JEE MAIN April'19

PAPER WITH SOLUTION

12 April 2019 _ Evening _ Physics

1. Half lives of two radioactive nuclei A and B are 10 minutes and 20 minutes, respectively. If, initially a sample has equal number of nuclei, then after 60 minutes, the ratio of decayed numbers of nuclei A and B will be -

(1) 8 : 1 (2) 9 : 8 (3) 1 : 8 (4) 3 :8

Sol. **2**

$$N_A = N_0\left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}} = N_0\left(\frac{1}{2}\right)^{\frac{60}{10}} = N_0\left(\frac{1}{2^6}\right)$$

$$N_B = N_0\left(\frac{1}{2}\right)^{\frac{60}{20}} = N_0\left(\frac{1}{2^3}\right)$$

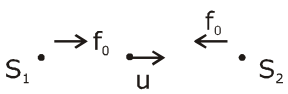
decayed ratio :- $\dfrac{(N_0 - N_A)}{(N_0 - N_B)} = \dfrac{N_0 - \dfrac{N_0}{2^6}}{N_0 - \dfrac{N_0}{2^3}}$

= 9/8

2. Two sources of sound S_1 and S_2 produce sound waves of same frequency 660 Hz. A listener is moving from source S_1 towards S_2 with a constant speed u m/s and he hears 10 beats/s. The velocity of sound is 330 m/s. Then, u equals -

(1) 2.5 m/s (2) 10.0 m/s (3) 15.0 m/s (4) 5.5 m/s

Sol. **1**



$f_1 = \dfrac{(v-u)}{v} \times f_0$ $f_2 = \dfrac{(v+u)}{v} \times f_0$

$f_2 - f_1 = 10$

$$\frac{f_0}{v}\left[v + u - (v - u)\right] = 10$$

$$\frac{f_0}{v}\left[2u\right] = 10$$

$$\frac{660}{330} \times 2 \times u = 10$$

$$u = \frac{10}{4} = 2.5 m/s$$

3. A tuning fork of frequency 480 Hz is used in an experiment for measuring speed of sound (υ) in air by resonance tube method. Resonance is observed to occur at two successive lengths of the air column, l_1 = 30 cm and l_2 = 70 cm. Then, υ is equal to -

(1) 338 ms^{-1} (2) 379 ms^{-1} (3) 332 ms^{-1} (4) 384 ms^{-1}

Sol. **4**

$$\frac{\lambda}{2} = \ell_2 - \ell_1$$

$$\lambda = 2(70 - 30)$$

= 2×40
= 80 cm
v = λf

$= \frac{80}{100} \times 480 = 384 m/s$

4. A plane electromagnetic wave having a frequency υ = 23.9 GHz propagates along the positive z-direction in free space. The peak value of the Electric Field is 60 V/m. Which among the following is the acceptable magnetic field component in the electromagnetic wave ?

(1) $\vec{B} = 2 \times 10^{-7} \sin(0.5 \times 10^3 z - 1.5 \times 10^{11} t)\ \hat{i}$

(2) $\vec{B} = 2 \times 10^{7} \sin(0.5 \times 10^3 z + 1.5 \times 10^{11} t)\ \hat{i}$

(3) $\vec{B} = 2 \times 10^{-7} \sin(1.5 \times 10^2 x + 0.5 \times 10^{11} t)\ \hat{j}$

(4) $\vec{B} = 60 \sin(0.5 \times 10^3 x + 1.5 \times 10^{11} t)\ \hat{k}$

Sol. **1**

$C_0 = \frac{E_0}{B_0}$

$B_0 = \frac{E_0}{C} = \frac{60}{3 \times 10^8}$

$\omega = 2\pi f = 2 \times 3.14 \times 23.9 \times 10^9$ Hz

$= 1.5 \times 10^{11}$ Hz

$K = \frac{\omega}{c} = \frac{1.5 \times 10^{11}}{3 \times 10^8} = 0.5 \times 10^3$

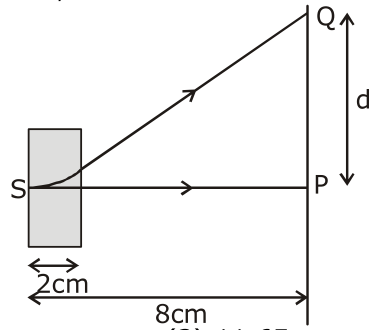
$B_0 = 2 \times 10^{-7}$

$\vec{B} = B_0 \sin(kz - \omega t)\hat{i}$

$\vec{B} = 2 \times 10^{-7} \sin(0.5 \times 10^3 z - 1.5 \times 10^{11} t)\ \hat{i}$

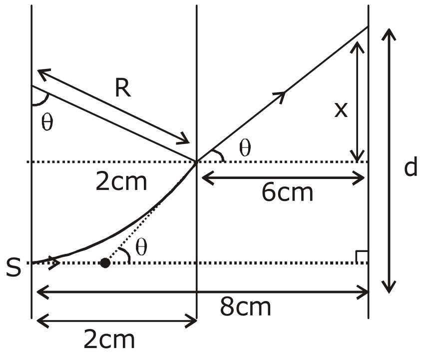
(as + z dir^n $prop^n$)

5. An electron, moving along the x-axis with an initial energy of 100 eV, enters a region of magnetic field $\vec{B}$ = (1.5 × 10^{-3} T) $\hat{k}$ at S (see figure). The field extends between x = 0 and x = 2 cm. The electron is detected at the point Q on a screen placed 8 cm away from the point S. The distance d between P and Q (on the screen) is -
(electron's charge = 1.6 × 10^{-19} C, mass of electron = 9.1 × 10^{-31} kg)



(1) 1.22 cm (2) 2.25 cm (3) 11.65 cm (4) 12.87 cm

Sol. **4**



$\text{Sin q} = \frac{2}{R}$ ....(1)

$\& R = \frac{mv}{qB}$ ....(2)

$= \frac{\sqrt{2mK_E}}{qB}$

$= \frac{\sqrt{2\times 9.1\times 10^{-3}\times 100\times 1.6\times 10^{-19}J}}{1.6\times 10^{-19}\times 1.5\times 10^{-3}}$

$R = \sqrt{5} \times 10^{-2}$ m

$\therefore \sin\theta = \frac{1}{\sqrt{5}}$

assume A is very small

$\tan\theta = \frac{2}{1} = \frac{x}{6}$

x = 12 cm

but d > x

So 12.87 cm

6. A solid sphere, of radius R acquires a terminal velocity υ_1 when falling (due to gravity) through a viscous fluid having a coefficient of viscosity η. The sphere is broken into 27 identical solid spheres. If each of these spheres acquries a terminal velocity, υ_2, when falling through the same fluid, the ratio (υ_1/υ_2) equals :

(1) 27 (2) 1/27 (3) 1/9 (4) 9

Sol. **4**

$V_T \propto R^2$

$R_2 = \left[\frac{R^3}{27}\right]^{\frac{1}{3}} = \frac{R}{3}$

$\frac{V_1}{V_2} = \frac{R^2}{\left(\frac{R}{3}\right)^2} = 9$

7. A particle is moving with speed $\upsilon = b\sqrt{x}$ along positive x-axis. Calculate the speed of the particle at time t = τ (assume that the particle is at origin at t = 0).

(1) $b^2\tau$ (2) $\frac{b^2\tau}{\sqrt{2}}$ (3) $\frac{b^2\tau}{2}$ (4) $\frac{b^2\tau}{4}$

Sol. **3**

$$V = b\sqrt{x}$$

$$\frac{dx}{dt} = b\sqrt{x}$$

$$\int_{x=0}^{x} \frac{dx}{\sqrt{x}} = b\int_{x=0}^{t} dt$$

$$\left.\frac{x^{\frac{-1}{2}+1}}{\frac{-1}{2}+1}\right]_{d}^{x} = bt$$

$$2\sqrt{x} = bt = \sqrt{x} = \frac{bt}{2}$$

$$\therefore V = \frac{dx}{dt}$$

$$= 2 \times \frac{1}{2\sqrt{x}}\left(\frac{dx}{dt}\right) = b \Rightarrow \frac{2}{bt} \times v = b$$

$$v = \frac{b^2}{2} \times \tau$$

8. A carnot engine has an efficiency of 1/6. When the temperature of the sink is reduced by 62°C, its efficiency is doubled. The temperatures of the source and the sink are, respectively -

(1) 99°C, 37°C (2) 124°C, 62°C (3) 62°C, 124°C (4) 37°C, 99°C

Sol. **1**

$$\eta = 1 - \frac{T_2}{T_1}$$

$$\frac{1}{6} = 1 - \frac{T_2}{T_1}$$

$$\frac{T_2}{T_1} = 1 - \frac{1}{6} = \frac{5}{6}$$

$$n' = 1 - \left(\frac{T_2 - 62}{T_1}\right)$$

$$\frac{1}{3} = 1 - \frac{T_2}{T_1} + \frac{62}{T_1}$$

$$\frac{1}{3} = \frac{1}{6} + \frac{62}{T_1}$$

$\Rightarrow T_1 = 62 \times 6 = 372K$

$\therefore = 99°C$

$\& \ T_2 = \frac{5}{6} \times T_1 = \frac{5}{6} \times 372 = 310K = 37°C$

Ans. - $T_1 = 99°C$
$T_2 = 37° C$

9. A moving coil galvanometer, having a ressitance G, produces full scale deflection when a current I_g flows through it. This galvanometer can be converted into (i) an ammeter of range 0 to I_0 ($I_0 > I_g$) by connecting a shunt resistance R_A to it and (ii) into a voltmeter of range 0 to V ($V = GI_0$) by connecting a series resistance R_V to it. Then -

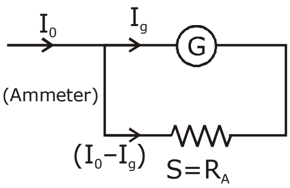
(1) $R_A R_V = G^2$ and $\frac{R_A}{R_V} = \frac{I_g}{(I_0 - I_g)}$

(2) $R_A R_V = G^2 \left(\frac{I_g}{I_0 - I_g}\right)$ and $\frac{R_A}{R_V} = \left(\frac{I_0 - I_g}{I_g}\right)^2$

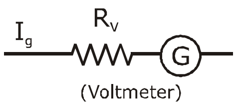
(3) $R_A R_V = G^2$ and $\frac{R_A}{R_V} = \left(\frac{I_g}{I_0 - I_g}\right)^2$

(4) $R_A R_V = G^2 \left(\frac{I_0 - I_g}{I_g}\right)$ and $\frac{R_A}{R_V} = \left(\frac{I_g}{(I_0 - I_g)}\right)^2$

Sol. **3**



$\left(I_0 - I_g\right) \times R_A = I_g \times G \quad (1)$



$V = I_g(R_V + G)$ (2)

given, $v = G \ I_0$

$I_g\left(R_V + G\right) = GI_0$

$\Rightarrow R_V = \frac{G\left(I_0 - I\right)}{I_g}$ (3)

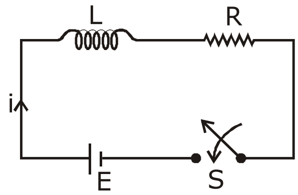
from (1), $R_A = \frac{I_g - G}{\left(I_0 - I_g\right)}$ (4)

$\therefore \frac{R_A}{R_V} = \frac{I_g.G}{\left(I_0 - I_g\right)} \times \frac{I_g}{G(I_0 - I_g)}$

$\frac{R_A}{R_V} = \frac{I_g^2}{\left(I_0 - I_g\right)^2}$

$R_A \cdot R_V = \left(\frac{I_g G}{I_0 - I_g}\right) \times \left(\frac{G\left(I_0 - I_g\right)}{I_g}\right) = (G)^2$

10. Consider the LR circuit shown in the figuer. If the switch S is closed at t = 0 then the amount of charge that passes through the battery between t = 0 and t = $\frac{L}{R}$ is -



(1) $\frac{EL}{7.3R^2}$ (2) $\frac{7.3EL}{R^2}$ (3) $\frac{2.7EL}{R^2}$ (4) $\frac{EL}{2.7R^2}$

Soll. **4**

$$i = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right)$$

where $\tau = \frac{L}{R}$

$$\int^{q} dq = \int_{0}^{\tau = L/R} idt$$

$$q = \int_0^{\tau} \frac{\varepsilon}{R}(1 - e^{-t/\tau})dt$$

$$q = \frac{\varepsilon}{R}\left[t - \frac{e^{-t/\tau}}{-1/\tau}\right]_0^{\tau} = \frac{\varepsilon}{R}\left[\tau + \frac{\tau}{e} - \tau\right]$$

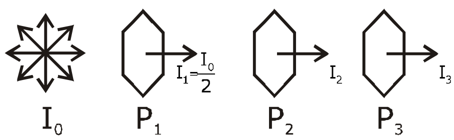
$$q = \frac{\varepsilon}{R} \times \frac{L}{R \times e} = \frac{\varepsilon L}{R^2 e}$$

$$q = \frac{\varepsilon L}{R^2 \times 2.7}$$

11. A sytem of three polarizers P_1, P_2, P_3 is set up such that the pass axis of P_3 is crossed with respect to that of P_1. The pass axis of P_2 is inclined at 60° to the pass axis of P_3. When a beam of unpolarized light of intensity I_0 is incident on P_1, the intensity of light transmitted by the three polarizers is I. The ratio (I_0/I) equals (nearly):

(1) 10.67 (2) 5.33 (3) 1.80 (4) 16.00

Sol. **1**



as we know, $I = I_0 \cos^2 \theta$

as angle b/w P_2 & P_3 = 60° and

P_1 and P_3 are crossed so angle b/w P_1 and P_2 = 90° – 60° = 30°

$\therefore I_2 = I_1 \cos^2 30°$

$I_2 = \frac{I_0}{2} \times \left(\frac{\sqrt{3}}{2}\right)^2 = \frac{I_0}{2} \times \frac{3}{4} = \frac{3}{8} I_0$

$\therefore I_3 = I_2 \cos^2 60°$

$I_3 = \frac{3}{8} I_0 \times \left(\frac{1}{2}\right)^2 = \frac{3}{8} I_0 \times \frac{1}{4} = \frac{3}{32} I_0$

to find $\frac{I_0}{I_3} = \frac{I_0}{\frac{3}{32} I_0} = \frac{32}{3} = 10.67$

12. A spring whose unstretched length is l has a force constant k. The spring is cut into two pieces of unstretched lengths l_1 and l_2 where, $l_1 = nl_2$ and n is an integer. The ratio k_1/k_2 of the corresponding force constants, k_1 and k_2 will be -

(1) $\frac{1}{n}$ (2) $\frac{1}{n^2}$ (3) n (4) n^2

Sol. **1**

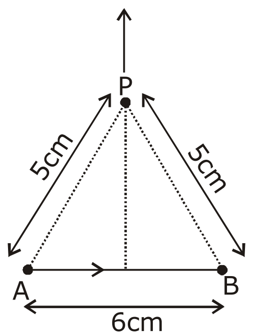
$K \cdot \ell$ = const.

$K_1 l_1 = K_2 \ell_2$

$\frac{K_1}{K_2} = \frac{\ell}{\ell_1} = \frac{\ell_2}{nl_2}$

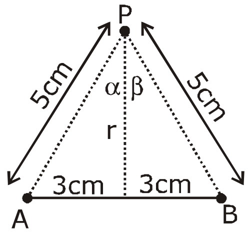
$\frac{K_1}{K_2} = \frac{1}{n}$

13. Find the magnetic field at point P due to a straight line segment AB of length 6 cm carrying a current of 5 A. (see figure) ($\mu_0 = 4\pi \times 10^{-7}$ N-A^{-2})



(1) 1.5×10^{-5} T (2) 2.0×10^{-5} T (3) 2.5×10^{-5} T (4) 3.0×10^{-5} T

Sol. **1**



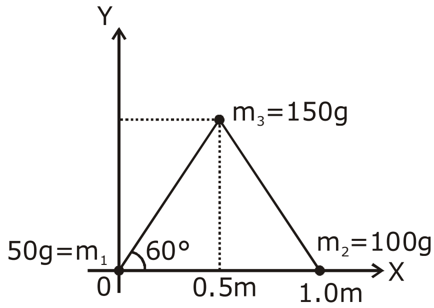
I = 5A

$r = \sqrt{5^2 - 3^2} = 4$ cm

$$B = \left(\frac{\mu_0}{4\pi}\right)\frac{I}{r}(\sin\alpha + \sin\beta)$$

$$= \frac{10^{-7} \times 5}{4 \times 10^{-2}}\left(\frac{3}{5} + \frac{3}{5}\right) = B = 1.5 \times 10^{-5}T$$

14. Three particles of masses 50 g, 100 g and 150 g are palced at the vertices of an equilateral triangle of side 1m (as shown in the figrue). The (x,y) coordiantes of the centre of mass will be-



(1) $\left(\frac{\sqrt{3}}{4}m, \frac{5}{12}m\right)$ (2) $\left(\frac{7}{12}m, \frac{\sqrt{3}}{8}m\right)$ (3) $\left(\frac{\sqrt{3}}{8}m, \frac{7}{12}m\right)$ (4) $\left(\frac{7}{12}m, \frac{\sqrt{3}}{4}m\right)$

Sol. 4

$$x_{cm} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$$

$$= \frac{0 + 100 \times 1 + 150 \times 0.5}{50 + 100 + 150} = \frac{175}{300} = \frac{7}{12}m$$

$$Y_{cm} = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3} = \frac{0 + 0 + 150 \times 0.5 \times \tan 60^\circ}{300} = \frac{75}{300} \times \sqrt{3} = \frac{\sqrt{3}}{4}m$$

$$CM = (x, y) = \left(\frac{7}{12}, \frac{\sqrt{3}}{4}\right)$$

15. Consider an electron in a hydrogen atom, revolving in its second excited state (having radius 4.65 Å). The de-Broglie wavelength of this electron is -

(1) 12.9 Å (2) 6.6 Å (3) 9.7 Å (4) 3.5 Å

Sol. 3

$mvr = \frac{nh}{2\pi}$ (n=3 a second excited state is)

$mvr = \frac{3h}{2\pi}$ (i)

$$mv = \frac{h}{\lambda} \qquad \text{(ii)}$$

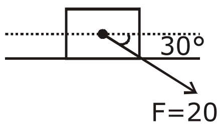
div eq.(i) by (ii)

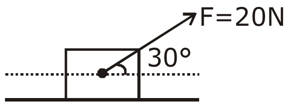
$$\frac{mvr}{mv} = \frac{\frac{3h}{2\pi}}{\frac{h}{\lambda}}$$

$$r = \frac{3\lambda}{2\pi}$$

$$\lambda = \frac{2\pi r}{3} = 9.7\text{Å}$$

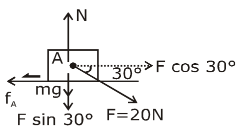
16. A block of mass 5 kg is (i) pushed in case (A) and (ii) pulled in case (B), by a force F = 20 N, making an angle of 30° with the horizontal, as shown in the figures. The coefficient of friction between the block and floor is μ = 0.2. The difference between the accelerations of the block, in case (B) and case (A) will be : (g = 10 ms^{-2})

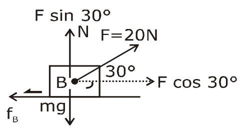
(A) 

(B) 

(1) 0.4 ms^{-2} (2) 3.2 ms^{-2} (3) 0.8 ms^{-2} (4) 0 ms^{-2}

Sol. **3**





N_A = mg + Fsin30°

$= 50 + 20 \times \frac{1}{2}$ = 60 N

$f_{A,L} = \mu N_A$

= 0.2×60 = 12 N

$$a_1 = \frac{F\cos 30° - f_{A,L}}{m_A}$$

$$= \frac{\frac{20\sqrt{3}}{2} - 12}{5} = 1m/s^2$$

= N_B = mg – Fsin30°

= 50 – 10 = 40 N

$f_{B,L} = \mu N_B$

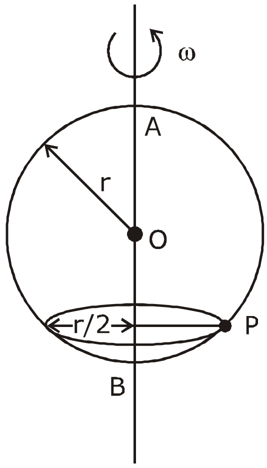
= 0.2×40 = 8N

$$a_2 = \frac{F\cos 30° - f_{B,L}}{m_B}$$

$$= \frac{\frac{20\sqrt{3}}{2} - 8}{5} = 1.8m/s^2$$

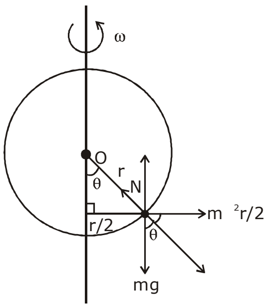
$$|a_2 - a_1| = 0.8m/s^2$$

17. A smooth wire of length $2\pi r$ is bent into a circle and kept in a vertical plane. A bead can slide smoothly on the wire. When the circle is rotating with angular speed ω about the vertical diameter AB, as shown in figure, the bead is at rest with respect to the circular ring at position P as shown. Then the value of ω^2 is equal to :



(1) $\left(g\sqrt{3}\right)/r$ (2) $\frac{\sqrt{3}g}{2r}$ (3) $2g/r$ (4) $2g/\left(r\sqrt{3}\right)$

Sol. **4**



$$\sin\theta = \frac{r}{2r} \Rightarrow \theta = 30^\circ$$

$$\tan 30^\circ = \frac{\omega^2 r}{2g}$$

$$\omega^2 = \frac{2g}{r\sqrt{3}}$$

18. A small speaker delivers 2 W of audio output. At what distance from the speaker will one detect 120 dB intensity sound? [Given reference intensity of sound as 10^{-12} W/m^2]

(1) 20 cm (2) 30 cm (3) 40 cm (4) 10 cm

Sol. **3**

Sound level $120 = 10 \log_{10}\left(\frac{I}{10^{-12}}\right)$

$I = 1 W/m^2$

$$\frac{P}{4\pi R^2} = 1$$

$$R = \frac{1}{\sqrt{2\pi}} m = 0.40m = 40cm$$

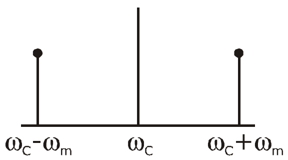
19. In an amplitude modulator circuit, the carrier wave is given by, $c(t) = 4 \sin (20000\,\pi t)$ while modulating signal is given by, $m(t) = 2 \sin (2000\pi t)$. The values of modulation index and lower side band frequency are :

(1) 0.5 and 10 kHz (2) 0.5 and 9 kHz (3) 0.4 and 10 kHz (4) 0.3 and 9 kHz

Sol. **2**

modulation index

$$m = \frac{V_m}{V_C} = \frac{2}{4} = \frac{1}{2} = 0.5$$



lower side band $= \omega_c - \omega_m = f_c - f_m$

$$\frac{20000\pi}{2\pi} - \frac{200\pi}{2\pi} = 10000 - 1000 = 9000Hz = 9KHz$$

20. The electron in a hydrogen atom first jumps from the third excited state to the second excited state and subsequently to the first excited state. The ratio of the respective wavelengths, λ_1/λ_2, of the photons emitted in this process is :

(1) 20/7 (2) 9/7 (3) 27/5 (4) 7/5

Sol. **1**

$$\frac{1}{\lambda_1} = R\left(\frac{1}{3^2} - \frac{1}{4^2}\right)$$

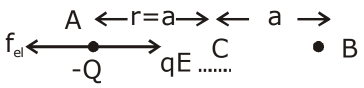
$$\frac{1}{\lambda_2} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$\frac{\lambda_1}{\lambda_2} = \frac{5R}{36} \times \frac{144}{7R} = \frac{20}{7}$$

21. Let a total charge 2Q be distributed in a sphere of radius R, with the charge density given by $\rho(r)=kr$, where r is the distance from the centre. Two charges A and B, of –Q each, are placed on diametrically opposite points, at equal distance, a, from the centre. If A and B do not experience any force, then :

(1) $a = \frac{3R}{2^{1/4}}$ (2) $a=R/\sqrt{3}$ (3) $a=8^{-1/4}R$ (4) $a=2^{-1/4}R$

Sol. **3**



$$\oint E.dA = \frac{q_{in}}{\varepsilon_0} = \int \rho dv$$

$$E4\pi r^2 = \int \frac{kr4\pi r^2}{\varepsilon_0}$$

$$E = \frac{K}{4}a^2$$

$$\frac{Q^2}{4\pi\varepsilon(2a)^2} = Q \times \frac{k}{4}a^2$$

$$\frac{Q}{4\pi\varepsilon_o k} = a^4$$

also $2Q = \int_0^R \rho dv$

$$2Q = \frac{KR^4.4\pi}{4}$$

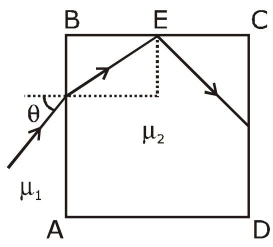
$$\frac{Q}{4\pi k} = \frac{R^4}{8}$$

from (1) & (2)

$$a^4 = \frac{R^4}{8}$$

$$a = R(8)^{-\frac{1}{4}}$$

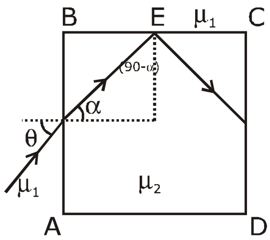
22. A transparent cube of side d, made of a material of refractive index μ_2, is immersed in a liquid of refractive index $\mu_1(\mu_1<\mu_1)$. A ray is incident on the face AB at an angle θ(shown in the figure). Total internal reflection takes place at point E on the face BC.



Then θ must satisfy :

(1) $\theta > \sin^{-1}\frac{\mu_1}{\mu_2}$ (2) $\theta > \sin^{-1}\sqrt{\frac{\mu_2^2}{\mu_1^2} - 1}$ (3) $\theta < \sin^{-1}\frac{\mu_1}{\mu_2}$ (4) $\theta < \sin^{-1}\sqrt{\frac{\mu_2^2}{\mu_1^2} - 1}$

Sol. 4



At AB

$\mu_1 \sin\theta = \mu_2 \sin\alpha$ ..(1)

At BC, for T.I.R. $(90–\alpha) > i_c$

taking sine both sides

$\sin(90-\alpha) > \sin\ i_c$

$\cos\alpha > \dfrac{\mu_1}{\mu_2}$ ....(2)

$\sqrt{1-\sin^2\alpha} > \dfrac{\mu_1}{\nu_2}$

$1 - \dfrac{\mu_1^2 \sin^2\theta}{\mu_2^2} > \dfrac{\mu_1}{\mu_2}$

$1 - \dfrac{\mu_1^2}{\mu_2^2} > \dfrac{\mu_1^2}{\mu_2^2}\sin^2\theta$

$\sqrt{\dfrac{\mu_2^2}{\mu_1^2} - 1} > \sin\theta$

$\theta < \sin^{-1}\left(\sqrt{\dfrac{\mu_2^2}{\mu_1^2} - 1}\right)$

23. The ratio of the weights of a body on the Earth's surface to that on the surface of a planet is 9:4. The mass of the planet is $\frac{1}{9}$th of that of the Earth. If 'R' is the radius of the Earth, what is the radius of the planet? (Take the planets to have the same mass density)

(1) $\dfrac{R}{4}$ (2) $\dfrac{R}{2}$ (3) $\dfrac{R}{3}$ (4) $\dfrac{R}{9}$

Sol. 2

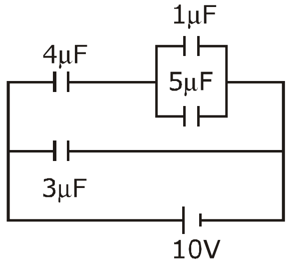
$\dfrac{g_E}{g_P} = \dfrac{9}{4}$

$g = \dfrac{GM}{R^2} \Rightarrow \dfrac{g_E}{g_p} = \dfrac{M_E}{R_E^2} \times \dfrac{R_P^2}{M_P}$

$$\frac{R_P}{R_E} = \frac{1}{2}$$

$$R_P = \frac{R}{2}$$

24. In the given circuit, the charge on 4μF capacitor will be :



(1) 5.4 μC (2) 9.6 μC (3) 24 μC (4) 13.4 μC

Sol. **3**

$$\frac{C_1}{C_2} = \frac{V_2}{V_1}$$

$$V = \frac{Q}{C} = \frac{V_2}{V_1}$$

$V_1 = \frac{3}{2}V_2$ (i)

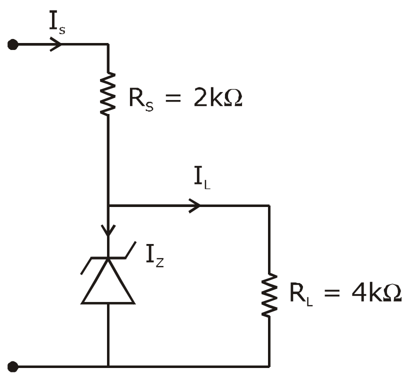
$v_1 + v_2 = 10$ v (ii)

by equation (i) & (ii)

$v_1 = 6$ V

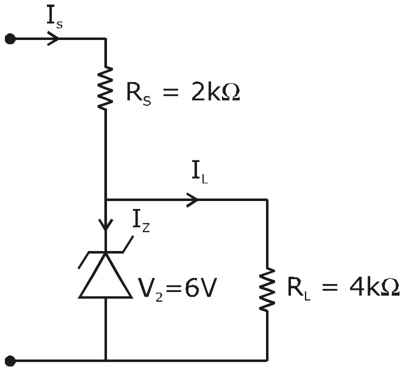
$Q_1 = 6\times4 = 24\mu C$

25. Figure shows a DC voltage regulator circuit, with a Zener diode of breakdown voltage = 6V. If the unregulated input voltage varies between 10V to 16V, then what is the maximum Zener current?



(1) 2.5 mA (2) 1.5 mA (3) 3.5 mA (4) 7.5 mA

Sol. **3**



$$I_L = \frac{V_z}{R_L} = \frac{6}{4} = 1.5mA$$

for $v_1 = 10$ V, $I_S = \frac{V_1 - V_z}{R_S} = \frac{10-6}{2} = \frac{4}{2} = 2mA$

$I_Z = I_S - I_L = 2mA - 1.5mA = 0.5$ mA

for $V_2 = 16V$, $I_S = \frac{16-6}{2} = 5mA$

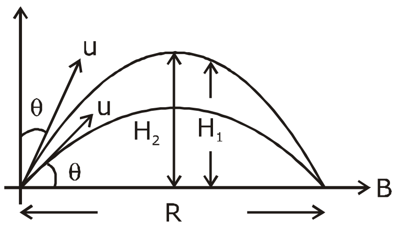
$I_Z = I_S - I_L = 5 - 1.5 = 3.5mA$

$\therefore$ max^m $I_z = 3.5mA$

26. Two particles are projected from the same point with the same speed u such that they have the same range R, but different maximum heights, h_1 and h_2. Which of the following is correct?

(1) $R^2 = 2\,h_1h_2$ (2) $R^2 = 16\,h_1h_2$ (3) $R^2 = 4\,h_1h_2$ (4) $R^2 = h_1h_2$

Sol. **2**



$$H_1 = \frac{u^2 \sin^2\theta}{2g}, H_2 = \frac{u^2 \sin^2(90-\theta)}{2g}$$

$$R^2 = \frac{u^4.4\sin^2\theta.cm^2\theta}{g^2}$$

$$H_1H_2 = \frac{u^4\sin^2\theta \times Cm^2\theta}{4g^2}$$

$R^2 = 16H_1H_2$

27. The number density of molecules of a gas depends on their distance r from the origin as, $n(r) = n_0 e^{-\alpha r^4}$. Then the total number of molecules is proportional to :

(1) $n_0 \alpha^{-3/4}$ (2) $n_0 \alpha^{-3}$ (3) $n_0 \alpha^{1/4}$ (4) $\sqrt{n_0}\,\alpha^{1/2}$

Sol. **1**

$$N = \int n dV = \int_0^r n_0 e^{-\alpha r^4} \times 4\pi r^2 dr$$

integration by parts I Late

28. A uniform cylindrical rod of length L and radius r, is made from a material whose Young's modulus of Elasticity equals Y. When this rod is heated by temperature T and simultaneously subjected to a net longitudinal compressional force F, its length remains unchanged. The coefficient of volume expansion, of the material of the rod, is (nearly) equal to :

(1) $F/(3\pi r^2 YT)$ (2) $9F/(\pi r^2 YT)$ (3) $3F/(\pi r^2 YT)$ (4) $6F/(\pi r^2 YT)$

Sol. **3**

Stress, $\sigma = \frac{F}{A}$

$$\frac{\text{stress}}{\text{strain}} = Y$$

$$\therefore \frac{F/A}{\alpha \Delta T} = Y$$

$$\frac{F}{A\Delta TY} = \alpha$$

$$\frac{F}{\pi r^2 \times T.Y} = \alpha$$

$\& \ \gamma = 3\alpha$

$$r = \frac{3F}{\pi r^2 YT}$$

29. A diatomic gas with rigid molecules does 10 J of work when expanded at constant pressure. What would be the heat energy absorbed by the gas, in this process?

(1) 40 J (2) 35 J (3) 30 J (4) 25 J

Sol. **2**

$$\frac{W}{Q} = \frac{R}{C_p} \left(\begin{array}{c} \text{At const pressure} \\ \text{as } Q = nC_p\Delta T \\ W = nR\Delta T \end{array} \right)$$

$$\frac{10}{Q} = \frac{R}{\frac{7}{2}R}$$

$Q = 35J$

30. One kg of water, at 20°C, is heated in an electric kettle whose heating element has a mean (temperature averaged) resistance of 20Ω. The rms voltage in the mains is 200 V. Ignoring heat loss from the kettle, time taken for water to evaporate fully, is close to :
[Specific heat of water = 4200 J/(kg °C), Latent heat of water = 2260 kJ/kg]
(1) 10 minutes (2) 16 minutes (3) 3 minutes (4) 22 minutes

Sol. **4**

$$ms\Delta T + mL = \frac{V^2}{R} \times t$$

$$1 \times 4200 \times (100 - 20) + 1 \times 2260 \times 10^3 = \frac{(200)^2}{20} \times t$$

$$4200 \times 80 + 2266 \times 10^3 = \left(\frac{200 \times 200}{20}\right)^t$$

t = 1298 s

$$= \frac{1298}{60} \text{min}$$

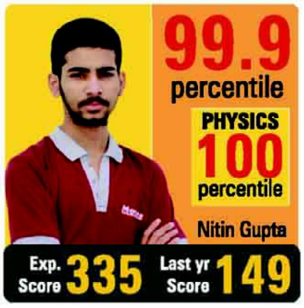
= 21.6 min

$\simeq$ 22min

मोशन ने बनाया साधारण को असाधारण

JEE Main Result Jan'19

4 RESIDENTIAL COACHING PROGRAM (DRONA) STUDENTS ABOVE 99.9 PERCENTILE



Total Students Above 99.9 percentile - **17**

Total Students Above 99 percentile - **282**

Total Students Above 95 percentile - **983**

% of Students Above 95 percentile $\frac{983}{3538}$ = **27.78%**

Scholarship on the Basis of 12th Class Result

Marks PCM or PCB	Hindi State Board	State Eng OR CBSE
70%-74%	30%	20%
75%-79%	35%	25%
80%-84%	40%	35%
85%-87%	50%	40%
88%-90%	60%	55%
91%-92%	70%	65%
93%-94%	80%	75%
95% & Above	90%	85%

New Batches for Class 11th to 12th pass
17 April 2019 & 01 May 2019

हिन्दी माध्यम के लिए पृथक बैच

Scholarship on the Basis of JEE Main Percentile

Score	JEE Mains Percentile	English Medium Scholarship	Hindi Medium Scholarship
225 Above	Above 99	Drona Free (Limited Seats)	
190 to 224	Above 97.5 To 99	100%	100%
180 to 190	Aboev 97 To 97.5	90%	90%
170 to 179	Above 96.5 To 97	80%	80%
160 to 169	Above 96 To 96.5	60%	60%
140 to 159	Above 95.5 To 96	55%	55%
74 to 139	Above 95 To 95.5	50%	50%
66 to 73	Above 93 To 95	40%	40%
50 to 65	Above 90 To 93	30%	35%
35 to 49	Above 85 To 90	25%	30%
20 to 34	Above 80 To 85	20%	25%
15 to 19	75 To 80	10%	15%

सैन्य कर्मियों के बच्चो के लिए 50% छात्रवृत्ति | **प्री-मेडिकल में छात्राओं को 50% छात्रवृत्ति**