JEE ADVANCED-2017

PHYSICS

1. **Ans. (A)**

2. **Ans. (B)**

Sol.

$$m = \frac{4\pi R^3}{3}\rho$$

$$\ell n(m) = \ell n\left(\frac{4\pi}{3}\right) + \ell n(\rho) + 3\ell n(R)$$

$$0 = 0 + \frac{1}{\rho}\frac{d\rho}{dt} + \frac{3}{R}\frac{dR}{dt}$$

$$\Rightarrow \left(\frac{dR}{dt}\right) = v \propto -R \times \frac{1}{\rho}\left(\frac{d\rho}{dt}\right)$$

$$v \propto R$$

3. **Ans. (D)**

Sol.

$$t = \sqrt{\frac{L}{5}} + \frac{L}{300}$$

$$dt = \frac{1}{\sqrt{5}}\frac{1}{2}L^{-1/2}dL + \left(\frac{1}{300}dL\right)$$

$$dt = \frac{1}{2\sqrt{5}}\frac{1}{\sqrt{20}}dL + \frac{dL}{3000} = 0.01$$

$$dL\left(\frac{1}{20} + \frac{1}{300}\right) = 0.01$$

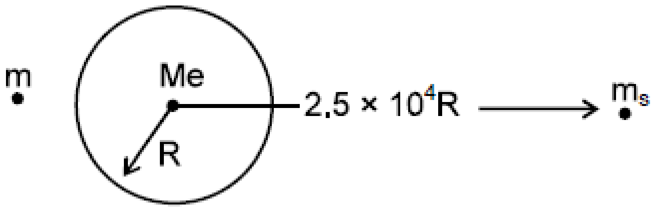
$$dL\left[\frac{15}{300}\right]=0.01$$

$$dL=\frac{3}{16}$$

$$\frac{dL}{L}\times 100=\frac{3}{16}\times\frac{1}{20}\times 100=\frac{15}{16}\simeq 1\%$$

4. **Ans. (C)**

Sol.



Given $\sqrt{\frac{2GM_e}{R}}=11.2\,\text{km/s}$

$$\frac{1}{2}mv^2-\frac{GmM_e}{R}-\frac{GM_sm}{2.5\times 10^4 R}\geq 0$$

For $v=v_e$

$$v_e^2=\frac{2GM_e}{R}+\frac{2GM_e}{2.5\times 10^4 R}$$
$$=\frac{2GM_e}{R}+\frac{6\times 10^5 GM_e}{2.5\times 10^4 R}$$

$$=\frac{GM_e}{R}(2+24)$$
$$=\sqrt{\frac{26GM_e}{R}}=40.4\,\text{km/sec.}$$

5. **Ans. (D)**

Sol.

$$\vec{S} = \vec{P} + b\vec{R} = \vec{P} + b\left(\vec{Q} - \vec{P}\right) = \vec{P}(1-b) + b\vec{Q}$$

6. **Ans. (A)**

Sol.

$$\frac{hc}{\lambda} = W + KE_{\max}$$

$$KE = \frac{P^2}{2m_e} = \frac{h^2}{2m_e\lambda_d^2}$$

$$\frac{hc}{\lambda} = \phi_0 + \frac{h^2}{2m_e\lambda_d^2}$$

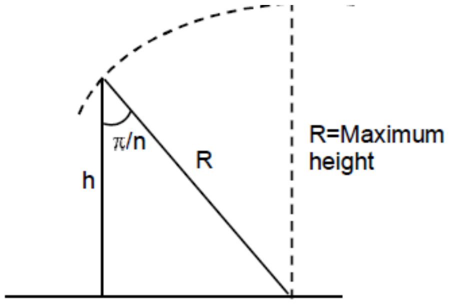
$$-\frac{hc}{\lambda^2}d\lambda = 0 + \frac{h^2}{2m_e}\frac{(-2)}{\lambda_d^3}d\lambda_d$$

$$\frac{d\lambda_d}{d\lambda} = \frac{2m_e\lambda_d^3}{h^2 \times \lambda^2}.hc$$

$$\frac{d\lambda_d}{d\lambda} \propto \frac{d\lambda_d^3}{\lambda^2}$$

7. **Ans. (D)**

Sol.



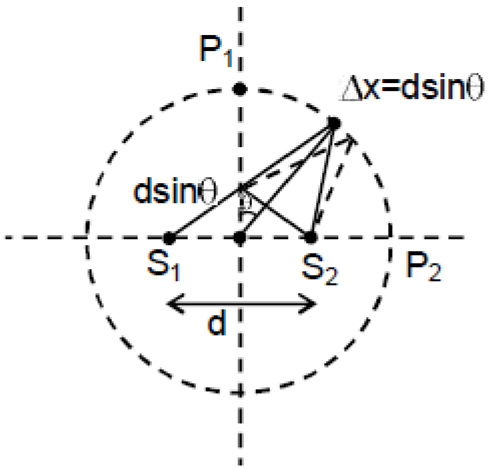
$$\cos\left(\frac{\pi}{n}\right)=\frac{h}{R}$$

$$\Delta = \quad R-h=\frac{h}{\cos\left(\frac{\pi}{n}\right)}-h$$

$$= \qquad h\left[\frac{1}{\cos\left(\frac{\pi}{n}\right)-1}\right]$$

8. **Ans. (AC)**

Sol.



$\lambda = 600\,\text{nm}$

at P_1 $\quad \Delta x = 0$

at P_2 $\quad \Delta x = 1.8\text{mm} = n\lambda$

$$\text{No. maximum will be} = n = \frac{\Delta x}{\lambda} = \frac{1.8\,\text{mm}}{600\,\text{mm}} = 3000$$

at P_2 $\Delta x = 3000\lambda$

hence bright fright will be formed.

at P_2 3000^{th} maxima is formed.

For $'D'$ option

$\Delta x = d\sin\theta$

$d\Delta x = d\cos.d\theta$

$R\lambda = d\cos\theta.Rd\theta$

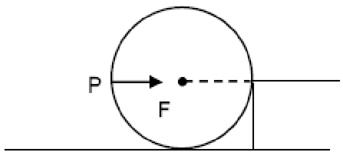
$Rd\theta = \dfrac{R\lambda}{d\cos\theta}$

as we move from P_1 to P_2

$\theta\uparrow \cos\theta\downarrow Rd\theta\uparrow$

9. **Ans. (C)**

Sol.



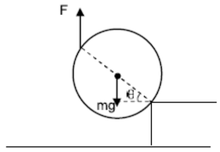
$\tau = 0$**,** it can never climb, so option (A) is incorrect.

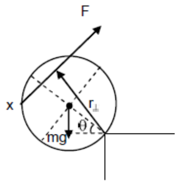
(B) Wheel can climb, so option (B) is incorrect.

(C) $\tau = F(2R\cos\theta) - mg\cos\theta$
$\tau \propto \cos\theta$

Since when θ increases, τ decreases.

So its correct.

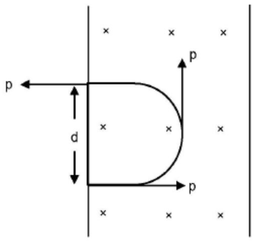


(D) 

$\tau = Fr_{\perp} - mg\cos\theta$; τ increases with θ

10. **Ans. (CD)**

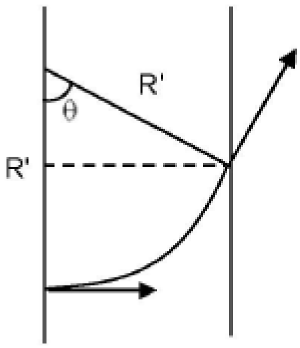
Sol.

(A) 

$|\Delta \vec{p}| = \sqrt{2}p$

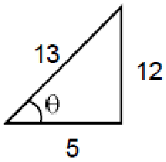
(B)
$$R' = \frac{mv}{QB}$$
$$d = 2R' = \frac{2mv}{QB} \quad d \propto m$$

(C)
$$R'(1-\cos\theta) = R$$
$$R'\sin\theta = \frac{3R}{2}$$
$$\frac{\sin\theta}{1-\cos\theta} = \frac{3}{2}$$
$$\frac{2\sin\frac{\theta}{2}\cos\frac{\theta}{2}}{2\sin^2\frac{\theta}{2}} = \frac{3}{2}$$



$$\cot\frac{\theta}{2}=\frac{3}{2}\Rightarrow \tan\frac{\theta}{2}=\frac{2}{3}$$

$$\Rightarrow \tan\theta=\frac{2\left(\frac{2}{3}\right)}{1-\frac{4}{9}}=\frac{\frac{4}{3}}{\frac{5}{9}}=\frac{4}{3}\times\frac{9}{5}=\frac{12}{5}$$



$$\sin\theta=\frac{12}{15}$$

$$R'\left(\frac{12}{13}\right)=\frac{3R}{2};R'=\frac{13R}{8}=\frac{P}{QB};B=\frac{8P}{13QR}$$

(D) $\frac{P}{QB}<\frac{3R}{2}$

$B>\frac{2P}{3QR}$

11. **Ans. (ACD)**

Sol.

$(A)\,\&\,(C)$ After long time current through $R=I=\frac{V}{R}$

And

$$L_1 I_1 = L_2 I_2$$

$$\frac{I_1}{I_2} = \frac{L_2}{L_1}$$

$$I_1 = \frac{L_2 I}{L_1 + L_2} \quad I_2 = \frac{L_1 I}{L_1 + L_2} = \left(\frac{L_1}{L_1 + L_2}\right)\frac{V}{R}$$

(B) $t = 0 \quad I = 0$

12. **Ans. (AC)**

Sol.

$$V_{xy} = V_x - V_y = \left(V_{xy}\right)_0 \sin\left(\omega t + \phi_1\right)$$

$$\left(V_{xy}\right)_0 = \sqrt{V_0^2 + V_0^2 - 2V_0^2 \cos\frac{2\pi}{3}} = \sqrt{3}V_0$$

$$\left(V_{xy}\right)_{rms} = \frac{\left(V_{xy}\right)_0}{\sqrt{2}} = \sqrt{\frac{3}{2}}V_0$$

$$V_{yz} = V_y - V_z = \left(V_{yz}\right)_0 \sin\left(\omega t + \phi_2\right)$$

$$\left(V_{yz}\right)_0 = \sqrt{V_0^2 + V_0^2 - 2V_0^2 \cos\frac{2\pi}{3}} = \sqrt{3}V_0$$

$$\left(V_{yz}\right)_{rms} = \frac{\left(V_{yz}\right)_0}{\sqrt{2}} = \sqrt{\frac{3}{2}}V_0$$

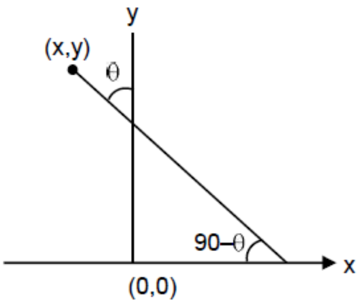
$$V_{xz} = V_x - V_z = \left(V_{xz}\right)_0 \sin\left(\omega t + \phi_3\right)$$

$$\left(V_{xz}\right)_0 = \sqrt{V_0^2 + V_0^2 - 2V_0^2 \cos\frac{2\pi}{3}} = \sqrt{3}V_0$$

$$\left(V_{xz}\right)_{rms} = \frac{\left(V_{xz}\right)_0}{\sqrt{2}} = \sqrt{\frac{3}{2}}V_0$$

13. **Ans. (CD)**

Sol.



$$x = -\frac{\ell}{2}\sin\theta$$

$$y = \ell\cos\theta$$

$$\frac{y^2}{\ell^2} + \frac{4x^2}{\ell^2} = 1$$

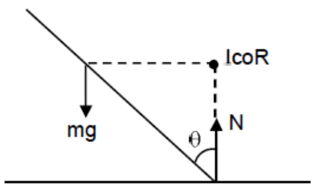
Path of A is ellipse

$$mg\frac{\ell}{2}\sin\theta = \left(\frac{m\ell^2}{12} + m\frac{\ell^2}{4}\sin^2\theta\right)\alpha = \frac{m\ell^2}{12}\left(1+3\sin^2\theta\right)\alpha$$

$$\alpha = \frac{6g\sin\theta}{\ell\left(1+3\sin^2\theta\right)}$$

$$\text{torgue w.r.t} = \frac{m\ell^2}{3}\alpha$$

$$= \frac{m\ell^2}{3}\left(\frac{6g\sin\theta}{1+3\sin^2\theta}\right)$$

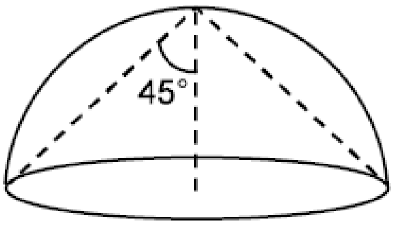


(C) $y_{cm} = \frac{L}{2}\left(1-\cos\theta\right)$

(D) midpoint will fall vertically downwards

14. **Ans. (CD)**

Sol.



(A) ϕ total due to charge Q is $= \frac{Q}{\varepsilon_0}$

So ϕ through the curved and flat surface will be less than $\frac{Q}{\varepsilon_0}$

(B) The component of the electric field perpendicular to the flat surface will decrease so we move away from the centre as the distance increases (magnitude of electric field decreases) as well as the angle between the normal and electric field will increase.

Hence the component of the electric field normal to the flat surface is not sonstant.

Aliter:

$$x = \frac{R}{\cos\theta}$$

$$E = \frac{KQ}{X^2} = \frac{KQ\cos^2\theta}{R^2}$$

$$E\perp = \frac{KQ\cos^3\theta}{R^2}$$

As we move away from centre $\theta\uparrow \cos\theta\downarrow$ So $E\perp\downarrow$

(C) Since the circumference is equidistance from $'Q'$ it will be equipotential

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

(D)

$$\Omega = 2\pi(1-\cos\theta); \theta = 45°$$

$$\phi = -\frac{\Omega}{4\pi}\times\frac{\Omega}{\varepsilon_0} = -\frac{2\pi(1-\cos\theta)}{4\pi}\frac{Q}{\varepsilon_0}$$

$$= -\frac{Q}{2\varepsilon_0}\left(1-\frac{1}{\sqrt{2}}\right)$$

15. **Ans. (D)**

Sol.

$$E_C = \frac{1}{2}CV_0^{\,2}; \qquad E_D = V_0 CV_0 - \frac{1}{2}CV_0^2 = \frac{1}{2}CV_0^2$$

$$\therefore E_C = E_D$$

16. **Ans. (B)**

Sol.

$$E_{D_1} = \frac{V_0}{3}\left(\frac{CV_0}{3}\right) - \frac{1}{2}C.\left(\frac{V_0}{3}\right)^2 = \frac{CV_0^2}{9} - \frac{CV_0^2}{18} = \frac{CV_0^2}{18}$$

$$E_{D_2} = \frac{2V_0}{3}\left[\frac{2CV_0}{3} - \frac{CV_0}{3}\right] - \left[\frac{1}{2}C\left(\frac{2V_0}{3}\right)^2 - \frac{1}{2}C\left(\frac{2V_0}{3}\right)^2\right]$$

$$= \frac{2V_0}{3}\left[\frac{CV_0}{3}\right] - \frac{1}{2}C\left[\frac{4V_0^2}{9} - \frac{V_0^2}{9}\right]$$

$$= \left(\frac{2}{9} - \frac{1}{2\times 9}\times 3\right)CV_0^2 = \left(\frac{2}{9} - \frac{1}{6}\right)CV_0^2 = \left(\frac{12-9}{9\times 6}\right)CV_0^2$$

$$E_{D_2} = \frac{1}{18}CV_0^2$$

$$E_{D_3} = V_0\left[CV_0 - \frac{2CV_0}{3}\right] - \left[\frac{1}{2}CV_0^2 - \frac{1}{2}C\left(\frac{2V_0}{3}\right)^2\right]$$

$$= \frac{1}{3}CV_0^2 - \frac{1}{2}CV_0^2\left[1 - \frac{4}{9}\right]$$

$$= \left(\frac{1}{3} - \frac{5}{18}\right)CV_0^2 = \left(\frac{6-5}{18}\right)CV_0^2 = \left(\frac{1}{18}\right)CV_0^2$$

$$\text{Total} = \left(\frac{1}{18} + \frac{1}{18} + \frac{1}{18}\right)CV_0^2$$

$$= \frac{8}{18}CV_0^2$$

$$E_D = \frac{3}{9}\left[\frac{1}{2}CV_0^2\right] = \frac{1}{3}\left(\frac{1}{2}CV_0^2\right)$$

17. **Ans. (D)**

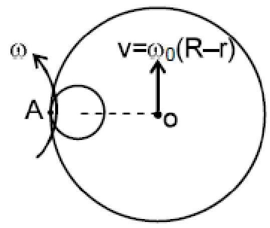
Sol.

A will be I OR

$$\omega R = \omega_0 \left(R - r\right)$$

$$\omega R = \omega_0 \left(\frac{R-r}{R}\right)$$

$$K.E = \frac{1}{2}\left(2mR^2\right)\omega^2 = m\omega_0^2 \left(R-r\right)^2$$



18. **Ans. (A)**