JEE (ADVANCE) SOLUTIONS – 2015 – CODE '8'
PHYSICS
PAPER-1

Q.1 [2]

$$10.4\ eV = -\frac{13.6\ eV}{n^2} + \frac{hc}{\lambda}$$

$$10.4\ eV = -\frac{13.6\ eV}{n^2} + \frac{1242}{90}$$

$$n^2 = 4 \Rightarrow n = 2$$

Q.2. [2]

$$-\frac{GMm}{R+h} = -\frac{GMm}{R} + \frac{1}{2}mv^2$$

Also $\frac{GMm}{R} = \frac{1}{2}mv_e^2$ and $g' = \frac{g}{4} = \frac{g}{(1+\frac{h}{R})^2}$

$$\Rightarrow v_e^2 = v^2 2 \Rightarrow v_e = \sqrt{2}v$$

Q.3. [7] for A: $\frac{1}{2}mv_1^2 + \frac{1}{2}\left(\frac{1}{2}mR^2\right)\frac{v_1^2}{R^2} + mg \times 30$

$$= \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{1}{2}mR^2\right)\frac{v^2}{R^2}$$

for B $\Rightarrow \frac{1}{2}mv_2^2 + \frac{1}{2}\left(\frac{1}{2}mR^2\right)\frac{v_2^2}{R^2} + mg \times 27$

$$= \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{1}{2}mR^2\right)\frac{v^2}{R^2}$$

As the R.H.S.s are equal
Left hand sides will also be equal
So $\frac{3}{4}mv_1^2 + mg \times 30 = \frac{3}{4}mv_2^2 + mg \times 27$

$$v_2^2 = 49 \Rightarrow v_2 = 7$$

Q.4 [2].

$$\frac{\sigma T_A^4 \times 4\pi (400R)^2}{\sigma T_B^4 \times 4\pi R^2} = 10^4$$

$$\because \lambda_A T_A = \lambda_B T_B$$

$$\left(\frac{\lambda_A}{\lambda_B}\right)^4 = 16 \Rightarrow \frac{\lambda_A}{\lambda_B} = 2$$

Q.5. [3]

$$N_0 \lambda E_0 \times \frac{12.5}{100} = \text{Power Needed/sec}$$

$N_0 \rightarrow$ total No of atoms (fuel) present initially

$E_0 \rightarrow$ Energy released/decay

Energy ~~Ener~~ required $N_0 \lambda E_0 \times \frac{12.5}{100} \times nT$ [T in years]

$$N_0 \times \frac{.693}{T} \times \frac{12.5}{100} \times nT \quad [\text{T in years}]$$

No of atoms ~~dec~~ remain after nT years

$$= N_0 \left(\frac{1}{2}\right)^n$$

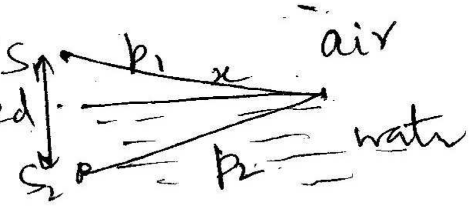
So the no of atoms decayed $= N_0 - N_0\left(\frac{1}{2}\right)^n$

The energy released

$$= E_0 N_0\left[1 - \left(\frac{1}{2}\right)^n\right] = N_0 \times \frac{.693}{T} \times \frac{12.5 \times nT}{100}$$

$$\Rightarrow n = 3$$

Q.6. [3]



~~equivalent~~
Equivalent optical path of p_2

$p = \frac{4}{3}\sqrt{x^2+d^2}$

So the path diff.

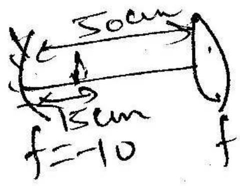
$\frac{4}{3}\sqrt{x^2+d^2} - \sqrt{x^2+d^2} = m\lambda$

$\Rightarrow x^2+d^2 = 9m^2\lambda^2$

$\Rightarrow x^2 = 9m^2\lambda^2$

So $p = 3$

Q.7. [7]



$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ [for the mirror]

$f=-10$, $u=-15$

$v=-30$

So u for the lens $=-20$cm

hence v for the lens $=-20$cm.

$\Rightarrow |M_1| = m_{mirror} \times m_{lens}$

$= 2\times 1 = 2$,

In second case $v_{mirror} = -30$cm
[focal length of the mirror is not affected by the liquid] ...

Now in liquid focal length of the lens

$$\frac{1}{f'} = \left(\frac{1.5}{7/6} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

In air $\frac{1}{f} = (1.5 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

so $f' = \frac{35}{2}$

so u for the lens $= -20$

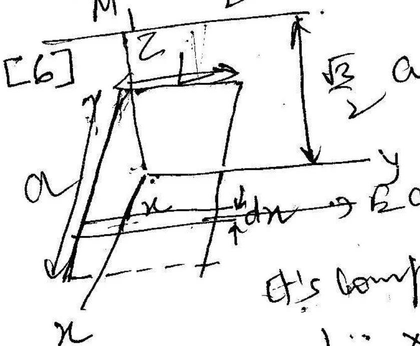
v for the lens $= +140$ cm

Now $|M_2| = m_{mirror} \times m_{lens}$

$= 2 \times \frac{140}{20} = 7 \times 2 = 14$

$\Rightarrow \frac{M_2}{M_1} = \frac{14}{2} = 7$

Q. 8. [6]



E at this pt $= \frac{1}{2\pi\varepsilon_0} \times \frac{\lambda}{\sqrt{z^2+x^2}}$

it's component along the area Ldx

$\frac{1}{2\pi\varepsilon_0} \times \frac{\lambda}{\sqrt{z^2+x^2}} \times \frac{z}{\sqrt{z^2+x^2}}$

So flux of this area

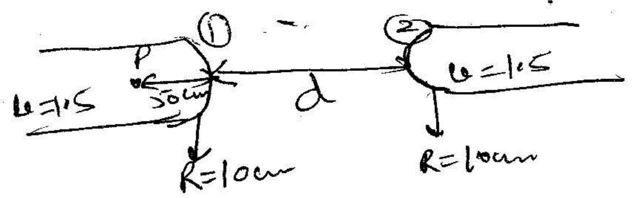
$\frac{1}{2\pi\varepsilon_0} \times \frac{\lambda}{(z^2+x^2)} zL\,dx$

total flux $= 2\int_0^{a} \frac{1}{2\pi\varepsilon_0} \times \frac{\lambda z L}{(z^2+x^2)} dx$

$z = \frac{\sqrt{3}}{2}a$

$= \frac{\lambda L}{6\varepsilon_0} \Rightarrow n = 6$

Q.9. (B)



for the surface S_2

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2-\mu_1}{R}$$

$$\frac{1.5}{\infty} - \frac{1}{u} = \frac{0.5}{10} \Rightarrow u = -20$$

Now for surface ①

$$\frac{1}{v} + \frac{3}{2\times 50} = \frac{1-1.5}{(-10)}$$

$v = 50$ cm

This image will be object for S_2

So $d = 50 + 20 = 70$ cm

Q.10 (A) (B) (C) Net displacement along x axis = (L+R)

" " , y axis = 0

So $F = Bi(L+R)\sin 90$

Net displacement is only along x-axis & if B is along x-axis

$\theta = 0$ so $F = 0$

If B is along y axis still net displacement is along x axis, which ⊥ so $F = Bi(L+R)$

Q.11. (A)(B)(D) Total $U = 1\times C_{V_{H_2}}T + n\,C_{V_{He}}T$

$U = 4RT$

So U/mole $= 2RT$

11. (A)

$$\frac{v_{mix}}{v_{He}} = \sqrt{\frac{\gamma_{mix} RT \, M_{He}}{M_{mix} \gamma_{He} RT}} = \sqrt{\frac{6}{5}}$$

$$C_{v(mix)} = \frac{1 \times \frac{3}{2}R + 1 \times \frac{5}{2}R}{1+1}$$

$$C_{p(mix)} = C_{v(mix)} + R$$

$$\gamma_{mix} = C_{p(mix)} / C_{v(mix)}$$

$$M_{mix} = \frac{1 \times 2 + 1 \times 4}{1+1}$$

$$\frac{v_{rms\,He}}{v_{rms\,H_2}} = \sqrt{\frac{3RT \times 2}{4 \times 3RT}} = \frac{1}{\sqrt{2}}$$

Q.12 (B)

$$R = \rho \frac{l}{A}$$

$$R_{Fe} = \frac{50 \times 10^{-3} \times 1.0 \times 10^{-7}}{2 \times 2 \times 10^{-6}}$$

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$$

[Parallel]

$$R_{Al} = \frac{2.7 \times 10^{-8} \times 50 \times 10^{-3}}{(49-4) \times 10^{-6}}$$

$$= \frac{1875}{64}$$

Q.13 (A)(C)

$$\frac{hc}{\lambda} = W + eV$$

$$\text{so } V = \frac{hc}{\lambda e} - \frac{W}{e}$$

Q.14 (B)(D)

L.C of Vernier $= \dfrac{\text{part of the main scale}}{\text{No of parts in the V.Scale}}$

$$= \left(\frac{1}{8} \times \frac{10}{10}\right) \text{mm}$$

& pitch = 2 divisions of linear scale

L.C of screw gauge $= \dfrac{\text{pitch}}{\text{No of parts}}$

Q.15 [A] [C] [D]

$$h = [ML^2T^{-1}] \quad c = LT^{-1} \quad G = M^{-1}L^3T^{-2}$$

$$M \propto \sqrt{\frac{hc}{G}} \quad L \propto \sqrt{\frac{hG}{c^3}}$$

Q.16 [B] [D] $E_1 = \frac{1}{2} m\omega^2 a^2$ & $p = mv = m\omega_1 a = b \Rightarrow \frac{a}{b} = \frac{1}{m\omega_1}$

for 2nd $E_2 = \frac{1}{2} m\omega_2^2 R^2$ & $m\omega_2 = 1$

$$\frac{a}{b} = \frac{\omega_2}{\omega_1} = n^2 \quad \frac{E_1}{\omega_1^2 a^2} = \frac{E_2}{\omega_2^2 R^2} = \frac{E_1}{\omega_1} = \frac{E_2}{\omega_2}$$

Q.17. [D]

$$MR^2\omega = \left(MR^2 + \frac{M}{8} \times \frac{9}{25} R^2 + \frac{M}{8} x^2\right) \times \frac{8}{9}\omega$$

$$\Rightarrow x = \frac{4}{5} R$$

Q.18. [C] $\underleftrightarrow{2a}$

For $-q$ Net electric field exactly at the mid point is zero, so it is in equilibrium. but when it is displaced towards right, net field becomes towards left & force on it will be towards right, so it keeps moving along that direction

but for the +q charge net force will be towards left so it gets back.

$$F = q \times \frac{1}{2\pi\varepsilon_0} \lambda \left[\frac{1}{a-x} - \frac{1}{a+x}\right] = \frac{q}{2\pi\varepsilon_0} \times \frac{2x}{a^2 - x^2}$$

as $x \ll a$

$$F = \frac{q}{2\pi\varepsilon_0} \times \frac{2x}{a^2} = mA \Rightarrow A \propto -x$$

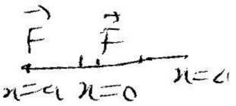
Q.19.

A → R T
B → P, S
C → P, Q, R, T
D → P, Q, R, T

20. A → P, Q, R, T
B → Q, S
C → P, Q, R, S
D → P, R, T

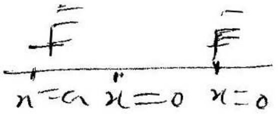
$F = -\frac{dU}{dx}\hat{i} = \frac{U_0}{2}\left(1-\left(\frac{x}{a}\right)^2\right) \times \left[-2\frac{x}{a} \times \frac{1}{a}\right] = 2U_0\left\{1-\left(\frac{x}{a}\right)^2\right\}\left(\frac{x}{a^2}\right)$

If $x = 0 \Rightarrow F = \frac{U_0}{2}\left[2 \times 1 \times 0\right] = 0 \cdot U = \frac{U_0}{2}$



If $x = a \Rightarrow \vec{F} = 0$ & $U = 0$
If $x = a \Rightarrow \vec{F} = 0$ & $U = 0$

(B) $\vec{F} = -\frac{U_0}{2} \times 2\left(\frac{x}{a}\right) \times \frac{1}{a} = \frac{U_0 x}{a^2} \times 1$



If $x = 0$ $F = 0$ & $U = 0$
If $x = a$ $F = -\frac{U_0}{a}\hat{i}$ $= \frac{U_0}{2}$
If $x = -a \Rightarrow \vec{F} = +\frac{U_0}{a}\hat{i}$ & $U = \frac{U_0}{2}$