JEE ADVANCED-2012

PHYSICS

1. Sol. (A)

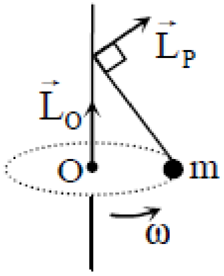
$$L.C. = \frac{0.5}{100} = 0.005\text{mm}$$

$$\frac{\Delta Y}{Y} = \frac{\Delta \ell}{\ell} + \frac{2\Delta(d)}{d}$$

$$\frac{\Delta \ell}{\ell} = \frac{0.005\times10^{-3}}{0.25\times10^{-3}} = \frac{1}{50}$$

$$2\frac{\Delta(d)}{d} = \frac{2\times0.005\times10^{-3}}{0.5\times10^{-3}} = \frac{1}{50}$$

2. **Sol. (C)**



3. **Sol. (B)**

$$P_T = (1.5-1)\left(\frac{1}{14}-0\right)+(1.2-1)\left(0-\frac{1}{-14}\right) = \frac{0.5}{14}+\frac{0.2}{14} = \frac{1}{20}$$

$$f = +20\,\text{cm}$$

$$\frac{1}{v} - \frac{1}{-40} = \frac{1}{20}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{40} = \frac{1}{40}$$

$$\therefore v = 40\,\text{cm}$$

4. **Sol. (B)**

$$\tau = \omega \frac{dI}{dt} = \omega \frac{d}{dt}\left(C + mv^2t^2\right)$$

$$= m\omega v^2 2t.$$

5. **Sol. (D)**

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

Required ratio $= \sqrt{\frac{M_{Ar}}{M_{He}}} = \sqrt{\frac{40}{4}} = \sqrt{10}$

$$= 3.16.$$

6. **Sol. (C)**

$$qE = mg$$

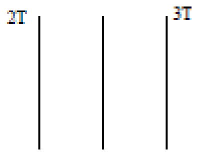
$$q\left(V/d\right) = mg$$

$$V = \frac{mgd}{q}$$

$$= \frac{1.67\times10^{-27}\times10\times10^{-2}}{1.6\times10^{-19}}$$

$$= \frac{10^{-28}}{10^{-19}} = 10^{-9}V$$

7. **Sol. (C)**



$$\sigma A(2T)^4 + \sigma A(3T)^4 = \sigma 2A(T')^4$$

$$16T^4 + 81T^4 = 2(T')^4$$

$$97T^4 = 2(T')^4$$

$$\therefore T' = \left(\frac{97}{2}\right)^{1/4} T \quad (T')^4 = \frac{97}{2}T^4$$

8. **Sol. (A)**

$$\frac{2v\sin 45^0}{g} = 1$$

$$\therefore v = \sqrt{50}\ \text{m/s}$$

9. **Sol. (D)**

$$\lambda_R > \lambda_G > \lambda_B$$

$$\therefore \beta_R > \beta_G > \beta_B$$

10. **Sol. (D)**

11. **Sol. (C, D)**

If $\theta = 90°$, $\vec{B}$ exerts no force on q.

If $\theta = 0°$, $10°$, the charge particle moves in helix with increasing pitch due to $\vec{E}$ along y-axis.

12. **Sol. (A, C, D)**

Net flux through the cubical region $= \dfrac{-q+3q-q}{\varepsilon_0} = \dfrac{q}{\varepsilon_0}$

The flux passing through the faces $x = \dfrac{-a}{2}, x = +\dfrac{a}{2}$ and $z = +\dfrac{a}{2}$ are same due to symmetry.

13. **Sol. (B, D)**

At the open end, the phase of a pressure wave changes by π radian due to reflection. At the closed end, there is no change in the phase of a pressure wave due to reflection.

14. **Sol. (A, C)**

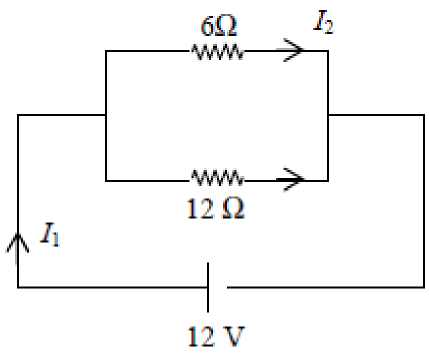
At $\theta = 45°$, $\text{mg}\sin\theta = 1\times\cos\theta$

At $\theta > 45°$, $\text{mg}\sin\theta > 1\times\cos\theta$ (friction acts upward)

At $\theta < 45°$, $\text{mg}\sin\theta < 1\times\cos\theta$ (friction acts downward)

15. **Sol. (A, B, C, D)**

Nodes P and Q are equipotential and nodes S and T are equipotential from wheatstone bridge, no current passes through PQ and ST.



$$I_1 = \frac{12}{4} = 3A$$

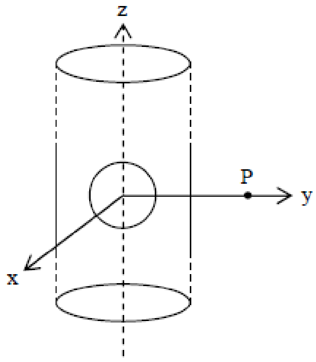
$$I_2 = I_1\left(\frac{12}{6+12}\right) = 2A$$

16. **Sol. (7)**

$$M = \frac{N\phi}{I} = \frac{2\left[\frac{\mu_0 I R^2}{2\left(8R^3\right)}\right]a^2 \cos 45^\circ}{I} \frac{\mu_0 a^2}{8R2^{1/2}} = \frac{\mu_0 a^2}{R2^{7/2}}$$

So $P = 7$

17. **Sol. (6)**



$$\vec{E}=\frac{\lambda(\hat{j})}{2\pi\varepsilon_0(2R)}+\frac{K\left(\rho\frac{4}{3}\pi\frac{R^3}{8}\right)(-\hat{j})}{4R^2}$$

$$\vec{E}=\frac{\rho\pi R^2(\hat{j})}{4\pi\varepsilon_0 R}+\frac{K\pi\rho R(-\hat{j})}{24}$$

$$\vec{E}=K\pi\rho R(\hat{j})+\frac{K}{24}\rho\pi R(-\hat{j})$$

$$\vec{E}=K\rho\pi R\frac{23}{24}(\hat{j})=\frac{23}{96\varepsilon_0}\rho R(\hat{j})$$

$$\Rightarrow k=6$$

18. **Sol. (7)**

$$0+\frac{1}{2}mv^2=\frac{K(Q)e}{10\times10^{-15}}=\frac{K(120e)e}{10\times10^{-15}}$$

$$\frac{1}{2}\times\frac{5}{3}\times10^{-27}v^2=\frac{9\times10^9\times120\times(1.6\times10^{-19})^2}{10\times10^{-15}}$$

$$v=\frac{9\times6\times10^9\times120\times2.56\times10^{-38}}{50\times10^{-42}}$$

$$v=\sqrt{331.776\times10^{13}}$$

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

$$\lambda = \frac{4.2\times10^{-15}\times1.6\times10^{-19}}{\frac{5}{3}\times10^{-27}\times\sqrt{331.776\times10^{13}}} = \frac{4.2\times4.8\times10^{-34}}{57.6\times5\times10^{-21}} = 0.07\times10^{-13}$$

$$\lambda = 7\times10^{-15} = 7\,fm$$

19. **Sol. (3)**

$$I_P = \left[\frac{4mR^2}{2} + m\left(4R^2\right)\right] - \left[\frac{m}{4}\frac{R^2}{2} + \frac{m}{4}5R^2\right]$$

$$I_P = mR^2\left[\left(2+4\right) - \left(\frac{1}{8} + \frac{5}{4}\right)\right]$$

$$I_P = mR^2\left(6 - \frac{11}{8}\right) = \frac{37}{8}mR^2 \quad \ldots(1)$$

$$I_0 = \left(\frac{4mR^2}{2}\right) - \left(\frac{m}{4}\frac{R^2}{2} + \frac{m}{4}R^2\right)$$

$$I_0 = mR^2\left[2 - \left(\frac{1}{8} + \frac{1}{4}\right)\right] = mR^2\left[2 - \frac{3}{8}\right] = mR^2\left(\frac{13}{8}\right) \quad \ldots(2)$$

So $\frac{I_p}{I_0} = \frac{37/8}{13/8} 3$ (Nearest Integer)

20. **Sol. (5)**

$$B = \frac{\mu_0\left(J\pi a^2\right)}{2\pi a} - \frac{\mu_0\left(J\pi a^2/4\right)}{2\pi\left(\frac{3a}{2}\right)}$$

$$B = \frac{5\mu_0 Ja}{12} = \frac{\mu_0 NJa}{12}$$

So $N = 5$