JEE ADVANCED-2012

PHYSICS

1. **Sol. (A)**

   In each rotation relative speed becomes zero twice and becomes maximum twice.

2. **Sol. (B)**

   Magnetic moment, $\vec{M} = I\vec{A} = I\left(\frac{\pi}{2}+1\right)a^2\hat{K}$

3. **Sol. (D)**

   Inside the cavity, $B = 0$

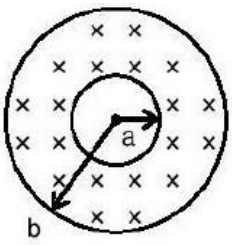
   Outside the cylinder, $B = \frac{\mu_0 I}{2\pi r}$

   In the shaded region

   $$B = \frac{\mu_0 I}{2\pi r\left(b^2 - a^2\right)}\left(r - \frac{a^2}{r}\right)$$

   at $r = a, B = 0$

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



4. **Sol. (A)**

$$\frac{V_m + V_a + V_w}{2}\rho_w g = V_m \rho_c \rho_w g + V_m \rho_w g$$

$$V_w = V_m\left(1-2\rho_C\right)+V_a$$

if $\rho_C > \frac{1}{2} \Rightarrow V_w < V_a$

if $\rho_C < \frac{1}{2} \Rightarrow V_w < V_a$

where, V_w = volume occupied by water in the shell

V_a = volume occupied by air in the shell

V_m = volume of the material in the shell

5. **Sol. (C)**

Let 'q' be the final charge on $3\mu F$ capacitor then

$$\frac{80-q}{2} = \frac{q}{3} \Rightarrow q = 48\mu C$$

6. **Sol. (D)**

$$\begin{aligned}\Delta Q &= nC_p\Delta T \text{ (Isobaric process)}\\ &= 2\times\frac{5}{2}R\times(35-30)\\ &= 208J\end{aligned}$$

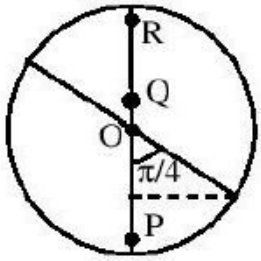
7. **Sol. (C)**

At $t = \frac{1}{8} \times \frac{2\pi}{\omega} = \frac{\pi}{4\omega}$

x-coordinate of $P = \omega R\left(\frac{\pi}{4\omega}\right)$

$= \frac{\pi R}{4} > R\cos 45°$

$\therefore$ Both particles P and Q land in unshaded region.



8. **Sol. (B)**

$L + e = \frac{\lambda}{4}$

$\Rightarrow L = \frac{\lambda}{4} - e$

$= 16.4 - 1.2 = 15.2\,\text{cm}$

9. **Sol. (A)**

10. **Sol. (D)**

11. **Sol. (D)**

12. **Sol. (C)**

13. **Sol. (C)**

14. **Sol. (B)**

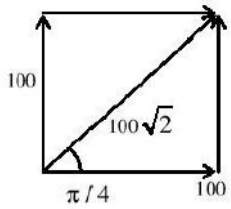
15. **Sol. (A,C)**

$I_{\text{upper}} = \dfrac{20}{100\sqrt{2}}; +\dfrac{\pi}{4}$ ahead of voltage

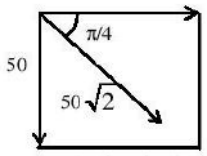
$I_{\text{lower}} = \dfrac{20}{50\sqrt{2}}; -\dfrac{\pi}{4}$ behind of voltage

$I = \sqrt{I_1^2 + I_2^2} = \sqrt{\dfrac{1}{10}} \approx 0.3\text{A}$

$V_{100\Omega} = \dfrac{20}{100\sqrt{2}} \times 100 = 10\sqrt{2}$.



Capacitive circuit

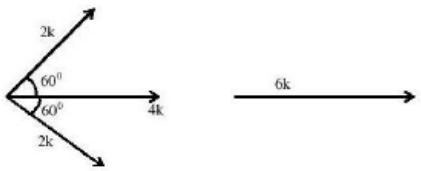


Inductive circuit

16. **Sol. (A, B, C)**

Line PR is perpendicular bisector of all the dipoles.

At point $O: \dfrac{1}{4\pi\varepsilon_0}\sum\dfrac{Q_1}{r_i} = 0$



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

By calculation, if Mass of $P = m$

and Radius of $P = R$

Then Mass of $Q = 8M$

and radius of $Q = 2R$

and Mass of $R = 9M$

and radius of $R = 9^{1/3}R$

$$V_P \sqrt{\frac{2GM}{R}}$$

$$V_Q = \sqrt{\frac{2G8M}{2R}} = 2V_P$$

$$V_R = \sqrt{\frac{2G8M}{9^{1/3}R}} = 9^{1/3}V_P$$

$$\therefore \quad V_R > V_Q = V_P$$

$$\frac{V_Q}{V_P} = 2$$

18. **Sol. (A, B)**

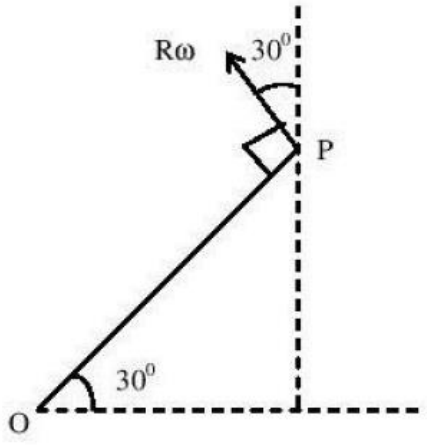
$$\vec{V}_0 (3R)\omega\hat{i} = 0$$

$$\therefore \quad \vec{v}_0 = 3R\omega\hat{i}$$

$$\vec{v}_{P,O} = \frac{-R\omega}{4}\hat{i} + \frac{R\omega\sqrt{3}}{4}\hat{j}$$

$\therefore \quad \vec{v}_P = \vec{v}_{P,O} + \vec{v}_O$

$$= \frac{11}{4} R\omega \hat{i} + R\omega \frac{\sqrt{3}}{4} \hat{j}$$



19. **Sol. (D)**

$$a = \frac{Mg \sin\theta}{M + \frac{I}{R^2}}$$

$$a_P = \frac{Mg \sin\theta}{M + \frac{MR^2}{R^2}} \approx \frac{g}{2}$$

$$a_Q = g \sin\theta \text{ as } I_Q \sim 0$$

$$\therefore \quad \omega_P = \frac{\sqrt{2.\frac{g}{2}.\ell}}{R}$$

$$\omega_Q = \frac{\sqrt{2.g.\ell}}{R}$$

$\therefore \quad \omega_Q > \omega_P$

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

$\phi = \text{zero}$

$\therefore \dfrac{d\phi}{dt} = \text{zero}$

$\therefore A, C$ are correct.