SECTION-A

PHYSICS

1. For the same cross-sectional area and for a given load, the ratio of depressions for the beam of a square cross-section and circular cross-section is

(a) $3 : \pi$ (b) $\pi : 3$ (c) $1 : \pi$ (d) $\pi : 1$

2. If three equal masses m are placed at the three vertices of an equilateral triangle of side $1/m$ then what force acts on a particle of mass $2m$ placed at the centroid?

(a) Gm^2 (b) $2Gm^2$ (c) Zero (d) $-Gm^2$

3. In a reverse biased diode when the applied voltage changes by 1 V, the current is found to change by 0.5 µA. The reverse bias resistance of the diode is

(a) 2×10^5 W   (b) 2×10^6 W

(c) $200 \, \Omega$ (d) $2 \, \Omega$

4. Two simple harmonic motions are represented

by the equations $y_1 = 0.1 \sin\left(100\pi t + \dfrac{\pi}{3}\right)$ and

$y_1 = 0.1 \cos \pi t$.

The phase difference of the velocity of particle 1 with respect to the velocity of particle 2 is

(a) $\dfrac{\pi}{3}$ (b) $\dfrac{-\pi}{6}$ (c) $\dfrac{\pi}{6}$ (d) $\dfrac{-\pi}{3}$

5. A stretched wire 60 cm long is vibrating with its fundamental frequency of 256 Hz. If the length of the wire is decreased to 15 cm and the tension remains the same. Then the fundamental freuqency of the vibration of the wire will be

(a) 1024   (b) 572

(c) 256   (d) 64

6. A soap film of surface tension 3×10^{-2} formed in a rectangular frame cam support a straw as shown in Fig. If $g = 10 \, ms^{-12}$, the mass of the straw is

(a) 0.006 g

(b) 0.06 g

(c) 0.6 g

(d) 6 g

7. A circular disc of radius R is removed from a bigger circular disc of radius 2R such that the circumferences of the discs coincide. The centre of mass of the new disc is α/R form the centre of the bigger disc. The value of α is

(a) 1/4   (b) 1/3

(c) 1/2   (d) 1/6
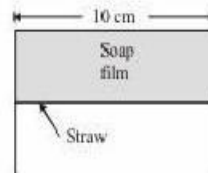
8. Two sources of equal emf are connected to an external resistance R. The internal resistance of the two sources are R_1 and R_2 ($R_2 > R_1$). If the potential difference across the source having internal resistance R_2 is zero, then

(a) $R = R_2 - R_1$

(b) $R = R_2 \times (R_1 + R_2)/(R_2 - R_1)$

(c) $R = R_1 R_2 /(R_2 - R_1)$

(d) $R = R_1 R_2 /(R_1 - R_2)$

9. A vessel contains oil (density = 0.8 gm/cm³) over mercury (density = 13.6 gm/cm³). A homogeneous sphere floats with half of its volume immersed in mercury and the other half in oil. The density of the material of the sphere in gm/cm³ is

(a) 3.3   (b) 6.4   (c) 7.2   (d) 12.8

10. A current of I ampere flows in a wire forming a circular arc of radius r metres subtending an angle θ at the centre as shown. The magnetic field at the centre O in tesla is
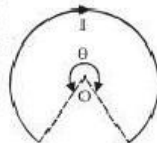
(a) $\dfrac{\mu_0 I\theta}{4\pi r}$

(b) $\dfrac{\mu_0 I\theta}{2\pi r}$

(c) $\dfrac{\mu_0 I\theta}{2r}$

(d) $\dfrac{\mu_0 I\theta}{4r}$

11. A broadcast radio transmitter radiates 12 kW when percentage of modulation is 50%, then the unmodulated carrier power is

(a) 5.67 kW   (b) 7.15 kW

(c) 9.6 kW   (d) 12 kW

12. Two trains are moving towards each other with speeds of 20 m/s and 15 m/s relative to the ground. The first train sounds a whistle of frequency 600 Hz. The frequency of the whistle heard by a passenger in the second train before the train meets, is (the speed of sound in air is 340 m/s)

(a) 600 Hz   (b) 585 Hz

(c) 645 Hz   (d) 666 Hz

13. A particle of mass M is situated at the centre of a spherical shell of same mass and radius a. The gravitational potential at a point situated at $\dfrac{a}{2}$ distance from the centre, will be:

(a) $-\dfrac{3GM}{a}$

(b) $-\dfrac{2GM}{a}$

(c) $-\dfrac{GM}{a}$

(d) $-\dfrac{4GM}{a}$

14. For a particle executing SHM the displacement x is given by $x = A \cos \omega t$. Identify the graph which represents the variation of potential energy (P.E.) as a function of time t and displacement x.
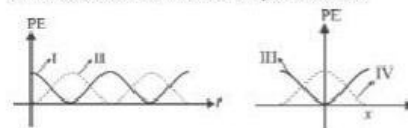
(a) I, III   (b) II, IV

(c) II, III   (d) I, IV

15. A beam of electrons is moving with constant velocity in a region having simultaneous perpendicular electric and magnetic fields of strength 20 Vm⁻¹ and 0.5 T respectively at right angles to the direction of motion of the electrons. Then the velocity of electrons must be:

(a) 8 m/s   (b) 20 m/s

(c) 40 m/s   (d) $\dfrac{1}{40}$ m/s

16. The period of oscillation of a magnet in a vibration magnetometer is 2 sec. The period of oscillation of a magnet whose magnetic moment is four times that of the first magnet is

(a) 1 sec   (b) 5 sec

(c) 8 sec   (d) 0.5 sec

17. A cell having an emf ε and internal resistance r is connected across a variable external resistance R. As the resistance R is increased, the plot of potential difference V across R is given by
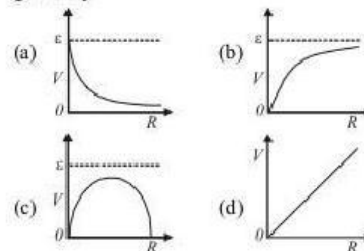
18. The transition from the state $n = 4$ to $n = 3$ in a hydrogen like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition from

    (a) $2 \to 1$ (b) $3 \to 2$

    (c) $4 \to 2$ (d) $5 \to 4$

19. A light rod of length $2m$ suspended from the ceiling horizontally by means of two vertical wires of equal length. A weight W is hung from a light rod as shown in figure.
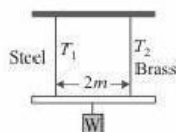
    The rod hung by means of a steel wire of cross-sectional area $A_1 = 0.1$ cm^2 and brass wire of cross-sectional area $A_2 = 0.2$ cm^2. To have equal stress in both wires, $T_1/T_2 =$

    (a) 1/3   (b) 1/4   (c) 4/3   (d) 1/2

20. For which angle between two equal vectors $\vec{A}$ and $\vec{B}$ will the magnitude of the sum of two vectors be equal to the magnitude of each vector?

    (a) $\theta = 60°$ (b) $\theta = 120°$

    (c) $\theta = 0°$ (d) $\theta = 90°$

21. The width of a slit is 0.012 mm. Monochromatic light is incident on it. The angular position of first bright line is 5.2°. The wavelength of incident light is [$\sin 5.2° = 0.0906$].

    (a) 6040 Å   (b) 4026 Å

    (c) 5890 Å   (d) 7248 Å

22. The least coefficient of friction for an inclined plane inclined at angle α with horizontal in order that a solid cylinder will roll down without slipping is

    (a) $\frac{2}{3}\tan\alpha$ (b) $\frac{2}{7}\tan\alpha$

    (c) $\tan\alpha$ (d) $\frac{5}{7}\tan\alpha$

23. Two balls are projected at an angle θ and $(90° - \theta)$ to the horizontal with the same speed. The ratio of their maximum vertical heights is

    (a) $1:1$ (b) $\tan\theta : 1$

    (c) $1 : \tan\theta$ (d) $\tan^2\theta : 1$

24. A rod PQ of mass M and length L is hinged at end P. The rod is kept horizontal by a massless string tied to point Q as shown in figure. When string is cut, the initial angular acceleration of the rod is

    (a) g/L

    (b) $2g/L$

    (c) $\dfrac{2g}{3L}$

    (d) $\dfrac{3g}{2L}$

25. Let Q denote the charge on the plate of a capacitor of capacitance C. The dimensional formula for $\dfrac{Q^2}{C}$ is

    (a) $[L^2M^2T]$ (b) $[LMT^2]$

    (c) $[L^2MT^{-2}]$ (d) $[L^2M^2T^2]$

26. A common emitter amplifier has a voltage gain of 50, an input impedance of 100Ω and an output impedance of 200Ω. The power gain of the amplifier is

    (a) 500   (b) 1000   (c) 1250   (d) 50

27. A glass flask is filled up to a mark with 50 cc of mercury at 18°C. If the flask and contents are heated to 38°C, how much mercury will be above the mark? (α for glass is 9×10^{-6}/°C and coefficient of real expansion of mercury is 180×10^{-6}/°C)

    (a) 0.85 cc   (b) 0.46 cc

    (c) 0.153 cc   (d) 0.05 cc

28. With the increase in temperature, the angle of contact

    (a) decreases

    (b) increases

    (c) remains constant

    (d) sometimes increases and sometimes decreases

29. A prism has a refracting angle of 60°. When placed in the position of minimum deviation, it produces a deviation of 30°. The angle of incidence is

    (a) 30°   (b) 45°   (c) 15°   (d) 60°

30. A planet in a distant solar system is 10 times more massive than the earth and its radius is 10 times smaller. Given that the escape velocity from the earth's surface is 11 km s^{-1}, the escape velocity from the surface of the planet would be

    (a) 1.1 km s^{-1} (b) 11 km s^{-1}

    (c) 110 km s^{-1} (d) 0.11 km s^{-1}

31. The fringe width in a Young's double slit experiment can be increased if we decrease
    (a) width of slits
    (b) separation of slits
    (c) wavelength of light used
    (d) distance between slits and screen

32. Two radiations of photons energies 1 eV and 2.5 eV, successively illuminate a photosensitive metallic surface of work function 0.5 eV. The ratio of the maximum speeds of the emitted electrons is
    (a) 1 : 4   (b) 1 : 2   (c) 1 : 1   (d) 1 : 5

33. An electromagnetic wave going through vacuum is described by $E = E_0 \sin(kx - \omega t)$; $B = B_0 \sin(kx - \omega t)$. Which of the following equations is true?
    (a) $E_0 k = B_0 \omega$ (b) $E_0 \omega = B_0 k$
    (c) $E_0 B_0 = \omega k$ (d) None of these

34. A galvanometer of resistance $100\,\Omega$ gives a full scale deflection for a current of 10^{-5} A. To convert it into a ammeter capable of measuring upto 1 A, we should connect a resistance of
    (a) $1\,\Omega$ in parallel   (b) $10^{-3}\,\Omega$ in parallel
    (c) $10^5\,\Omega$ in series   (d) $100\,\Omega$ in series

35. A spherical ball of iron of radius 2 mm is falling through a column of glycerine. If densities of glycerine and iron are respectively 1.3×10^3 kg/m^3 and 8×10^3 kg/m^3. η for glycerine $= 0.83$ Nm^{-2} sec, then the terminal velocity is
    (a) 0.7 m/s   (b) 0.07 m/s
    (c) 0.007 m/s   (d) 0.0007 m/s

36. A Carnot engine whose low temperature reservoir is at 7°C has an efficiency of 50%. It is desired to increase the efficiency to 70%. By how many degrees should the temperature of the high temperature reservoir be increased?
    (a) 840 K   (b) 280 K   (c) 560 K   (d) 380 K

37. The two blocks, $m = 10$ kg and $M = 50$ kg are free to move as shown. The coefficient of static friction between the blocks is 0.5 and there is no friction between M and the ground. A minimum horizontal force F is applied to hold m against M that is equal to
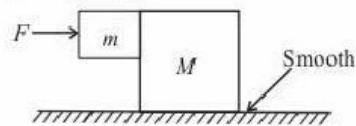
    (a) 100 N   (b) 50 N   (c) 240 N   (d) 180 N

38. The pressure on a square plate is measured by measuring the force on the plate and length of the sides of the plate by using the formula $P = \dfrac{F}{\ell^2}$. If the maximum errors in the measurement of force and length are 6% and 3% respectively, then the maximum error in the measurement of pressure is
    (a) 1%   (b) 2%   (c) 12%   (d) 10%

39. An electron of mass m and charge e initially at rest gets accelerated by a constant electric field E. The rate of change of de-Broglie wavelength of this electron at time t ignoring relativistic effects is
    (a) $\dfrac{-h}{e\,E t^2}$ (b) $\dfrac{-eht}{E}$
    (c) $\dfrac{-mh}{e\,E t^2}$ (d) $\dfrac{-h}{e E}$

40. A plano-convex lens is made of material of refractive index 1.6. The radius of curvature of the curved surface is 60 cm. The focal length of the lens is
    (a) 50 cm   (b) 100 cm
    (c) 200 cm   (d) 400 cm

41. A mass m is revolving in a vertical circle at the end of a string of length 20 cm. By how much does the tension of the string at the lowest point exceed the tension at the topmost point?
    (a) 2 mg   (b) 4 mg   (c) 6 mg   (d) 8 mg

42. Two conducting circular loops of radii R_1 and R_2 are placed in the same plane with their centres coinciding. If $R_1 \gg R_2$, the mutual inductance M between them will be directly proportional to
    (a) R_1/R_2 (b) R_2/R_1
    (c) R_1^2 / R_2 (d) R_2^2 / R_1

43. If $x = at + bt^2$, where x is the distance travelled by the body in kilometers while t is the time in seconds, then the unit of b is
    (a) km/s   (b) kms
    (c) km/s^2 (d) kms^2

44. An organ pipe P_1 closed at one end vibrating in its first overtone and another pipe P_2 open at both ends vibrating in third overtone are in resonance with a given tuning fork. The ratio of the length of P_1 to that of P_2 is
    (a) 8/3   (b) 3/8   (c) 1/2   (d) 1/3