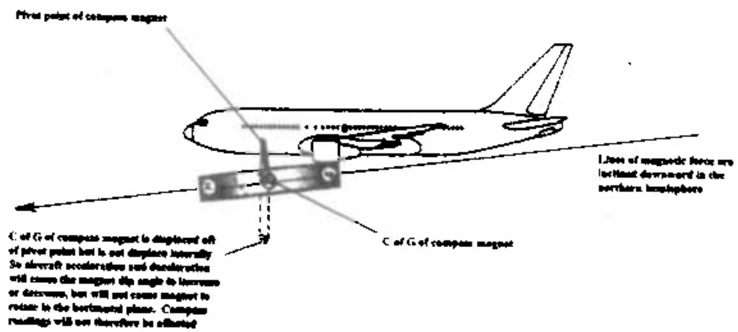
This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate.

The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic south pole and vertically into the ground at the magnetic north pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy.

In order to minimise this problem, compasses are typically suspended such that their C of G is lower than their pivot. In this way the weight of the magnet is made to oppose the dipping caused by the lines of magnetic force. This is termed pendulous suspension. Although this reduces compass dip, it does not entirely eliminate it. This means that whenever an aircraft heading is anything other than magnetic north or south, the C of G of the compass magnet will be off-set to one side of the pivot.

Whenever an aircraft decelerates on such a heading, the lateral displacement of the C of G and the inertia its compass magnet, cause the C of G of the magnet to move ahead of the suspension point. This will cause the magnet to rotate. The magnitude and direction of this rotation is determined by the aircraft heading, the hemisphere and the deceleration rate. But if the heading is north or south the C of G of the magnet will be directly in front of or behind the suspension point, so no rotation will occur.

This question specifies deceleration on a southerly heading, so the compass magnet will not rotate. The compass will therefore indicate no turn (option c). The effect of dip when flying on a northerly heading is illustrated below.



EFFECT OF DIP WHEN FLYING NORTH

COMPASS 31. c.

The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic south pole and vertically into the ground at the magnetic north pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy. In order to minimise this problem, compasses are typically suspended such that their suspension point is above their C of G (option c).

COMPASS 32. a.

The sensing element in a direct reading magnetic compass is a small bar magnet. By aligning itself with the lines of magnetic force produced by the magnet field of the earth, it continuously points towards the magnetic north. But because the sensor is simply a magnet, its alignment can be affected by any other source of magnet field. The degree to which compass alignment is affected depends upon the strength of the magnetic fields produced by these sources. This in turn is proportional to the proximity of the source to the compass. Even a relatively weak magnet close to the compass can seriously degrade its accuracy.

The main sources of magnetic fields in aircraft are electrical currents and magnetically hard iron. The term magnetically hard iron refers to the phenomenon whereby some ferrous materials are difficult to magnetise, but retain there magnetism for long periods. So any magnetised hard iron (option a) materials located close to the compass within an aircraft, will affect the compass readings. Soft iron (option c) loses its magnetism very quickly so it will not affect compass readings. The term mild iron (option b) has no specific meaning with regard to magnetism or compasses. As explained in the answer to question Compass 30, accelerations on northerly (option d) and southerly headings do not affect compass accuracy.

COMPASS 33. b.

Gyro drift due to earth rotation is termed apparent wander. It is caused by the fact that the gyro is carried around with the earth as it rotates. It is negative in the northern hemisphere and positive in the southern hemisphere. The rate of apparent wander can be calculated using the standard equation:

Apparent wander in ^{0} per hour = 15^0 x the sin of the angle of latitude.

So drift rate is greatest where the sin of the latitude is greatest. This occurs at 90^0 degrees north and south, where:

Apparent wander = 15^0 x 1, which = 15^0 per hour (option b)

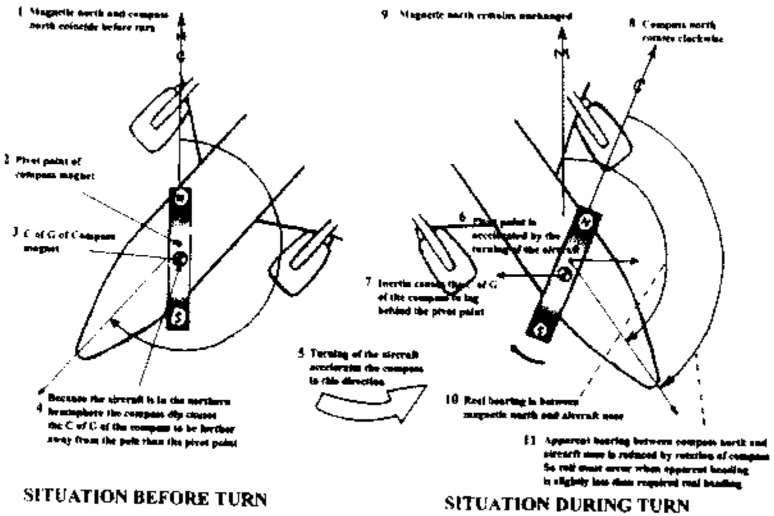
Or more intuitively, a gyro at the poles will drift one full revolution per day. That is 360^0 per 24 hours, which is 360/15, or 15^0 per hour.

COMPASS 34. a.

Whenever an aircraft turns, the compass is accelerated in the direction of the turn. If the aircraft is not over the magnetic equator, its compass magnet will be dipped, due to the dip of the lines of magnetic force around the earth. This will cause the C of G of the magnet to be displaced as illustrated in the diagrams in the answer to question compass 3.

Because the C of G of the compass magnet is no longer directly below its pivot point, acceleration of the compass during turns about the north and south magnetic

poles, will cause the magnet to rotate. This will cause the compass indications to alter as illustrated below.



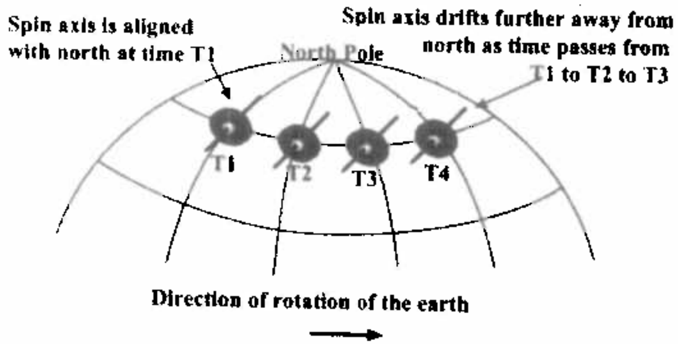
COMPASS ERROR WHEN TURNING SW TO SE IN NORTHERN HEMISPHERE

This question can be solved by visualising these general effects, or more simply by noting that if the aircraft is in the same hemisphere as the pole through which it is turning, the compass will turn in the same direction as the aircraft, but at a greater rate. This will cause the compass to under read when turning clockwise and over read when turning anti-clockwise. If the aircraft and the pole through which it turns are in opposite hemispheres, then the compass will turn in the opposite direction to the aircraft. This will cause the compass to over read when turning clockwise and under read when turning anti-clockwise.

This questions specifies a turn from SW to SE in the northern hemisphere. This means that the aircraft and the (south) pole through which it turns are in opposite hemispheres. So the compass will be sluggish, which means that as the aircraft turns anti-clockwise, the slower moving compass will appear to turn clockwise when viewed from within the aircraft. This will cause the compass to under indicate. So to achieve a new heading of SE (135 degrees), the roll out must occur at a lower compass indication. Only option a, 115 degrees satisfies this condition.

COMPASS 35. b.

Gyro drift due to earth rotation is termed apparent wander. It is caused by the fact that the gyro is carried around with the earth as it rotates, as illustrated below. It is negative in the northern hemisphere and positive in the southern hemisphere. The rate of apparent wander can be calculated using the standard equation:



Apparent wander in ° per hour = 15° x the sin of the angle of latitude.

So drift rate is zero where sin of the angle of latitude is zero. This occurs at the equator where the latitude and the sine of the latitude is zero.

Transport wander (TW) is similar to earth rate wander, but is caused by the movement of an aircraft as it flies around the earth. Transport wander can be calculated using the standard equation:

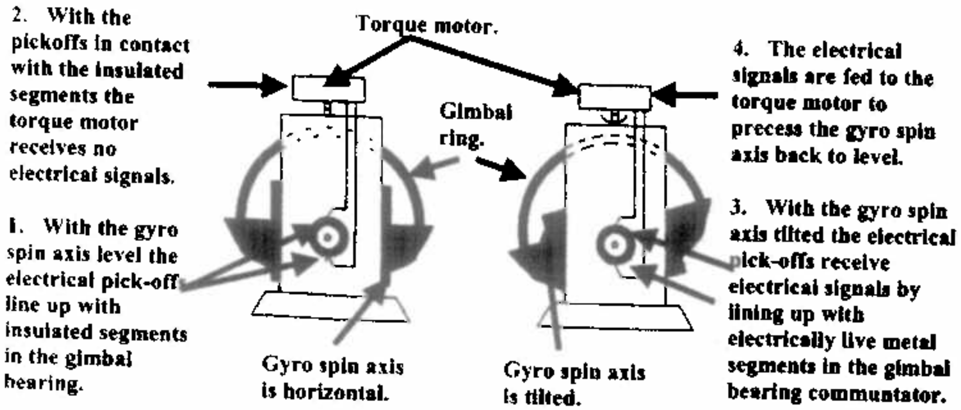
TW in °/hour = easterly ground speed x the tan of the angle of latitude.

So TW will be zero where the tan of the angle of latitude is zero. This occurs at the equator where the latitude and the tangent of latitude are both zero.

So earth rate wander and transport wander will be zero at the equator (option b).

COMPASS 36. d.

A typical gyro magnetic compass self-levelling system is illustrated below.



DIRECTIONAL GYRO SELF-LEVELLING SYSTEM.

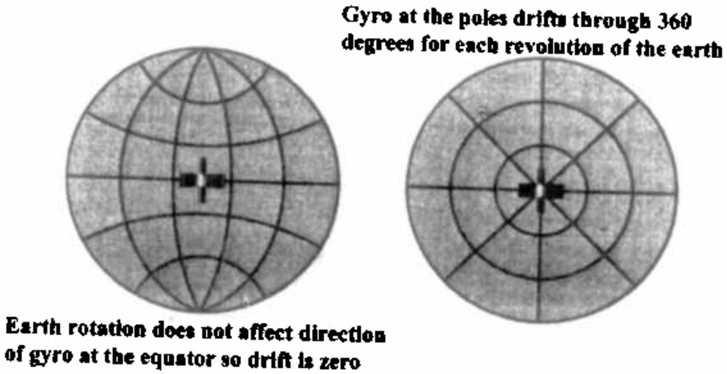
The purpose of the torque motor is to maintain the gyro spin axis in the yawing plane of the aircraft. It does this by means of electrical currents which are controlled by commutator–like segments in the gimbal bearings. These bearings are not part of the error detector, flux valve, nor amplifier, so the most appropriate solution to this question is probably option d, the gimbal tilt unit. It should however be noted that this term is not in general use. The question is therefore somewhat dubious, but is included in this book because it has been reported by a number of students.

COMPASS 37. c.

Gyro drift due to earth rotation is termed apparent wander. It is caused by the fact that the gyro is carried around with the earth as it rotates. It is negative in the northern hemisphere and positive in the southern hemisphere. The rate of apparent wander can be calculated using the standard equation:

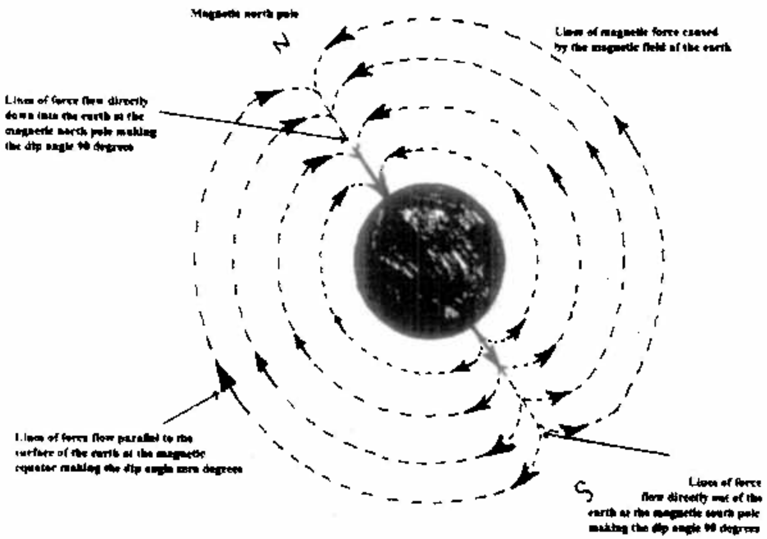
Apparent wander in ° per hour = 15° x the sin of the angle of latitude.

So drift rate is maximum where the sin of the angle of latitude is maximum. This occurs at 90° north and south. The sin of 90° is 1, so the maximum possible drift rate is 15° per hour (option c). The relationship between drift an latitude is illustrated below.



COMPASS 38. d.

The term dip angle refers to the vertical component of the lines of force created by the earths magnetic field. These lines flow vertically upwards, out of the ground at the magnetic south pole and vertically into the ground at the magnetic north pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. So the dip angle is 90° at the North and South poles as illustrated below.



VARIATION OF DIP ANGLE WITH MAGNETIC LATITUDE

COMPASS 39. c.

Gyro drift due to earth rotation is termed apparent wander. It is caused by the fact that the gyro is carried around with the earth as it rotates. It causes the dalignement spin axis to rotate clockwise in the northern hemisphere and anti-clockwise in the southern hemisphere. The rate of apparent wander can be calculated using the standard equation:

Apparent wander in ° per hour = 15° x the sin of the angle of latitude.

So at 45° north the drift will be 15° x sin 45°, which is 10.6° per hour clockwise (option c).

COMPASS 40. c.

This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate. The general effects are illustrated in the diagrams in the answers to questions Compass 3 and 13.

This type of question can be answered by visualising the general effects or more simply, by noting that accelerations on easterly or westerly headings always cause an apparent turn towards the nearest magnetic pole.

This question specifies acceleration on a north easterly heading, so the compass magnet will rotate clockwise as illustrated in the diagram in the answer to question Compass 13. This will give an apparent turn towards the north pole, so the compass will indicate less than 45° (option c).

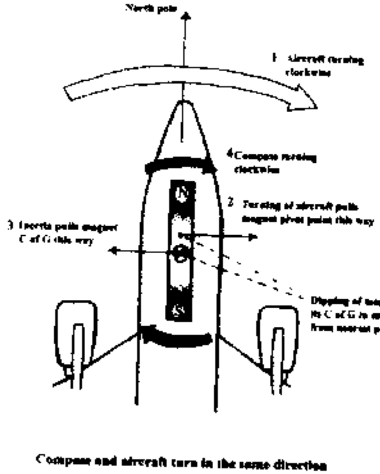
COMPASS 41. d.

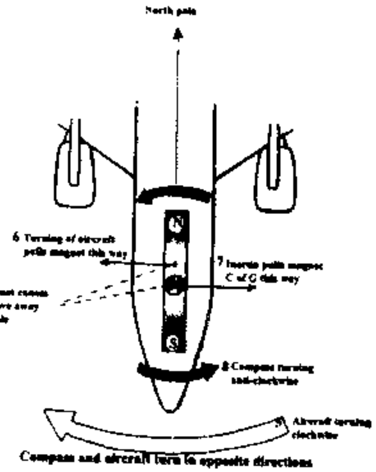
Whenever an aircraft turns, the compass is accelerated in the direction of the turn. If the aircraft is not over the magnetic equator, its compass magnet will be dipped, due to the dip of the lines of magnetic force around the earth. This will cause the C of G of the magnet to be displaced as illustrated in the diagrams in the answer to question compass 3.

Because the C of G of the compass magnet is no longer directly below its pivot point, acceleration of the compass during turns about the north and south magnetic poles, will cause the magnet to rotate. This will cause the compass indications to alter as illustrated below.

This question can be solved by visualising these general effects, or more simply by noting that if the aircraft is in the same hemisphere as the pole through which it is turning, the compass will turn in the same direction as the aircraft, but at a greater rate. This will cause the compass to under read when turning clockwise and over read when turning anti-clockwise. This effect is illustrated in the diagram below.

The questions specifies a right turn through 90 degrees to North, when in the northern hemisphere. This means turning from West (270 degrees) to North (360 degrees). So the aircraft is turning clockwise and it and the (north) pole to which it turns are in same hemispheres. So the compass will under read. So to achieve a heading of 360 degrees, the roll out must occur at some slightly lower heading. All of the options satisfy this condition but option d, 350 degrees is the closest and hence the most probable.





TURNING ERROR WHEN AIRCRAFT IS POINTING TOWARDS NEAREST POLE

TURNING ERROR WHEN AIRCRAFT IS POINTING AWAY FROM NEAREST POLE

COMPASS 42, b.

The magnets of a compass point towards compass north. This is determined by the combined effects of the magnetic field of the earth and the magnetic fields generated by components within each aircraft. The direction to the magnetic north pole is termed magnetic north. Because the magnetic fields within each individual aircraft are slightly different from those in all other aircraft, it is unlikely that compass north and magnetic north with be identical. The term compass deviation refers to the difference between magnetic north and compass north for a given compass. The purpose of compass swinging is to reduce compass deviation to the minimum possible value. Compass swings must therefore be carried out after any event that is likely to have significantly altered compass deviation.

Such events include:

- Lightening strikes.
- Large changes in magnetic latitude.
- Long periods of storage on any one heading.
- Replacement of certain major components.

Option b, long term changes in latitude, is the only one that meets these criteria. It should be noted that although short term changes in latitude (option a) also alter deviation, it would be impracticable to carry out a compass swing after such changes, because for long north-south routes, this would require a compass swing after every flight. Changes in longitude (option c and d), have much smaller effects on deviation, so they do not require compass swinging.

COMPASS 43, c.

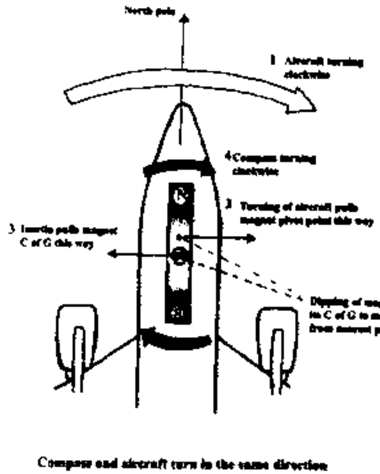
This question specifies a "remote indicating compass". This could mean a gyro stabilised compass as illustrated in the answer to question Compass 14, or a more rudimentary system, employing only a magnetic detector, selsyn synchro error detector and indicator. This has the advantage that the magnetic detector can be located at some point outside the cockpit and remote from local magnetic interference, but suffers from acceleration and turning errors just like a direct reading compass.

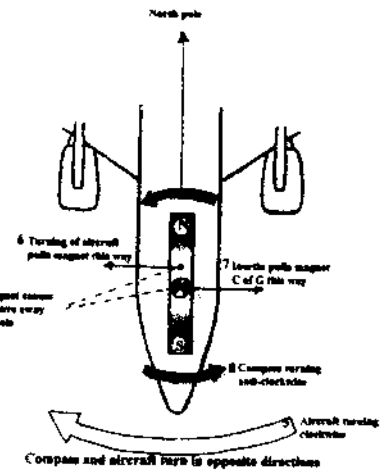
Whether the question is intended to refer to the gyro or non-gyro system makes little difference in that in both systems the flux valve signals are sent to the error detector (option c). In the gyro system error signals then pass to an amplifier and ultimately to a precession coil. In the non-gyro system the rotor of the selsyn is fed with AC current. This current reacts wit the error signals to turn the rotor so that it aligns with the, magnetic detector. It should be noted that the precessing torque motor (option b)does not receive flux valve signals, because its purpose is to keep the gyro spin axis within the yawing plane of the aircraft. It is fed with AC current via segmented bearing which sense tilt.

COMPASS 44, d.

Whenever an aircraft turns, the compass is accelerated in the direction of the turn. If the aircraft is not over the magnetic equator. Its compass magnet will be dipped, due to the dip of the lines of magnetic force around the earth. This will cause the C of G of the magnet to be displaced as illustrated in the diagrams in the answer to question compass 3.

Because the C of G of the compass magnet is no longer directly below its pivot point, acceleration of the compass during turns about the north and south magnetic poles, will cause the magnet to rotate. This will cause the compass indications to alter as illustrated below.





TURNING ERROR WHEN AIRCRAFT IS POINTING TOWARDS NEAREST POLE

TURNING ERROR WHEN AIRCRAFT IS POINTING AWAY FROM NEAREST POLE

This question can be solved by visualising these general effects, or more simply by noting that if the aircraft is in the opposite hemisphere to the pole through which it is turning, the compass will turn in the opposite direction to the aircraft. This will cause the compass to over read when turning clockwise and under read when turning anti-clockwise.

The question specifies a clockwise turn from SE (135 degrees), to SW (225 degrees), in the northern hemisphere, so the aircraft and (south) pole through which it turns are in opposite hemispheres. This will cause the compass to over read, so roll out must occur at a heading greater than the 225 required. Only option d, 245 satisfies this condition.

COMPASS 45. a.

Whenever an aircraft turns, the compass is accelerated in the direction of the turn. If the aircraft is not over the magnetic equator. Its compass magnet will be dipped, due to the dip of the lines of magnetic force around the earth. This will cause the C of G of the magnet to be displaced as illustrated in the diagrams in the answer to question compass 3.

Because the C of G of the compass magnet is no longer directly below its pivot point, acceleration of the compass during turns about the north and south magnetic poles, will cause the magnet to rotate. This will cause the compass indications to alter as illustrated in question COMPASS 44.

This question can be solved by visualising these general effects, or more simply by noting that if the aircraft is in the opposite hemisphere as the pole through which it is turning, the compass will turn in the opposite direction to the aircraft. This will cause the compass to over read when turning clockwise and under read when turning anti-clockwise. This effect is illustrated below.

The question specifies an anti-clockwise turn from SW (225 degrees), to SE (135 degrees), in the northern hemisphere, so the aircraft and (south) pole through which it turns are in opposite hemispheres. This will cause the compass to under read, so roll out must occur at a heading lower than the 135 required. Only option a, 115 satisfies this condition.

COMPASS 46. d.

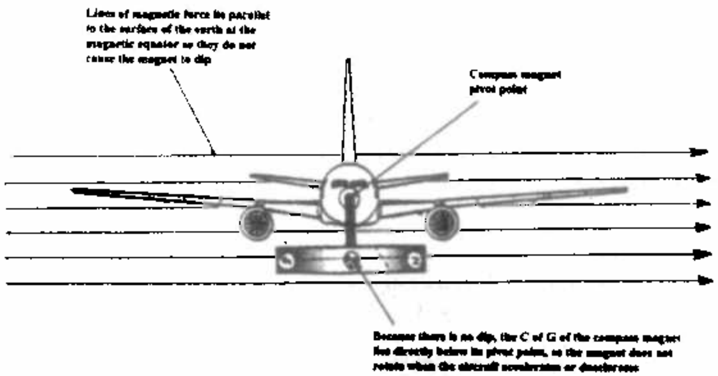
This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate.

The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic south pole and vertically into the ground at the magnetic north pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The

inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy.

In order to minimise this problem, compasses are typically suspended such that their C of G is lower than their pivot. In this way the weight of the magnet is made to oppose the dipping caused by the lines of magnetic force. This is termed pendulous suspension. Although this reduces compass dip, it does not entirely eliminate it. This means that whenever an aircraft heading is anything other than magnetic north or south, the C of G of the compass magnet will be off-set to one side of the pivot.

Whenever an aircraft accelerates or decelerates on such a heading, the lateral displacement of the C of G and the inertia its compass magnet, causes the magnet to rotate. The magnitude and direction of this rotation is determined by the aircraft heading, the magnetic latitude and the acceleration or deceleration rate. This question specifies deceleration on a westerly heading on the magnetic equator. But as illustrated below, the dip angle is zero at the magnetic equator, so the C of G of the compass magnets will be directly below the pivot point. So the magnets will not rotate, regardless of the acceleration or deceleration. The compass will therefore indicate no turn (option d). This answer illustrates the general fact that accelerations and decelerations will not cause compass errors when over the magnetic equator.



ZERO DIP AT THE MAGNETIC EQUATOR

COMPASS 47. c.

The rose should be aligned with zero degrees but is stuck on 075 degrees. So the system is over reading by 75 degrees. The ADF pointer points towards the beacon, so the relative bearing is the indicated bearing minus the error, which is 270 – 75 = 195 degrees (option c)

COMPASS 48. d.

The Directional Gyro Indicator or DGI provides a stable heading reference that is free from the turning and acceleration errors that affect direct reading compasses. To achieve this it employs a gyro that is tied to the yawing plane of the aircraft. Like all other gyros it is susceptible to transport wander (1), earth rate wander (2) and mechanical imperfection (4). Corrections for earth rate wander are provided by a latitude nut, which precesses the gyro at the same rate but in the opposite sense to that caused by earth rate. Because transport wander is dependent upon east/west groundspeed and latitude, it cannot be overcome by the latitude nut.

The DGI, like all horizontal gyros, is also susceptible to small transient gimbal errors when the aircraft pitches and rolls. This is because pitching and rolling cause the outer gimbal to rotate slightly about its own axis, in order to maintain the spin axis horizontal. This is translated into a heading indication error in the DGI. So the DGI is susceptible to all of the above errors.

COMPASS 49. b.

Gyro drift due to earth rotation is termed apparent wander. It is caused by the fact that the gyro is carried around with the earth as it rotates. It causes the spin axis to wander clockwise in the northern hemisphere and anti-clockwise in the southern hemisphere. The rate of apparent wander is proportional to latitude. The purpose of the latitude nut is to compensate for earth rate wander (option b). It does this by precessing the gyro at a rate that is equal but opposite to the earth rate.

Transport wander (option d) rate is determined by latitude and ground speed, so it cannot be compensated for in this manner. Both earth rate wander (option b) and transport wander (option d) can be said to be sources of latitude error. So option c is not entirely correct.

COMPASS 50. a.

Earth rate error (option b) is caused by the fact that the gyro is carried around with the earth as it rotates. It should be noted that in this condition the aircraft remains stationary on the surface of the earth. Transport wander (option a) is similar, but is caused by the movement of an aircraft as it flies around the earth. Both a and b are forms of latitude error (option d) but are not generally referred to as such. Gyros do not exhibit altitude errors (option c). So option a, transport wander is the most appropriate for this question.

COMPASS 51. d.

The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic south pole and vertically into the ground at the magnetic north pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The

inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy.

In order to minimise this problem, compasses are typically suspended such that their C of G is lower than their pivot. In this way the weight of the magnet is made to oppose the dipping caused by the lines of magnetic force. This is termed pendulous suspension. Although this reduces compass dip, it does not entirely eliminate it.

This means that whenever an aircraft heading is anything other than magnetic north or south, the C of G of the compass magnet will be off-set to one side of the pivot. Whenever an aircraft accelerates or decelerates on such a heading, the lateral displacement of the C of G and the inertia its compass magnet, causes the magnet to rotate. The magnitude and direction of this rotation is determined by the aircraft heading, the magnetic latitude and the acceleration or deceleration rate. These effects are illustrated in the diagrams in the answers to questions Compass 3 and 13. So one of the factors causing errors ona DRMC is acelerations on east/west headings.

COMPASS 52. b.

The detector unit in a remote indicating magnetic compass employs a flux valve to produce an electrical signal, representing the direction of the magnetic field of the earth. To do this it employs AC current (option b) to generate an alternating magnetic field. This alternating magnetic field interacts with the non-alternating magnetic field of the earth to produce an electrical signal representing heading. If a DC current (option a) were to be used the flux valve would immediately become magnetically saturated and remain so.

COMPASS 53. c.

This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate. The general effects are illustrated in the diagrams in the answers to questions Compass 3 and 13.

This type of question can be answered by visualising the general effects or more simply, by noting that decelerations on easterly or westerly headings always cause an apparent turn away from the nearest magnetic pole.

This question specifies deceleration on a easterly heading in the northern hemisphere, so there will be an apparent turn away from the pole. This means that the compass card will rotate anti-clockwise, causing the compass to over read (option c0.

COMPASS 54. c.

This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate. The general effects are illustrated in the diagrams in the answers to questions Compass 3 and 13.

This type of question can be answered by visualising the general effects or more simply, by noting that accelerations on easterly or westerly headings always cause an apparent turn towards the nearest magnetic pole.

This question specifies acceleration on a westerly heading in the northern hemisphere, so the comapass card will turn anti-clockwise indicating a turn north (option c).

COMPASS 55. a.
Gyro drift due to earth rotation is termed apparent wander or earth rate wander. It is caused by the fact that the gyro is carried around with the earth as it rotates. The rate of apparent wander is proportional to latitude. The purpose of the latitude nut is to compensate by precessing the gyro at a rate that is equal but opposite to the earth rate wander. If correctly adjusted, this will completely eliminate wander provided the aircraft remains stationary on the ground. This questions specifies that the system has been adjusted in this manner, so the indication will remain at 100 degrees (option a), regardless of the time that the aircraft remains in that condition.

COMPASS 56. b
The rose should be aligned with zero degrees but is stuck on 090 degrees. So the system is over reading by 90 degrees. The ADF pointer points towards the beacon, so the relative bearing is the indicated bearing minus the error, which is 240 – 90 = 150 degrees (option b)

COMPASS 57. c.
This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate.

The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic south pole and vertically into the ground at the magnetic north pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy.

In order to minimise this problem, compasses are typically suspended such that their C of G is lower than their pivot. In this way the weight of the magnet is made to oppose the dipping caused by the lines of magnetic force. This is termed pendulous suspension. Although this reduces compass dip, it does not entirely eliminate it. This means that whenever an aircraft heading is anything other than

magnetic north or south, the C of G of the compass magnet will be off-set to one side of the pivot.

Whenever an aircraft accelerates or decelerates on such a heading, the lateral displacement of the C of G and the inertia its compass magnet, causes the magnet to rotate. The magnitude and direction of this rotation is determined by the aircraft heading, the magnetic latitude and the acceleration or deceleration rate. This question specifies deceleration on a southerly heading so the compass magnet will not rotate regardless of acceleration rate or latitude. The compass will therefore indicate no apparent turn (option c).

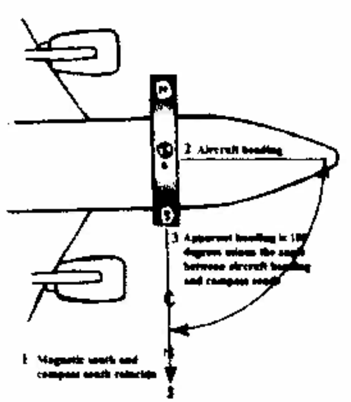
COMPASS 58. d.
The accuracy of compasses is degraded by the presence of magnetic fields within the aircraft. The term deviation refers to the difference between compass north and magnetic north. The compass deviation card (option d) provides a record of deviation on various heading. Isoclinal lines (option b) indicate the dip or Z component of the magnetic field of the earth. Isogonal lines (option c) indicate the direction or H component of the magnetic filed of the earth. Neither of these can be used alone to determine deviation. The term "compass card" (option a) has no specific meaning. So deviation cane be found using the compass deviation card (option d).

COMPASS 59. b.
This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate.

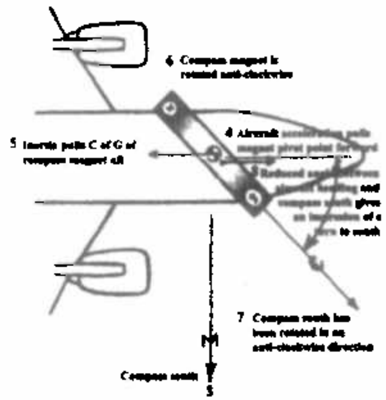
The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic south pole and vertically into the ground at the magnetic north pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy.

In order to minimise this problem, compasses are typically suspended such that their C of G is lower than their pivot. In this way the weight of the magnet is made to oppose the dipping caused by the lines of magnetic force. This is termed pendulous suspension. Although this reduces compass dip, it does not entirely eliminate it. This means that whenever an aircraft heading is anything other than magnetic north or south, the C of G of the compass magnet will be off-set to one side of the pivot.

Whenever an aircraft accelerates or decelerates on such a heading, the lateral displacement of the C of G and the inertia its compass magnet, causes the magnet to rotate. The magnitude and direction of this rotation is determined by the aircraft heading, the hemisphere and the acceleration or deceleration rate. This question specifies acceleration on a north easterly heading in the southern hemisphere, so the compass magnet will rotate anti-clockwise as illustrated below. The compass will therefore indicate a turn to the south (option b). This illustrates the general point that acceleration will always cause an apparent turn towards the nearest pole. This effect is illustrated in the diagram below.



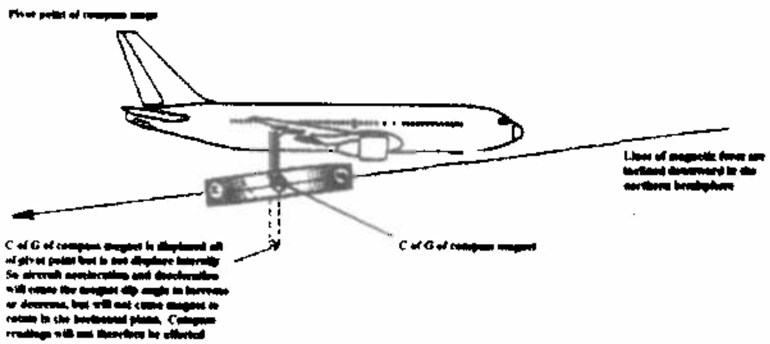
SITUATION BEFORE ACCELERATION
IN EASTERLY DIRECTION



SITUATION DURING ACCELERATION
IN EASTERLY DIRECTION

COMPASS 60. b.

Whenever an aircraft turns, the compass is accelerated in the direction of the turn. If the aircraft is not over the magnetic equator. Its compass magnet will be dipped, due to the dip of the lines of magnetic force around the earth. This will cause the C of G of the magnet to be displaced as illustrated below.

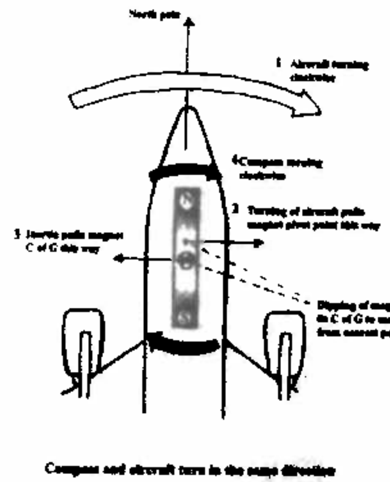


EFFECT OF DIP WHEN FLYING NORTH

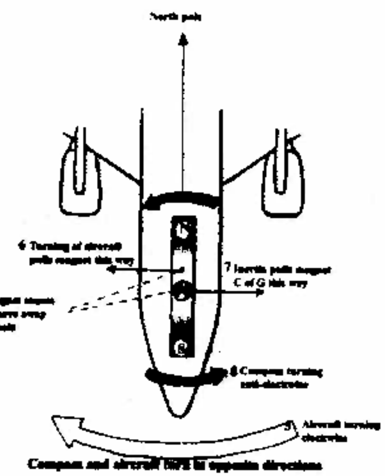
Because the C of G of the compass magnet is no longer directly below its pivot point, acceleration of the compass during turns about the north and south magnetic poles, will cause the magnet to rotate. This will cause the compass indications to alter as illustrated below.

This question can be solved by visualising these general effects, or more simply by noting that if the aircraft is in the opposite hemisphere as the pole through which it is turning, the compass will turn in the opposite direction to the aircraft. This will cause the compass to over read when turning clockwise and under read when turning anti-clockwise.

The question specifies an anti-clockwise turn from SW (225 degrees), to SE (135 degrees), in the northern hemisphere, so the aircraft and (south) pole through which it turns are in opposite hemispheres. This will cause the compass to under read, so roll out must occur at a heading lower than the 135 required. Only option b, 115 satisfies this condition.



TURNING ERROR WHEN AIRCRAFT IS POINTING TOWARDS NEAREST POLE



TURNING ERROR WHEN AIRCRAFT IS POINTING AWAY FROM NEAREST POLE

COMPASS 61. c.

Whenever an aircraft turns, the compass is accelerated in the direction of the turn. If the aircraft is not over the magnetic equator. Its compass magnet will be dipped, due to the dip of the lines of magnetic force around the earth. This will cause the C of G of the magnet to be displaced as illustrated in the diagrams in the answer to question COMPASS 60.

Because the C of G of the compass magnet is no longer directly below its pivot point, acceleration of the compass during turns about the north and south magnetic poles, will cause the magnet to rotate. This will cause the compass indications to alter as illustrated in the answer to question COMPASS 60.

This question can be solved by visualising these general effects, or more simply by noting that if the aircraft is in the opposite hemisphere as the pole through which it is turning, the compass will turn in the opposite direction to the aircraft. This will cause the compass to over read when turning clockwise and under read when turning anti-clockwise.

The question specifies a clockwise turn from NW (315 degrees), to NE (045 degrees), in the southern hemisphere, so the aircraft and (north) pole through which it turns are in opposite hemispheres. This will cause the compass to over read, so roll out must occur at a heading greater than the 045 required. Only option c, 055 degrees, satisfies this condition.

COMPASS 62. b.

Whenever an aircraft turns, the compass is accelerated in the direction of the turn. If the aircraft is not over the magnetic equator. Its compass magnet will be dipped, due to the dip of the lines of magnetic force around the earth. This will cause the C of G of the magnet to be displaced as illustrated in the diagrams in the answer to question compass 60.

Because the C of G of the compass magnet is no longer directly below its pivot point, acceleration of the compass during turns about the north and south magnetic poles, will cause the magnet to rotate. This will cause the compass indications to alter as illustrated in the answer to question Compass 60.

This question can be solved by visualising these general effects, or more simply by noting that if the aircraft is in the opposite hemisphere as the pole through which it is turning, the compass will turn in the opposite direction to the aircraft. This will cause the compass to over read when turning clockwise and under read when turning anti-clockwise.

The question specifies a turn from NW (315 degrees), to SE (135 degrees), in the northern hemisphere. This means that the aircraft is turning either clockwise through the north pole which is in the same hemisphere, or anti-clockwise, through the south pole which is in the opposite hemisphere. In both cases this will cause the compass card to rotate clockwise, causing the compass to under-read. So roll out must occur at a heading lower than the 135 degrees required. Only option b, 125 degrees satisfies this condition.

COMPASS 63. d.

Whenever an aircraft turns, the compass is accelerated in the direction of the turn. If the aircraft is not over the magnetic equator. Its compass magnet will be dipped, due to the dip of the lines of magnetic force around the earth. This will cause the C

of G of the magnet to be displaced as illustrated in the diagrams in the answer to question compass 3.

Because the C of G of the compass magnet is no longer directly below its pivot point, acceleration of the compass during turns about the north and south magnetic poles, will cause the magnet to rotate. This will cause the compass indications to alter as illustrated in the answer to question Compass 10.

This question can be solved by visualising these general effects, or more simply by noting that if the aircraft is in the same hemisphere as the pole through which it is turning, the compass will turn in the same direction as the aircraft but at a greater rate. This will cause the compass to under read when turning clockwise and over read when turning anti-clockwise.

The question specifies a turn from NW (315 degrees), to SE (135 degrees), in the southern hemisphere. This means that the aircraft is turning either clockwise through the north pole which is in the opposite hemisphere, or anti-clockwise, through the south pole which is in the same hemisphere. In both cases this will cause the compass card to rotate anti-clockwise, causing the compass to over-read. So roll out must occur at a heading greater than the 135 degrees required. Only option d, 145 degrees satisfies this condition.

COMPASS 64. b.

The rose should be aligned with zero degrees but is stuck on 090 degrees. So the system is over reading by 90 degrees. The ADF pointer points towards the beacon, so the relative bearing is the indicated bearing minus the error, which is 200 – 90 = 110 degrees (option b)

COMPASS 65. c.

The rose should be aligned with zero degrees but is stuck on 090 degrees. So the system is over reading by 90 degrees. The ADF pointer points towards the beacon, so the relative bearing is the indicated bearing minus the error, which is 270 – 90 = 180 degrees (option c)

COMPASS 66. c.

The rose should be aligned with zero degrees but is stuck on 080 degrees. So the system is over reading by 80 degrees. The ADF pointer points towards the beacon, so the relative bearing is the indicated bearing minus the error, which is 120 – 80 = 40 degrees (option c)

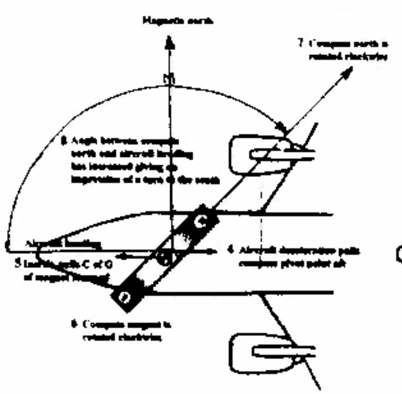
COMPASS 67. a.

This question is concerned with the effects of deceleration on a direct reading magnetic compass. These effects depend upon the magnetic latitude, the direction of flight and the deceleration rate.

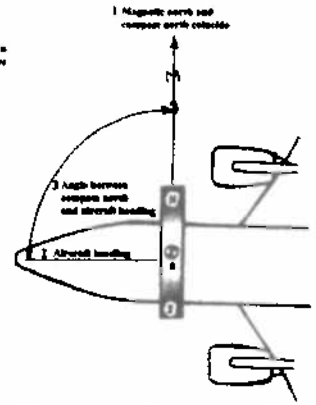
The lines of force produced by the earths magnetic field flow vertically upwards, out of the ground at the magnetic south pole and vertically into the ground at the magnetic north pole. The degree to which they are inclined vertically at all other points on the earth is determined by the magnetic latitude. At the magnetic equator they are horizontal or parallel with the surface. As magnetic latitudes increase towards the magnetic poles the degree of inclination also increases. The inclination of the lines of force causes the magnets in compasses to dip below the horizontal, thereby reducing their accuracy.

In order to minimise this problem, compasses are typically suspended such that their C of G is lower than their pivot. In this way the weight of the magnet is made to oppose the dipping caused by the lines of magnetic force. This is termed pendulous suspension. Although this reduces compass dip, it does not entirely eliminate it. This means that whenever an aircraft heading is anything other than magnetic north or south, the C of G of the compass magnet will be off-set to one side of the pivot.

Whenever an aircraft accelerates or decelerates on such a heading, the lateral displacement of the C of G and the inertia its compass magnet, causes the magnet to rotate. The magnitude and direction of this rotation is determined by the aircraft heading, the magnetic latitude and the acceleration or deceleration rate. This question specifies deceleration on a westerly heading in the northern hemisphere. This will cause compass to rotate clockwise, giving the impression of a turn to the south, as illustrated in the diagram below. This answer illustrates the more general point that decelerations on easterly or westerly headings cause an apparent turn away from the nearest pole. So the aircraft will appear to turn to the south (option a).



SITUATION DURING DECELERATION
IN WESTERLY DIRECTION



SITUATION BEFORE DECELERATION
IN WESTERLY DIRECTION

WARN/REC 1. b.
Requirements for flight data recorders are detailed in a number of JAR documents, including JAR OPS 1.715, JAR OPS 1.720 and JAR OPS 1.725. among other things these require that the FDR be located in the vicinity of the rear pressure bulkhead.

WARN/REC 2. a.
JAR OPS 1.700 requires that all aircraft first certificated under JAR on or after 1 April 1998 which have multiple turbine engines and 9 or more seats, or a maximum authorised take-off mass over 5700 Kg, shall have a cockpit voice recorder capable of recording for:

a. 2 hours for aircraft over 5700 Kg maximum take-off mass.
b. 30 minutes for aircraft of 5700 Kg or less, maximum take-off mass.

This question includes both the 2 hour and 30 minute minima. Students should therefore select 30 minutes because it is the lesser of the two, and make a written statement to this effect to draw the attention of the examiners to this matter.

WARN/REC 3. a.
In its most basic form a stall warning systems senses only angle of attack (A of A). More sophisticated versions fitted to larger aircraft also sense other parameters such as slat/flap position, gear position, attitude, CAS, and pitch rates.

WARN/REC 4. d.
The requirements for the use of flight data recorders (FDR) in JAR certificated aircraft are detailed in JAR OPS 1.715. For multi engine turbine powered aircraft with 9 or more passenger seats, or a maximum authorised take-off mass over 5700 Kg, these requirements include the capability to record data for at least:

a. 25 hours for aircraft of more than 5700 Kg maximum take-off mass.
b. 10 hours for aircraft of 5700 Kg or less maximum take-off mass.

Students should therefore select 25 hours (option d).

WARN/REC 5. d.
The upper and lower limits for the operation of the GPWS are as follows:

Mode 1.	Excessive descent rate.	2450 ft and 50 ft agl.
Mode 2.	Excessive terrain closure.	1800 ft and 50 ft agl.
Mode 3.	Loss of altitude after take-off or go-around.	700 ft and 50 ft agl.
Mode 4.	Unsafe terrain clearance.	500 ft and 50 ft agl.
Mode 5.	Aircraft below ILS glidepath.	500 ft and 50 ft agl.

So the upper and lower limits for the overall system are 2450 ft and 50 ft.

WARN/REC 6. a.

JAR OPS 1.700 requires that all aircraft first certificated under JAR on or after 1 April 1998 which have multiple turbine engines and 9 or more seats, and all aircraft having a maximum authorised take-off mass over 5700 Kg, shall have a cockpit voice recorder capable of recording:

a. Vice communications transmitted from and received on the flight deck by radio.
b. Voice communications of flight crew on the flight deck using intercom.
c. Voice audio signals introduced into the flight deck headsets or speakers, identifying navigation/approach aids.
d. Voice communications of the flight crew on the flight deck using the public address system.
e. The aural environment of the flight deck, including an uninterrupted record of all audio signals received from each boom and mask microphone in use.

Comparing the above list with the options in this question reveals that only option a is true. Options b, c and d are untrue because they can be taken to include the passenger cabin crew.

WARN/REC 7. c.

JAR regulations require that a GPWS system is to be fitted to :

a. All turbine powered aeroplanes having a maximum take-off mass of more than 15000 Kg, or more than 30 passenger seats.

b. All aircraft having a maximum certificated take-off mass in excess of 5700 Kg, or more than 9 passenger seats, after 1 January 1999.

The system is to be capable of providing aural signals (which may be supplemented by visual signals) (option c), to give distinctive and timely warnings of sink rate, ground proximity, incorrect landing configuration and downward glide slope deviation.

WARN/REC 8. c.

In its most basic form, the stall warning system fitted to light aircraft senses only angle of attack. But to obtain JAR certification, large passenger carrying aircraft must be provided with systems capable of indicating the approach of the stall condition in all configurations. In order to achieve this, such systems typically employ the following:

a. Landing gear squat switches to detect when the aircraft has lifted-off the ground.
b. A of A sensors.
c. Flap/slat configuration sensors.
d. A computer or warning module to analyse the inputs from the various sensors and generate appropriate outputs.

e. An aural warning facility.
f. An auto-ignition system to prevent engine flame out at high angles of attack.
g. A stick shaker to give tactile indication of approaching stall.
h. A stick pusher system to reduce attitude once stall has commenced.

Option c is therefore the most accurate in this question.

WARN/REC 9. d.

JAR regulations require that a turbojet aircraft and all turboprop aircraft with maximum take-off max in excess of 5700 Kg or having more than 9 passenger seats, and all aircraft having a maximum authorised take-off mass over 5700 Kg, must have an altitude alert system capable of the following: ,

a. Alerting the flight crew upon approaching a pre-selected altitude in the climb and descent.
b. Alerting the crew by at last an audible signal when departing above or below the pre-selected altitude.

In the majority of systems the mandatory aural indication is supplemented by a visual indication in the form of a light. In the Boeing 737 system for example, two amber alert lights illuminate and a two second C-chord sounds when the aircraft comes within 900 ft of the pre-selected altitude. The light then extinguishes when within 300 ft of the pre-selected altitude. If the aircraft then deviates, the amber lights start to flash and the 2 second tone is sounded, when the altitude error reaches 300 ft. If the deviation continues to increase, the lights will extinguish at 900 ft above or below the pre-selected altitude. It should be noted that the altitude alerting system is in no way connected with auto-trim (options a and b)

WARN/REC 10. d.

JAR OPS 1.700 requires that all aircraft first certificated under JAR on or after 1 April 1998 which have multiple turbine engines and 9 or more seats, shall have a cockpit voice recorder capable of recording:

I. Voice communications transmitted from and received on the flight deck by radio.
II. Voice communications of flight crew on the flight deck using intercom.
III. Voice audio signals introduced into the flight deck headsets or speakers, identifying navigation/approach aids.
IV. Voice communications of the flight crew on the flight deck using the public address system.
V. The aural environment of the flight deck, including an uninterrupted record of all audio signals received from each boom and mask microphone in use.

Comparing the above list with the options in this question reveals that only option d, (1, 3, 4) is correct, because (2) refers to cabin crew discussions.

WARN/REC 11. a.
JAR regulations require that a turbojet aircraft and all turboprop aircraft with maximum take-off max in excess of 5700 Kg or having more than 9 passenger seats must have an altitude alert system capable of the following: ,

I. Alerting the flight crew upon approaching a pre-selected altitude in the climb and descent.
II. Alerting the crew by at last an audible signal when departing above or below the pre-selected altitude.

In the majority of systems the mandatory aural indication is supplemented by a visual indication in the form of a light. In the Boeing 737 system for example, two amber alert lights illuminate and a two second C-chord sounds when the aircraft comes within 900 ft of the pre-selected altitude. The light then extinguishes when within 300 ft of the pre-selected altitude. If the aircraft then deviates, the amber lights start to flash and the 2 second tone is sounded, when the altitude error reaches 300 ft. If the deviation continues to increase, the lights will extinguish at 900 ft above or below the pre-selected altitude It should be noted that these systems do not indicate when the pre-selected altitude has actually been reached (options c and d). Option a is therefore the mosta accurate in this question.

WARN/REC 12. a.
AMC OPS 1.715(c) requires that flight data recorders shall automatically commence recording before the aircraft becomes capable of moving under its own power and shall automatically stop recording after it ceases to be capable of moving under its own power.

WARN/REC 13. d.
The requirements for the use of flight data recorders (FDR) in JAR certificated aircraft are detailed in JAR OPS 1.715. For multi engine turbine powered aircraft with 9 or more passenger seats, these requirements include the capability to record data for at least:

I. 25 hours for aircraft of more than 5700 Kg maximum take-off mass.
II. 10 hours for aircraft of 5700 Kg or less maximum take-off mass.

JAR OPS 1.700 requires that all aircraft first certificated under JAR on or after 1 April 1998 which have multiple turbine engines and 9 or more seats, and all aircraft having a maximum authorised take-off mass over 5700 Kg, shall have a cockpit voice recorder capable of recording for:

I. 2 hours for aircraft over 5700 Kg maximum take-off mass.
II. 30 minutes for aircraft of 5700 Kg or less, maximum take-off mass.

Option d, 25 hour and 2 hours is therefore the most appropriate.

WARN/REC 14. c.
GPWS modes include the following:

Mode 1.	Excessive descent rate in excess of 7350 fpm between 2450 ft agl and 50 ft agl. And more than 1500 fpm at 50 ft agl.
Mode 2A.	Excessive terrain closure of more than 6000 fpm below 1800 ft agl with flaps not in landing configuration.
Mode 2B.	Excessive terrain closure of more than 2063 fpm below 50 ft agl, with not in landing configuration. Or 3000 fpm between 790 ft agl and 220 ft agl, then 2250 fpm between 220 ft agl and 50 ft agl with flaps in landing configuration.
Mode 3.	Loss of altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around.
Mode 4.	Unsafe terrain clearance if descent rate is 1900 fpm or more between 500 ft agl and 50 ft agl.
Mode 5.	Aircraft below ILS glidepath between 500 ft agl and 50 ft agl.
Mode 6.	Indicates that the aircraft has reached decision height in a cat 2 or 3 ILS approach.

So option c (2,5,6,7) is correct.

WARN/REC 15. c.
GPWS modes include the following:

Mode 1.	Excessive descent rate in excess of 7350 fpm between 2450 ft agl and 50 ft agl. And more than 1500 fpm below 50 ft agl.
Mode 2A.	Excessive terrain closure of more than 6000 fpm below 1800 ft agl with flaps not in landing configuration.
Mode 2B.	Excessive terrain closure of more than 2063 fpm below 50 ft agl, with not in landing configuration. Or 3000 fpm between 790 ft agl and 220 ft agl, then 2250 fpm between 220 ft agl and 50 ft agl with flaps in landing configuration.
Mode 3.	Loss of altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around.
Mode 4.	Unsafe terrain clearance if descent rate is 1900 fpm or more between 500 ft agl and 50 ft agl.
Mode 5.	Aircraft below ILS glidepath between 500 ft agl and 50 ft agl.
Mode 6.	Indicates that the aircraft has reached decision height in a cat 2 or 3 ILS approach.

It should be noted that although mode 6 operates only at decision height and so cannot truly be descried as providing altitude readouts (7) this is included in all of the options. GPWS does not provide any form of indication of excessive bank (1) angle at any altitude

WARN/REC 16. b.
JAR OPS 1.710 requires that CVR shall automatically commence recording before the aircraft becomes capable of moving under its own power and shall

automatically stop recording after it ceases to be capable of moving under its own power.

WARN/REC 17. a.
GPWS mode 3, provides an audible alert whenever the aircraft loses altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around. The mode 3 alerts and warnings are as follows:

SYSTEM	ALERT	WARNING
Basic GPWS	None	"Whoop Whoop Pull Up"
Advanced GPWS	"Don't Sink"	None

The question asks for mode 3 audible alerts, so option a, "Don't Sink" is correct for advanced GPWS only.

WARN/REC 18. a.
The various JAR regulations for CVR equipment require that it be fitted with a device to aid location and be of crash/fire resistant construction (4). These regulations do not not specify independent battery power (3). In some cases the CVR is integrated with the FDR (2)but there is no specific requirement for this. The CVR must also have microphones to detect voice communications (1). So of the factors listed in this question, only (1) and (4) are mandatory (option a).

WARN/REC 19. a.
JAR regulations require that a turbojet aircraft and all turboprop aircraft with maximum take-off max in excess of 5700 Kg or having more than 9 passenger seats must have an altitude alert system capable of the following:

I. Alerting the flight crew upon approaching a pre-selected altitude in the climb and descent.
II. Alerting the crew by at last an audible signal when departing above or below the pre-selected altitude.

These are factors (1) and (2) in this question, so option a is correct. It should be noted that (3) and (4) are provided by GPWS.

WARN/REC 20. c.
JAR OPS 1.710 requires that CVR shall automatically commence recording before the aircraft becomes capable of moving under its own power and shall automatically stop recording after it ceases to be capable of moving under its own power (option c).

WARN/REC 21. b.
Requirements for flight data recorders are detailed in a number of JAR documents, including JAR OPS 1.715, JAR OPS 1.720 and JAR OPS 1.725. among other things these require that the FDR be located in the vicinity of the rear pressure bulkhead (option b).

WARN/REC 22. b.
JAR regulations require that a turbojet aircraft and all turboprop aircraft with maximum take-off max in excess of 5700 Kg or having more than 9 passenger seats must have an altitude alert system capable of the following:

a. Alerting the flight crew upon approaching a pre-selected altitude in the climb and descent.
b. Alerting the crew by at last an audible signal when departing above or below the pre-selected altitude (option b).

WARN/REC 23. d.
GPWS modes include the following:

Mode 1. Excessive descent rate in excess of 7350 fpm between 2450 ft agl and 50 ft agl. And more than 1500 fpm below 50 ft agl.
Mode 2A. Excessive terrain closure of more than 6000 fpm below 1800 ft agl with flaps not in landing configuration.
Mode 2B. Excessive terrain closure of more than 2063 fpm below 50 ft agl, with not in landing configuration. Or 3000 fpm between 790 ft agl and 220 ft agl, then 2250 fpm between 220 ft agl and 50 ft agl with flaps in landing configuration.
Mode 3. Loss of altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around.
Mode 4. Unsafe terrain clearance if descent rate is 1900 fpm or more between 500 ft agl and 50 ft agl.
Mode 5. Aircraft below ILS glidepath between 500 ft agl and 50 ft agl.
Mode 6. Indicates that the aircraft has reached decision height in a cat 2 or 3 ILS approach.

So the limits for GPWS operations are 50 ft and 2450 ft agl.

WARN/REC 24. d.
JAR OPS 1.700 requires that all aircraft first certificated under JAR on or after 1 April 1998 which have multiple turbine engines and 9 or more seats, shall have a cockpit voice recorder capable of recording:

I. Voice communications transmitted from and received on the flight deck by radio.
II. Voice communications of flight crew on the flight deck using intercom.
III. Voice audio signals introduced into the flight deck headsets or speakers, identifying navigation/approach aids.

iv. Voice communications of the flight crew on the flight deck using the public address system.
v. The aural environment of the flight deck, including an uninterrupted record of all audio signals received from each boom and mask microphone in use.

So (1), (2), and (3) are untrue because they can be taken to include cabin crew and passengers. (5) is also untrue because it is only the voice messages that are recorded rather than the beacon signals. So only option d, "All discussions between the crew and ATC" is true in this question.

WARN/REC 25. d.

This question might be interpreted as referring to Mode 1 "excessive descent rate" or mode 3 "loss of altitude after take-of or go-around". But in mode 3 only advanced GPWS uses the alert message "Don't sink". But even this system does not use the warning "Whoop Whoop Pull Up" in mode 3.

In mode 1 the basic GPWS does not provide any alert but gives the warning "Whoop Whoop Pull Up". In the advanced system the mode 1 alert is "Sink Rate" and the warning is "Whoop Whoop Pull Up". So only the advanced GPWS produces the messages indicated in option d of the question. No version of GPWS uses the other combinations.

WARN/REC 26. d.

JAR OPS 1.700 requires that all aircraft first certificated under JAR on or after 1 April 1998 which have multiple turbine engines and 9 or more seats, shall have a cockpit voice recorder capable of recording:

a. Voice communications transmitted from and received on the flight deck by radio.
b. Voice communications of flight crew on the flight deck using intercom.
c. Voice audio signals introduced into the flight deck headsets or speakers, identifying navigation/approach aids.
d. Voice communications of the flight crew on the flight deck using the public address system.
e. The aural environment of the flight deck, including an uninterrupted record of all audio signals received from each boom and mask microphone in use.

Comparing the above list with the options in this question reveals that option d is correct.

WARN/REC 27. c.

GPWS modes include the following:

Mode 1. Excessive descent rate in excess of 7350 fpm between 2450 ft agl and 50 ft agl. And more than 1500 fpm below 50 ft agl.
Mode 2A. Excessive terrain closure of more than 6000 fpm below 1800 ft agl with flaps not in landing configuration.

Mode 2B. Excessive terrain closure of more than 2063 fpm below 50 ft agl, with not in landing configuration. Or 3000 fpm between 790 ft agl and 220 ft agl, then 2250 fpm between 220 ft agl and 50 ft agl with flaps in landing configuration.
Mode 3. Loss of altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around.
Mode 4. Unsafe terrain clearance if descent rate is 1900 fpm or more between 500 ft agl and 50 ft agl.
Mode 5. Aircraft below ILS glidepath between 500 ft agl and 50 ft agl.
Mode 6. Indicates that the aircraft has reached decision height in a cat 2 or 3 ILS approach.

So (1) and (2) are untrue because GPWS does not monitor stall or angle of attack. (3) and (4) are both true. (5) might be taken to be true in the sense that Mode 2B is sensitive to flap setting. So option c is the most appropriate.

WARN/REC 28. a.

GPWS modes include the following:

Mode 1. Excessive descent rate in excess of 7350 fpm between 2450 ft agl and 50 ft agl. And more than 1500 fpm below 50 ft agl.
Mode 2A. Excessive terrain closure of more than 6000 fpm below 1800 ft agl with flaps not in landing configuration.
Mode 2B. Excessive terrain closure of more than 2063 fpm below 50 ft agl, with not in landing configuration. Or 3000 fpm between 790 ft agl and 220 ft agl, then 2250 fpm between 220 ft agl and 50 ft agl with flaps in landing configuration.
Mode 3. Loss of altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around.
Mode 4. Unsafe terrain clearance if descent rate is 1900 fpm or more between 500 ft agl and 50 ft agl.
Mode 5. Aircraft below ILS glidepath between 500 ft agl and 50 ft agl.
Mode 6. Indicates that the aircraft has reached decision height in a cat 2 or 3 ILS approach.

So (3) and (5) are untrue because GPWS does not operate above 3450 ft agl, and does not monitor AOB. (1) and (2) and (4) are all true (option a).

WARN/REC 29. d.

GPWS modes include the following:

Mode 1. Excessive descent rate in excess of 7350 fpm between 2450 ft agl and 50 ft agl. And more than 1500 fpm below 50 ft agl.
Mode 2A. Excessive terrain closure of more than 6000 fpm below 1800 ft agl with flaps not in landing configuration.
Mode 2B. Excessive terrain closure of more than 2063 fpm below 50 ft agl, with not in landing configuration. Or 3000 fpm between 790 ft agl and

220 ft agl, then 2250 fpm between 220 ft agl and 50 ft agl with flaps in landing configuration.

Mode 3. Loss of altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around.

Mode 4. Unsafe terrain clearance if descent rate is 1900 fpm or more between 500 ft agl and 50 ft agl.

Mode 5. Aircraft below ILS glidepath between 500 ft agl and 50 ft agl.

Mode 6. Indicates that the aircraft has reached decision height in a cat 2 or 3 ILS approach.

So only option d is true.

WARN/REC 30. b.

GPWS uses the following inputs:

a. Height above ground from the Radio Altimeter (option b).
b. Vertical speed from a barometric VSI or altimeter.
c. Glidepath deviation from the ILS system.
d. Undercarriage position from micro-switches.
e. Flap position from micro-switches.

WARN/REC 31. b.

In the Boeing 737 system the two amber "ALTITUDE ALERT" lights illuminate when approaching closer than 900 ft from selected altitude, then extinguish when within 300 ft. When deviating from selected altitude the amber lights start to flash at 300 ft deviation then cease to flash at 900 ft deviation (option b).

WARN/REC 32. a.

GPWS modes include the following:

Mode 1. Excessive descent rate in excess of 7350 fpm between 2450 ft agl and 50 ft agl. And more than 1500 fpm below 50 ft agl.

Mode 2A. Excessive terrain closure of more than 6000 fpm below 1800 ft agl with flaps not in landing configuration.

Mode 2B. Excessive terrain closure of more than 2063 fpm below 50 ft agl, with not in landing configuration. Or 3000 fpm between 790 ft agl and 220 ft agl, then 2250 fpm between 220 ft agl and 50 ft agl with flaps in landing configuration.

Mode 3. Loss of altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around.

Mode 4. Unsafe terrain clearance if descent rate is 1900 fpm or more between 500 ft agl and 50 ft agl.

Mode 5. Aircraft below ILS glidepath between 500 ft agl and 50 ft agl.

Mode 6. Indicates that the aircraft has reached decision height in a cat 2 or 3 ILS approach.

So only option a is true. It should be noted that option c is untrue because it refers to pressure altitude rather than height agl.

WARN/REC 33. a.

In its most basic form, the stall warning system fitted to light aircraft senses only angle of attack. But to obtain JAR certification, large passenger carrying aircraft must be provided with systems capable of indicating the approach of the stall condition in all configurations. In order to achieve this, such systems typically employ the following:

i. Landing gear squat switches to detect when the aircraft has lifted-off the ground.
ii. A of A sensors.
iii. Flap/slat configuration sensors.
iv. A computer or warning module to analyse the inputs from the various sensors and generate appropriate outputs.
v. An aural warning facility.
vi. An auto-ignition system to prevent engine flame out at high angles of attack.
vii. A stick shaker to give tactile indication of approaching stall.
viii. A stick pusher system to reduce attitude once stall has commenced.

So only option a is true.

WARN/REC 34. c.

In its most basic form, the stall warning system fitted to light aircraft senses only angle of attack. But to obtain JAR certification, large passenger carrying aircraft must be provided with systems capable of indicating the approach of the stall condition in all configurations. In order to achieve this, such systems typically employ the following:

i. Landing gear squat switches to detect when the aircraft has lifted-off the ground.
ii. A of A sensors.
iii. Flap/slat configuration sensors.
iv. A computer or warning module to analyse the inputs from the various sensors and generate appropriate outputs.
v. An aural warning facility.
vi. An auto-ignition system to prevent engine flame out at high angles of attack.
vii. A stick shaker to give tactile indication of approaching stall.
viii. A stick pusher system to reduce attitude once stall has commenced.

So only option c is true.

WARN/REC 35. b.
GPWS modes include the following:

Mode 1. Excessive descent rate in excess of 7350 fpm between 2450 ft agl and 50 ft agl. And more than 1500 fpm below 50 ft agl.
Mode 2A. Excessive terrain closure of more than 6000 fpm below 1800 ft agl with flaps not in landing configuration.
Mode 2B. Excessive terrain closure of more than 2063 fpm below 50 ft agl, with not in landing configuration. Or 3000 fpm between 790 ft agl and 220 ft agl, then 2250 fpm between 220 ft agl and 50 ft agl with flaps in landing configuration.
Mode 3. Loss of altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around.
Mode 4. Unsafe terrain clearance if descent rate is 1900 fpm or more between 500 ft agl and 50 ft agl.
Mode 5. Aircraft below ILS glidepath between 500 ft agl and 50 ft agl.
Mode 6. Indicates that the aircraft has reached decision height in a cat 2 or 3 ILS approach.

So only option b is true.

WARN/REC 36. a.
GPWS modes include the following:

Mode 1. Excessive descent rate in excess of 7350 fpm between 2450 ft agl and 50 ft agl. And more than 1500 fpm below 50 ft agl.
Mode 2A. Excessive terrain closure of more than 6000 fpm below 1800 ft agl with flaps not in landing configuration.
Mode 2B. Excessive terrain closure of more than 2063 fpm below 50 ft agl, with not in landing configuration. Or 3000 fpm between 790 ft agl and 220 ft agl, then 2250 fpm between 220 ft agl and 50 ft agl with flaps in landing configuration.
Mode 3. Loss of altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around.
Mode 4. Unsafe terrain clearance if descent rate is 1900 fpm or more between 500 ft agl and 50 ft agl.
Mode 5. Aircraft below ILS glidepath between 500 ft agl and 50 ft agl.
Mode 6. Indicates that the aircraft has reached decision height in a cat 2 or 3 ILS approach.

GPWS does not monitor AOB, so only option a is true.

WARN/REC 37. c.
GPWS modes include the following:

Mode 1. Excessive descent rate in excess of 7350 fpm between 2450 ft agl and 50 ft agl. And more than 1500 fpm below 50 ft agl.
Mode 2A. Excessive terrain closure of more than 6000 fpm below 1800 ft agl with flaps not in landing configuration.
Mode 2B. Excessive terrain closure of more than 2063 fpm below 50 ft agl, with not in landing configuration. Or 3000 fpm between 790 ft agl and 220 ft agl, then 2250 fpm between 220 ft agl and 50 ft agl with flaps in landing configuration.
Mode 3. Loss of altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around.
Mode 4. Unsafe terrain clearance if descent rate is 1900 fpm or more between 500 ft agl and 50 ft agl.
Mode 5. Aircraft below ILS glidepath between 500 ft agl and 50 ft agl.
Mode 6. Indicates that the aircraft has reached decision height in a cat 2 or 3 ILS approach.

So the GPWS is operational from 50 ft to 2450 ft agl (option c).

WARN/REC 38. d.
JAR OPS 1.710 requires that CVR shall automatically commence recording before the aircraft becomes capable of moving under its own power and shall automatically stop recording after it ceases to be capable of moving under its own power. Comparing these requirements with the options, reveals that option d is the most accurate.

WARN/REC 39. b.
GPWS mode 3, provides an audible alert whenever the aircraft loses altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around. The mode 3 alerts and warnings are as follows:

SYSTEM	ALERT	WARNING
Basic GPWS	None	"Whoop Whoop Pull Up"
Advanced GPWS	"Don't Sink"	None

The question asks for mode 3 audible alerts, so option b, "Don't Sink" is correct for advanced GPWS only.

WARN/REC 40. d.

JAR regulations require that a turbojet aircraft and all turboprop aircraft with maximum take-off max in excess of 5700 Kg or having more than 9 passenger seats must have an altitude alert system capable of the following:

I. Alerting the flight crew upon approaching a pre-selected altitude in the climb and descent.
II. Alerting the crew by at last an audible signal when departing above or below the pre-selected altitude.

So only option d is true.

WARN/REC 41. c.

The requirements for the use of flight data recorders (FDR) in JAR certificated aircraft are detailed in JAR OPS 1.715. For multi engine turbine powered aircraft with 9 or more passenger seats, these requirements include the capability to record data for at least:

I. 25 hours for aircraft of more than 5700 Kg maximum take-off mass.
II. 10 hours for aircraft of 5700 Kg or less maximum take-off mass.

JAR OPS 1.700 requires that all aircraft first certificated under JAR on or after 1 April 1998 which have multiple turbine engines and 9 or more seats, shall have a cockpit voice recorder capable of recording for:

I. 2 hours for aircraft over 5700 Kg maximum take-off mass.
II. 30 minutes for aircraft of 5700 Kg or less, maximum take-off mass.

So option c is true for the FDR of an aircraft of more than 5700 Kg and the CVR of one of less than 5700 Kg.

WARN/REC 42. b.

GPWS modes include the following:

Mode 1. Excessive descent rate in excess of 7350 fpm between 2450 ft agl and 50 ft agl. And more than 1500 fpm below 50 ft agl.
Mode 2A. Excessive terrain closure of more than 6000 fpm below 1800 ft agl with flaps not in landing configuration.
Mode 2B. Excessive terrain closure of more than 2063 fpm below 50 ft agl, with not in landing configuration. Or 3000 fpm between 790 ft agl and 220 ft agl, then 2250 fpm between 220 ft agl and 50 ft agl with flaps in landing configuration.
Mode 3. Loss of altitude of more than 70 ft between 700 ft agl and 50 ft agl, or more than 10 ft below 50 ft agl, after take-off or go-around.
Mode 4. Unsafe terrain clearance if descent rate is 1900 fpm or more between 500 ft agl and 50 ft agl.
Mode 5. Aircraft below ILS glidepath between 500 ft agl and 50 ft agl.

Mode 6. Indicates that the aircraft has reached decision height in a cat 2 or 3 ILS approach.

So only statements 2, 4, 5 and 6 (option b) are true.

WARN/REC 43. a.

JAR OPS 1.715 (c) requires that FDR shall automatically commence recording before the aircraft becomes capable of moving under its own power and shall automatically stop recording after it ceases to be capable of moving under its own power. Comparing these requirements with the options, reveals that option a, is the most accurate.

WARN/REC 44. c.

JAR regulations require that GPWS provides at least aural signals, which may be supplemented with visual signals giving timely and distinctive warnings of sink rate, ground proximity, altitude loss after take-off and go-around, incorrect landing configuration, and downward glideslope deviation. In the basic GPWS system these warnings consist of both a red "Pull up" light and a audible "Whoop Whoop " message followed by a "Pull up, Pull up" message. It should be noted that basic GPWS mode 5 provides only an alert consisting of an illuminated "Glideslope" light and an audible "Glideslope" message. Option c is therefore the most accurate in this question.

WARN/REC 45. d.

A basic stall warning system of the type used in light aircraft senses only angle of attack (Alpha). The sensor is usually a small vacuum probe or a flapper switch on the leading edge of the wing.

WARN/REC 46. d.

The requirements for the use of flight data recorders (FDR) in JAR certificated aircraft are detailed in JAR OPS 1.715. For multi engine turbine powered aircraft with 9 or more passenger seats, and all aircraft of maximum take-off mass over 5700 Kg, these requirements include the capability to record data for at least:

I. At least 25 hours for aircraft of more than 5700 Kg maximum take-off mass (option d).
II. At least 10 hours for aircraft of 5700 Kg or less maximum take-off mass.

WARN/REC 47. b.

Requirements for flight data recorders are detailed in a number of JAR documents, including JAR OPS 1.715, JAR OPS 1.720 and JAR OPS 1.725. among other things these require that the FDR be located in the vicinity of the rear pressure bulkhead of pressurised aircraft (option b).

WARN/REC 48. d.
JAR regulations require that a turbojet aircraft and all turboprop aircraft with maximum take-off max in excess of 5700 Kg or having more than 9 passenger seats must have an altitude alert system capable of the following:

I. Alerting the flight crew upon approaching a pre-selected altitude in the climb and descent.
II. Alerting the crew by at last an audible signal when departing above or below the pre-selected altitude.

Altitude alerting systems do not take any automatic corrective actions such as engaging or disengaging systems, so only option d is true.

WARN/REC 49. b.
JAR OPS 1.700 requires that all aircraft first certificated under JAR on or after 1 April 1998 which have multiple turbine engines and 9 or more seats, shall have a cockpit voice recorder capable of recording:

I. Voice communications transmitted from and received on the flight deck by radio.
II. Voice communications of flight crew on the flight deck using intercom.
III. Voice audio signals introduced into the flight deck headsets or speakers, identifying navigation/approach aids.
IV. Voice communications of the flight crew on the flight deck using the public address system.
V. The aural environment of the flight deck, including an uninterrupted record of all audio signals received from each boom and mask microphone in use.

Comparing the above list with the options in this question reveals that only option b is correct because all of the other options include (1) "cabin crew intercom discussions", which is untrue.

WARN/REC 50. d.
JAR OPS 1.715 requires that all multi engine turbine powered aircraft with 9 or more passenger seats, and for all aircraft having a maximum take-off mass over 5700 Kg aircraft certificated under JAR after 1 April 1998 be provided with flight data recorders.

TCAS 1 a.
The TCAS system is based upon interactions between airborne SSR transponders (option a). These continuously transmit identity codes. By interrogating each other's transponders, each aircraft is able to determine the relative bearing, speed and (in some modes) the altitude of other aircraft in the vicinity. TCAS II also uses the radio altimeter to inhibit descent commands when close to the ground, and Mode S transponders to obtain altitude data of other aircraft. The transponders

themselves obtain information from the INS/IRS and may use inputs from additional equipment depending on aircraft type. Of the options listed in this question, option a is the most accurate because a serviceable SSR transponder is absolutely essential to the operation of TCAS systems.

TCAS 2 b.
The TCAS system is based upon interactions between airborne transponders. These continuously transmit identity codes. By interrogating each other's transponders each aircraft is able to determine the relative bearing, speed and (in some modes) the altitude of other aircraft in the vicinity. This means that no protection is available against aircraft not equipped with a serviceable SSR transponder (option b).

TCAS 3 c.
Avoidance resolutions provided by TCAS are called Resolution Advisory or RA messages. Preventative RA messages are those which prevent conflicts rather than resolving them. One example of a preventative RA is "Monitor vertical speed". This requires the pilot to monitor the VSI or IVSI and avoid the red arcs which indicate the speeds that will cause conflicts.

Corrective RA messages, give the corrective actions to be take to resolve conflicts. These might include instructions to climb or descend or to change rate of climb or descent. It should be noted that with II all such instructions apply in the vertical plane only (option c). Instructions in the azimuth plane are part of the planned TCAS III system.

TCAS 4 d.
Avoidance resolutions provided by TCAS are called Resolution Advisory or RA messages. Preventative RA messages are those which prevent conflicts rather than resolving them. One example of a preventative RA is "Monitor vertical speed". This requires the pilot to monitor the VSI or IVSI and avoid the red arcs which indicate the speeds that will cause conflicts.

Corrective RA messages, give the corrective actions to be take to resolve conflicts. These might include instructions to climb or descend or to change rate of climb or descent (option d). It should be noted that with II all such instructions apply in the vertical plane only. Instructions in the azimuth plane are part of the planned TCAS III system.

TCAS 5 c.
The TCAS system is based upon interactions between airborne transponders (option c). These continuously transmit identity codes. By interrogating each other each transponder is able to determine the relative bearing, speed and (in some modes) the altitude of other aircraft in the vicinity. TCAS II uses the radio altimeter to inhibit descent commands when close to then ground, and Mode S transponders to obtain altitude data of other aircraft. The transponders

themselves obtain information form the INS/IRS and may use inputs from additional equipment depending on aircraft type. Of the options listed in this question, option c is the most accurate because the SSR transponders is fundamental to the operation of TCAS.

TCAS 6 b.
The TCAS system is based upon interactions and replies between airborne transponders (option b). These continuously transmit identity codes. By interrogating each other each transponder is able to determine the relative bearing, speed and (in some modes) the altitude of other aircraft in the vicinity.

TCAS 7 c.
The TCAS system is based upon interactions between airborne transponders. These continuously transmit identity codes. By interrogating each other each transponder is able to determine the relative bearing, speed and in some modes the altitude of other aircraft in the vicinity.

The basic TCAS I system provides only Traffic Advisory or TA messages relating to adjacent traffic which might represent a threat to the aircraft. In TCAS II this system is enhanced to provide both TA messages and Resolution Advisory or RA message, giving instructions on how to resolve conflicts in the vertical plane (option c). To enable TCAS II to achieve this, both aircraft must be using Mode C transponders.

A Traffic Advisory or TA indicates the approximate position of traffic relative to the parent aircraft. Information provided includes position in the horizontal plane (azimuth) and vertical plane, of transponding aircraft in the vicinity which may become a threat. Resolution advisories or RA messages, provide aural and visual indications of the manoeuvres to be made or the manoeuvre restrictions to be applied to resolve conflicts with aircraft transponding in mode C.

Corrective advisories or Corrective RA messages, advise the pilot to deviate from his current altitude, rate of climb or rate of descent in order to resolve a conflict. Preventative advisory messages give advice on which rates of climb or descent need to be avoided. Option c is therefore the most appropriate in this question.

TCAS 8. d.
TCAS information can be displayed in a number of ways. The most common of these are on a dedicated TCAS display (1) and the EFIS EHSI display (4). In some aircraft it can be displayed on the weather radar screen (2). In some aircraft the display may take the form of a variometer represented on a liquid crystal screen which allows the display of TA and RA messages (3). This means that all of the statements in this question are correct (option d).

TCAS 9 c.
Close traffic which does not represent a direct threat is indicated by a blue (cyan) or white empty lozenge symbol on the TCAS II display (option c).

TCAS 10 c.
A resolution advisory (RA) is provided by TCAS II when an intruder is assessed to be a direct threat. Such aircraft are indicated by a full red square (option c), together with an arrow indicating whether the intruder is climbing or descending and numbers indicating relative height of the intruder.

TCAS 11 b.
An intruding traffic advisory is indicated by a full yellow circle on the TCAS display (option b).

TCAS 12 a.
TCAS II gives resolution advisories (RA) in the vertical plane only. These might include instructions to climb, descend, or alter rates of climb or descent (option a). Resolution advisories in the horizontal plane are to be provided by the planned TCAS III system.

TCAS 13 b.
The basic TCAS I system provides only Traffic Advisory or TA messages relating to adjacent traffic which might represent a threat to the aircraft. In TCAS II this system is enhanced to provide both TA messages and Resolution Advisory or RA message, giving instructions on how to resolve conflicts in the vertical plane. To enable TCAS II to achieve this, both aircraft must be using Mode C transponders.

A Traffic Advisory or TA indicates the approximate position of traffic relative to the parent aircraft. Information provided includes position in the horizontal plane (azimuth) and vertical plane, of transponding aircraft in the vicinity which may become a threat. Resolution advisories or RA messages, provide aural and visual indications of the manoeuvres to be made or the manoeuvre restrictions to be applied to resolve conflicts with aircraft transponding in mode C.

Corrective advisories or RA messages, advise the pilot to deviate from his current rate of climb or descent in order to resolve a conflict. Preventative advisory messages give advice on which rates of climb or descent need to be avoided. Mode C gives altitude information. Because RA, corrective advisory and resolution advisory messages all relate to the vertical relative position of the aircraft, they are only available if the intruder aircraft is transponding on Mode C. This question relates to aircraft with a Mode C transponder, so both TA and vertical RA messages will be provided (option b).

TCAS 14 c.
The basic TCAS I system provides only Traffic Advisory or TA messages relating to adjacent traffic which might represent a threat to the aircraft. In TCAS II this system is enhanced to provide both TA messages and Resolution Advisory or RA message, giving instructions on how to resolve conflicts in the vertical plane. To enable TCAS II to achieve this, both aircraft must be using Mode C transponders.

A Traffic Advisory or TA indicates the approximate position of traffic relative to the parent aircraft. Information provided includes position in the horizontal plane (azimuth) and vertical plane, of transponding aircraft in the vicinity which may become a threat. Resolution advisories or RA messages, provide aural and visual indications of the manoeuvres to be made or the manoeuvre restrictions to be applied to resolve conflicts with aircraft transponding in mode C.

Corrective advisories or RA messages, advise the pilot to deviate from his current rate of climb or descent in order to resolve a conflict. Preventative advisory messages give advice on which rates of climb or descent need to be avoided. Mode C gives altitude information. Because RA, corrective advisory and resolution advisory messages all relate to the vertical relative position of the aircraft, they are only available if the intruder aircraft is transponding on Mode C. This question relates to an intruding aircraft without a Mode C transponder, so only a Traffic Advisory message will be provided (option c).

TCAS 15 c.
The TCAS system is based upon interactions between airborne transponders which continuously transmit identity codes and other data. By interrogating each other each aircraft is able to determine the relative bearing, speed and (in some modes) the pressure altitude of other aircraft in the vicinity.

TCAS II uses the radio altimeter (statement 2) to inhibit descent commands when close to the ground, and Mode S transponders to obtain pressure altitude data of other aircraft (statement 1). TCAS may also obtain data from other systems depending upon the specific equipment configuration of the parent aircraft (statement 3). TCAS does not obtain data directly from INS/IRS (statement 4). Option c is therefore the most accurate in this question.

TCAS 16 c.
The basic TCAS I system provides only Traffic Advisory or TA messages relating to adjacent traffic which might represent a threat to the aircraft. In TCAS II this system is enhanced to provide both TA messages and Resolution Advisory or RA message, giving instructions on how to resolve conflicts in the vertical plane. To enable TCAS II to achieve this, both aircraft must be using Mode C transponders. No current TCAS system provides ground proximity warnings or horizontal RA messages, so option c is the most accurate in this question.

TCAS 17 c.
The TCAS system is based upon interactions between airborne transponders. These continuously transmit identity codes. By interrogating each other each aircraft is able to determine the relative bearing, speed and in some modes the altitude of other aircraft in the vicinity.

A Traffic Advisory or TA indicates the approximate position of traffic relative to the parent aircraft. Information provided includes position in the horizontal plane (azimuth) and vertical plane, of transponding aircraft in the vicinity which may become a threat. Resolution advisories or RA messages, provide aural and visual indications of the manoeuvres to be made or the manoeuvre restrictions to be applied to resolve conflicts with aircraft transponding in mode C.

The basic TCAS I system provides only TA messages relating to adjacent traffic which might represent a threat to the aircraft. In TCAS II this system is enhanced to provide both TA messages and resolution advisory or RA message, giving instructions on how to resolve conflicts in the vertical plane. To enable TCAS II to achieve this, both aircraft must be using Mode C transponders. No current TCAS system provides ground proximity warnings or horizontal RA messages. Option c is therefore the most accurate in this question.

TCAS 18 a.
TCAS II gives resolution advisories (RA) in the vertical plane only. These might include instructions to climb, descend, or modify effectively the vertical speed of the aircraft (option b). Resolution advisories in the horizontal plane are to be provided by the planned TCAS III system. A preventative RA is provided when risk of collision does not currently exist, but might exist if the vertical speed of one or more aircraft changed. So a preventative RA advises the pilot to avoid certain deviations from current vertical rate but does not require any change to be made to that rate (option a). A corrective RA is provided when a change of vertical speed is required to prevent a collision.

TCAS 19. a.
A Traffic Advisory or TA indicates the approximate position of traffic relative to the parent aircraft. Information provided includes position in the horizontal plane (azimuth) and vertical plane, of transponding aircraft in the vicinity which may become a threat. Resolution advisories or RA messages, provide aural and visual indications of the manoeuvres to be made or the manoeuvre restrictions to be applied to resolve conflicts with aircraft transponding in mode C.

Corrective advisories or RA messages, advise the pilot to deviate from his current rate of climb or descent in order to resolve a conflict. Preventative advisory messages give advice on which rates of climb or descent need to be avoided. Mode C gives altitude information. Because RA, Corrective advisory and resolution advisory messages all relate to the vertical relative position of the aircraft, they are only available if the intruder aircraft is transponding on Mode C. This question relates to aircraft without a Mode C transponder, so only a TA will be provided (option a).

TCAS 20. d.
TCAS information can be displayed in a number of ways. The most common of these are on a dedicated TCAS display and the EFIS PFD and ND displays. In some aircraft it can be displayed on the weather radar screen. Also in some small, non-EFIS equipped aircraft, it may be displayed on a small instrument which might be described as a variometer. So if this question is interpreted in the broadest possible sense, option d is correct

TCAS 21. a.
Although TCAS is able to detect aircraft transponding in modes A, C and S, the nature of the messages it can provide is determined by the transponder modes being used. RA messages relate to relative vertical positions which are provided only by mMode C transponders. So RA messages are available only if Mode C is in use. If only Mode A is in use TCAS can provide on TA messages. If however both aircraft have TCAS II and Mode S transponders the system in each aircraft are able to communicate to provide coordinated avoidance manoeuvres (option a).

TCAS 22. c.
TCAS RA messages take various forms, examples of which are detailed below:

Preventative RA. "Monitor Vertical Speed", means that the VSI or IVSI must be monitored to avoid the red colour coded arcs.

Corrective RA. "Climb, Climb, Climb", means that the aircraft must be climbed at a rate equal to or greater than, that indicated on the TCAS display.

"Reduce climb, Reduce climb", means that the rate of climb must be reduced to that indicated on the TCAS display.

"Descend, Descend, Descend", means that the aircraft must descend at a rate equal to or greater than that indicated on the TCAS display.

"Reduce descent, Reduce descent", means that the rate of descent must be reduced to that indicated on the TCAS display.

" Clear conflict", means that the separation between the two aircraft is increasing.

The correct response to such messages is to comply immediately and smoothly (option c). ATC should then be informed of any deviation from ATC instructions as soon as possible. Deviations from ATC instructions should be the minimum possible to comply with the TCAS RA.

TCAS 23. c.
The TCAS system is based upon interactions between airborne transponders (option c). These continuously transmit identity codes. By interrogating each other each aircraft is able to determine the relative bearing, speed and in some modes the altitude of other aircraft in the vicinity. The system does not therefore rely on ground-based radars, primary radars, or RT communications and direction finders.

TCAS 24. d
The TCAS system is based upon interactions between airborne transponders (option c). These continuously transmit identity codes. By interrogating each other each aircraft is able to determine the relative bearing, speed and (in some modes) the altitude of other aircraft in the vicinity. TCAS II uses the radio altimeter to inhibit descent commands when close to then ground, and Mode S transponders to obtain altitude data of other aircraft. In some aircraft the transponders also obtain information form the INS/IRS and may use inputs from additional equipment depending on aircraft type.

TCAS 25. b.
Preventative RA messages are those which prevent conflicts rather than resolving them. They are issued when no risk of collision currently exists, but such risk might exist if the vertical speed of one or more of the aircraft changes. One example of a preventative RA is "Monitor vertical speed"(option b). This requires the pilot to monitor the VSI or IVSI and avoid the red arcs which indicate the speeds that will cause conflicts.

Corrective RA messages, give the corrective actions to be take to resolve conflicts. These might include instructions to climb or descend or to change rate of climb or descent. It should be noted that with II all such instructions apply in the vertical plane only. Instructions in the azimuth plane are part of the planned TCAS III system. The message "Traffic, Traffic" is a traffic advisory or TA.

TCAS 26. a.
The TCAS system uses a number of coloured symbols to represent different things. An example of one such symbol is a solid red square (option a) which indicates a resolution advisory or RA. It should be noted that the colour red indicates an immediate threat. Symbols of this colour are therefore used only in resolution advisory (RA).

TCAS 27. d.
The basic TCAS I system provides only TA messages relating to adjacent traffic which might represent a threat to the aircraft. In TCAS II this system is enhanced to provide both TA messages and resolution advisory or RA message, giving instructions on how to resolve conflicts in the vertical plane. To enable TCAS II to achieve this, both aircraft must be using Mode C transponders. So

when fitted with Mode C tranpsonders TCAS II can provide vertical plane TA and RA messages (option d)

TCAS 28. d.
An intruder aircraft need not necessarily possess TCAS in order to be detected by the TCAS system, Provided the intruder has at least a Mode A transponder it will be provide sufficient information for a TCAS equipped aircraft to generate TA messages. Similarly, the generation of RA messages by TCAS II requires that the intruder possess some form of altitude reporting transponder system, but not necessarily TCAS. So TCAS can provide both TA and RA messages relating to a non-TCAS intruder, provided the intruder is operating an appropriate transponder (option d).

TCAS 29. a.
An intruder aircraft need not necessarily possess TCAS in order to be detected by the TCAS system, Provided the intruder has at least a Mode A transponder it will provide sufficient information for a TCAS equipped aircraft to generate TA messages. Similarly, the generation of RA messages by TCAS II requires that the intruder possess some form of altitude reporting transponder system, but not necessarily TCAS. So TCAS can provide both TA and RA messages relating to a non-TCAS intruder, provided the intruder is operating an appropriate transponder. If however an intruder has no form of transponder fitted, TCAS will be unable to detect it, so no warnings will be given (option a).

TCAS 30. d.
The TCAS system uses a number of coloured symbols to represent different things. Non-conflicting traffic, which does not represent a threat and is not proximate (not within 6nm or + or – 1200 ft) is classed as "other traffic". Such traffic is indicated by a hollow diamond symbol. This is white on EFIS and cyan on the EVSI/TCAS display (option d).

TCAS 31. a.
TCAS II gives resolution advisories (RA) in the vertical plane only. These might include instructions to climb, descend, or alter rates of climb or descent. Resolution advisories in the horizontal plane are to be provided by the planned TCAS III system.

TCAS 32. c.
A resolution advisory (RA) is provided by TCAS II when an intruder is assessed to be a direct threat. Such aircraft are indicated by a solid red square, together with an arrow indicating whether the intruder is climbing or descending and numbers indicating relative height of the intruder.

TCAS 33. d.
TCAS information can be displayed in a number of ways. The most common of these are on a dedicated TCAS display (option a) and the EFIS PFD and ND displays (option c). In some aircraft it can be displayed on the weather radar display (option b). This means that TCAS may be displayed on any of the displays listed in this question depending on the aircraft type (option d).

TCAS 34. c.
An intruder aircraft need not necessarily possess TCAS in order to be detected by the TCAS system, If the intruder has a Mode C transponder it will provide sufficient information for a TCAS II equipped aircraft to generate vertical plane TA and RA messages (option c).

TCAS 35. d.
The TCAS system uses a number of coloured symbols to represent different things. Non-conflicting traffic, which does not represent a threat and is not proximate (not within 6nm or + or – 1200 ft) is classed as "other traffic". Such traffic is indicated by a hollow diamond symbol. This is white on EFIS and cyan on the EVSI/TCAS display.

TCAS 36. b.
TCAS corrective RA messages take various forms, examples of which are detailed below:

"Climb, Climb, Climb", means that the aircraft must be climbed at a rate equal to or greater than, that indicated on the TCAS display.

"Reduce climb, Reduce climb", means that the rate of climb must be reduced to that indicated on the TCAS display.

"Descend, Descend, Descend", means that the aircraft must descend at a rate equal to or greater than that indicated on the TCAS display.

"Reduce descent, Reduce descent", means that the rate of descent must be reduced to that indicated on the TCAS display.

Corrective RA messages do not however include any instructions to turn or to contact ATC. So option b, (2, 3, 4, 5) is the most accurate.

TCAS 37. b.
TCAS RA messages relate to aircraft which constitute an immediate threat. It is therefore essential that corrective action be taken immediately. The correct response to such messages is to disengage the autopilot immediately and comply with the descent or climb commands in a smooth manner. ATC should then be informed of any deviation from ATC instructions as soon as possible. Deviations

from ATC instructions should be the minimum possible to comply with the TCAS RA.

TCAS 38. c.
TCAS TA messages relate to aircraft which do not constitute an immediate threat. Unauthorised manoeuvres might however cause such traffic to become a threat. It is therefore essential that ATC be contacted before any avoiding action is taken.

TCAS 39. d.
TCAS corrective RA messages take various forms, examples of which are detailed below:

"Climb, Climb, Climb", means that the aircraft must be climbed at a rate equal to or greater than, that indicated on the TCAS display.

"Reduce climb, Reduce climb", means that the rate of climb must be reduced to that indicated on the TCAS display.

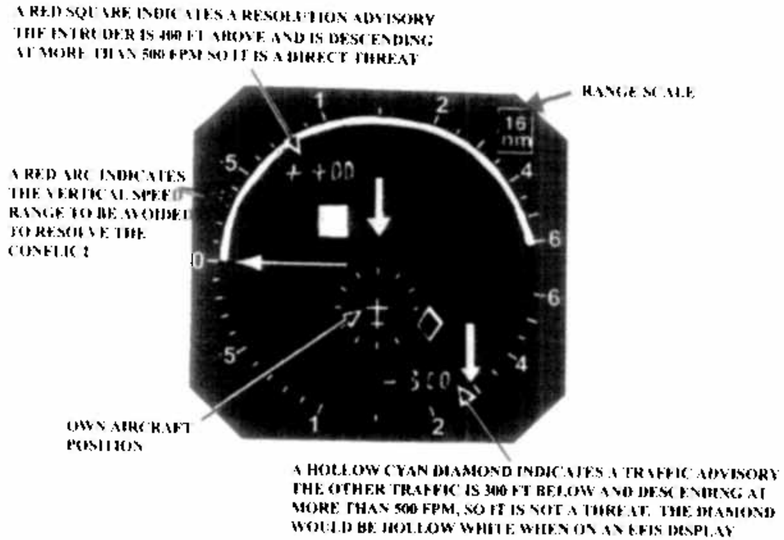
"Descend, Descend, Descend", means that the aircraft must descend at a rate equal to or greater than that indicated on the TCAS display.

"Reduce descent, Reduce descent", means that the rate of descent must be reduced to that indicated on the TCAS display.

Corrective RA messages do not however include any instructions to turn or to contact ATC. So option d is the most accurate in this question.

TCAS 40. a.
A resolution advisory (RA) is provided by TCAS II when an intruder is assessed to be a direct threat. Such aircraft are indicated by a solid red square, together with an arrow indicating whether the intruder is climbing or descending and numbers indicating relative height of the intruder. The –300 and upward pointing arrow in this question indicate an aircraft which is 300 ft below and climbing at more than 500 fpm.

An example of how this information might appear on the display is illustrated below.



COMBINED VSI/TCAS DISPLAY UNIT

TCAS 41. b.
A resolution advisory (RA) is provided by TCAS II when an intruder is assessed to be a direct threat. Such aircraft are indicated by a solid red square, together with an arrow indicating whether the intruder is climbing or descending and numbers indicating relative height of the intruder. The +300 and downward pointing arrow in this question indicate an aircraft which is 300 ft above and descending at more than 500 fpm.

TCAS 42. a.
A resolution advisory (RA) is provided by TCAS II when an intruder is assessed to be a direct threat. Such aircraft 250 ft above and climbing at 500 fpm is indicated by a solid red square, together with an upward pointing arrow and +250 (option a). It should however be noted that this would constitute a threat only if the TCAS aircraft was climbing at a greater rate.

TCAS 43. a.
For the purposes of TCAS, Proximate traffic is defined as any other transponding aircraft within 6 nm and plus or minus 1200 ft.

TCAS 44. a.
For the purposes of TCAS, "other traffic" is defined as, traffic not qualifying as proximity or intruder but within the display range and within 2700 ft above or below.

TCAS 45. a.
A TCAS traffic advisory or TA message, indicates aircraft in the vicinity which do not currently constitute a threat but which may become a threat in the future.

TCAS 46. b.
A TCAS resolution advisory or RA is an aural and visual recommendation of the manoeuvres or manoeuvre restrictions in the vertical plane, to resolve conflicts with mode C SSR capable aircraft.

TCAS 47. a.
A TCAS corrective advisory is a resolution advisory which tells the pilot which rates of climb or descent to use to resolve conflicts. Examples include the following.

"Climb, Climb, Climb", means that the aircraft must be climbed at a rate equal to or greater than, that indicated on the TCAS display.

"Reduce climb, Reduce climb", means that the rate of climb must be reduced to that indicated on the TCAS display.

"Descend, Descend, Descend", means that the aircraft must descend at a rate equal to or greater than that indicated on the TCAS display.

TCAS 48. a.
When TCAS indications are provided on the VSI they will include symbols to indicate the vertical positions of intruder and proximate traffic (1). These will be accompanied by arrows to indicate the vertical motion of intruder and proximate traffic (2). The rates of climb or descent to be avoided (3), and the recommended rate of climb or decent to resolve conflicts 4) are indicated by coloured arcs around the outer edge of the display. The track and CAS of intruder and proximate traffic(5) are not however indicated by TCAS I or II systems.

TCAS 49. b.
The TCAS system uses a number of coloured symbols to represent different things. Non-conflicting traffic, which does not represent a threat and is not proximate (not within 6nm or + or – 1200 ft) is classed as "other traffic". Such traffic is indicated by a hollow diamond symbol. This is white on EFIS and cyan on the EVSI/TCAS display.

TCAS 50. b.
The principal difference between TCAS I and TCAS II is that I provides only TA whilst II also provides RA. In order to produce the RA, TCAS II employs mode S transponders in each aircraft. These communicate to swap information and to agree corrective actions to be taken by each to resolve conflicts. It should however be noted that each aircraft requires only one mode S transponder. No version of TCAS employs ground based radars, nor IRS/INS inputs to the autopilot. TCAS II uses radio altimeter inputs only to inhibit descent commands at low levels. This questions specifically refers to TCAS II, so option b is the most appropriate, but option a is also true to a limited degree.

TCAS 51. b.
The principal difference between TCAS I and TCAS II is that I provides only TA whilst II also provides RA in the vertical plane (option b). The planned TCAS III will also proved RA in the horizontal plane.

TCAS 52. b.
A resolution advisory (RA) is provided by TCAS II when an intruder is assessed to be a direct threat. An example of such an aircraft might be 250 ft above and descending at 500 fpm. This would be indicated by a solid red square (option a), together with a downward pointing arrow to indicate that it is descending, and +250 to indicate that it currently 250 ft above the parent aircraft.

TCAS 53. a.
The principal difference between TCAS I and TCAS II is that I provides only TA whilst II also provides RA in the vertical plane. The planned TCAS III will also proved RA in the horizontal plane (option a).

TCAS 54. a.
The principal difference between TCAS I and TCAS II is that I provides only TA whilst II also provides RA in the vertical plane. TCAS II corrective RA messages take various forms, examples of which are detailed below:

"Climb, Climb, Climb", means that the aircraft must be climbed at a rate equal to or greater than, that indicated on the TCAS display.

"Reduce climb, Reduce climb", means that the rate of climb must be reduced to that indicated on the TCAS display.

"Descend, Descend, Descend", means that the aircraft must descend at a rate equal to or greater than that indicated on the TCAS display.

"Reduce descent, Reduce descent", means that the rate of descent must be reduced to that indicated on the TCAS display.

So corrective actions given by TCAS include instructions to climb or descend (option a). Corrective RA messages do not however include any instructions to turn or to contact ATC.

TCAS 55. a.
TCAS employs transponders in each aircraft (option a). These communicate to swap information and to agree coordinated corrective actions to be taken be each to resolve conflicts. It should however be noted that each aircraft requires only one mode S transponder. No version of TCAS employs ground based radars, nor IRS/INS inputs to the autopilot. TCAS II uses radio altimeter inputs only to inhibit descent commands at low levels.

TCAS 56. c.
TCAS information can be displayed in a number of ways. These include a dedicated TCAS display (4) and the EFIS PFD and ND displays (1). In some aircraft it can be displayed on the weather radar screen (5). TCAS information is not however displayed on EICAS (2) nor ECAM (3) displays. The correct answer is therefore 1, 4, 5, but this is not an option. Of the options offered in this question, option c (1, 4.) is therefore the most accurate.

TCAS 57. b.
The TCAS system works on the basis of the exchange of information between transponders in each aircraft. In the case of TCAS II these must be mode S transponders (4). Information from the RADALT (3) is also used by TCAS II to prevent it from giving instructions to descend when at low altitude. In addition to this, TCAS in some aircraft types also obtains additional data from other equipment that is peculiar to that type of aircraft (5). But TCAS does not generally obtain inputs directly from a the inertial reference unit (1), nor from the barometric altimeter (2). So 3, 4 and 5 are correct (option b).

TCAS 58. b.
A resolution advisory (RA) is provided by TCAS II when an intruder is assessed to be a direct threat. Such an aircraft would be represented by a solid red square (option b).

TCAS 59. a.
TCAS II corrective RA messages take various forms, examples of corrective RA are detailed below:

> "Climb, Climb, Climb", means that the aircraft must be climbed at a rate equal to or greater than, that indicated on the TCAS display.
>
> "Reduce climb, Reduce climb", means that the rate of climb must be reduced to that indicated on the TCAS display.

> "Descend, Descend, Descend", means that the aircraft must descend at a rate equal to or greater than that indicated on the TCAS display.
>
> "Reduce descent, Reduce descent", means that the rate of descent must be reduced to that indicated on the TCAS display.

It should be noted that corrective RA always involve a change in vertical motions. The statement "monitor vertical speed" in option d, is a preventative RA. It should also be noted that the term "traffic" is not an RA, but a TA.

TCAS 60. d.
The principal difference between TCAS I and TCAS II is that I provides only TA whilst II also provides RA. In order to produce the RA, TCAS II employs mode S transponders in each aircraft (option a). These communicate to swap information and to agree coordinated corrective actions to be taken be each to resolve conflicts. If however the intruder aircraft has only a mode C transponder, TCAS II can still produce TA and RA in the vertical plane, but these cannot be coordinated between the two aircraft. TCAS I and TCAS II cannot provide TA and RA in the horizontal plane.

TCAS 61. c.
Proximate traffic is any other transponding aircraft within 6 nm and plus or minus 1200 ft. Such traffic is indicated as a cyan solid diamond (option c), plus a vertical arrow to indicate whether it is climbing or descending and digits to show its relative height.

TCAS 62. d.
TCAS indicates relative height by means of a + or – sign and numbers. For example, -300 means that the traffic is 300 ft below.

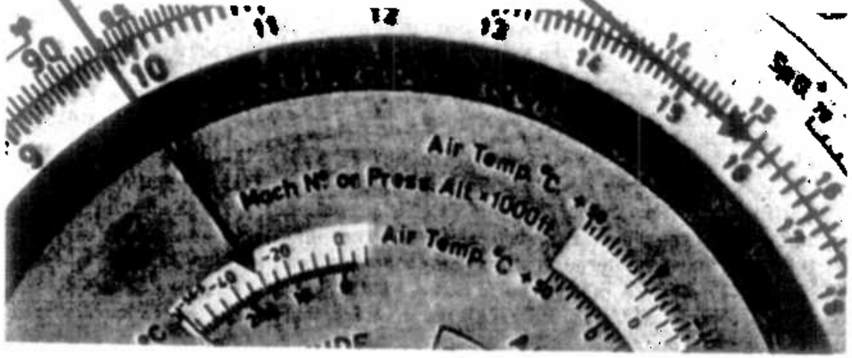
TCAS 63. d.
The TCAS system uses a number of coloured symbols to represent different things. Non-conflicting traffic, which does not represent a threat and is not proximate (not within 6nm or + or – 1200 ft) is classed as "other traffic". Such traffic is indicated by a hollow diamond symbol. This is white on EFIS and cyan on the EVSI/TCAS display.

CRP5 1. b.

This type of problem can be solved using the CRP5 as illustrated below.

1. In the altitude window set the temperature of -30°C against the indicated altitude of 16000 ft.

2. Against 16 on the inner scale read of true altitude of 15.2 on the outer scale. This means that true alt = 1500 ft (option b).



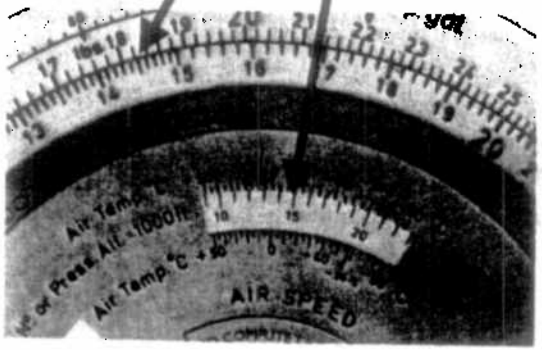
The true altitude is 15200 ft (option b).

CRP5 2. c.

This type of problem can be solved using the CRP5 as illustrated below.

2. Against 145 Kts CAS on the inner scale read off 182.5 Kts TAS on the outer scale.

1. In the airspeed window set -15°C against the altitude of 15000 ft.



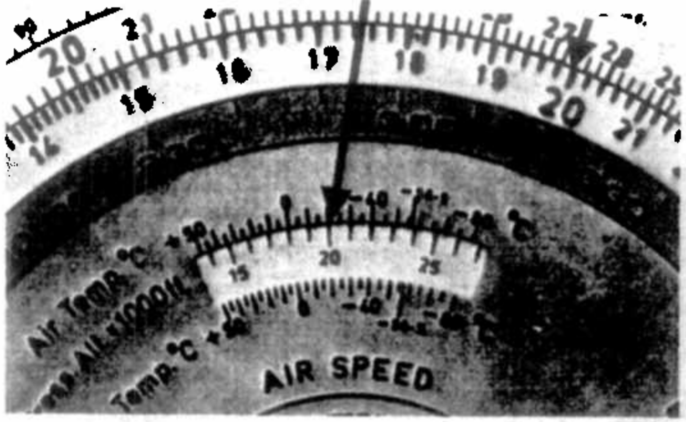
So the resulting TAS of 182.5 Kts is closest to is 183 Kts (option c).

CRP5 3. b.

This type of problem can be solved using the CRP5 as illustrated below.

1. In the airspeed window set the temperature of -20°c against the altitude of 20000 ft.

2. Against 200 Kts CA[S] the inner scale read off 274 TAS on the outer scale.



The resulting TAS of 274 Kts is closest to 273 Kts (option b).

CRP5 4. b.

This type of problem can be solved using the CRP5 as follows.

First to find the actual temperature.

1. Against the TAS of 499 Kts on the outer scale set Mach 0.84 on the inner scale.

2. In the airspeed window against [t] mach index pointer read off -40°C. Thi[s] the actual temperature at this level.

But in the ISA the standard temperature between 36000 ft and 65000 ft is -56.5°C.

ISA deviation is equal to actual temperature minus ISA temperature.

So the deviation = -40°c -(-56.5°C) = +16.5°C or approximately +17°C (option b).

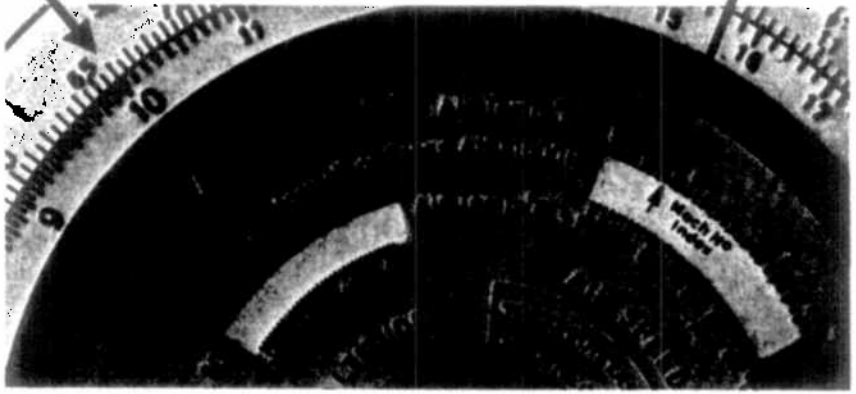
CRP5 5. c.

This type of problem can be solved using the CRP5 as follows.

The ISA temperature at sea level is +15°C.

1. In the airspeed window set the Mach index pointer against +15°C.

2. Against 1 on the inner scale read off 660 Kts on the outer scale.



This figure of 660 Kts for the local speed of sound at mean sea level in the ISA is closest to 661 Kts (option c).

CRP5 6. c.

This type of problem can be solved using the CRP5 as follows.

Local speed of sound depends only on temperature so the altitude is not relevant.

1. In the airspeed window set th Mach index pointer against -40°C.

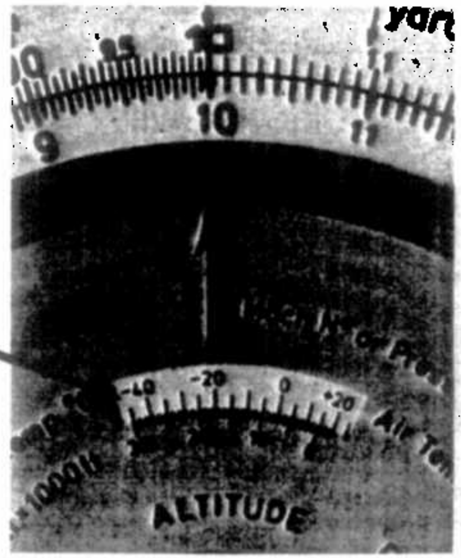
2. Against 1 on the inner scale read off 596 kts on the outer scale.

So the local speed of sound is 596 Kts (option c).

CRP5 7. b.

This type of problem can be solved using the CRP 5 by first setting up ISA conditions by setting the 1 on the inner scale against 1 on the outer scale as illustrated below.

Against 29000 ft in the altitude window read off -43°C. This is the ISA temperature at FL290.



This means that in the ISA the temperature at FL29 ft is -43°C.

The actual temperature at any point in the atmosphere is equal to the ISA temperature plus the temperature deviation.

The question specifies a deviation of -6°C so the actual temperature at FL290 = ISA plus deviation which = -43°C + -6°C = -49°C. Now find the LSS as follows:

2. Against 1 on the inner scale read off 583 Kts.

1. In the airspeed window set the mach index mark against -49°C.

So the local speed of sound is 583 Kts (option b).

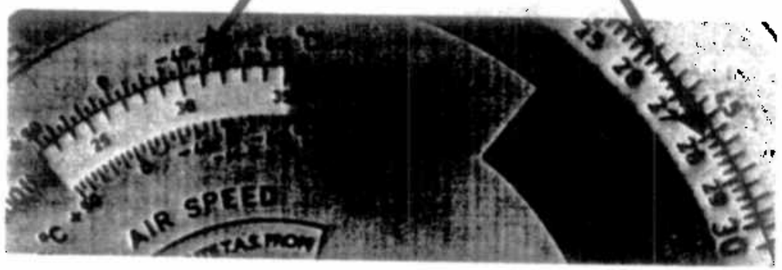
CRP5 8. a.

This type of problem can be solved using the CRP5 as illustrated below.

The local speed of sound in air depends only on temperature, so the altitude is not relevant to this question.

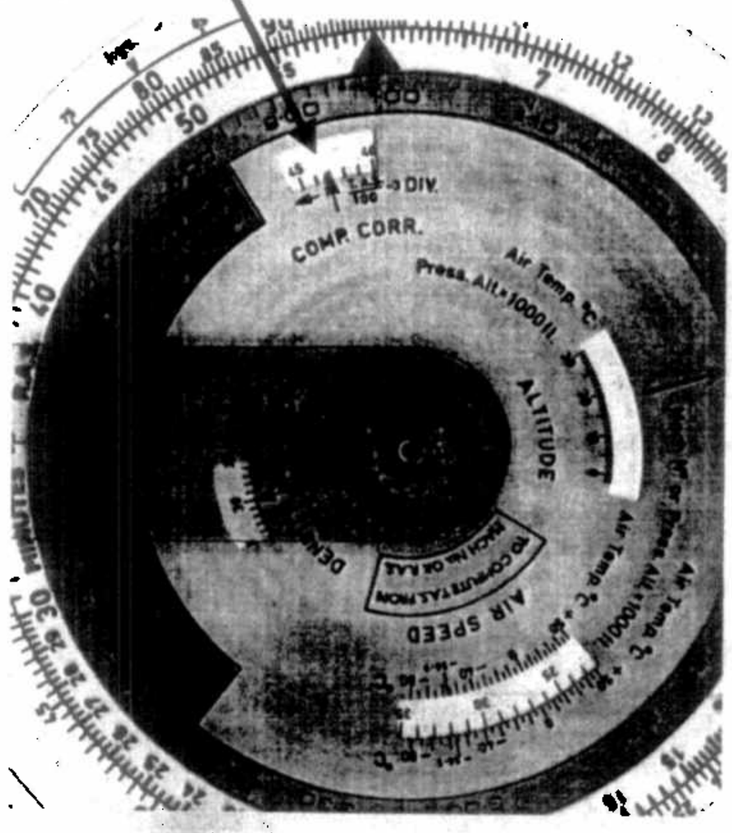
1. In the airspeed window set 31000 ft against -48°C.

2. Against 280 Kts CAS on the inner scale read off 455 Kts TAS on the outer scale.



But the TAS of 455 Kts is greater than 300 Kts so it is necessary to correct for compressibility error as illustrated below.

3. Using the formula below the compresibility correction wind (455 / 100) – 3 = 1.55. This correction factor must be aplied by rotating the pointer 1.55 units to the left. This diagram illustrates the condition before rotation. The diagram on the next page illustrates the situation afetr applying the correction.



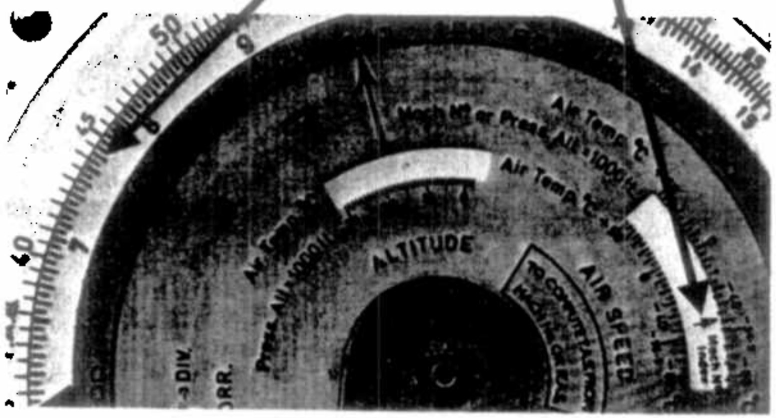
5. Against 280 Kts CAS on the inner scale read off 443 Kts TAS

4. In the compressibility correction window the pointer has been rotated to the left by a distance of 1.55 units.

This 443 Kts TAS can now be used to find the mach number as illustrated below.

7. Against 443 Kts on the outer scale read off mach 0.76 on the inner scale (option a).

6. In the airspeed window set the mach index against -48°C.



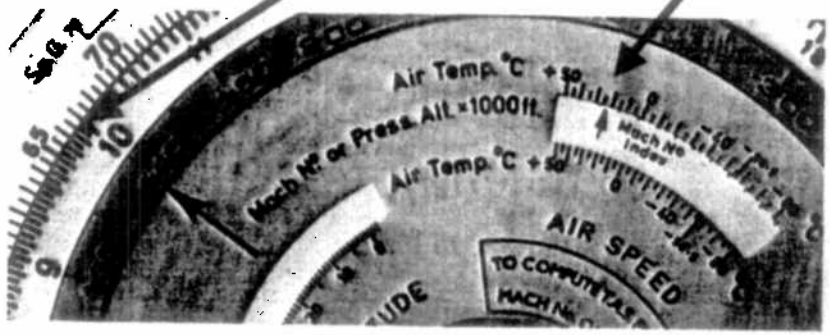
So the mach number is 0.76 (option a).

CRP5 9. c.

This type of problem can be solved using the CRP5 as illustrated below.

2. Against 1 on the inner scale read off 670 on the outer scale. This is closest to 671 Kts option c.

1. In the airspeed window set the Mach index pointer against 23°C.

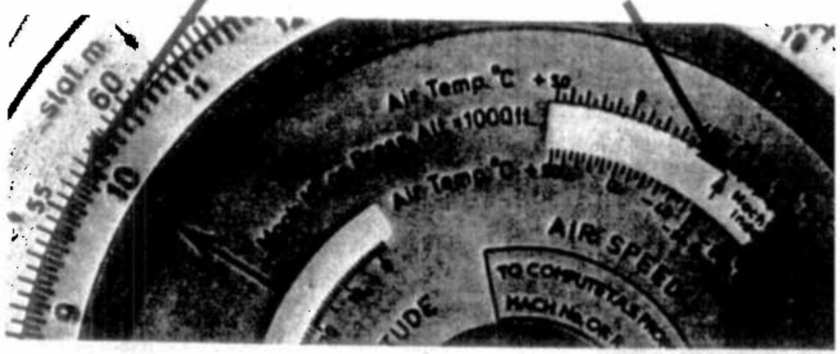


CRP5 10. c.

If a 0.1M change gives a change of 57 Kts then the local sped of sound M1 = 10 x 57 = 570 Kts.

1. Set 1 on the inner scale against 570 kts on the outer scale.

2. Against the Mach index pointer in the airspeed window read off -59°C.



This means that the actual temperature at FL650 is -59°C.

In the ISA the temperature between FL360 and FL650 is constant at -56.5°C.

The temperature deviation is equal to the actual temperature minus the ISA temperature. So deviation = -59°C –(-56.5°C) = -2.5°C (option c).

CRP5 11. a.
This type of problem can be solved using the CRP5 as illustrated below.

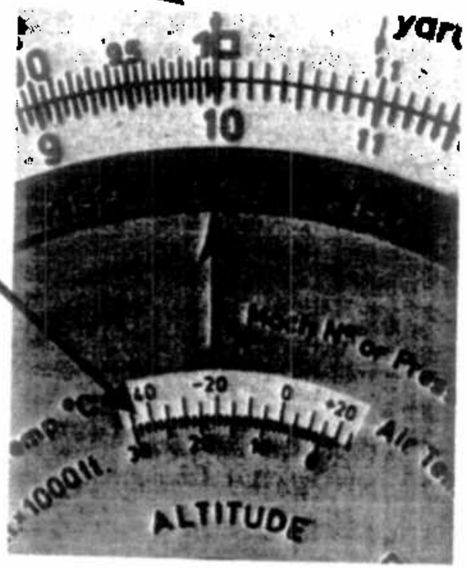
1. Against 500 Kts TAS on the outer scale set mach 0.86 on the inner scale.

2. Against the mach index pointer in the airspeed window read off -50°C.

This is the actual temperature.

3. To get ISA temperature at this altitude set 10 on the outer scale against 10 on the inner scale.

4. Then in the altitude window read off the ISA temperature of -44°C against 29000 ft.

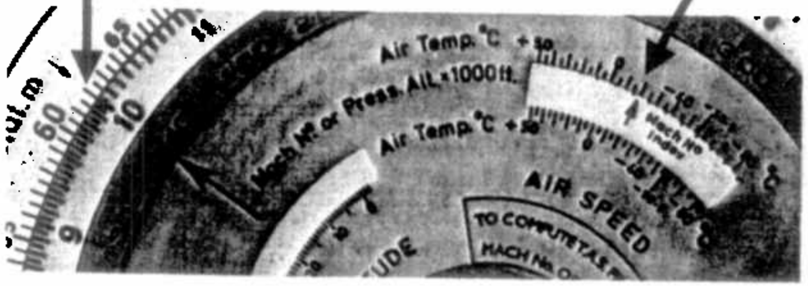


Temperature deviation = Actual temperature minus ISA temperature which is in this case -50°C -(-44°C) = -6°C. This is closest to -8°C option a.

CRP5 12. b.
An increase of 0.15 in mach number is 93 Kts so mach 1 = 93/0.15 = 620 Kts. This means that the local speed of sound is 620 Kts TAS.

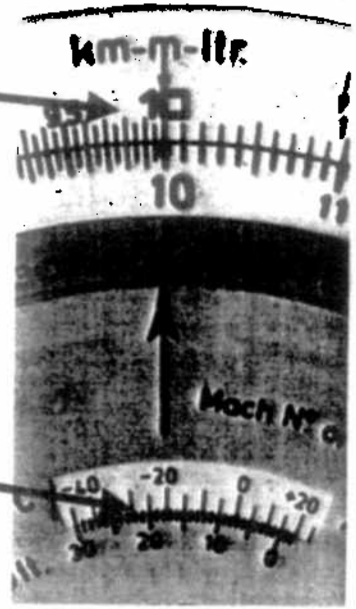
1. Against 620 on the outer scale set 1 on the inner scale.

2. Against the mach index pointer in the airspeed window read off the actual temperature of -20°C.



ISA temperature is equal to actual temperature minus temperature deviation. The temperature deviation is stated to be +9°C so the ISA temperature at the given flight level = -20°C -(+9°C) = - 29°C.

1. To set up ISA conditions set 10 on the outer scale against 10 on the inner scale.



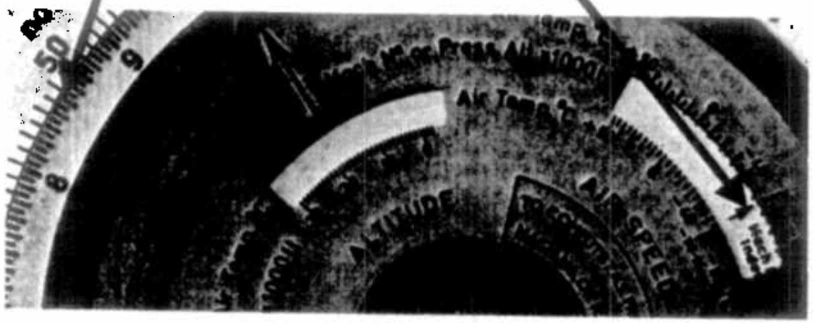
2. Against -29°C in the altitude window read off 22000 ft which is FL220 (option b).

CRP5 13. c.

This type of problem can be solved using the CRP5 as illustrated below.

1. In the airspeed window set the mach index pointer against -56.5°C.

2. Against 0.85 on the inner scale read off 487 Kts TAS on the outer scale.



This result of 487 Kts is closest to 485 Kts (option c).

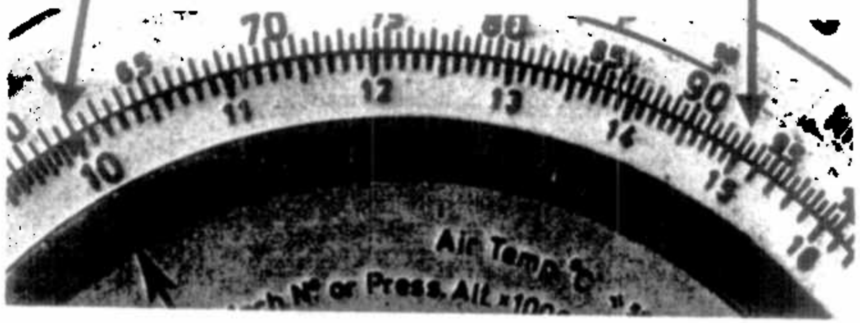
CRP5 14. c.

If 0.15M = 93 Kts then M1 = 93/0.15 = 620 Kts (option c).

To carry out this division on the CRP5.

1. Set 93 on the outer scale against 0.15 on the inner scale.

2. Then against 10 on the inner scale read off 620 on the outer scale.



CRP5 15. a.

An increase of 0.15 in mach number is 93 Kts so mach 1 = 93/0.15 = 620 Kts. This means that the local speed of sound is 620 Kts TAS.

1. Against 620 on the outer scale set 1 on the inner scale.

2. Against the mach index pointer in the airspeed window read of the actual temperature of -20°C.

The temperature deviation is stated to be +5°C so the ISA temperature at the given flight level will be actual – ISA deviation, which = -20°C -(+5°C) = - 25°C.

1. Against -25°C in the altitude window read off 20000 ft which is FL200 (option a).

2. To set up ISA conditions set 10 on the outer scale against 10 on the inner scale.