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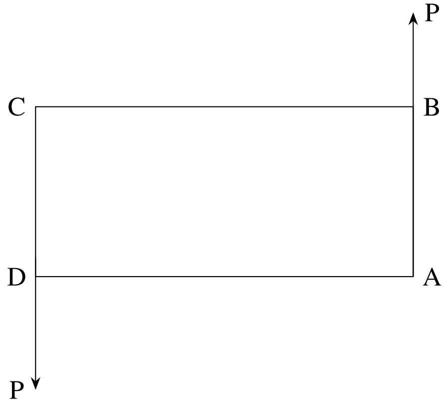
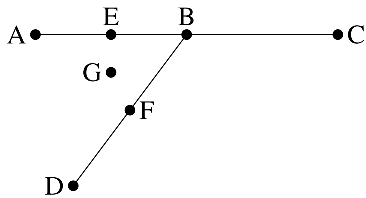
13) The relation between an airplane's true airspeed V_{TAS} and equivalent airspeed V_{EAS} in terms of the density ratio $\left(\sigma = \frac{\rho}{\rho_0}\right)$, where ρ_0 is the air density at sea-level and ρ is the air density at the altitude at which the airplane is flying, is given by the formula:
    a) $\frac{V_{EAS}}{V_{EAS}} = \sigma$
    b) $\frac{V_{EAS}}{V_{EAS}} = \sigma^2$
    c) $\frac{V_{EAS}}{V_{EAS}} = \sqrt{\sigma}$
    d) $\frac{V_{EAS}}{V_{EAS}} = \frac{1}{\sqrt{\sigma}}$
14) An unswept fixed-winged aircraft has a large roll stability if the wing is placed
    a) low on the fuselage and has negative dihedral angle
    b) low on the fuselage and has positive dihedral angle
    c) high on the fuselage and has negative dihedral angle
    d) high on the fuselage and has positive dihedral angle
15) Thrust available from a turbojet engine
    a) increases as altitude increases
    b) increases up to the troposphere and then decreases
    c) remain constant at all altitudes
    d) decreases as altitude increases
16) If $C_{m_{CG}}$ is the pitching moment coefficient about the center of gravity of an aircraft, and α is the angle of attack, then $\frac{dC_{m_{CG}}}{d\alpha}$ is
    a) a stability derivative which represents stiffness in pitch
    b) a stability derivative which represents damping in pitch
    c) a control derivative in pitch
    d) positive for an aircraft that is stable in pitch
17) The life of a geo-stationary communications satellite is limited by
    a) the working life of the on-board electronic circuitry
    b) the time it takes for its orbit to decay due to atmospheric drag
    c) the quantity of on-board fuel available for station-keeping
    d) the number of meteorite impacts that the satellite structure can withstand before breaking up
18) For a critically damped single degree of freedom spring - mass - damper system with a damping constant c of $4\,N\frac{s}{m}$ and spring constant k of $16\,\frac{N}{m}$, the system mass m is
    a) $0.5\,kg$
    b) $0.25\,kg$
    c) $2\,kg$
    d) $4\,kg$

19) In a thin walled rectangular tube subjected to equal and opposite forces P as shown in the figure, the shear stress along leg AB is



a) zero
b) constant non-zero
c) varies linearly
d) varies parabolically

20) For the thin walled beam cross section as shown in the figure, the shear centre lies at



a) Mid point of AB, i.e. at point E
b) Mid point of BD, i.e. at point F
c) Junction point B
d) at a point G lying within the area ABC

21) Let M_0 be the total mass of a single rocket, M_P be the total mass of propellant, M_L be the mass of payload carried by the rocket and M_S be the mass of inert structural components. If I_{sp} is the specific impulse of the propulsion system (*in seconds*) and g is the acceleration due to gravity, then the maximum velocity that can be attained by the rocket vehicle in absence of gravity and atmospheric drag is given by

a) $gI_{sp} \ln\left(\frac{M_0}{M_P}\right)$
b) $gI_{sp} \ln\left(\frac{M_0}{M_L+M_P} - 1\right)$
c) $gI_{sp} \ln\left(\frac{M_0}{M_S}\right)$
d) $gI_{sp} \ln\left(\frac{M_0}{M_0-M_P}\right)$

22) An ideal axial compressor is driven by an ideal turbine across which the total temperature ratio is 0.667. If the total temperature at turbine inlet is $T_0 = 1500\,K$

and specific heat of gas $c_p = 1\,\frac{kJ}{kg}K$, the power drawn by the compressor per unit mass flow rate of air is approximately

a) $300\,\frac{kW}{kg}s$
b) $1000\,\frac{kW}{kg}s$
c) $600\,\frac{kW}{kg}s$
d) $500\,\frac{kW}{kg}s$

23) The performance of a solid rocket motor is improved by replacing the old propellant with the new one. The new propellant gives a combustion temperature 40% higher than the previous propellant without appreciable change in molecular weight of combustion products and other operating parameters. By approximately what percentage is the specific impulse of the new motor higher than the old one?

a) 18%
b) 96%
c) 42%
d) 112%

24) A solid rocket motor has an end burning grain of cross-sectional area $A_{CS} = 0.4\,m^2$. The density of propellant is $\rho_p = 1500\,\frac{kg}{m^3}$ and has linear regression rate $r = 5\,\frac{mm}{s}$. If the specific impulse of the propulsion system is $I_{sp} = 200\,seconds$, the thrust produced by the motor is approximately

a) $3\,kN$
b) $6\,kN$
c) $1.5\,kN$
d) $12\,kN$