PHYSICS

SECTION-A

1. Two hollow conducting spheres of radii R_1 and R_2 ($R_1 >> R_2$) have equal charges. The potential would be

(1) More on smaller sphere

(2) Equal on both the spheres

(3) Dependent on the material property of the sphere

(4) More on bigger sphere

Answer (1)

Sol. Potential of conducting hollow sphere $= \frac{KQ}{R}$

Now, Q = same

$\Rightarrow V \propto \frac{1}{R} \Rightarrow$ more the radius less will be the potential.

$\Rightarrow$ Hence potential would be more on smaller sphere

2. The angular speed of a fly wheel moving with uniform angular acceleration changes from 1200 rpm to 3120 rpm in 16 seconds. The angular acceleration in rad/s^2 is

(1) 4π (2) 12π

(3) 104π (4) 2π

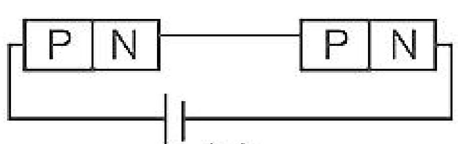
Answer (1)

Sol. Angular acceleration $\alpha = \frac{\omega_f - \omega_i}{t}$

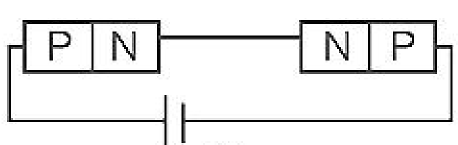
$\omega_f = 3120 \times \frac{2\pi}{60}$ rad/s

$\omega_i = 1200 \times \frac{2\pi}{60}$ rad/s

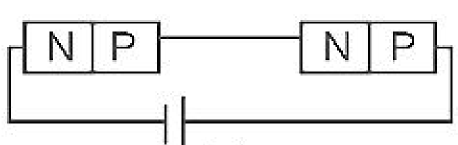
$\Rightarrow \alpha = \frac{(3120 - 1200)}{16} \times \frac{2\pi}{60} = 4\pi$

3. 

(a)



(b)



(c)

In the given circuits (a), (b) and (c), the potential drop across the two p-n junctions are equal in

(1) Circuit (b) only (2) Circuit (c) only

(3) Both circuits (a) and (c) (4) Circuit (a) only

Answer (3)

Sol. Potential drops across the *p-n* junctions will be same if either both junctions are forward biased or both junction are reverse biased.

In figure (a) and (c), both junctions are forward biased therefore both have same potential.

In figure (b) first junction is forward biased and second junction is reverse biased, so both junctions have different potential difference.

4. Two objects of mass 10 kg and 20 kg respectively are connected to the two ends of a rigid rod of length 10 m with negligible mass. The distance of the center of mass of the system from the 10 kg mass is

(1) $\frac{20}{3}$ m

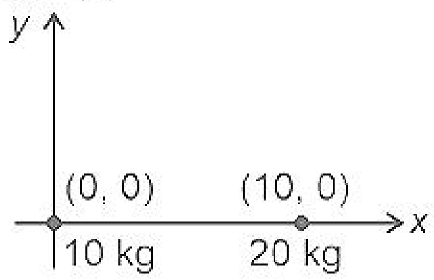
(2) 10 m

(3) 5 m

(4) $\frac{10}{3}$ m

Answer (1)

Sol.



$$X_{cm} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$$

$$= \frac{10\times 0 + 20\times 10}{10+20}$$

$$= \frac{200}{30}$$

$$= \frac{20}{3} \text{ m}$$

5. A biconvex lens has radii of curvature, 20 cm each. If the refractive index of the material of the lens is 1.5, the power of the lens is

(1) +20 D

(2) +5 D

(3) Infinity

(4) +2 D

Answer (2)

Sol. Power of lens is given by

$$P = \frac{1}{f(m)}$$

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

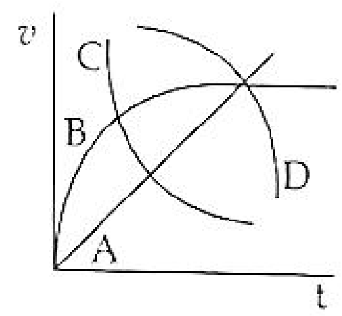
$$\frac{1}{f} = \left\{\frac{3}{2} - 1\right\}\left(\frac{1}{20} + \frac{1}{20}\right)$$

$f = 20$ cm

$$P = \frac{1}{20\times 10^{-2}}$$

$= 5$ D

6. A spherical ball is dropped in a long column of a highly viscous liquid. The curve in the graph shown, which represents the speed of the ball (v) as a function of time (t) is

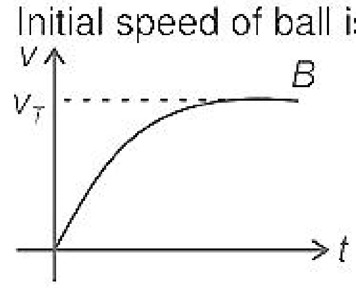


(1) B (2) C

(3) D (4) A

Answer (1)

Sol. Initial speed of ball is zero and it finally attains terminal speed



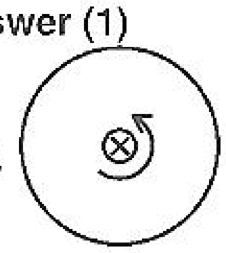
7. The ratio of the radius of gyration of a thin uniform disc about an axis passing through its centre and normal to its plane to the radius of gyration of the disc about its diameter is

(1) $\sqrt{2}:1$ (2) $4:1$

(3) $1:\sqrt{2}$ (4) $2:1$

Answer (1)

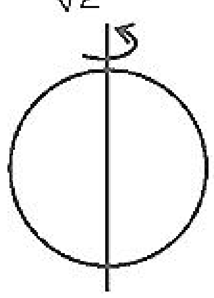
Sol.



$$I_1 = \frac{MR^2}{2}$$

$$k_1 = \sqrt{\frac{I_1}{M}}$$

$$= \frac{R}{\sqrt{2}}$$



$$I_2 = \frac{MR^2}{4}$$

$$k_2 = \sqrt{\frac{I_2}{M}}$$

$$= \frac{R}{2}$$

$$\frac{k_1}{k_2} = \frac{\frac{R}{\sqrt{2}}}{\frac{R}{2}}$$

$$= \sqrt{2}:1$$

8. A shell of mass m is at rest initially. It explodes into three fragments having mass in the ratio 2 : 2 : 1. If the fragments having equal mass fly off along mutually perpendicular directions with speed v, the speed of the third (lighter) fragment is

(1) $\sqrt{2}v$ (2) $2\sqrt{2}v$

(3) $3\sqrt{2}v$ (4) v

Answer (2)

Sol. Momentum of the system would remain conserved.

Initial momentum = 0

Final momentum should also be zero.

Let masses be $2m$, $2m$, and m

Momentum along x-direction $= 2mv\hat{i}$

Momentum along y-direction $= 2mv\hat{j}$

Net momentum $= \sqrt{(2mv)^2 + (2mv)^2} = \sqrt{2} \cdot 2mv$

Now, $2\sqrt{2}mv = mv'$

$\boxed{v' = 2\sqrt{2}v}$

9. A long solenoid of radius 1 mm has 100 turns per mm. If 1 A current flows in the solenoid, the magnetic field strength at the centre of the solenoid is

(1) 12.56×10^{-2} T (2) 12.56×10^{-4} T

(3) 6.28×10^{-4} T (4) 6.28×10^{-2} T

Answer (1)

Sol. We know, magnetic field at centre of solenoid

$B = \mu_0 \frac{N}{\ell} I = \mu_0 nI$ $\left[n = \frac{N}{\ell}\right]$

$= 4\pi \times 10^{-7} \times 100 \times 10^{3} \times 1$ $\left[n = \frac{100}{10^{-3}}\right]$

$= 4\pi \times 10^{-2}$ T

$B = 12.56 \times 10^{-2}$ T

10. Let T_1 and T_2 be the energy of an electron in the first and second excited states of hydrogen atoms, respectively. According to the Bohr's model of an atom, the ratio $T_1 : T_2$ is

(1) 4 : 1 (2) 4 : 9

(3) 9 : 4 (4) 1 : 4

Answer (3)

Sol. $E_n = \frac{E_0}{n^2}$, For first excited state $\Rightarrow n = 2$

For second excited state $\Rightarrow n = 3$

$$\Rightarrow \quad \frac{T_1}{T_2} = \frac{\frac{E_0}{4}}{\frac{E_0}{9}} = \frac{9}{4}$$

11. A light ray falls on a glass surface of refractive index $\sqrt{3}$, at an angle 60°. The angle between the refracted and reflected rays would be

(1) 60° (2) 90°

(3) 120° (4) 30°

Answer (2)

Sol. Given $i = 60°$ and $\mu = \sqrt{3}$

$\Rightarrow$ Here, angle of incidence $\Rightarrow i = \tan^{-1}(\mu)$

Hence, reflected and refracted rays would be perpendicular to each other.

12. If a soap bubble expands, the pressure inside the bubble

(1) Increases (2) Remains the same

(3) Is equal to the atmospheric pressure (4) Decreases

Answer (4)

Sol. Excess pressure inside the bubble = $\Delta P = \frac{4T}{R}$

$$P_{in} = P_{out} + \frac{4T}{R}$$

as 'R' increases 'P' decreases

13. Plane angle and solid angle have

(1) Dimensions but no units (2) No units and no dimensions

(3) Both units and dimensions (4) Units but no dimensions

Answer (4)

Sol. Plane angle = $\frac{\text{Arc}}{\text{Radius}} = \frac{[L]}{[L]} \longrightarrow \text{Unit} = \text{Radian}$

$= [M^0L^0T^0]$

Solid angle = $\frac{\text{Area}}{(\text{Radius})^2} \longrightarrow \text{Unit} = \text{Steradian}$

$= \frac{L^2}{L^2} = [M^0L^0T^0]$

$\therefore$ Both have units but no dimensions

14. When light propagates through a material medium of relative permittivity ε_r and relative permeability μ_r, the velocity of light, v is given by (c-velocity of light in vacuum)

(1) $v = \sqrt{\frac{\mu_r}{\varepsilon_r}}$ (2) $v = \sqrt{\frac{\varepsilon_r}{\mu_r}}$

(3) $v = \frac{c}{\sqrt{\varepsilon_r \mu_r}}$ (4) $v = c$

Answer (3)

Sol. $v = \frac{1}{\sqrt{\varepsilon_m \mu_m}}$

$$v = \frac{1}{\sqrt{\varepsilon_0 \varepsilon_r \mu_0 \mu_r}}$$

Since $c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$

$$\Rightarrow v = \frac{c}{\sqrt{\varepsilon_r \mu_r}}$$

15. Two resistors of resistance, 100 Ω and 200 Ω are connected in parallel in an electrical circuit. The ratio of the thermal energy developed in 100 Ω to that in 200 Ω in a given time is

(1) 2 : 1 (2) 1 : 4

(3) 4 : 1 (4) 1 : 2

Answer (1)

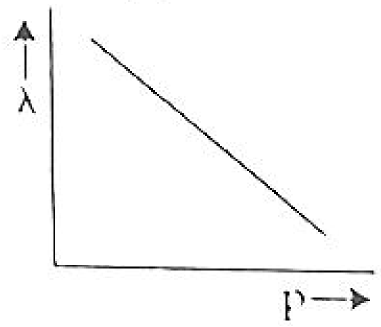
Sol. For parallel combination

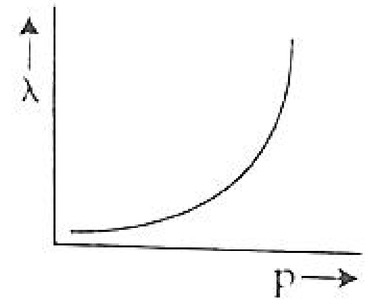
$$P = \frac{V^2}{R}$$

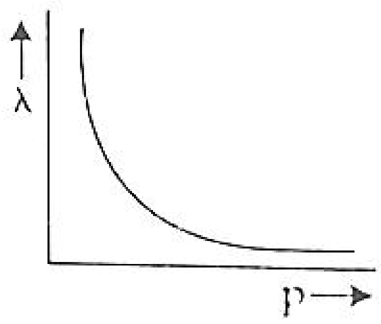
$$\frac{P_1}{P_2} = \frac{R_2}{R_1}$$

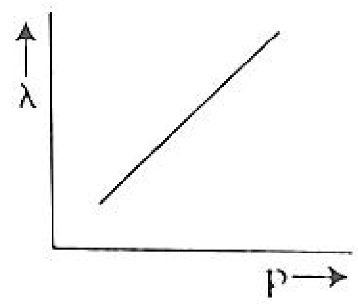
$$\Rightarrow \frac{P_1}{P_2} = \frac{200}{100} = \frac{2}{1}$$

16. The graph which shows the variation of the de Broglie wavelength (λ) of a particle and its associated momentum (p) is

(1) 

(2) 

(3) 

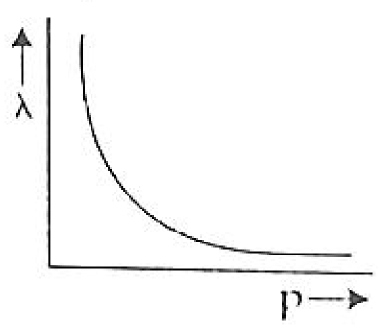
(4) 

Answer (3)

Sol. de-Broglie wavelength associated with a particle is given by

$$\lambda = \frac{h}{p}$$

$$\lambda \propto \frac{1}{p}$$



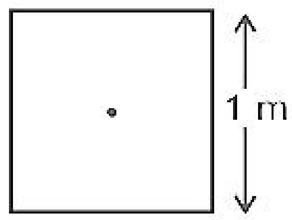
17. A square loop of side 1 m and resistance 1 Ω is placed in a magnetic field of 0.5 T. If the plane of loop is perpendicular to the direction of magnetic field, the magnetic flux through the loop is

(1) 0.5 weber (2) 1 weber

(3) Zero weber (4) 2 weber

Answer (1)

Sol.



Magnetic flux $(\phi_B) = \vec{B}\cdot\vec{A}$

$\vec{B}$ and $\vec{A}$ are in same direction, therefore

$\phi_B = B.A = 0.5 \times 1^2$

$= 0.5$ Wb

18. The dimensions $[MLT^{-2}A^{-2}]$ belong to the

(1) Self inductance (2) Magnetic permeability

(3) Electric permittivity (4) Magnetic flux

Answer (2)

Sol. Dimensional formula of magnetic permeability is $[MLT^{-2}A^{-2}]$

19. When two monochromatic lights of frequency, ν and $\frac{\nu}{2}$ are incident on a photoelectric metal, their stopping potential becomes $\frac{V_s}{2}$ and V_s respectively. The threshold frequency for this metal is

(1) 3ν (2) $\frac{2}{3}\nu$

(3) $\frac{3}{2}\nu$ (4) 2ν

Answer (3*)

Sol. Since $k_{max} = eV_s = h\nu - \phi$

$$\frac{eV_S}{2} = h\nu - h\nu_0 \quad \ldots(i)$$

$$eV_S = \frac{h\nu}{2} - h\nu_0 \quad \ldots(ii)$$

$$\frac{1}{2}\left[\frac{h\nu}{2} - h\nu_0\right] = h\nu - h\nu_0$$

$$\Rightarrow \quad h\nu_0 - \frac{h\nu_0}{2} = h\nu - \frac{h\nu}{4}$$

$$\Rightarrow \quad \frac{h\nu_0}{2} = \frac{3h\nu}{4}$$

$$\nu_0 = \frac{3\nu}{2}$$

* Language of question is wrongly framed. The values of stopping potentials should be interchanged.

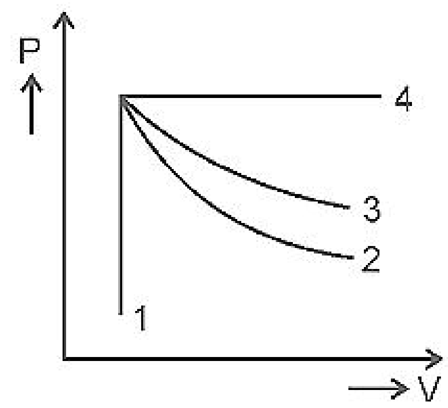
20. In half wave rectification, if the input frequency is 60 Hz, then the output frequency would be

(1) 30 Hz
(2) 60 Hz
(3) 120 Hz
(4) Zero

Answer (2)

Sol. In half wave rectifier, the output frequency is same as that of input frequency.

21. An ideal gas undergoes four different processes from the same initial state as shown in the figure below. Those processes are adiabatic, isothermal, isobaric and isochoric. The curve which represents the adiabatic process among 1, 2, 3 and 4 is



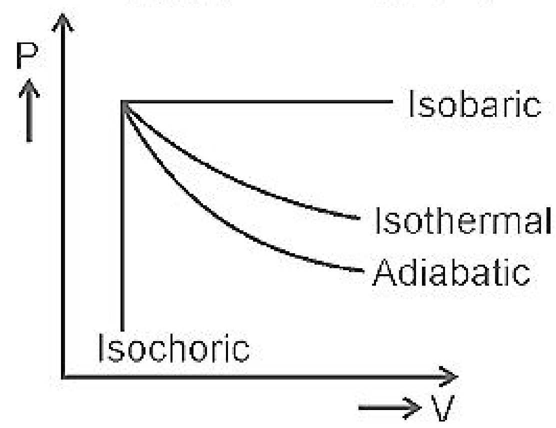
(1) 2
(2) 3
(3) 4
(4) 1

Answer (1)

Sol. $\left(\frac{dP}{dV}\right)_{\text{adiabatic}} = -\gamma P$

$\left(\frac{dP}{dV}\right)_{\text{isothermal}} = -P$

$\left(\frac{dP}{dV}\right)_{\text{adiabatic}} > \left(\frac{dP}{dV}\right)_{\text{isothermal}}$



22. Match List-I with List-II

	List-I (Electromagnetic waves)		List-II (Wavelength)
(a)	AM radio waves	(i)	10^{-10} m
(b)	Microwaves	(ii)	10^{2} m
(c)	Infrared radiations	(iii)	10^{-2} m
(d)	X-rays	(iv)	10^{-4} m

Choose the correct answer from the options given below

(1) (a) - (iii), (b) - (ii), (c) - (i), (d) - (iv)
(2) (a) - (iii), (b) - (iv), (c) - (ii), (d) - (i)
(3) (a) - (ii), (b) - (iii), (c) - (iv), (d) - (i)
(4) (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)

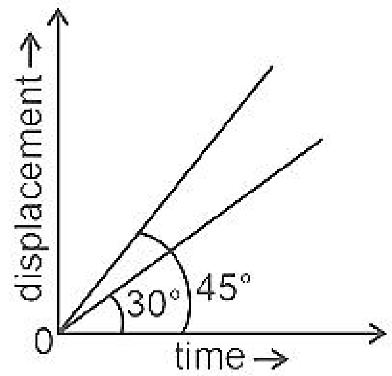
Answer (3)

Sol.

Waves	Wavelength
AM radio waves	10^2 m
Microwaves	10^{-2} m
Infrared radiations	10^{-4} m
X-rays	10^{-10} m

(a) - (ii)
(b) - (iii)
(c) - (iv)
(d) - (i)

23. The displacement-time graphs of two moving particles make angles of 30° and 45° with the *x*-axis as shown in the figure. The ratio of their respective velocity is



(1) 1 : 1 (2) 1 : 2

(3) $1 : \sqrt{3}$ (4) $\sqrt{3} : 1$

Answer (3)

Sol. Slope of *x*-*t* curves gives the velocity

$$\Rightarrow \text{Ratio} = \frac{\tan 30^\circ}{\tan 45^\circ} = \frac{\frac{1}{\sqrt{3}}}{1} = 1 : \sqrt{3}$$

24. In a Young's double slit experiment, a student observes 8 fringes in a certain segment of screen when a monochromatic light of 600 nm wavelength is used. If the wavelength of light is changed to 400 nm, then the number of fringes he would observe in the same region of the screen is

(1) 8 (2) 9

(3) 12 (4) 6

Answer (3)

Sol. $\beta = \frac{\lambda D}{d}$

Let length of segment of screen = l

$\Rightarrow l = 8\beta_1 = \frac{8\lambda_1 D}{d}$ ...(1)

and $l = n\beta_2 = \frac{n\lambda_2 D}{d}$ ...(2)

from (1) and (2)

$8\lambda_1 = n\lambda_2$

$8(600 \text{ nm}) = n(400 \text{ nm})$

$n = 12$

25. The peak voltage of the ac source is equal to

(1) The rms value of the ac source

(2) $\sqrt{2}$ times the rms value of the ac source

(3) $1/\sqrt{2}$ times the rms value of the ac source

(4) The value of voltage supplied to the circuit

Answer (2)

Sol. We know,

RMS value of A.C. $E_{rms} = \frac{E_0}{\sqrt{2}}$

$E_0 = \sqrt{2}E_{rms}$

26. If the initial tension on a stretched string is doubled, then the ratio of the initial and final speeds of a transverse wave along the string is

(1) $\sqrt{2}:1$

(2) $1:\sqrt{2}$

(3) 1 : 2

(4) 1 : 1

Answer (2)

Sol. We know, velocity of transverse wave

$v = \sqrt{\frac{T}{\mu}}$

$\therefore \quad v_i = \sqrt{\frac{T}{\mu}}$ and $v_f = \sqrt{\frac{2T}{\mu}}$

$\therefore \quad \frac{v_i}{v_f} = \frac{1}{\sqrt{2}}$

27. Given below are two statements

Statement I : Biot-Savart's law gives us the expression for the magnetic field strength of an infinitesimal current element (Idl) of a current carrying conductor only.

Statement II : Biot-Savart's law is analogous to Coulomb's inverse square law of charge q, with the former being related to the field produced by a scalar source, Idl while the latter being produced by a vector source, q.

In light of above statements choose the most appropriate answer from the options given below

(1) Both Statement I and Statement II are incorrect

(2) Statement I is correct and Statement II is incorrect

(3) Statement I is incorrect and Statement II is correct

(4) Both Statement I and Statement II are correct

Answer (2)

Sol. According to Biot-Savart's law $d\vec{B} = \frac{\mu_0}{4\pi}\frac{Id\vec{l} \times \vec{r}}{r^3}$ which is applicable for infinitesimal element. It is analogous to Coulomb's law, where $Id\vec{l}$ is vector source and electric field is produced by scalar source q.

Here statement I is correct and statement II is incorrect.

28. As the temperature increases, the electrical resistance

(1) Decreases for both conductors and semiconductors

(2) Increases for conductors but decreases for semiconductors

(3) Decreases for conductors but increases for semiconductors

(4) Increases for both conductors and semiconductors

Answer (2)

Sol. As the temperature increases the resistivity of the conductor increases hence the electrical resistance increases. However for semiconductor the resistivity decreases with the temperature. Hence electrical resistance of semiconductor decreases.

29. The energy that will be ideally radiated by a 100 kW transmitter in 1 hour is

(1) 36×10^4 J (2) 36×10^5 J

(3) 1×10^5 J (4) 36×10^7 J

Answer (4)

Sol. Energy = Power × time

$E = 100 \times 10^3 \times 3600$

$= 36 \times 10^7$ J

30. A body of mass 60 g experiences a gravitational force of 3.0 N, when placed at a particular point. The magnitude of the gravitational field intensity at that point is

(1) 50 N/kg (2) 20 N/kg

(3) 180 N/kg (4) 0.05 N/kg

Answer (1)

Sol. $F = mE_G$

$$3 = \frac{60}{1000} E_G$$

$E_G = 50$ N/kg

31. In the given nuclear reaction, the element X is

$^{22}_{11}\text{Na} \rightarrow X + e^+ + \nu$

(1) $^{23}_{10}\text{Ne}$ (2) $^{22}_{10}\text{Ne}$

(3) $^{22}_{12}\text{Mg}$ (4) $^{23}_{11}\text{Na}$

Answer (2)

Sol. The nuclear reaction is given as

$^{22}_{11}\text{Na} \rightarrow {}^{A}_{Z}X + {}_{+1}e^0 + \nu$

From conservation of atomic number

$11 = Z + 1 \Rightarrow Z = 10 \Rightarrow \text{Ne}$

From conservation of mass number

$22 = A + 0 \Rightarrow A = 22$

$\therefore \quad {}^{A}_{Z}X = {}^{22}_{10}\text{Ne}$

32. The angle between the electric lines of force and the equipotential surface is

(1) 45°
(2) 90°
(3) 180°
(4) 0°

Answer (2)

Sol. $dV = -\vec{E} \cdot d\vec{r}$

$dV = -Edr\cos\theta$

For equipotential surface,

$dV = 0$

$\cos\theta = 0$

$\Rightarrow \theta = 90°$

33. A copper wire of length 10 m and radius $\left(\frac{10^{-2}}{\sqrt{\pi}}\right)$ m has electrical resistance of 10 Ω. The current density in the wire for an electric field strength of 10 (V/m) is

(1) 10^6 A/m^2
(2) 10^{-5} A/m^2
(3) 10^5 A/m^2
(4) 10^4 A/m^2

Answer (3)

Sol. Resistance, $R = \rho\frac{L}{A} = \frac{L}{\sigma A}$

$\Rightarrow \quad \sigma = \frac{L}{RA}$

Also current density $j = \sigma E = \frac{LE}{RA}$

$$j = \frac{10 \times 10}{10 \times \pi\left(\frac{10^{-2}}{\sqrt{\pi}}\right)^2} = \frac{100}{10 \times \pi \times \left(\frac{10^{-4}}{\pi}\right)}$$

$= 10^5$ A/m^2

34. The ratio of the distances travelled by a freely falling body in the 1st, 2nd, 3rd and 4th second

(1) 1 : 4 : 9 : 16
(2) 1 : 3 : 5 : 7
(3) 1 : 1 : 1 : 1
(4) 1 : 2 : 3 : 4

Answer (2)

Sol. $S_{n^{th}} = u + \frac{1}{2}a(2n-1)$

$S_{1^{st}} = \frac{1}{2}g(2\times 1 - 1) = \frac{g}{2}$

$S_{2^{nd}} = \frac{1}{2}g(2\times 2 - 1) = 3\left(\frac{1}{2}g\right)$

$S_{3^{rd}} = \frac{1}{2}g(2\times 3 - 1) = 5\times\left(\frac{1}{2}g\right)$

$S_{4^{th}} = \frac{1}{2}g(2\times 4 - 1) = 7\times\left(\frac{1}{2}g\right)$

$S_{1^{st}} : S_{2^{nd}} : S_{3^{rd}} : S_{4^{th}}$

$= 1 : 3 : 5 : 7$

35. An electric lift with a maximum load of 2000 kg (lift + passengers) is moving up with a constant speed of 1.5 ms^{-1}. The frictional force opposing the motion is 3000 N. The minimum power delivered by the motor to the lift in watts is : (g = 10 m s^{-2})

(1) 20000 (2) 34500

(3) 23500 (4) 23000

Answer (2)

Sol. $F_{up} = 2000g + 3000$

$= 23000$ N

Minimum power $P_{min} = \vec{F} \cdot \vec{v}$

$$P_{min} = Fv = 23000 \times \frac{3}{2}$$

$= 34500$ W

SECTION-B

36. The volume occupied by the molecules contained in 4.5 kg water at STP, if the intermolecular forces vanish away is

(1) 5.6×10^{3} m^3 (2) 5.6×10^{-3} m^3

(3) 5.6 m^3 (4) 5.6×10^{6} m^3

Answer (3)

Sol. From ideal gas equation

$PV = nRT$ $\left[n = \frac{\text{mass of water}}{\text{mol. wt.}} = \frac{4.5 \times 10^3}{18}\right]$

$$V = \frac{nRT}{P}$$

At. STP $\Rightarrow T = 273$ K

$P = 10^5$ N/m^2

$$V = \frac{4.5 \times 10^3}{18} \times \frac{8.3 \times 273}{10^5} = 5.66 \text{ m}^3$$

37. The area of a rectangular field (in m^2) of length 55.3 m and breadth 25 m after rounding off the value for correct significant digits is

(1) 1382

(2) 1382.5

(3) 14×10^2

(4) 138×10^1

Answer (3)

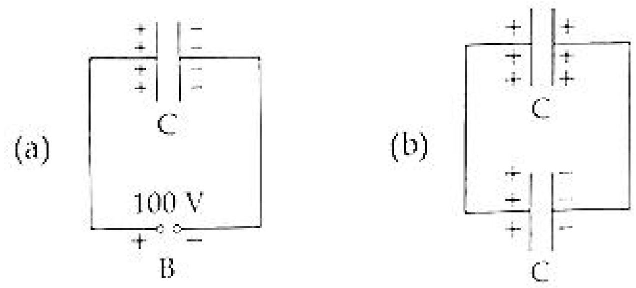
Sol. Area = Length × Breadth

$= 55.3 \times 25$ m^2

$= 1382.5$ m^2

$= 14 \times 10^2$ m^2 (Rounding off of two significant figures)

38. A capacitor of capacitance C = 900 pF is charged fully by 100 V battery B as shown in figure (a). Then it is disconnected from the battery and connected to another uncharged capacitor of capacitance C = 900 pF as shown in figure (b). The electrostatic energy stored by the system (b) is



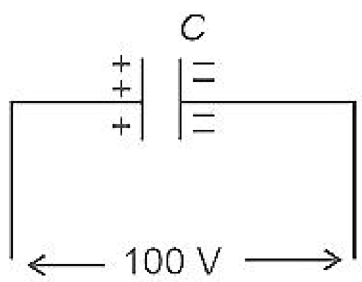
(1) 3.25×10^{-6} J
(2) 2.25×10^{-6} J
(3) 1.5×10^{-6} J
(4) 4.5×10^{-6} J

Answer (2)

Sol. $q_1 = CV$

$= 900 \times 10^{-12} \times 100$

$= 9 \times 10^{-8} C$



$$V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

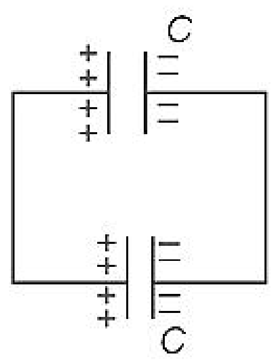
$$= \frac{9 \times 10^{-8} + 0}{1800 \times 10^{-12}} = \frac{100}{2} = 50\,\text{V}$$

$$U = \frac{1}{2}(C_1 + C_2)V^2$$

$$= \frac{1}{2} \times 1800 \times 10^{-12} \times 50 \times 50$$

$$= 225 \times 10^{-8}$$

$$U = 2.25 \times 10^{-6}\ \text{J}$$



39. Match List-I with List-II

	List-I		List-II
(a)	Gravitational constant (G)	(i)	$[L^2T^{-2}]$
(b)	Gravitational potential energy	(ii)	$[M^{-1}L^3T^{-2}]$
(c)	Gravitational potential	(iii)	$[LT^{-2}]$
(d)	Gravitational intensity	(iv)	$[ML^2T^{-2}]$

Choose the correct answer from the options given below

(1) (a) - (ii), (b) - (iv), (c) - (i), (d) - (iii)

(2) (a) - (ii), (b) - (iv), (c) - (iii), (d) - (i)

(3) (a) - (iv), (b) - (ii), (c) - (i), (d) - (iii)

(4) (a) - (ii), (b) - (i), (c) - (iv), (d) - (iii)

Answer (1)

Sol. (a) $[G] = \frac{Fr^2}{m_1 m_2}$

$$[G] = \frac{Fr^2}{m_1 m_2} = \frac{[MLT^{-2}]\,L^2}{[MM]} = [M^{-1}L^3T^{-2}]$$

(b) Gravitational potential energy = $[ML^2T^{-2}]$

(c) Gravitational potential = $\frac{PE}{m}$ = $[L^2T^{-2}]$

(d) Gravitational field intensity = $\frac{F}{m}$ = $[LT^{-2}]$

40. Two pendulums of length 121 cm and 100 cm start vibrating in phase. At some instant, the two are at their mean position in the same phase. The minimum number of vibrations of the shorter pendulum after which the two are again in phase at the mean position is:

(1) 9

(2) 10

(3) 8

(4) 11

Answer (4)

Sol. $T = 2\pi\sqrt{\frac{L}{g}}$

Let n_1 and n_2 be integer.

$n_1 T_1 = n_2 T_2$

$$2\pi n_1\sqrt{\frac{1.21}{g}} = 2\pi n_2\sqrt{\frac{1.00}{g}}$$

$$\Rightarrow \frac{n_2}{n_1} = \frac{11}{10}$$

$\therefore$ After completion of 11th oscillation of shorter pendulum, it will be in phase with longer pendulum.

41. Given below are two statements : One is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A): The stretching of a spring is determined by the shear modulus of the material of the spring.

Reason (R): A coil spring of copper has more tensile strength than a steel spring of same dimensions.

In the light of the above statements, choose the **most appropriate** answer from the options given below

(1) Both **(A)** and **(R)** are true and **(R)** is not the correct explanation of **(A)**

(2) **(A)** is true but **(R)** is false

(3) **(A)** is false but **(R)** is true

(4) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**

Answer (2)

Sol. It is true that stretching of spring is determined by shear modulus of the spring as when coil spring is stretched neither its length nor its volume changes, there is only change in its shape.

Tensile strength of steel is more than that of copper.

Hence Assertion is true and reason is false.

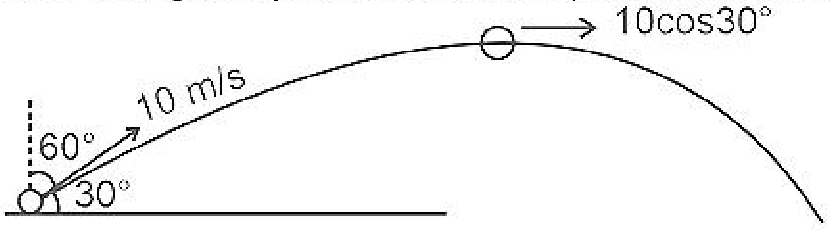
42. A ball is projected with a velocity, 10 ms^{-1}, at an angle of 60° with the vertical direction. Its speed at the highest point of its trajectory will be

(1) $5\sqrt{3}$ ms^{-1} (2) 5 ms^{-1}

(3) 10 ms^{-1} (4) Zero

Answer (1)

Sol. At highest point vertical component of velocity become zero.



At highest point speed of object = 10cos30°

$= 5\sqrt{3}$ m/s

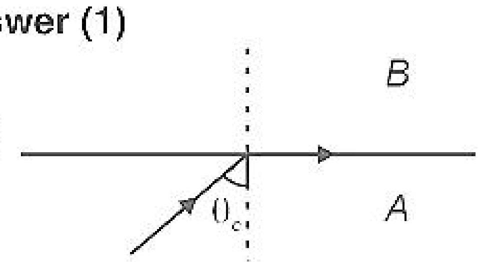
43. Two transparent media *A* and *B* are separated by a plane boundary. The speed of light in those media are 1.5×10^8 m/s and 2.0×10^8 m/s, respectively. The critical angle for a ray of light for these two media is

(1) $\sin^{-1}(0.750)$ (2) $\tan^{-1}(0.500)$

(3) $\tan^{-1}(0.750)$ (4) $\sin^{-1}(0.500)$

Answer (1)

Sol.



$$\mu_A = \frac{3\times10^8}{1.5\times10^8} = 2$$

$$\mu_B = \frac{3\times10^8}{2\times10^8} = 1.5$$

For TIR, ray of light should travel from denser to rarer medium

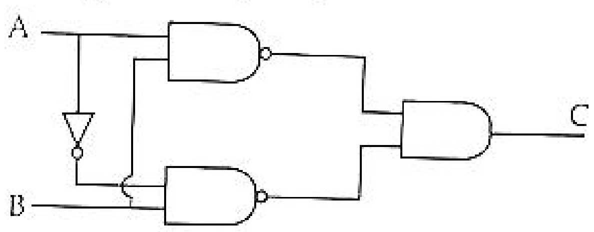
$\mu_A \sin\theta_C = \mu_B \sin 90°$

$2 \sin\theta_C = 1.5 \sin 90°$

$\sin\theta_C = 0.75$

$\theta_C = \sin^{-1}(0.75)$

44.



The truth table for the given logic circuit is

(1)

A	*B*	*C*
0	0	1
0	1	0
1	0	0
1	1	1

(2)

A	*B*	*C*
0	0	1
0	1	0
1	0	1
1	1	0

(3)

A	*B*	*C*
0	0	0
0	1	1
1	0	0
1	1	1

(4)

A	*B*	*C*
0	0	0
0	1	1
1	0	1
1	1	0

Answer (2)

Sol. $C = \left(\overline{A \cdot B}\right) \cdot \left(\overline{\overline{A} \cdot B}\right)$

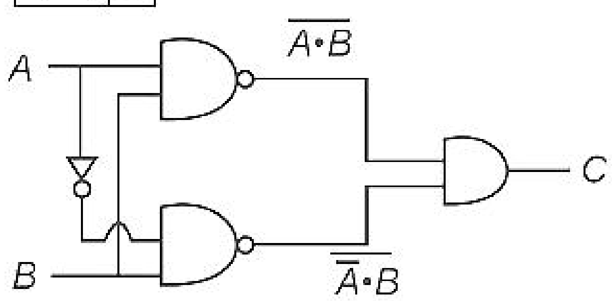
$\Rightarrow\ C = \overline{A \cdot B + \overline{A} \cdot B}$

$\Rightarrow\ C = \overline{\left(A + \overline{A}\right)B}$

$\Rightarrow\ C = \overline{B}$

The truth table would be

A	B	C
0	0	1
0	1	0
1	0	1
1	1	0



45. A series LCR circuit with inductance 10 H, capacitance $10\ \mu F$, resistance $50\ \Omega$ is connected to an ac source of voltage, $V = 200\sin(100t)$ volt. If the resonant frequency of the LCR circuit is ν_0 and the frequency of the ac source is ν, then

(1) $\nu_0 = \nu = \frac{50}{\pi}$ Hz

(2) $\nu_0 = \frac{50}{\pi}$ Hz, $\nu = 50$ Hz

(3) $\nu = 100$ Hz; $\nu_0 = \frac{100}{\pi}$ Hz

(4) $\nu_0 = \nu = 50$ Hz

Answer (1)

Sol. $\omega L = \frac{1}{\omega C}$

$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10 \times 10 \times 10^{-6}}}$

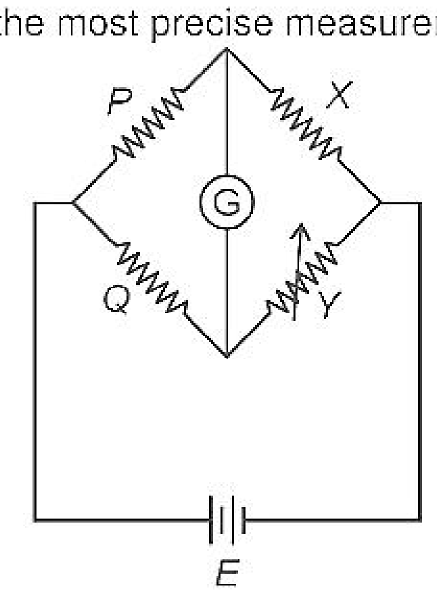
$\omega = 100$

$\omega = 2\pi f \Rightarrow f = \frac{\omega}{2\pi}$

$\nu_0 = f_0 = \frac{100}{2\pi} = \frac{50}{\pi}$ Hz, $\omega = 100$

$\nu = f = \frac{100}{2\pi} = \frac{50}{\pi}$

46. A wheatstone bridge is used to determine the value of unknown resistance X by adjusting the variable resistance Y as shown in the figure. For the most precise measurement of X, the resistances P and Q



(1) Should be approximately equal and are small
(2) Should be very large and unequal
(3) Do not play any significant role
(4) Should be approximately equal to 2X

Answer (1)

Sol. We know, a wheatstone bridge is said to be most precise when it is most sensitive. This can be done by making ratio arms equal. Thus (4) is correct option.

47. From Ampere's circuital law for a long straight wire of circular cross-section carrying a steady current, the variation of magnetic field in the inside and outside region of the wire is

(1) A linearly increasing function of distance upto the boundary of the wire and then linearly decreasing for the outside region.

(2) A linearly increasing function of distance r upto the boundary of the wire and then decreasing one with $\frac{1}{r}$ dependence for the outside region.

(3) A linearly decreasing function of distance upto the boundary of the wire and then a linearly increasing one for the outside region.

(4) Uniform and remains constant for both the regions.

Answer (2)

Sol. Answer (4)

Inside point

$$B = \frac{\mu_0 I r^2}{R^2 \times 2\pi r}$$

$$= \frac{\mu_0 I r}{R^2 \times 2\pi}$$

$B \propto r$

Outside point

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B \propto \frac{1}{r}$$

48. A big circular coil of 1000 turns and average radius 10 m is rotating about its horizontal diameter at 2 rad s^{-1}. If the vertical component of earth's magnetic field at that place is 2×10^{-5} T and electrical resistance of the coil is 12.56 Ω, then the maximum induced current in the coil will be

(1) 1.5 A

(2) 1 A

(3) 2 A

(4) 0.25 A

Answer (2)

Sol. $\phi_B = NBA \cos\omega t$

$$\varepsilon = \frac{-d\phi_B}{dt} = -NBA\omega(-\sin\omega t)$$

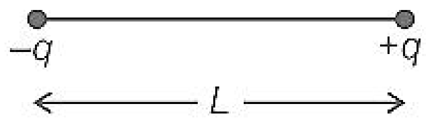
$\varepsilon = NBA\omega \sin \omega t$

$i_{max} = \frac{\varepsilon_{max}}{R} = \frac{NBA\omega}{R}$

$= \frac{1000 \times 2 \times 10^{-5} \times \pi(10)^2 \times 2}{12.56}$

= 1 A

49. Two point charges $-q$ and $+q$ are placed at a distance of L, as shown in the figure.



The magnitude of electric field intensity at a distance $R (R >> L)$ varies as:

(1) $\frac{1}{R^3}$

(2) $\frac{1}{R^4}$

(3) $\frac{1}{R^6}$

(4) $\frac{1}{R^2}$

Answer (1)

Sol. For $R >> L$, arrangement is an electric dipole

$E = \frac{2p}{4\pi\varepsilon_0 R^3}$; where $p = qL$

$E \propto \frac{1}{R^3}$

50. A nucleus of mass number 189 splits into two nuclei having mass number 125 and 64. The ratio of radius of two daughter nuclei respectively is

(1) 4 : 5

(2) 5 : 4

(3) 25 : 16

(4) 1 : 1

Answer (2)

Sol. Radius of nuclei with mass number A varies as

$R = R_0 A^{1/3}$

$\frac{R_1}{R_2} = \left(\frac{125}{64}\right)^{1/3} = \frac{5}{4} = 5 : 4$