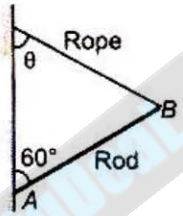
1. A string that is stretched between fixed supports separated by 75.0 cm has resonant frequencies of 420 Hz and 315 Hz, with no intermediate resonant frequencies. What is the lowest resonant frequency?
   (a) 250 Hz (b) 317 Hz
   (c) 180 Hz (d) 105 Hz

2. Suppose 4.0 mol of an ideal gas undergoes a reversible isothermal expansion from volume V_1 to volume $V_2 = 2.0\,V_1$ at temperature $T = 400$ K. Find the entropy change of the gas. (Take $\ln 2 = 0.693$)
   (a) 23.0 J/K (b) 42.0 J/K
   (c) 51.6 J/K (d) 56.9 J/K

3. A uniform rod AB of mass m is hinged to a wall at its lower end, while its upper end is held by a rope attached to the wall. For what value of θ, the tension in the rope is equal to $\frac{mg}{2}$?



   (a) 30° (b) 60°
   (c) 45° (d) None of these

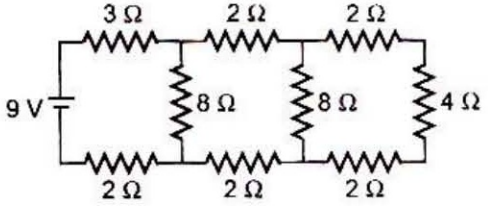
4. Three sinusoidal waves of the same frequency travel along a string in the positive x-direction. Their amplitudes are y, $\frac{y}{2}$ and $\frac{y}{3}$ and their phase constants are 0, $\frac{\pi}{2}$ and π respectively. What is the amplitude of the resultant wave?
   (a) 0.63 y (b) 0.72 y
   (c) 0.83 y (d) 0.52 y

5. A sample of gas expands from an initial pressure and volume of 10 Pa and 1.0 m^3 to a final volume of 2.0 m^3. During the expansion, the pressure and volume are related by the equation $p = aV^2$, where $a = 10\ N/m^8$. Find the work done by the gas during the expansion.
   (a) 23 J (b) 18 J
   (c) 9 J (d) 43 J

6. Two point +ve charges q each are placed at $(-a, 0)$ and $(a, 0)$. A third +ve charge q_0 is placed at $(0, y)$. Find the value of y for which the force at q_0 is maximum.
   (a) $\frac{a}{\sqrt{3}}$ (b) $\frac{a}{\sqrt{2}}$
   (c) a (d) $2a$

7. A particle of mass 40 mg and carrying a charge 5×10^{-9} C is moving towards a fixed charge of magnitude 10^{-8} C. When it is at a distance of 10 cm from the fixed charge, it has a velocity of 50 cm/s. At what distance from the fixed charge will the particle come momentarily to rest?
   (a) 1.3×10^{-3} m (b) 1.9×10^{-3} m
   (c) 3.9×10^{-2} m (d) 4.7×10^{-2} m

8. In the circuit shown in the figure

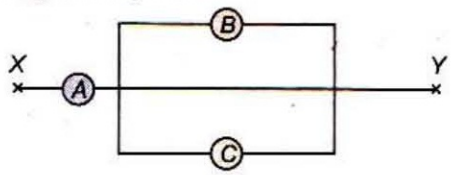


The current through 3 Ω resistance is

(a) 0.5 A (b) 0.7 A

(c) 1.0 A (d) 1.2 A

9. A, B and C are voltmeters of resistance R, $1.5R$ and $3R$ respectively. When some potential difference is applied between X and Y, the voltmeter readings are V_A, V_B and V_C respectively. Then



(a) $V_A = V_B = V_C$ (b) $V_A \neq V_B = V_C$

(c) $V_A = V_B \neq V_C$ (d) $V_A \neq V_B \neq V_C$

10. A galvanometer has a resistance of 30 Ω and a current of 2.0 mA gives full scale deflection. How will you convert this galvanometer into a voltmeter of 0.2 V range?

(a) 700 Ω resistance should be connected parallel to the galvanometer

(b) 70 Ω resistance should be connected to the galvanometer

(c) 700 Ω resistance should be connected in series with the galvanometer

(d) 70 Ω resistance should be used in series with the galvanometer

11. A beam of 450 nm light is incident on a metal having work function 2 eV and placed in a magnetic field B. If the most energetic electrons emitted are bent into circular arc of radius 0.2 m, find B.

(a) 2.36×10^{-4} T (b) 1.46×10^{-5} T

(c) 6.9×10^{-5} T (d) 9.2×10^{-6} T

12. The de-Broglie wave length is given by

(a) $p = \dfrac{2\pi\hbar}{\lambda}$ (b) $p = \dfrac{\hbar}{2\lambda}$

(c) $p = \dfrac{2\pi}{\hbar\lambda}$ (d) $p = \dfrac{2\pi}{\lambda}$

13. Which of the following truth tables corresponds to NAND gate.

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

(i)

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

(ii)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

(iii)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	1

(iv)

(a) (iv) (b) (iii)

(c) (ii) (d) (i)

14. The range of nuclear force is of the order of

(a) 2×10^{-10} m (b) 1.5×10^{-20} m

(c) 1.2×10^{-4} m (d) 1.4×10^{-15} m

15. What is the momentum of a photon having frequency 1.5×10^{13} Hz?

(a) 3.3×10^{-29} kg-m/s

(b) 3.3×10^{-34} kg-m/s

(c) 6.6×10^{-34} kg-m/s

(d) 6.6×10^{-32} kg-m/s

16. The two headlights of an approaching car are 1.4 m apart. At what maximum distance will the eye resolve them. Assume that the pupil diameter is 5.0 mm and the wavelength of light is 550 nm.

(a) 5 km (b) 10 km

(c) 8 km (d) 5.3 km

17. Find the wavelength of light that may excite an electron in the valence band of diamond to the conduction band. The energy gap is 5.50 eV.

(a) 226 nm (b) 312 nm

(c) 432 nm (d) 550 nm

18. A copper wire of length 50.0 cm and total resistance of 1.1×10^{-2} Ω is formed into a circular loop and placed perpendicular to a uniform magnetic field that is increasing at the constant rate of 10.0 mT/s. At what rate is thermal energy generated in the loop?

(a) 1.32×10^{-8} W (b) 2.36×10^{-4} W

(c) 3.68×10^{-6} W (d) 4.23×10^{-5} W

19. An electron is moving at a speed of 100 m/s along the x-axis through uniform electric and magnetic fields. The magnetic field is directed along the z-axis and has magnitude 5.0 T. In unit vector notation, what is the electric field?

(a) $100\mathbf{j}\dfrac{\text{V}}{\text{m}}$ (b) $-100\mathbf{k}\dfrac{\text{V}}{\text{m}}$

(c) $-100\mathbf{k}\dfrac{\text{V}}{\text{m}}$ (d) $500\mathbf{j}\dfrac{\text{V}}{\text{m}}$

20. The half-life of ${}_{92}U^{238}$ undergoing α-decay is 1.5×10^{17} s. What is the activity of 238 g sample of ${}_{92}U^{238}$?

(a) $2.8 \times 10^6\ s^{-1}$ (b) $3.9 \times 10^7\ s^{-1}$
(c) $4.3 \times 10^8\ s^{-1}$ (d) $5.6 \times 10^9\ s^{-1}$

21. An intrinsic semiconductor has a resistivity of 0.50-Ω m at room temperature. Find the intrinsic carrier concentration, if the mobilities of electrons and holes are $0.39\ m^2/V\text{-}s$, and $0.11\ m^2/V\text{-}s$ respectively

(a) $1.2 \times 10^{18}/m^3$ (b) $2.5 \times 10^{19}/m^3$
(c) $1.9 \times 10^{20}/m^3$ (d) $3.1 \times 10^{21}/m^3$

22. The wavelength of spectral line coming from a distant star shifts from 600 nm to 600.1 nm. The velocity of the star relative to earth is

(a) 50 km/s (b) 100 km/s
(c) 25 km/s (d) 200 km/s

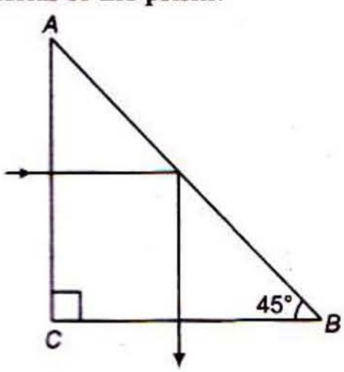
23. A bulb is placed at a depth of $2\sqrt{7}$ m in water $\left(\mu_w = \frac{4}{3}\right)$ and a floating opaque disc is placed over the bulb so that the bulb is not visible from the surface. What is the minimum diameter of the disc?

(a) 8 m (b) 12 m
(c) 15 m (d) 20 m

24. What is the refractive index of material of a plano-convex lens, if the radius of curvature of the convex surface is 10 cm and focal length of the lens is 30 cm?

(a) $\frac{6}{5}$ (b) $\frac{7}{4}$
(c) $\frac{2}{3}$ (d) $\frac{4}{3}$

25. A ray of light incident normally on one of the faces of a right angle prism is found to be totally reflected as shown in figure. What is the minimum value of the refractive index of the material of the prism?



(a) $\sqrt{2}$ (b) $\sqrt{\frac{3}{2}}$
(c) $\frac{4}{3}$ (d) None of these

26. In a two slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the plane of slits. If the screen is moved by 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-5} m. If the distance between slits is 10^{-3} m, the wavelength of light will be

(a) 3000 Å (b) 4000 Å
(c) 6000 Å (d) 7000 Å

27. For base station to mobile communication, the required frequency bond is

(a) 540-1600 kHz
(b) 200-325 MHz
(c) 5.9-6.42 GHz
(d) 840-935 MHz

28. A Carnot refrigerator extracts 35.0 kJ as heat during each cycle, operating with a coefficient of performance of 4.60. Find the energy per cycle transferred as heat to the surroundings

(a) 42.6 kJ (b) 53.2 kJ
(c) 63.9 kJ (d) 72.5 kJ

29. A carrier wave of peak voltage 10 V is used to transmit a message signal. What should be the peak voltage of the modulating signal in order to have a modulation index of 80%?

(a) 8 V (b) 10 V
(c) 12 V (d) 14 V

30. In the following equation, x, t and F represent respectively, displacement, time and force

$$F = a + bt + \frac{1}{c + dx} + A \sin(\omega t + \phi)$$

The dimensional formula for $A \cdot d$ is

(a) $[T^{-1}]$ (b) $[L^{-1}]$
(c) $[M^{-1}]$ (d) $[TL^{-1}]$

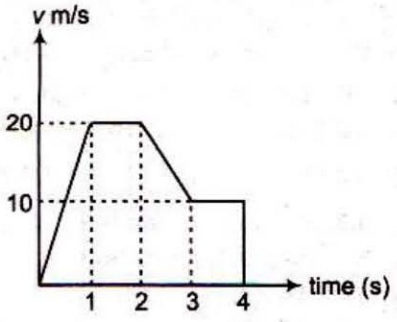
31. The angle between the vectors $\mathbf{A} = \mathbf{i} + \mathbf{j}$ and $\mathbf{B} = \mathbf{i} + \mathbf{j} + c\mathbf{k}$ is 30°. Find the unknown c.

(a) zero (b) ± 1
(c) $\pm\sqrt{\frac{2}{3}}$ (d) $\pm\frac{1}{2}$

32. Resultant of two vectors **A** and **B** is of magnitude P. If **B** is reversed, then resultant is of magnitude Q. What is the value of $P^2 + Q^2$?

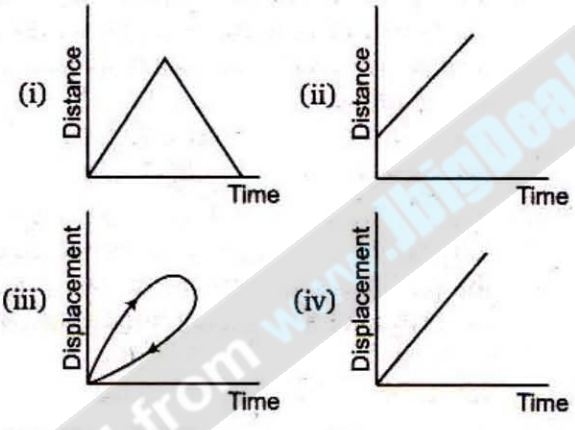
(a) $2(A^2 + B^2)$ (b) $2(A^2 - B^2)$
(c) $(A^2 - B^2)$ (d) $(A^2 + B^2)$

33. From the adjoining graph, the distance traversed by the particle is 4 s is



(a) 60 m (b) 25 m
(c) 55 m (d) 30 m

34. Which of the following graphs is/are not possible.



(a) (i) and (iii)
(b) (i) only
(c) (ii) and (iii)
(d) (iii) only

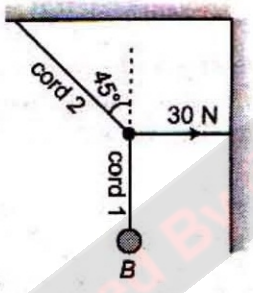
35. A body travelling along a straight line traverse one-third the distance with a velocity of 5 m/s. The remaining part of the distance was covered with velocity 3 m/s for half the time and with velocity 2 m/s for the other half of the time. The average velocity of the body over the whole time of motion will be

(a) 3 m/s (b) 5 m/s
(c) 2 m/s (d) 2.5 m/s

36. A projectile is thrown with an initial velocity of $\mathbf{v} = (p\mathbf{i} + q\mathbf{j})$ m/s. If the range of the projectile is double the maximum height reached by it, then

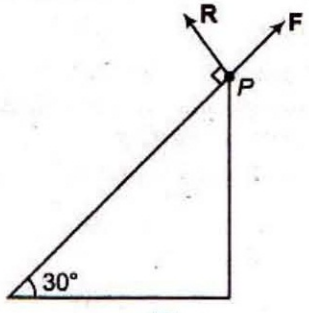
(a) $p = 2q$ (b) $q = 4p$
(c) $q = 2p$ (d) $q = p$

37. In the figure shown, the tension in the horizontal cord is 30 N. Find the weight of the body B.



(a) 40 N (b) 30 N
(c) 20 N (d) 10 N

38. In the following figure, an object of mass 1.2 kg is at rest at point P. If R and F are the reaction and the frictional force, respectively, then



(a) $R = 6$ N; $F = 6\sqrt{3}$ N
(b) $R = 3$ N; $F = 3\sqrt{3}$ N
(c) $R = 6$ N; $F = 3$ N
(d) $R = 6\sqrt{3}$ N; $F = 6$ N

39. A body of mass 1.0 kg strikes elastically with another body at rest and continues to move in the same direction with one-fourth of its initial velocity. The mass of the other body is

(a) 0.6 kg (b) 2.4 kg
(c) 3.0 kg (d) 4.0 kg

40. Moment of inertia does not depend on

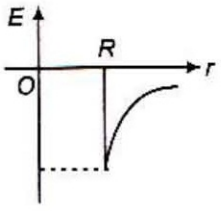
(a) mass distribution of body
(b) torque
(c) shape of the body
(d) the position of axis of rotation

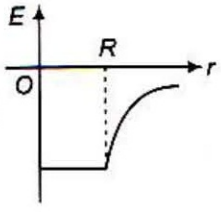
41. Three thin uniform rods each of mass M and length L are placed along the three axes of a Cartesian coordinate system. The moment of inertia of the system about z-axis is

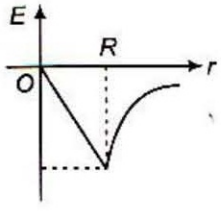
(a) $ML^{2/3}$ (b) $2ML^{2/3}$

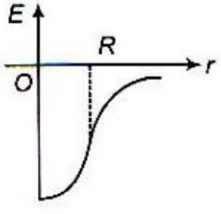
(c) $ML^{2/6}$ (d) ML^2

42. Which of the following graphs represents the gravitational field intensity due to solid sphere of radius R?

(i) 

(ii) 

(iii) 

(iv) 

(a) (i) only (b) (ii) only

(c) (iii) only (d) (iv) only

43. If a graph is plotted between T^2 and r^3 for a planet, then its slope will be

(a) $\frac{4\pi^2}{GM}$ (b) $\frac{GM}{4\pi^3}$

(c) $4\pi GM$ (d) GM

44. Three particles of equal mass m are situated at the vertices of an equilateral triangle of side l. What should be the velocity of each particle, so that they move on a circular path without changing l?

(a) $\sqrt{\frac{Gm}{2l}}$ (b) $\sqrt{\frac{Gm}{l}}$

(c) $\sqrt{\frac{2Gm}{l}}$ (d) $\sqrt{\frac{3}{2}\frac{Gm}{l}}$

45. A projectile is fired vertically upward from the surface of earth with a velocity of kv_e, where v_e is the escape velocity and $k < 1$. Neglecting air resistance, the maximum height to which it will rise, measured from the centre of the earth, is
(R = radius of earth)

(a) $\frac{R}{1-k^2}$ (b) $\frac{R}{k^2}$

(c) $\frac{1-k^2}{R}$ (d) $\frac{k^2}{R}$

46. The velocities of a particle in SHM at positions x_1 and x_2 are v_1 and v_2 respectively. Its time period will be

(a) $2\pi\sqrt{(v_1^2 - v_2^2)/(x_2^2 - x_1^2)}$

(b) $2\pi\sqrt{(x_1^2 + x_2^2)/(v_2^2 - v_1^2)}$

(c) $2\pi\sqrt{(x_2^2 - x_1^2)/(v_1^2 - v_2^2)}$

(d) $2\pi\sqrt{(x_2^2 + x_1^2)/(v_1^2 + v_2^2)}$

47. When a closed pipe is suddenly opened, the second overtone of closed pipe and first overtone of open pipe differ by 100 Hz. The fundamental frequency of the closed pipe will be

(a) 200 Hz (b) 150 Hz

(c) 100 Hz (d) 50 Hz

48. The phenomenon of beats can take place

(a) for longitudinal waves only

(b) for transverse waves only

(c) for sound waves only

(d) for both longitudinal and transverse waves

49. A solid sphere of mass 1.0 kg and diameter 0.3 m is suspended from a wire. If the twisting couple per unit twist for the wire is 6×10^{-3} N-m/rad, then the time period of small oscillations will be

(a) 0.7 s (b) 7.7 s

(c) 77 s (d) 777 s

50. A train approaching a railway crossing at a speed of 120 km/h sounds a whistle at frequency 640 Hz when it is 300 m away from the crossing. The speed of sound in air is 340 m/s. What will be the frequency heard by a person standing on a road perpendicular to the track through the crossing at a distance of 400 m from the crossing?

(a) 680 Hz

(b) 640 Hz

(c) 720 Hz

(d) 358 Hz

Answer – Key

1. d	2. a	3. b	4. c	5. a	6. b	7. d	8. c	9. a	10. d
11. d	12. a	13. d	14. d	15. a	16. b	17. a	18. b	19. d	20. a
21. b	22. a	23. b	24. d	25. a	26. c	27. b	28. a	29. a	30. b
31. c	32. a	33. c	34. a	35. b	36. c	37. b	38. d	39. a	40. b
41. *	42. c	43. a	44. b	45. a	46. c	47. c	48. a	49. b	50. a