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Read the following instructions carefully.

1. All questions in this paper are of objective type.
2. There are a total of 65 questions carrying 100 marks.
3. Questions 1 to 25 will carry 1 mark each and questions 26 to 55 will carry 2 marks each.
4. Questions 48 to 51 (2 pairs) are common data questions and questions 52 to 55 (2 pairs) are linked answer questions. The answer to the second question of the linked answer questions depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is unattempted, then the answer to the second question in the pair will not be evaluated.
5. Questions 56 to 65 belong to General Aptitude (GA). Questions 56 to 60 will carry 1 mark each and questions 61 to 65 will carry 2 marks each.
6. Unattempted questions will carry zero marks.
7. Wrong answers will carry negative marks. For Q.1–Q.25 and Q.56–Q.60, $\frac{1}{3}$ mark will be deducted for each wrong answer. For Q.26–Q.51 and Q.61–Q.65, $\frac{2}{3}$ mark will be deducted for each wrong answer. The question pairs (Q.52, Q.53), and (Q.54, Q.55) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair *i.e.*, for Q.52 and Q.54, $\frac{2}{3}$ mark will be deducted for each wrong answer. There is no negative marking for Q.53 and Q.55.

(1 Mark Questions)

1. A biplane of given wing area as of a monoplane, wing will have

(a) more drag and more lift
(b) less drag and more lift
(c) more drag and less lift
(d) None of the above

2. For a perfect crystal,

(a) entropy is maximum at perfect zero temperature
(b) entropy is zero at perfect zero temperature
(c) entropy decreases with increase in temperature
(d) None of the above

3. Maximum pressure losses occur in an engine across

(a) inlet (b) turbine
(c) compressor (d) nozzle

4. Velocity gradients in turbulent boundary layer are

(a) higher compared to laminar boundary layer
(b) lower compared to laminar boundary layer
(c) higher than laminar boundary layer in favourable pressure gradient, but lower in adverse pressure gradient regime
(d) lower than laminar boundary layer in favourable pressure gradient, but higher in adverse pressure gradient regime

5. If an aircraft has its centre of gravity on neutral point, then

(a) aircraft has maximum possible stability
(b) aircarft is neutrally stable
(c) static stability is minimum
(d) None of the above

6. A dutch-roll instability of an aircraft is

(a) a highly damped oscillatory motion with high frequency
(b) a highly damped oscillatory motion with low frequency
(c) a lightly damped oscillatory motion with low frequency
(d) None of the above

7. Characteristics of a short-term mode of longitudinal instability are

(a) constant speed, highly damped
(b) constant angle of attack, highly damped
(c) constant speed, lightly damped
(d) constant speed, constant angle of attack

8. The effect of tail on aircraft static stability is

(a) stabilizing
(b) de-stabilizing
(c) dependent on aft or forward position of tail
(d) None of the above

9. C_{l_α} of a wing is less than C_{l_α} of an airfoil because of
(a) wing is bigger
(b) wing tip vortices
(c) unsteadiness in flow associated with it
(d) downwash

10. For directional stability, an aircraft should have
(a) $C_{l\beta} < 0$ (b) $C_{l\beta} = 0$
(c) $C_{l\beta} > 0$ (d) $C_{m\alpha} < 0$
where, l is roll moment, m is pitching moment, α is angle of attack and β is side-slip angle.

11. From thin airfoil theory, lift curve slope $C_{l\alpha}$ is 2π for
(a) symmetric airfoil
(b) cambered airfoil
(c) Both (a) and (b)
(d) depends upon airfoil geometry

12. Across a normal shock
(a) velocity decreases, total pressure decreases, static pressure increases
(b) velocity increases, total pressure decreases, static pressure increases
(c) velocity decreases, total pressure decreases, static pressure decreases
(d) anything can happen

13. Mathematical form of area-velocity relation is
(a) $\dfrac{dA}{A} = (1 - M^2)\dfrac{du}{u}$ (b) $\dfrac{dA}{A} = (M^2 - 1)\dfrac{du}{u}$
(c) $\dfrac{du}{u} = (1 - M^2)\dfrac{dA}{A}$ (d) $\dfrac{du}{u} = (M^2 - 1)\dfrac{dA}{A}$

14. For an airfoil, C_p distribution in incompressible conditions is $C_{p,0}$. If flight Mach number is M_∞, then by Prandtl's correction, the approximate C_p distribution, in compressible conditions will be
(a) $C_p = \dfrac{C_{p,0}}{\sqrt{1-M_\infty^2}}$ (b) $C_p = \dfrac{\sqrt{1-M_\infty^2}}{C_{p,0}}$
(c) $C_p = C_{p,0}\sqrt{1-M_\infty^2}$ (d) $C_p = C_{p,0}\sqrt{M_\infty^2 - 1}$

15. Lift coefficient of a wing is increased two times, the new induced drag will be
(a) twice of previous value
(b) half of previous value
(c) same as before
(d) four times of previous value

16. Pitch control on an aircraft is achieved by
(a) elevator deflection (b) rudder deflection
(c) wing setting angle (d) tail setting angle

17. For an aircraft to be stable in pitch, roll and yaw directions, which of following must be valid?
(a) $C_{m\alpha} < 0,\ C_{n\beta} < 0,\ C_{l\beta} < 0$
(b) $C_{m\alpha} < 0,\ C_{n\beta} > 0,\ C_{l\beta} < 0$
(c) $C_{m\alpha} < 0,\ C_{n\beta} < 0,\ C_{l\beta} > 0$
(d) $C_{m\alpha} < 0,\ C_{n\beta} > 0,\ C_{l\beta} > 0$

18. For a satellite in orbit, its angular momentum is
(a) constant
(b) increasing
(c) decreasing
(d) dependent on type of orbit

19. The relation among Bulk modulus (K), Young modulus (E) and Poisson's ratio (ν) of a material is
(a) $K = \dfrac{E}{3(1-2\nu)}$ (b) $K = \dfrac{E(1+\nu)}{2}$
(c) $K = \dfrac{3E}{(1-2\nu)}$ (d) $K = \dfrac{E}{2(1+\nu)}$

20. An aircraft is flying with flight speed v and tail moment arm l_t. If pitch rate is q, then what will be change in angle of attack due to pitching?
(a) $\Delta\alpha = q\dfrac{l_t}{2v}$ (b) $\Delta\alpha = \dfrac{q\,l_t}{v}$
(c) $\Delta\alpha = \dfrac{2v}{q\,l_t}$ (d) $\Delta\alpha = \dfrac{v}{q\,l_t}$

21. If Airy's stress function is ϕ, then which of following is true?
(a) $\nabla^2 \phi = 0$ (b) $\nabla\phi = 0$
(c) $\nabla^4 \phi = 0$ (d) $\nabla^3 \phi = 0$

22. Von-Mises criterion in three-dimensional stress-strain problem is represented as
(a) $\sigma^3 - I_1\sigma^2 + I_2\sigma + I_3 = 0$
(b) $\sigma^3 - I_2\sigma^2 + I_1\sigma + I_3 = 0$
(c) $\sigma^3 - I_3\sigma^2 + I_2\sigma + I_1 = 0$
(d) $\sigma^3 - I_3\sigma^2 + I_1\sigma + I_2 = 0$
where, $\sigma_1, \sigma_2, \sigma_3$ are principal stresses and roots of given equation.

$$I_1 = \sigma_X + \sigma_Y + \sigma_Z$$
$$I_2 = \Sigma\,\sigma_i\,\sigma_j - \Sigma\,\tau_{ij}^2$$
$$I_3 = \begin{vmatrix} \sigma_X & \tau_{XY} & \tau_{XY} \\ \tau_{YX} & \sigma_Y & \tau_{YZ} \\ \tau_{ZX} & \tau_{ZY} & \sigma_Z \end{vmatrix}$$

23. In an elastic beam problem, boundary conditions at free end will be
(a) $M = 0,\ V = 0$ (b) $u = 0,\ \dfrac{\partial u}{\partial x} = 0$
(c) $M = 0,\ u = 0$ (d) $V = 0,\ \dfrac{\partial u}{\partial x} = 0$

where, u is displacement, x is coordinate in axial direction M is moment and V is shear force.

24. Critical load for a fixed-free column of length l will be

(a) $P_{cr} = \dfrac{\pi^2 EI}{l^2}$ (b) $P_{cr} = \dfrac{\pi^2 EI}{2l^2}$

(c) $P_{cr} = \dfrac{\pi^2 EI}{4l^2}$ (d) $P_{cr} = \dfrac{4\pi^2 EI}{l^2}$

25. For a plane stress problem, state of stress can be represented as Mohr's circle. The equation of Mohr's circle is

(a) $\left(\sigma_n - \dfrac{\sigma_X + \sigma_Y}{2}\right)^2 + \tau^2 = \left(\dfrac{\sigma_Y - \sigma_X}{2}\right)^2$

(b) $\left(\sigma_n + \dfrac{\sigma_X + \sigma_Y}{2}\right)^2 + \tau^2 = \left(\dfrac{\sigma_Y - \sigma_X}{2}\right)^2$

(c) $\left(\sigma_n + \dfrac{\sigma_X - \sigma_Y}{2}\right)^2 + \tau^2 = \left(\dfrac{\sigma_Y + \sigma_X}{2}\right)^2$

(d) $\left(\sigma_n - \dfrac{\sigma_X - \sigma_Y}{2}\right)^2 + \tau^2 = \left(\dfrac{\sigma_Y + \sigma_X}{2}\right)^2$

(2 Mark Questions)

26. Specific impulse (I_{sp}) will be maximum for a rocket with propulsion system of
(a) solid propellants
(b) liquid propellants
(c) electric propulsion system
(d) liquid H_2 + liquid O_2

27. Flow separation from a body surface occurs due to
(a) slowing down of flow in the boundary layer
(b) mixing and collision of fluid particles near the body surface
(c) Both of the above
(d) None of the above

28. If a two-dimensional uniform flow of free stream velocity u, separates from the body, then at separation point

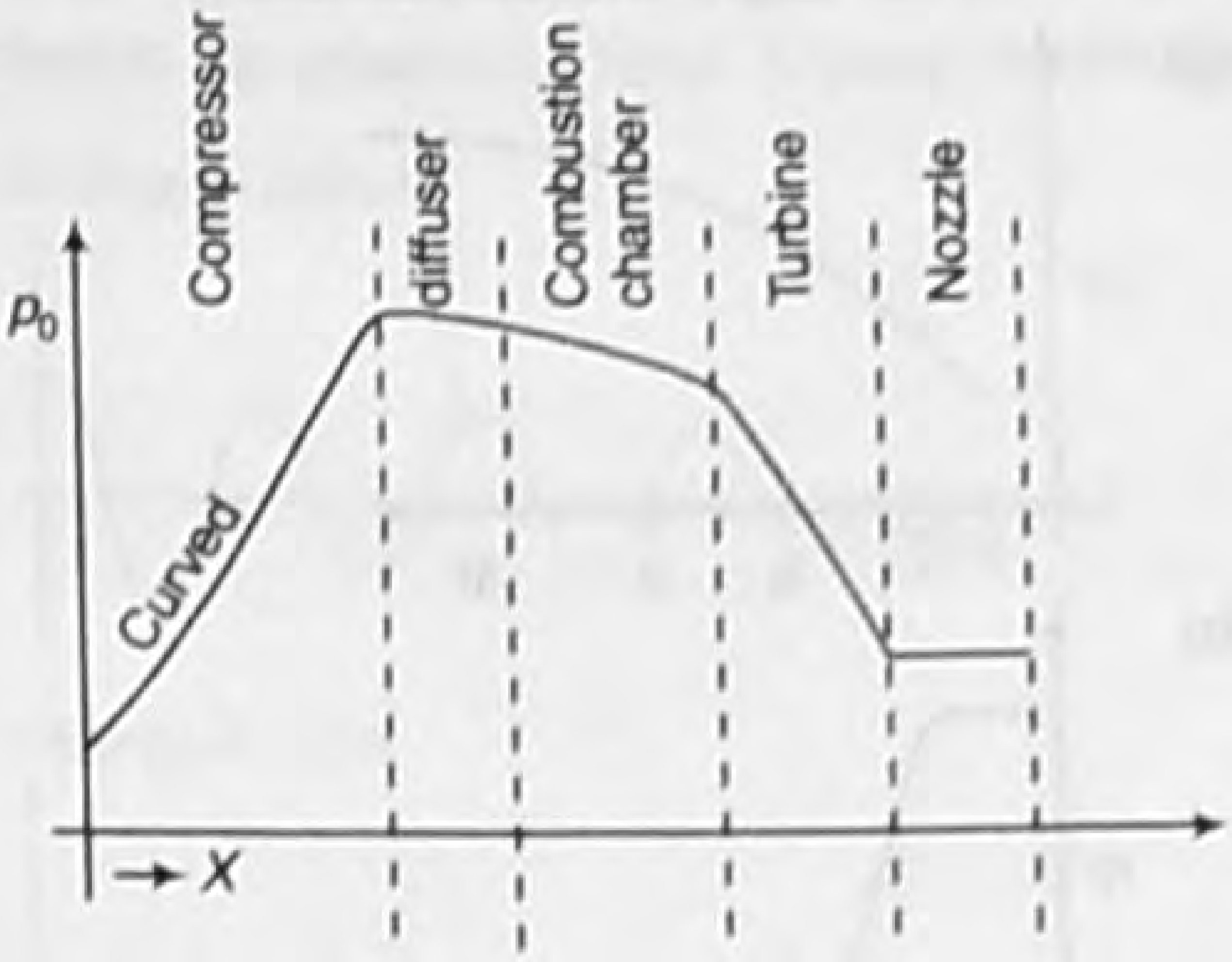
(a) $\left(\dfrac{\partial u}{\partial x}\right)_{y=0} = 0$ (b) $\left(\dfrac{\partial u}{\partial y}\right)_{y=0} = 0$

(c) $\left(\dfrac{\partial^2 u}{\partial y^2}\right)_{y=0} = 0$ (d) $\left(\dfrac{\partial^2 u}{\partial x^2}\right)_{y=0} = 0$

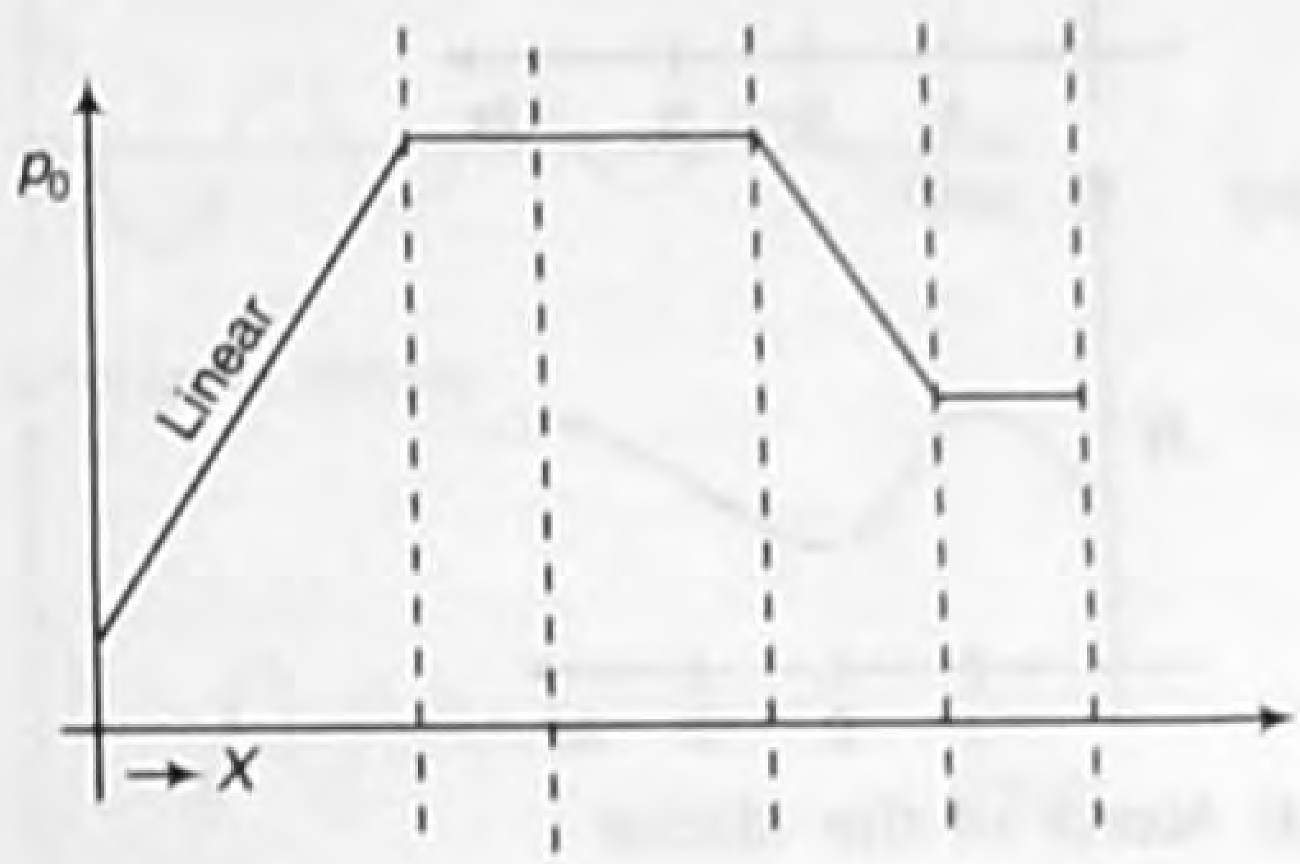
where, u is local velocity in X-direction at body surface. ($Y = 0$ lies at body surface.)

29. The correct representation of total pressure variation across an engine is (no component is ideal)

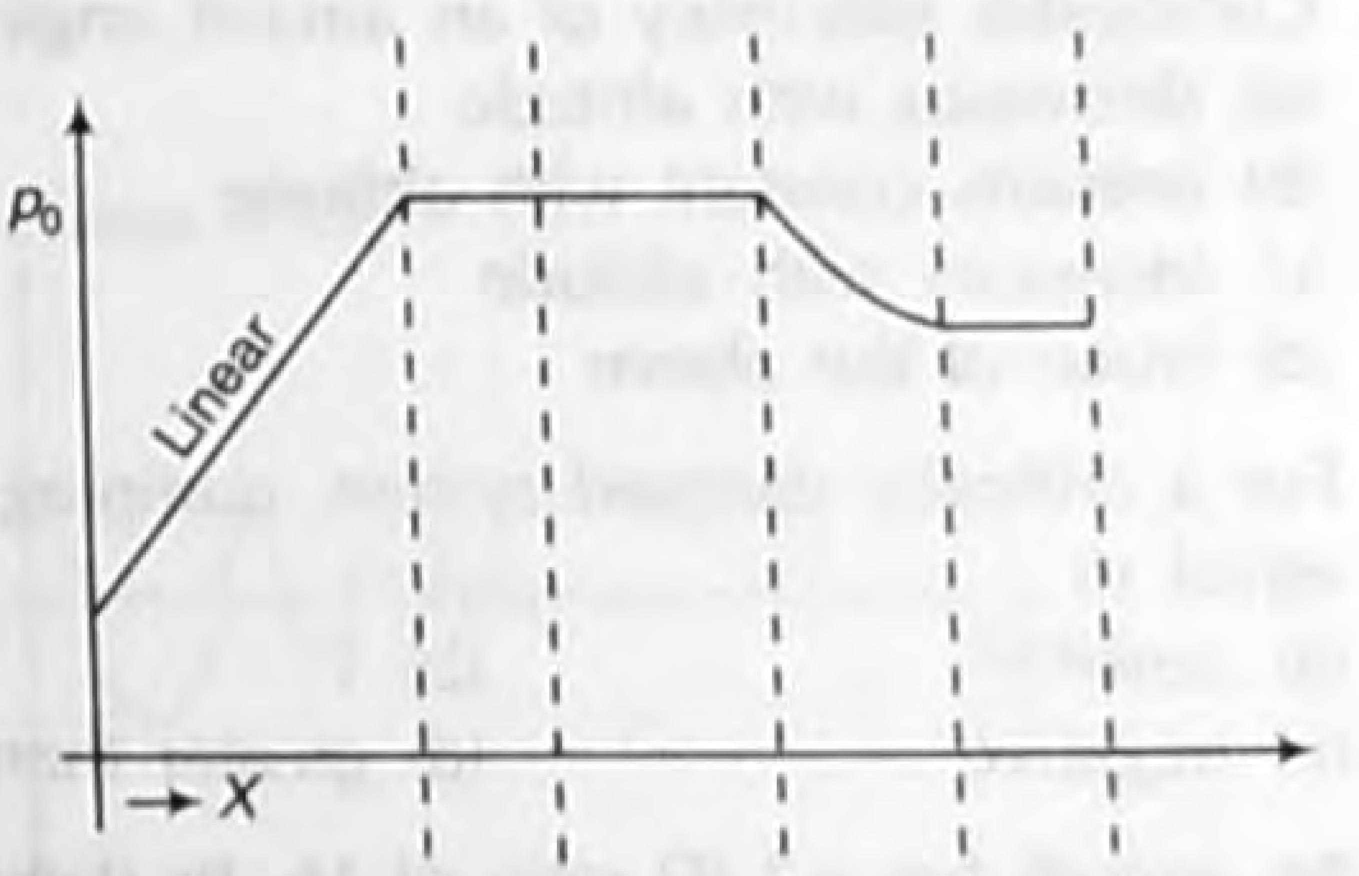
(a)



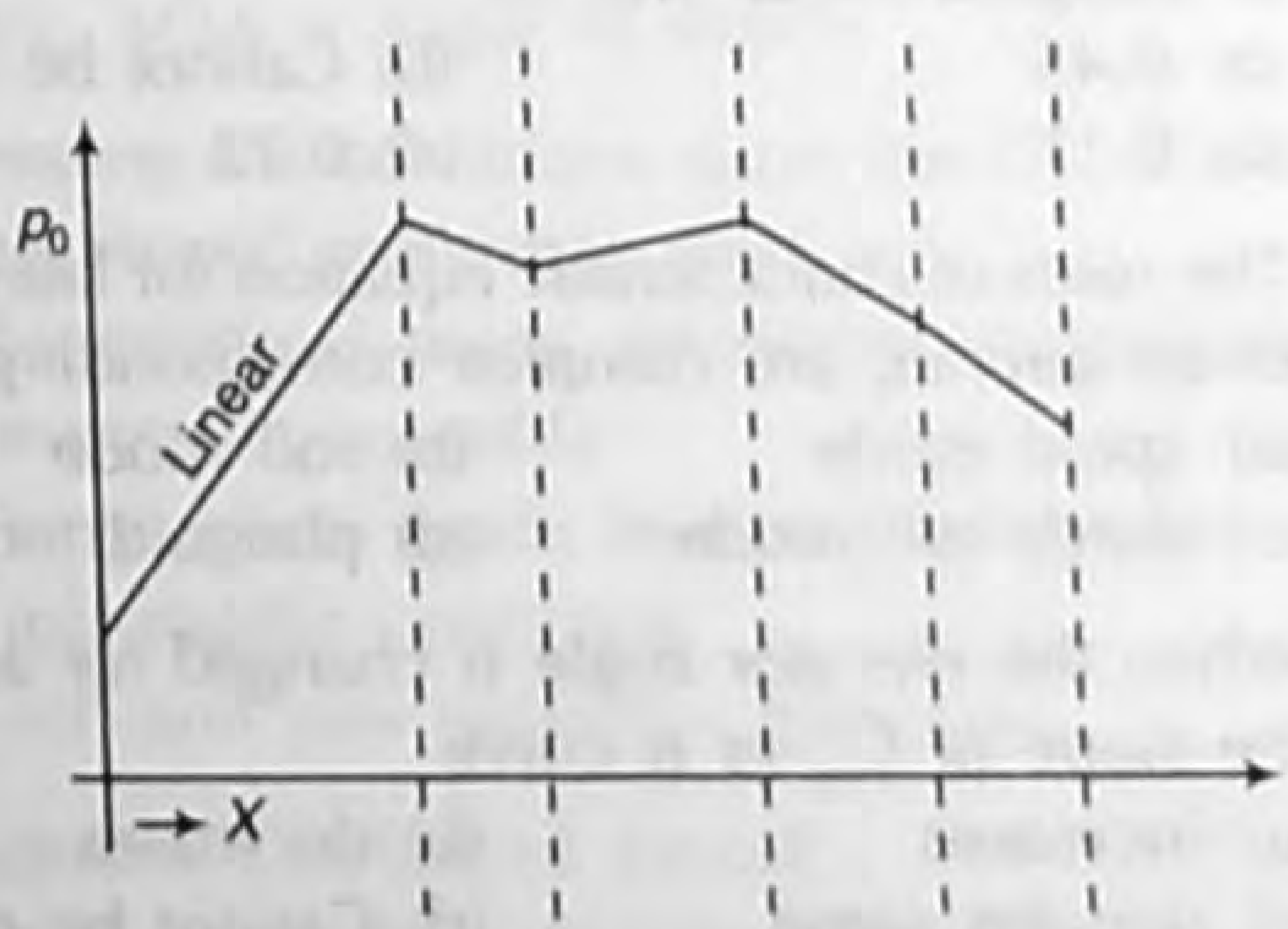
(b)



(c)



(d)

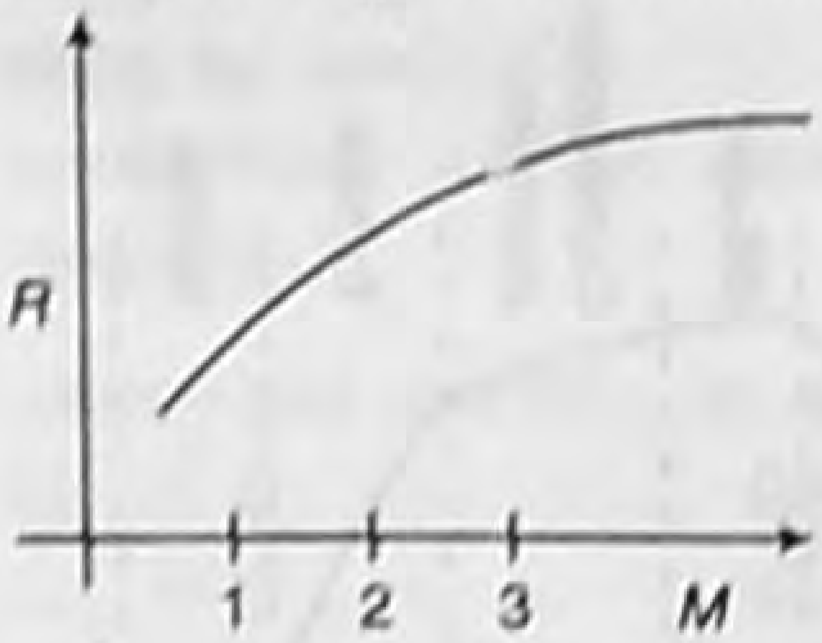


30. The expression for range of an aircraft is

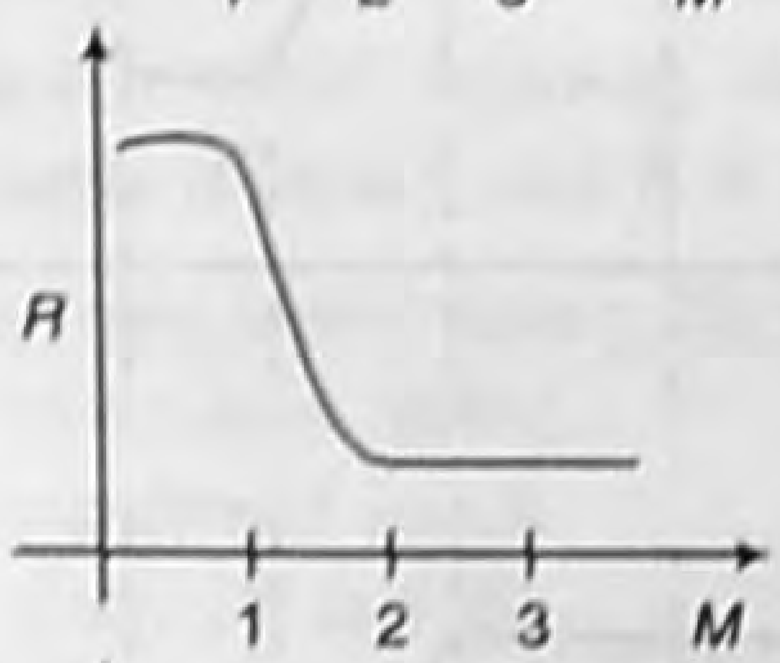
$$R = \eta_0 \left(\frac{L}{D}\right) \ln\left(\frac{m_1}{m_2}\right) \frac{Q_R}{g},$$ where m_1 and m_2 are initial and final masses of vehicle, Q_R is heat of reaction of propellant, η_0 is overall efficiency of

engine and (L/D) is lift-drag ratio. Which one of following is correct representation of range of an aircraft with flight-Mach number?

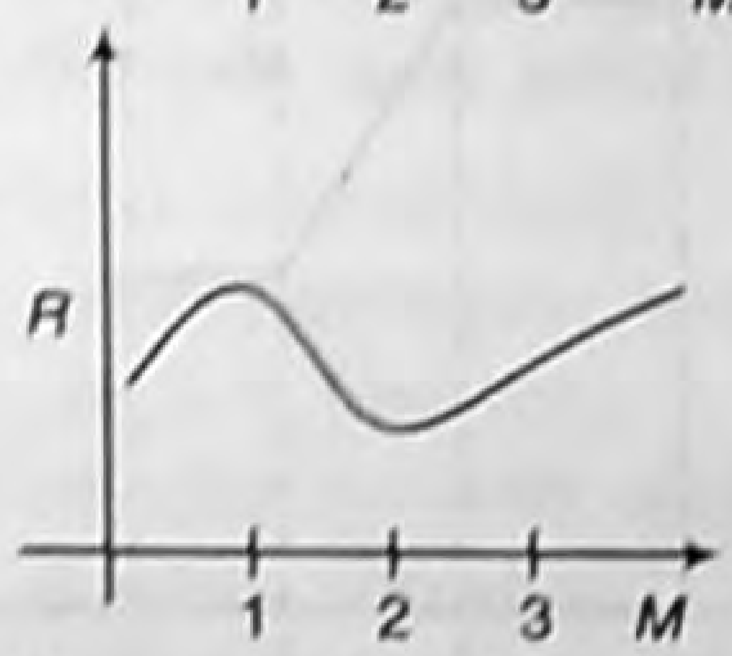
(a)



(b)



(c)



(d) None of the above

31. Combustor efficiency of an aircraft engine
(a) decreases with altitude
(b) remains constant with altitude
(c) increases with altitude
(d) None of the above

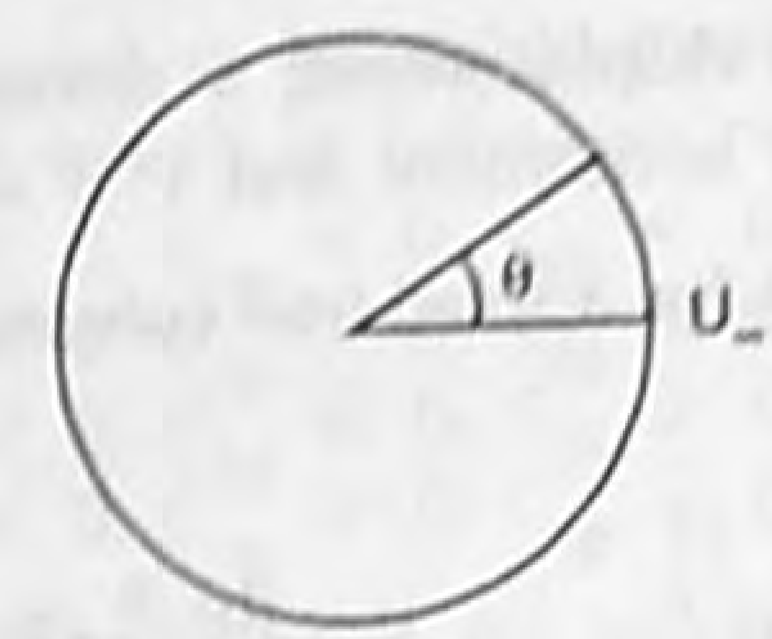
32. For a critically damped system, damping ratio ξ is equal to
(a) zero (b) 1
(c) negative (d) greater than one

33. An aircraft has a L/D ratio of 16. Its damping ratio in phugoid mode will be
(a) 0.45 (b) Cannot be calculated
(c) 0.11 (d) 0.22

34. The roots of characteristic equation for lateral motion of an aircraft, are complex corresponding to
(a) spiral mode (b) roll mode
(c) dutch roll mode (d) phugoid mode

35. When the elevator angle is changed for an aircraft, the slope of C_m vs α curve
(a) increases (b) decreases
(c) remains same (d) Cannot be decided

36. C_p distribution for potential flow over a cylinder varies as
(a) $1 - 4\sin^2\theta$ (b) $1 - 2\sin^2\theta$
(c) $1 - 4\sin 2\theta$ (d) $1 - 4\cos^2\theta$



37. Kutta-Joukowski theorem relates the lift and circulation over a body for
(a) two-dimensional body
(b) three-dimensional body
(c) Both (a) and (b)
(d) None of the above

38. Mathematical form of Kelvin's circulation theorem is
(a) $\frac{DT}{Dt} = 0$ (b) $\frac{DT}{Dt} < 0$
(c) $\frac{DT}{Dt} > 0$ (d) $\frac{DT}{Dt} = 1$

39. An elliptic wing has
(a) elliptic lift distribution, elliptic downwash
(b) elliptic lift distribution, constant downwash
(c) constant lift distribution, elliptic downwash
(d) None of the above

40. C_p distribution for potential flow over a sphere in a flow field varies as
(a) $1 - 9/4\sin^2\theta$ (b) $1 - 4\sin^2\theta$
(c) $1 - 9/4\sin 2\theta$ (d) $1 - 4\cos^2\theta$

41. Critical Mach number for a thick airfoil will be
(a) less than of a thin airfoil
(c) more than of a thin airfoil
(b) Cannot be related
(d) equal to thin airfoil

42. For a cusped airfoil
(a) trailing edge is always stagnation point
(b) trailing edge may or may not be stagnation point
(c) flow velocity above and below the trailing edge have different magnitudes
(d) flow velocity above and below the trailing edge have different directions

43. Positive dihedral effect can be produced by using
(a) swept back wings (b) swept forward wings
(c) Canard wing (d) rectangular wing

44. High wing aircraft when compared to a low wing aircraft, produces a
(a) greater dihedral effect (c) lower dihedral effect
(c) Cannot be compared (d) equal dihedral effect

45. A supercritical airfoil is used in supersonic vehicles because it
(a) has a relatively flat top which encourages a region of supersonic flow with less M to have weaker shock waves
(b) has more curved top so that flow accelerates faster and gives higher M
(c) has negative camber to have stabilizing contribution of wing in longitudinal stability
(d) is very thin to avoid drag and to produces weaker shocks

46. Interplanetory flight vehicles move on a
(a) circular path
(b) elliptical path
(c) hyperbolic/parabolic path
(d) straight path

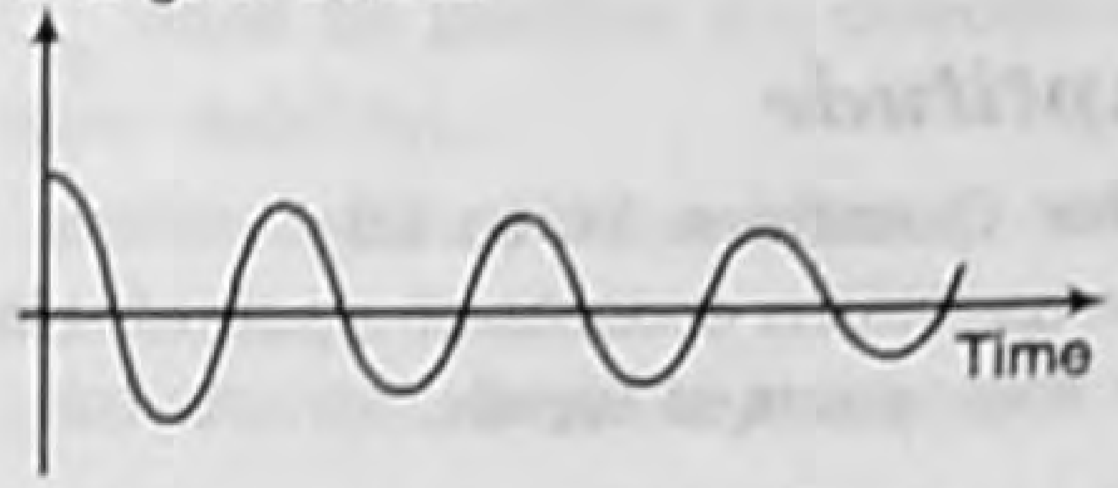
47. Typical flight (orbit) velocity of earth-satellites is of the order
(a) $v \geq 7.9$ km/s (c) $v \geq 3$ km/s
(c) $v \geq 11.2$ km/s (d) $v \geq 30$ km/s

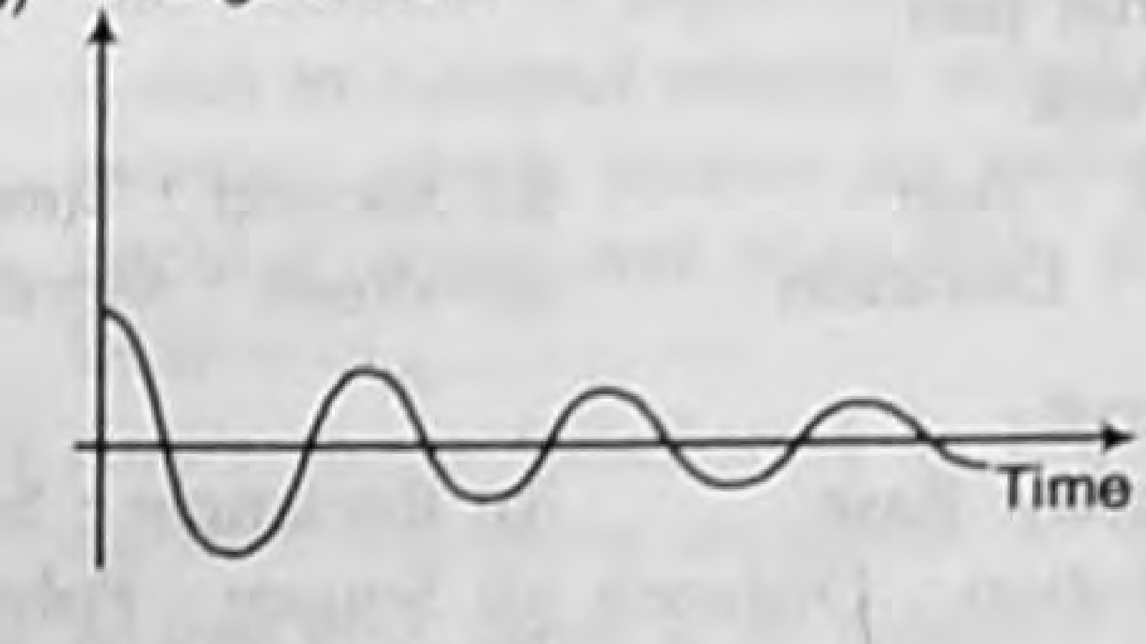
48. Pre-mixed flame when compared to diffusion flame, has a
(a) better control on fuel-air ratio
(b) Not at all control on fuel-air ratio
(c) worse control on fuel-air ratio
(d) None of the above

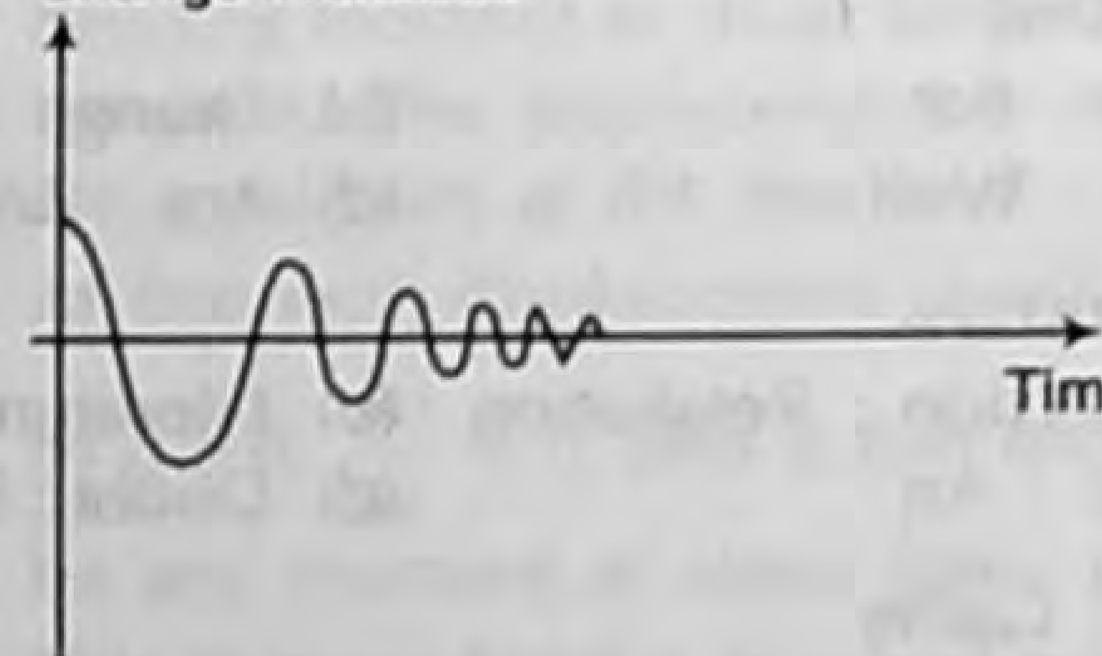
49. The kinetic energy of an earth-satellite in circular orbit around earth with increasing altitude
(a) increases
(b) decreases
(c) remains constant
(d) increases exponentially with altitude

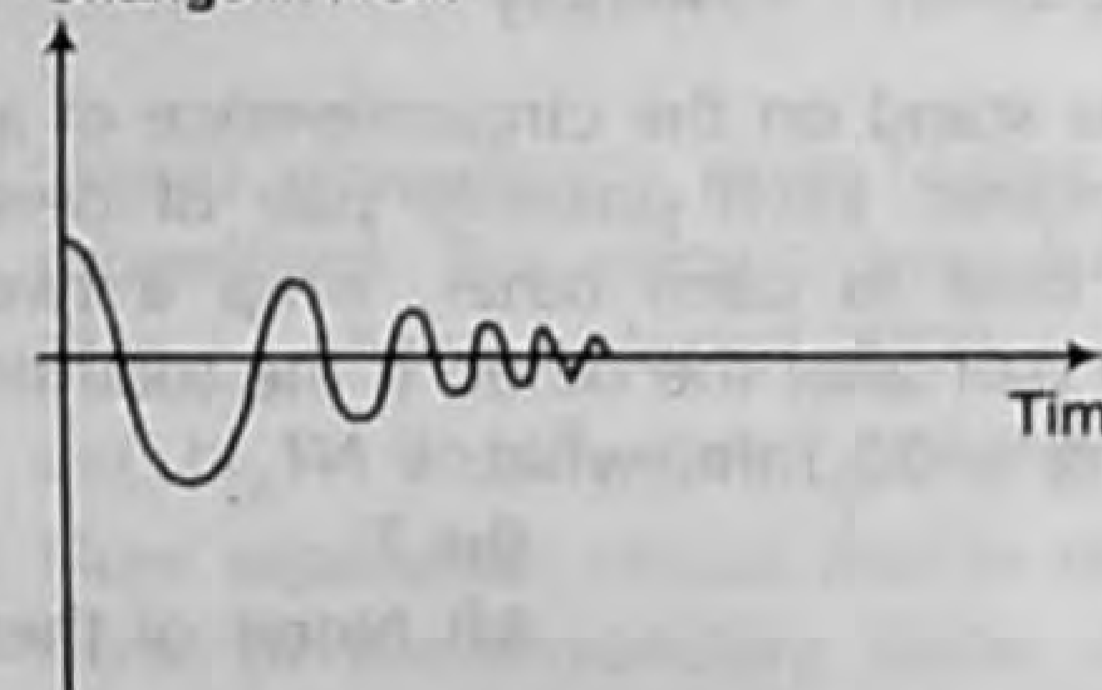
50. A satellite is in elliptic orbit of semi-mazor axis a around earth. The velocity of satellite at apogee will be
(a) $u_a = \sqrt{\dfrac{\mu}{a}\dfrac{(1-e)}{(1+e)}}$ (b) $u_a = \dfrac{\mu}{a}\sqrt{\dfrac{(1-e)}{(1+e)}}$
(c) $u_a = \sqrt{\dfrac{\mu}{a}\dfrac{(1+e)}{(1-e)}}$ (d) $u_a = \dfrac{\mu}{a}\sqrt{\dfrac{(1+e)}{(1-e)}}$
where, μ is standard gravitational potential and e is eccentricity of orbit.

51. A transversely isotropic material has
(a) a plane of symmetry in which elastic properties are isotropic
(b) two planes of symmetry in which elastic properties are isotropic
(c) no plane of symmetry
(d) None of the above

52. Dynamic response of an aircraft in longitudinal mode is in phugoid mode. Which of the following represents its graphical time history correctly?
(a) Change in altitude


(b) Change in AOA


(c) Change in altitude


(d) Change in AOA


where, AOA = Angle of Attack

53. If keeping rest conditions same, the CG of aircraft is being moved rearwards, then
(a) longitudinal mode becomes non-periodic and eventually unstable
(b) longitudinal mode becomes more stable
(c) roll stability increases
(d) roll and yaw stabilities increases

54. At absolute ceiling of aircraft
(a) rate of climb is maximum
(b) rate of climb is zero
(c) rate of climb is 100 ft/min
(d) None of the above

55. Flow past a circular cylinder can be understood as a combination of

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(a) uniform flow + vortex
(b) uniform flow + doublet flow
(c) doublet flow
(d) uniform flow + source flow

General Aptitude

Directions for Questions 56 to 60

Each of these questions consists of a pair of related words followed by four pairs of words.

56. Select the pair which best expresses the relation in the original pair.
Day : Week
(a) Week : Year (b) Second : Time
(c) Time : Duration (d) Week : Month

57. Arc : Curve
(a) Triangle : Base (b) Rectangle : Square
(c) Revolution : Distance (d) Square : Polygon

58. Jackal : Dog
(a) Crow : Bat (b) Orange : Lemon
(c) Tiger : Wolf (d) Ant : Antepol

59. Error : Mistake
(a) Connection : Retaliation (b) Literature : Poetry
(c) Music : Art (d) Doubt : Suspicion

60. Hockey : Game
(a) King : Rule
(b) Constitution : Assembly

61. *N* persons stand on the circumference of a circle at distinct points. Each possible pair of persons, not standing next to each other, sings a two minute song one pair after the other. If the total time taken for singing is 28 min, what is *N*?
(a) 5 (b) 7
(c) 9 (d) None of these

62. Ram has to travel from Hyderabad to Chennai which is a certain distance apart. 23% of the distance was travelled by bus, 50% of the remaining by train and rest of the distance 231 km by taxi. Find the distance between Hyderabad and Chennai in km.
(a) 600 (b) 462
(c) 231 (d) 856

63. *A* and *B* can do a piece of work in 45 days and 40 days respectively. They began to do the work together but *A* leaves after some days and then *B* completed the remaining work in 23 days. The number of days after which *A* left the work was how many days?
(a) 6 days (b) 9 days
(c) 12 days (d) 15 days

64. A dishonest businessman professes to sell his articles at cost price but he uses false weight with which he cheats by 10% while buying and by 10% while selling. Find his profit percentage.
(a) 20% (b) 21%
(c) 22.22% (d) 25%

65. Company Alpha buys free travel coupons from people who are awarded the coupons by Bravo airlines for flying frequently on Bravo airplanes. The coupons are sold to people who pay less for the coupons than they would pay by purchasing tickets from Bravo. This marketing of coupons results in lost revenue for Bravo.
To discourage the buying and selling of free travel coupons, it would be best for Bravo airlines to restrict the
(a) number of coupons that a person can be awarded in a particular year
(b) limiting the use of the coupons to those who were awarded the coupons and members of the immediate families
(c) days that the coupons can be used from Monday through Friday
(d) amount of time that the coupons can be used after they are issued