IIT-JEE-2011

PAPER-II

PHYSICS

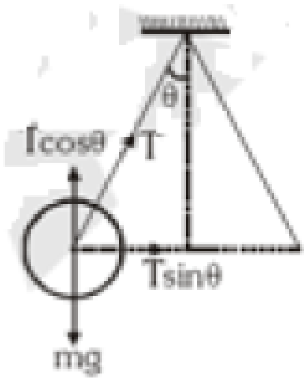
24. Answer: (A)

No. of moles $= n\dfrac{5.6}{22.4} = \dfrac{1}{4}$

$TV^{t-1} = cons\tan t \Rightarrow T_1(5.6)^{2/3} = T_2(8)^{2/3} = T_2 \Rightarrow 4T_1 = T_2$

$W = \dfrac{-nR\Delta T}{\gamma - 1} = -\dfrac{1R(3T_1)\times 3}{4\times 2} = -\dfrac{9}{8}RT_1.$ Therefore $W_{external} = \dfrac{9}{8}RT_1$

25. Answer: (D)



$T\sin\theta = m\omega^2 r$

$T\sin\theta = m\omega^2 L\sin\theta$

$T = m\omega^2 L$

$324 = \dfrac{1}{2}(\omega^2)\dfrac{1}{2}$

Therefore $\omega = 36$

26. Answer: (C)

$\phi = \int \bar{E}.\overset{\text{ɯ}}{dS} = Ex$ projected area perpendiuclar to $E(x\text{-axis}) = E\times a^2$

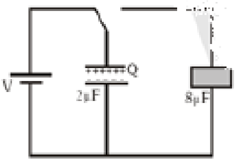
27. Answer: (A)

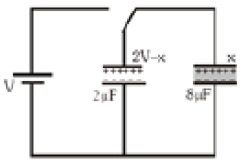
$$f' = \left(\frac{v}{v - v_5}\right)\left(\frac{v + v_0}{v}\right) f \Rightarrow f' = \left(\frac{320}{320 - 10}\right)\left(\frac{320 + 10}{320}\right) \times 8 \Rightarrow f' \approx 8.50\text{kHz}$$

28. Answer: (B)

Apply condition of wheatstone bridge, $\frac{x}{52+1} = \frac{10}{48+2} \Rightarrow x = \frac{10}{50} \times 53 \Rightarrow x = 10.6\Omega$

29. Answer: (D)





$$Q_1 = CV, Q_1 = 2V, \frac{2V - x}{2} = \frac{x}{8}, x = \frac{8V}{5} \Rightarrow V_i = \frac{1}{2} \times (2)V^2 = V^2; U_f = \left(\frac{8V}{5}\right)^2 + \frac{\left(\frac{2V}{5}\right)^2}{2 \times 2} = \frac{4V^2}{5}$$

$$\text{Loss} = \frac{4V^2}{5} \Rightarrow \%\text{loss} = \frac{\frac{4V^2}{5} \times 100}{V^2} = 80\%$$

30. Answer: (A)

$$\frac{1}{\lambda} = Rz^2\left(\frac{1}{n^2} - \frac{1}{m^2}\right)$$

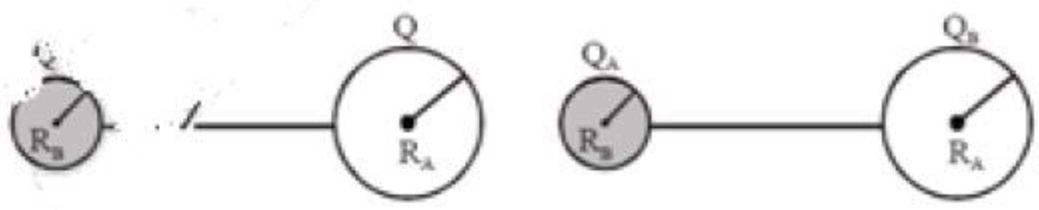
First line of Balmer of Hydrogen : $\frac{1}{6561} = R(1)^2\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$

Second line of Balmer of single ionized He: $\frac{1}{\lambda} = R\left(z^2\right)\left(\frac{1}{2^2} - \frac{1}{4^2}\right)$

Dividing : $\lambda = 6561 \times \frac{5}{9 \times 3} = 1215\mathring{A}$

SECTION – II

31. Answer: (ABCD)



$E_A^{inside}=0$ (because of electrostatic condition) So. A option is true.

$\Rightarrow v_A=v_B\Rightarrow \frac{kQ_A}{R_A}=\frac{kQ_B}{R_B}\Rightarrow \frac{Q_A}{Q_B}=\frac{R_A}{R_B}\Rightarrow R_B<R_A So, Q_B<Q_A, so\, B$ is true

$\Rightarrow \frac{\sigma_A 4\pi R_A^2}{\sigma_B 4\pi R_B^2}=\frac{R_A}{R_B}\Rightarrow \frac{\sigma_A}{\sigma_B}=\frac{R_A}{R_B}$, So C is true

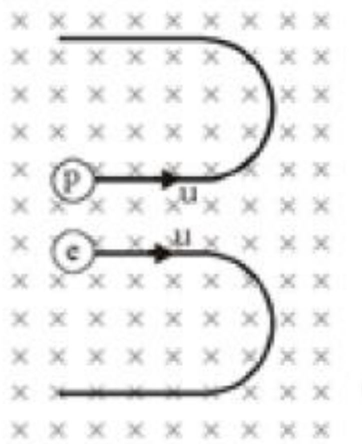
$E_{near\, surface}=\sigma\times\frac{1}{R}$. So. D is also true

32. Answer: (AD)

Torque for both the arrangement is same.

Since in case B disc is not rotating, there is no speed of the pendulum at equilibrium in case (B).

33. **Answer: (BD)**



By diagram B is true

$$T=\frac{2\pi m}{qB}$$

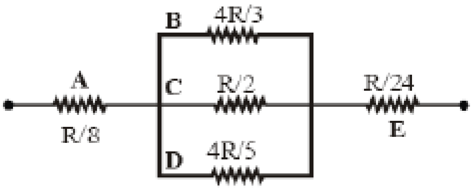
$T = \propto m$

$m_p > m_e$

$T_p > T_e$

So, D is also true

34. Answer: (ABCD)



•·In steady state : heat in $=$ heat out. So, A is true

•·Option B is also true because total heat is flowing through E.

•· $Q=\dfrac{\Delta T}{R}$

$Q=$ same

•· R_E is minimum. So, ΔT is minimum

So option C is true

•· $Q_B=\dfrac{\Delta T}{4R/3}, Q_C=\dfrac{\Delta T}{4R/2}, Q_D=\dfrac{\Delta T}{4R/5}, So, Q_B+Q_D=Q_C$.

Hence D is true

SECTION-III

35. Answer: (D)

Initial momentum was positive and final momentum negative. So option (D) is correct.

36. Answer: (C)

$$E \propto (amplitude)^2 \Rightarrow \text{so} \frac{E_2}{E_1} = \left(\frac{a}{2a}\right)^2 \Rightarrow E_1 = 4E_2$$

37. Answer: (B)

Since at sun time position was positive

38. Answer: (C)

$$\left[\frac{\sqrt{Ne^2}}{m \in_0}\right] = \sqrt{\frac{\left(\frac{1}{L^3}\right)(C^2)}{(M)\left(\frac{C^2T^2}{L^3M}\right)}} = \frac{1}{T} = [\omega]$$

39. Answer: (B)

$$\omega = 2\pi = \frac{2\pi c}{\lambda} = \sqrt{\frac{Ne^2}{m \in_0}} \Rightarrow \lambda = 2\pi c\sqrt{\frac{m \in_0}{Ne^2}}$$

$$\lambda = \frac{2\times 3.14\times 3\times 10^8}{1.6\times 10^{-19}}\sqrt{\frac{(10^{-30})(10 -^{11})}{(4\times 10^{27})}} = \frac{9.42}{1.6}\times 10^{27}\times 10^{-34} = 6\times 10^{-7}\, m = 60nm$$

SECTION-IV

40. Answer: (5)

Force to just prevent it from sliding $= mg\sin\theta - \mu mg\cos\theta$

Force to just push up the plane $= mg\sin\theta - \mu mg\cos\theta$

$$mg\sin\theta + \mu mg\cos\theta = 3(mg\sin\theta - \mu mg\cos\theta)$$

$$\frac{1}{\sqrt{2}} + \mu\frac{1}{\sqrt{2}} = 3\left(\frac{1}{\sqrt{2}} - \frac{\mu}{\sqrt{2}}\right) \Rightarrow \mu = \frac{1}{2} \Rightarrow N = 10\mu = 5$$

41. Answer: (4)

$$N_1 = 2N$$

$$N_1 - f = ma \quad \text{K (i)}$$

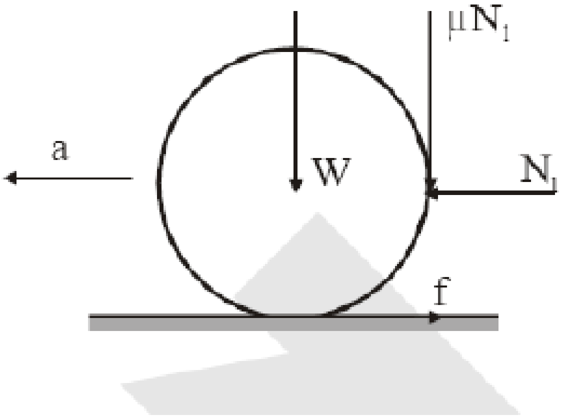
$$(f - \mu N_1)R = mR^2\alpha = ma \quad \text{K (ii)}$$

From equation (i) and (ii) we get

$$N_1(1-\mu) = 2ma$$

$$2(1-\mu) = 2\times 2\times 0.3$$

$$1-\mu = 0.6 \Rightarrow \mu = 0.4$$



42. Answer: (3)

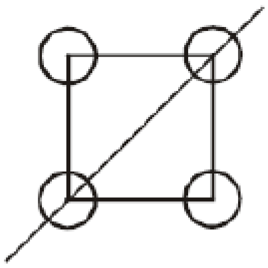
Line ab divides the soap film into two equal parts.

$$\frac{Kq^2}{a^2}\left[\sqrt{2}+\frac{1}{2}\right]\text{where } K=\frac{1}{4\pi\in_0}$$

$$\gamma\sqrt{2}a=\frac{Kq^2}{a^2}\left(\sqrt{2}+\frac{1}{2}\right);a^3=\frac{Kq^2}{\gamma}\left(\sqrt{2}+\frac{1}{2}\right);a=\left[\frac{q^2}{\gamma}\right]^{1/3}K\left(\sqrt{2}+\frac{1}{2}\right)^{1/3}\Rightarrow N=3$$

$$\text{where}\left[K\left(\sqrt{2}+\frac{1}{2}\right)\right]^{1/3}=k$$

43. Answer: (9)



$$I=\frac{2}{5}mR^2+\frac{2}{5}mR^2+\frac{2}{5}mR^2+m\left(\frac{a}{\sqrt{2}}\right)^2+\frac{2}{5}mR^2+m\left(\frac{a}{\sqrt{2}}\right)^2$$

$$I=\frac{8}{5}mR^2+ma^2+\left[\frac{8}{5}\times0.5\times\frac{5}{4}+0.5\times4^2\right]\times10^{-4}=(1+8)\times10^{-4}=N\Rightarrow N=9$$

44. Answer: (1)

$$A=\lambda N\Rightarrow10^{10}=\lambda N\Rightarrow N=\frac{10^{10}}{\lambda}=\left(10^{10}\right)\tau=10^{10}\times10^9=10^{19}$$

$$M=Nm=\left(10^{19}\right)\left(10^{-25}\right)=10^{-6}\text{kg}=1\text{mg}$$

45. Answer: (6)

$$\phi = B\pi r^2 = \left(\frac{\mu_0 I}{L}\right)\pi r^2 \mu_0 I_0 \frac{\pi r^2}{L}\cos 300t \Rightarrow \varepsilon_1 = \frac{d\phi}{dt} = \left(\frac{\mu_0 I_0 \pi r^2}{L}\right)300\sin 300t$$

$$i = \frac{\varepsilon}{R} = (\mu_0 I_0 \sin 300t)\left[\frac{\pi r^2 (300)}{LR}\right] \Rightarrow M = i\pi r^2 = \left[\frac{\pi^2 r^4 (300)}{LR}\right]\mu_0 I_0 \sin 300t$$

46. Answer: (3)

$$\frac{\Delta}{L} = \frac{YA}{mg} = \alpha\Delta\theta \Rightarrow m = \frac{YA}{g\alpha\Delta\theta}$$

$$m = \frac{(10^{11})(3.14)(10^{-6})}{(10)(10^{-5})(10)} \Rightarrow m = 3.14\text{kg} \Rightarrow m = 3$$