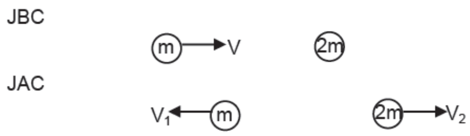
JEE MAIN-2018

PHYSICS

1. Sol.

Case-I



$$2V_2 - V_1 = V$$

$$V_2 + V_1 = V$$

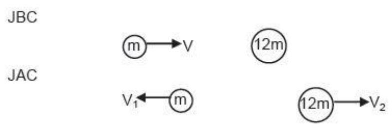
$$3V_2 = 2V$$

$$V_2 = \frac{2V}{3}$$

$$V_1 = \frac{V}{3}$$

$$P_d = \frac{\frac{1}{2}mV^2 - \frac{1}{2}mV_1^2}{\frac{1}{2}mV^2} = \frac{1-\frac{1}{9}}{1} = \frac{8}{9} = 0.89$$

Case-II



$$12V_2 - V_1 = V$$

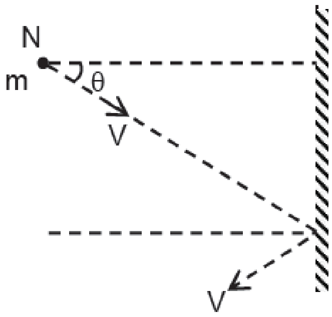
$$V_2 + V_1 = V$$

$$13V_2 = 2V$$

$$V_2 = \frac{2V}{13}$$

$$V_1 = V - \frac{2V}{13} = \frac{11V}{13} \quad \Rightarrow P_c = \frac{\frac{1}{2}mV^2 - \frac{1}{2}mV_1^2}{\frac{1}{2}mV^2} = \frac{1-\frac{121}{169}}{1} = \frac{48}{169} = 0.28$$

2. Sol.



$$F_{ovg} = 2\text{NmV}\cos\theta$$

$$\text{Pressure } \frac{= 2\text{NmV}\cos\theta}{A}$$

$$= \frac{2\left(10^{23}\right)\left(3.32\times10^{-27}\right)\frac{1}{\sqrt{2}}\times10^{3}}{2\times10^{-4}}$$

$$= 2.35\times10^{3}\ \text{N/m}^{2}$$

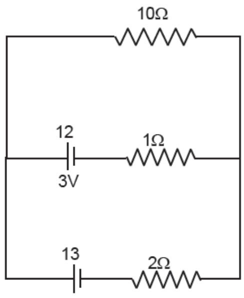
3. Sol.

$$\Delta P\,\frac{\text{mg}}{\text{a}}$$

$$K = -\frac{\frac{\text{mg}}{\text{A}}}{\frac{4\pi r^{2}dr}{\frac{4}{3}\pi r^{3}}}$$

$$\frac{dr}{r} = \frac{\text{mg}}{3\text{KA}}$$

4. Sol.



$$E_{qe} = \frac{\frac{12}{1} + \frac{13}{2}}{\frac{1}{1} + \frac{1}{2}}$$

$$= \frac{\frac{37}{2}}{\frac{3}{2}} = \frac{37}{3}$$

$$Y_{eq.} = \frac{2}{3}$$

$$I = \frac{\frac{37}{3}}{\frac{2}{3} + 10} = \frac{\frac{37}{3}}{\frac{32}{3}} = \frac{37}{32}$$

Voltage across load $= IR = \left(\frac{37}{32}\right)(10) = 11.56V$

5. Sol.

$$U = -\frac{K}{2r^2}$$

$$F = -\frac{du}{dr} = -\left(-\frac{K}{2}\left(-\frac{2}{r^3}\right)\right) = -\frac{K}{r^3}$$

$$\frac{K}{r^3} = \frac{mv^2}{r} \quad \Rightarrow \quad mv^2 = \frac{K}{r^2}$$

$$K.E. = \frac{1}{2}mv^2 = \frac{K}{2r^2}$$

$$E = P.E + K.E. = 0$$

6. Sol.

$$\mu(\mathrm{m}+\mathrm{m}_2)=\mathrm{m}_1$$

$$m+m_2=\frac{m_1}{\mu} \quad \Rightarrow \quad m=\frac{m_1}{\mu}-m_2$$

$$m=\frac{5}{0.15}-10=23.33\text{kg}$$

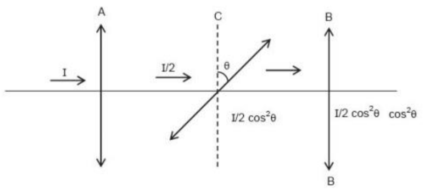
7. Sol.

$$hv_L=13.6ev$$

$$hv_P=\frac{13.6}{25}ev$$

$$\frac{v_L}{v_P}=25 \quad \Rightarrow \quad v_P=\frac{v_L}{25}$$

8. Sol.



$$\frac{I}{2}\cos^2\theta=\frac{I}{8}$$

$$\cos^2\theta=\frac{I}{4}$$

$$\cos^2\theta=\frac{1}{\sqrt{2}} \quad \Rightarrow \quad \theta=45°$$

9. Sol.

$$V_n = \left(\frac{2\pi Ke^2}{h}\right)\frac{1}{n}$$

$$E_n = -\frac{1}{2}mv_n^2$$

$$\lambda_n = \frac{h}{mv_n} = \left(\frac{h^2}{m2\pi Ke^2}\right)n \quad \lambda_n >>> \lambda_g$$

$$\frac{hc}{\wedge_n} = E_n - E_1 = \frac{1}{2}m\left(v_1^2 - v_n^2\right)$$

$$\frac{hc}{\wedge_n} = \frac{1}{2}m\left(\left(\frac{h}{m\lambda_g}\right)^2 - \left(\frac{h}{m\lambda_n}\right)^2\right)$$

$$\frac{hc}{\wedge_n} = \frac{h^2}{2m}\left(\frac{1}{\lambda_g^2} - \frac{1}{\lambda_n^2}\right) = \frac{h^2}{2m\lambda_g^2}\left(1 - \frac{\lambda_g^2}{\lambda_n^2}\right)$$

$$\frac{\wedge_n}{hc} = \frac{2m\lambda_g^2}{h^2}\frac{1}{\left(1 - \frac{\lambda_g^2}{\lambda_n^2}\right)}$$

since $\frac{\lambda_g}{\lambda_n} <<< 1$ so using binomial expansion

$$\Lambda_n = \left(\frac{2mc\lambda_g^2}{h}\right)\left(1 + \frac{\lambda g^2}{\lambda_n^2}\right) \quad \Rightarrow \quad \Lambda_n = A + \frac{B}{\lambda_n^2}$$

10. Sol.

For silicon diode barrior potential is $0.7V$

so $I = \frac{3-0.7}{200}$

$= 0.0115A$

$= 11.5mA$

11. Ans. (4)

Sol.

For circular path in magnetic field.

$$r = \frac{\sqrt{2mE}}{qB} \quad E = \text{kinetic energy}$$

So

	e	p	α
m	1/1836	1	4
q	$-e$	$+e$	$2e$

$$r_p = r_\alpha > r_e$$

12. Ans. (3)

Sol.

$$Q_{\text{cap}} = KC_0V$$

$$\left|Q_{\text{polarised}}\right| = \left|Q_{\text{cap}}\left(1-\frac{1}{k}\right)\right|$$

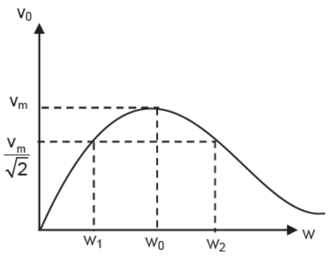
$$= \left(90\times10^{-12}\right)(20)\left(\frac{5}{3}\right)\left(1-\frac{3}{5}\right)\text{Coulomb}$$

$$= 1200\times10^{-12}\text{Coulomb}$$

$$= 1.2nc$$

13. Ans. (3)

Sol.



Band width $\omega_1 - \omega_2 = \frac{R}{L}$

Quality factor $Q = \frac{\omega_0}{\omega_1 - \omega_2} = \frac{\omega_0 L}{R}$

14. Ans. (1)

Sol.

$$N = \frac{1}{10}\frac{(10\text{kHz})}{(5\text{kHz})}$$

$$= \frac{10^9}{5\times10^3} = \frac{10^6}{5} = 2\times10^5$$

15. Ans. (3)

Sol.

$$f_0 = \frac{1}{2\ell}\sqrt{\frac{Y}{\rho}} = \frac{1}{2(0.6)}\sqrt{\frac{9.27\times10^{10}}{2.7\times10^3}} = 4.9\times10^3\,\text{Hz} \simeq 5\text{kHz}$$

16. **Ans. (2)**

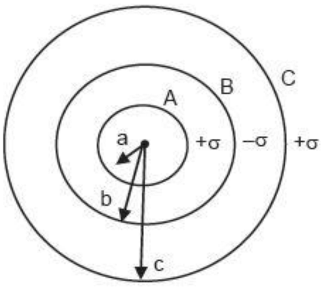
Sol.

$$I_p = I_0 + 7m(3R)^2$$

$$= \left(\frac{mR^2}{2} + 6\left(\frac{mR^2}{2} + m(2R)^2\right)\right) + 7m(3R)^2 = \frac{181}{2}mR^2$$

17. **Ans. (4)**

Sol.



$$V_B = \frac{1}{4\pi\varepsilon_0}\frac{4\pi a^2\sigma}{b} - \frac{1}{4\pi\varepsilon_0}\frac{4\pi b^2\sigma}{b} + \frac{1}{4\pi\varepsilon_0}\frac{4\pi c^2\sigma}{c} = \frac{\sigma}{\varepsilon_0}\left(\frac{a^2 - b^2}{b} + c\right)$$

18. **Ans. (4)**

Sol.

Using formula $r = R\left(\frac{\ell_1}{\ell_2} - 1\right)$

$$= 5\left(\frac{52}{40} - 1\right) = 5 \times \frac{12}{40} = 1.5\Omega$$

19. Ans. (1)

Sol.

$C =$ Speed in air

$V =$ Speed in medium

$$\frac{V}{C} = \frac{1}{2}$$

$\mu_{r_2} = 1$ (Non-magnetic)

$$\frac{V}{C} = \sqrt{\frac{\varepsilon_{r_1}}{\varepsilon_{r_2}}} = \frac{1}{2} \quad \Rightarrow \quad \frac{\varepsilon_{r_1}}{\varepsilon_{r_2}} = \frac{1}{4}$$

20. Ans. (3)

Sol.

Semi-angular width $= 30^\circ \quad a\sin\theta = \lambda$

$$a\sin 30^\circ = \lambda$$

Fringe width $\beta = \dfrac{\lambda D}{d}$

$$10^{-2} = \frac{10^{-6} \times \frac{1}{2} \times 0.5}{d}$$

$$d = \frac{5}{2} \times 10^{-5} = 25\mu m$$

21. Sol. $T = 2\pi\sqrt{\frac{m}{k}}$

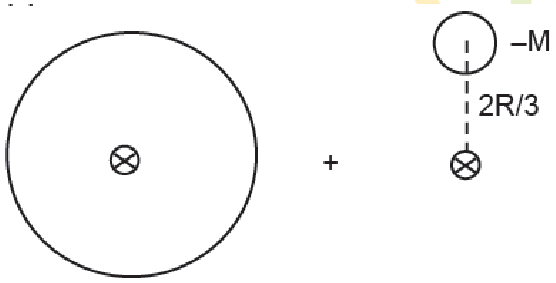
$$k = 4\pi^2 \times \frac{108\times10^{-3}}{6.02\times10^{23}} \times f^2$$

$$= \frac{4\times\pi^2\times108}{6.02} \times \frac{10^{24}\times10^{-3}}{10^{23}}$$

$$= 7.1 N/m$$

22. Ans. (3)

Sol.



[Using negative mass concept]

$$I = \frac{9MR^2}{2} - \left[\frac{M\left(\frac{R}{3}\right)^2}{2} + M\left(\frac{2R}{3}\right)^2\right]$$

$$= MR^2\left[\frac{9}{2} - \frac{1}{18} - \frac{4}{9}\right] = 4MR^2$$

23. Ans. (4)

Sol.

By conservation of linear momentum

$$mv_0 + 0 = mv_1 + mv_2$$

$$v_0 = v_1 + v_2 \qquad \ldots(1)$$

$$\frac{3}{2}\left[\frac{1}{2}mv_0^2\right] = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2$$

$$\frac{3}{2}v_0^2 = v_1^2 + v_2^2 \quad \ldots(2)$$

Solving equation (1) and (2)

$$v_1 = \frac{v_0}{2}\left(1+\sqrt{2}\right)$$

$$v_2 = \frac{v_0}{2}\left(1-\sqrt{2}\right)$$

$$\bar{v}_{rel} = \vec{v}_1 - \vec{v}_2$$

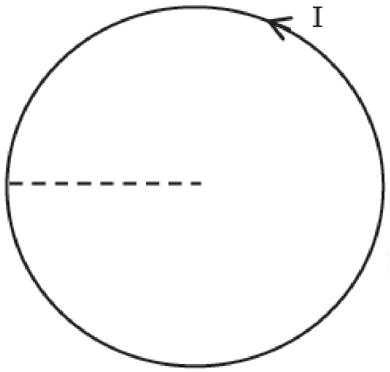
$$\frac{v_0}{2}\left[1+\sqrt{2}-1+\sqrt{2}\right]$$

$$= \frac{v_0}{2} \times 2\sqrt{2}$$

$$= \sqrt{2}v_0$$

24. Ans. (1)

Sol.



Dipole moment $(m) = I\pi R^2$

Magnetic induction $(B) = \frac{\mu_0 I}{2R}$

$B \alpha \frac{1}{\sqrt{m}}$

$\frac{B_1}{B_2} = \sqrt{\frac{m_2}{m_1}} = \sqrt{2}$

25. Ans. (1)

Sol.

$\frac{\Delta m}{m} \times 100 = 1.5$

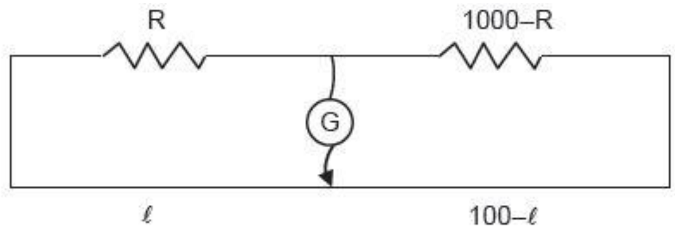
$\frac{\Delta \ell}{\ell} \times 100 = 1$

$d = \frac{m}{\ell^3} \Rightarrow \frac{\Delta d}{d} \times 100 = \frac{\Delta m}{m} \times 100 + \frac{3\Delta \ell}{\ell} \times 100$

$= 1.5 + 3 = 4.5\%$

26. Ans. (1)

Sol



Say resistances are R and $1000-R$

For case-I $\frac{R}{\ell}=\frac{1000-R}{100-\ell}$

For case-II $\frac{1000-R}{\ell-10}=\frac{R}{110-\ell}$

Multiplying both equation

$$\frac{R(1000-R)}{\ell(\ell-10)}=\frac{(1000-R)R}{(100-\ell)(110-\ell)}$$

$$\Rightarrow \ell^2-10\ell=11000+\ell^2-210\ell$$

$$\Rightarrow 200\ell=11000$$

$$\Rightarrow \ell=55\text{cm}$$

putting in first equation

$$\frac{R}{55}=\frac{1000-R}{45}$$

$$45R=55000-55R$$

$$R=550\Omega$$

27. Ans. (4)

Sol.

$e = 100\sin 30t$

$i = 20\sin\left(30t - \frac{\pi}{4}\right)$

$P_{av} = e_{rms} i_{rms} \cos\phi \quad = \frac{100}{\sqrt{2}} \cdot \frac{20}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} = \frac{1000}{\sqrt{2}} W$

wattless current $= \frac{I_0 \sin\phi}{\sqrt{2}} = \frac{20}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} = 10A$

28. Ans. (4) Incorrect

Sol.

As in distance *vs* time graph slope is equal to speed in the given graph slope increase initially which is incorrect

29. Ans. (1)

Sol.

For adiabatic process

$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1} \quad \gamma = \frac{5}{3}$

$\Rightarrow 300(V)^{\frac{2}{3}} = T_2 (2V)^{\frac{2}{3}}$

$\Rightarrow T_2 = \frac{300}{2^{\frac{2}{3}}} \approx 189\text{K}$

$\Delta U = \frac{f}{2} nR\Delta T$

$= \frac{3}{2} . 2 \frac{25}{3} (189 - 300)$

$= -2.7\text{kJ}$

30. Ans. (1)

Sol.

$$F = \frac{k}{R^n} = m\omega^2 R$$

$$\omega^2 \alpha \frac{1}{R^{n+1}} \Rightarrow \quad \therefore \quad T = \frac{2\pi}{\omega}$$

So

$$T \alpha R^{\frac{n+1}{2}}$$