JEE (ADVANCE) SOLUTIONS – 2015 – CODE '8'
PHYSICS
PAPER-2

Q.1 [4]

$E(t) = A^2 e^{-\alpha t}$

$\log E = 2\log A + \alpha t$

$\frac{\Delta E}{E} = 2\frac{\Delta A}{A} + \alpha \frac{\Delta t}{t}$

$\frac{\Delta E}{E} \times 100 = 2\frac{\Delta A}{A} \times 100 + \alpha \frac{\Delta t}{t}$

So $= 4\%$

$\alpha = 0.2 s^{-1}$

$100 \times \frac{\Delta A}{A} = 1.25\%$

$100 \times \frac{\Delta t}{t} = 1.5\%$

$t = 5$ secs

Q.2 [6]

$\rho_A(r) = \frac{Kr}{R}$ $\quad \rho_B(r) = K\left(\frac{r}{R}\right)^5$

A

$I_A = \int_0^R \frac{2}{3}(4\pi r^2 dr \frac{Kr}{R}) r^2$

$= \frac{2}{3} \times \frac{4\pi K}{R} \times \frac{R^6}{6}$

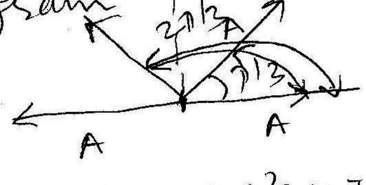
B

$I_B = \frac{2}{3}\int_0^R 4\pi r^2 dr \times K\frac{r^5}{R^5} r^2$

$I_B = \frac{2}{3}\frac{4\pi K}{R^5} \times \frac{R^{10}}{10}$

So $I_B/I_A = 6$

Q.3 [3] The different waves can be represented by the following phasor diagram [They have same amplitudes]



Resultant Amplitude

$= 2A\cos 30$

$= A\sqrt{3}$

$I = 3A^2 = n I_0$

Q.4 [2]

$A = N\lambda$ given that $\lambda_P = \frac{1}{\tau}$

$\frac{dA}{dt} = R$ & $\lambda_Q = \frac{1}{2\tau}$

They have same activity at $t=0$

& at $t = 2\tau$. $\frac{R_P}{R_Q} = \frac{n}{e}$

P ↓ Q ↓

[As the activity of both at $t=0$ is same but $\lambda_P = 2\lambda_Q$

Initial concentration of P is N_0 & that of Q is $2N_0$

After time t

$N(P) = N_0 e^{-\frac{1}{\tau}t}$ & $N(Q) = 2N_0 e^{-\frac{1}{2\tau}\times t}$

So $\frac{d(N_P)}{dt} = -N_0 \frac{1}{\tau} e^{-t/\tau}$

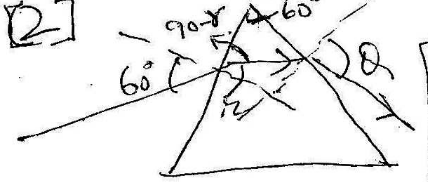
& $\frac{d(N_Q)}{dt} = -2N_0 \frac{1}{\tau} e^{-t/2\tau}$

~~$\frac{dN_P}{dt} = -N_0$~~

So $\frac{dA_P}{dt} = \frac{N_0}{\tau^2} e^{-2}$ & $\frac{dA_Q}{dt} = \frac{2N_0}{(2\tau)^2} e^{-1}$

So $\frac{R_P}{R_Q} = \frac{2}{e} = \frac{n}{e} \Rightarrow n = 2$

5. [2]



$\frac{\sin(60+r)}{\sin\theta} = \frac{1}{n}$

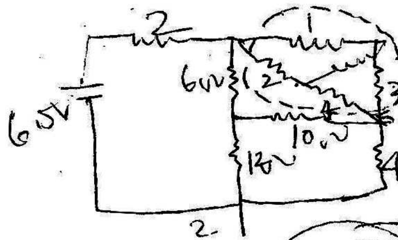
also $\frac{\sin 60}{\sin r} = n$ → get $\sin r$ & $\cos r$ from this

⇒ $\sin 60 \cos r + \cos 60 \sin r = \frac{\sin\theta}{n}$

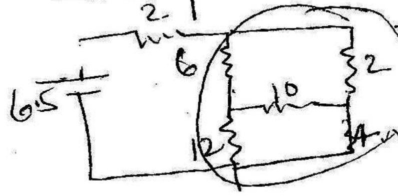
get $\sin\theta = f(n)$

Calculate $\frac{d\theta}{dn}$

Q.6 [1]



This is a balanced wheatstone bridge. It's equivalent 4Ω resistance = 2Ω.



This is another balanced wheatstone bridge. It's equivalent resistance is $\frac{18}{4}$ Ω

Net resistance $= \left(\frac{18}{4}+2\right) = \frac{26}{4}$

So $i = \frac{6.5}{6.5} = 1$ A.

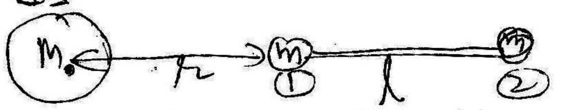
Q.7. [2]

$mvr = \frac{nh}{2\pi} \Rightarrow mv = \frac{nh}{2\pi r}$ [n=3]

$\lambda = \frac{h}{mv} = \frac{2\pi r}{3}$ also $r = a_0 \times \frac{9}{3}$ [For Li^{++} for n=3]

So $\frac{2\pi}{3} \times \frac{9}{3} a_0 = \pi p a_0 \Rightarrow p = 2$

Q. No. 8. [7]

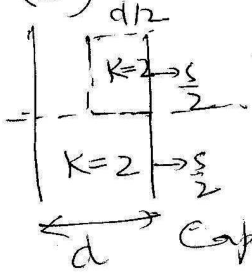


The tension in the rod will be zero if net attractive force on mass ① & ② is same.

$F_1 = F_2$

$$\frac{GMm}{9l^2} - \frac{Gm^2}{l^2} = \frac{GMm}{16l^2} + \frac{Gm^2}{l^2}$$

Q.9. (B) $C_1 = \frac{S\varepsilon_0}{d}$



The capacity of upper half

$C_3 = \dfrac{\frac{S}{2}\varepsilon_0}{\frac{d}{2\times4}+\frac{d}{2\times2}} = \dfrac{4S\varepsilon_0}{3d}$ $\left[C = \dfrac{A\varepsilon_0}{d-t+\frac{t}{K}}\right]$

Capacity of the lower half

$C_4 = \dfrac{S\varepsilon_0 \times \cancel{2}}{\cancel{2}\, d}$

C_3 & C_4 are in || so their equivalent

Capacity $C_2 = C_3 + C_4 = \cancel{\frac{S\varepsilon_0}{2d}}\cancel{\left(\frac{1}{3}\right)}\ \frac{S\varepsilon_0}{d}\left(1+\frac{4}{3}\right) =$

$= \frac{S\varepsilon_0}{d} \times \frac{7}{3}$

$\therefore \dfrac{C_2}{C_1} = \dfrac{7}{3}$

Q.10 [B] $\dfrac{P_1V_1}{T_1} = \dfrac{P_2V_2}{T_2} \Rightarrow \dfrac{P_1V_1}{T_1} = \dfrac{P_2\times 2V_1}{3T_1} \Rightarrow P_2 = \dfrac{3P_1}{2}$

$\Delta U = n\, C_v R \Delta T$

$= n\frac{3}{2}R \times 2T_1 = 3nRT = 3P_1V_1$

Q.11 [A] ${}^{236}_{92}U \longrightarrow {}^{140}_{54}Xe + {}^{94}_{38}Sr + x + y$

Total B.E of ${}^{236}U = 236 \times 7.5 = 1770$ MeV

Total B.E of Xe & Sr $= 140 \times 8.5 + 94 \times 8.5 = 1989$

from the law of conservation of momentum.

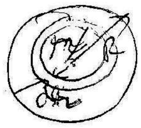
Net moment must be zero

So $\vec{P_x} = -\vec{P_y}$ & $\vec{p(Xe)} = -\vec{P(Sr)}$

$p = \sqrt{2m \times KE}$

12. [A] [B]

13. [B] [C]



The pressure P at a distance r from the center

= Attractive force on a layer of thickness dr at radius r

$= g\,dm$

$= G\dfrac{Mr}{R^3} \times 4\pi r^2 dr$

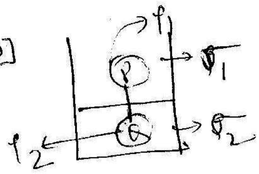
$= \dfrac{Gr}{R^3} \times \dfrac{4}{3}\pi R^3 \times \rho\, 4\pi r^2 dr$

So the total attractive force on the sphere of radius r due to all the layers above it.

$= \int_r^R G \times \frac{4}{3}\pi \times 4\pi \times \rho\, r^3 dr = G \times \frac{4}{3}\pi \times 4\pi\rho \dfrac{(R^4 - r^4)}{4}$

So the $P(r) = \dfrac{G \times \frac{4}{3}\pi \times 4\pi\rho\,(R^4 - r^4)}{4 \times 4\pi r^2}$

14. [A] [D]



$\vec{V}_P = \dfrac{2}{9} r^2 \dfrac{(\rho_1 - \sigma_2)}{\eta_2}$

$\vec{V}_Q = \dfrac{2}{9} r^2 \dfrac{(\rho_2 - \sigma_1)}{\eta_1}$

Also $T + \frac{4}{3}\pi r^3 \rho_1 g = \frac{4}{3}\pi r^3 \sigma_1 g$

& $T + \frac{4}{3}\pi r^3 \sigma_2 g = \frac{4}{3}\pi r^3 \rho_2 g$

$\cancel{\Rightarrow (\sigma_1 - \sigma_2)g = (\rho_1 - \rho_2)g}$

$(\rho_1 - \sigma_2) = (\sigma_1 - \rho_2)$

Q.15. [A] [C]

Q.16. [D] At any point inside the cavity the direction of E is along $\vec{a}$ & it's magnitude is same.

Q.17. [A] [C]

Q.18. [D]

Q.19. [A] [D]

$i = neAv_d$, (The force on electrons in $\vec{B}$)

$v_d = \frac{i}{neA} = \frac{i}{newd}$ due to the drift velocity of electrons)

The negative charges will be collected towards K

& +ve charges will be collected towards M

So in eq. of V is potential diff. $eE = evB$

$\cancel{e}\frac{V}{d} = \cancel{e} v_d B \Rightarrow V = B \times d \cdot \frac{i}{newd}$

hence [A] & [D]   So $V \propto \frac{1}{w}$ but independent of d

Q.20 [A] [C] from the above equation

$V \propto B$ & $V \propto \frac{1}{n}$