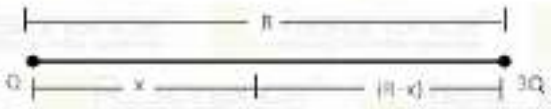
PART : PHYSICS

1. Two charge Q and 3Q are kept in a line separated by a distance R. If electric field is zero at a distance x from Q. Find the value of x



(1) $\left(\frac{R}{4}\right)$ (2) $\left(\frac{R}{3}\right)$ (3) $(\sqrt{3}-1)R$ (4) $\left(\frac{\sqrt{3}-1}{2}\right)R$

Ans. **(4)**

Sol. $E=\frac{KQ}{R^2}$

$$\frac{KQ}{x^2}=\frac{K3Q}{(R-x)^2}$$

$$\frac{1}{x}=\frac{\sqrt{3}}{R-x}$$

$$R-x=\sqrt{3}x$$

$$R=(1+\sqrt{3})x$$

$$x=\left(\frac{1}{1+\sqrt{3}}\right)R$$

$$x=\left(\frac{\sqrt{3}-1}{2}\right)R$$

2. Stopping potential for a surface is 8V if wavelength of incident light is λ and it is 2V for wavelength 3λ. Find threshold wavelength for the surface.

(1) 3λ (2) 9λ (3) $\frac{27}{32}\lambda$ (4) 18λ

Ans. **(2)**

Sol. $eV_s=\frac{hc}{\lambda}-\frac{hc}{\lambda_{th}}$

$$\Rightarrow 8eV=\frac{hc}{\lambda}-\frac{hc}{\lambda_{th}} \quad ...(1)$$

$$2eV=\frac{hc}{3\lambda}-\frac{hc}{\lambda_{th}} \quad ...(2)$$

From (1) and (2)

$\lambda_{th}=9\lambda$

3. If mass defect in a nuclear reaction is 0.4 g then find Q - value.

(1) 3.6×10^{12} J (2) 18×10^{12} J (3) 36×10^{12} J (4) 27×10^{2}J

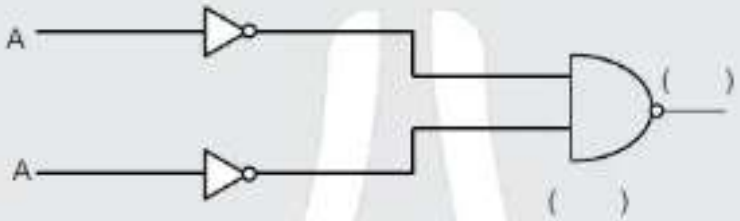
Ans. **(3)**

Sol. $Q = \Delta mc^2$

$$Q = \left(\frac{4}{10}\right) \times 10^{-3} (3 \times 10^8)^2$$

$$Q = 36 \times 10^{12} J$$

4. Output of given circuit represents which logic gate



(1) NAND Gate (2) NOR Gate

(3) OR Gate (4) AND Gate

Ans. **(3)**

Sol. $\overline{\overline{A}\,\overline{B}} = \left(\overline{\overline{A} + \overline{B}}\right) = A + B$

OR Gate

5. Find min deviation in a prism if refractive index $\mu = \cot(A/2)$. Here A represents angle of prism.

(1) $\pi - A$ (2) $\pi - 2A$ (3) $\frac{\pi}{2} - 2A$ (4) $\frac{\pi}{2} - \frac{A}{2}$

Ans. **(2)**

Sol. $$\mu = \cot\left(\frac{A}{2}\right) \Rightarrow \frac{\cos\frac{A}{2}}{\sin\frac{A}{2}} = \frac{\sin\frac{(\delta_{min} + A)}{2}}{\frac{\sin A}{2}}$$

$$\sin\left(\frac{\delta_{min} + A}{2}\right) = \cos\frac{A}{2} \Rightarrow \sin\left(\frac{\pi}{2} - \frac{A}{2}\right)$$

$$\frac{\delta_{min} + A}{2} = \frac{\pi}{2} - \frac{A}{2} \Rightarrow \delta_{min} = \pi - 2A$$

6. At a particular temperature, which of the following quantity is same for all gases?

(1) Average kinetic energy

(2) Average Speed

(3) R.M.S. Velocity

(4) Average Momentum

Ans. **(4)**

Sol. at any temperature average velocity is zero. So average momentum will be zero for any gas.

7. A coin is placed on a circular disc at a distance 'r', the friction coefficient between them is μ, the maximum angular velocity with which the disc can rotate without slipping of coin

(1) $\sqrt{\frac{2\mu g}{r}}$ (2) $\sqrt{\mu g r}$ (3) $\sqrt{\frac{\mu g}{r}}$ (4) $\sqrt{\frac{3\mu g}{r}}$

Ans. **(3)**

Sol. $N = mg$

$f = mw^2r$

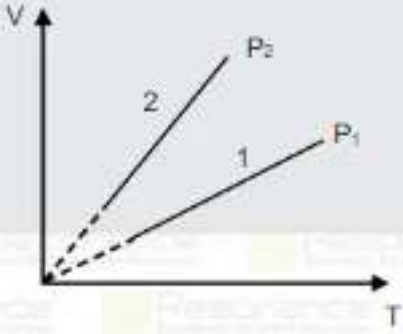
$f \le \mu N$ (For no slipping)

$\Rightarrow \quad \mu(mg) \ge mw^2r$

$\Rightarrow \quad w^2 \le \frac{\mu g}{r}$

$\Rightarrow \quad w_{max} = \sqrt{\frac{\mu g}{r}}$

8. Find relation between P_1 and P_2



(1) $P_2 < P_1$ (2) $P_2 > P_1$ (3) $P_1 = P_2$ (4) None of these

Ans. **(1)**

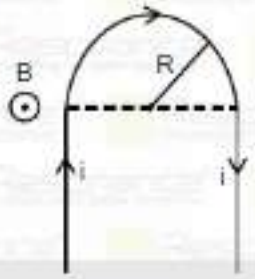
Sol. $PV = nRT$

$\frac{V}{T} = \left(\frac{nR}{P}\right)$

$(Slope)_2 > (Slope)_1$

$\therefore P_2 < P_1$

9. A current carrying wire is placed in an uniform external magnetic field as shown. Find the magnetic force on the given wire.



(1) BiR up (2) 2BiR up (3) BiR down (4) 2BiR down

Ans. **(4)**

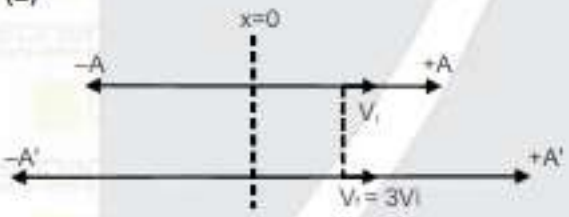
Sol. $F = BiL_{eff} = Bi2R$ down

10. A block is performing SHM of amplitude A. When it is at distance $\frac{2A}{3}$ from the mean position, its velocity is tripled by applying an impulse Find the new amplitude of motion.

(1) $\frac{3A}{7}$ (2) $\frac{7A}{3}$ (3) $\frac{5A}{3}$ (4) $\frac{3A}{5}$

Ans. **(2)**

Sol.



Velocity of at $x = \frac{2A}{3}$,

$V_i = \omega\sqrt{A^2 - \left(\frac{2A}{3}\right)^2}$

When velocity of oscillation at $x = \frac{2A}{3}$, become trippled . Then suppose A' becomes new amplitude of oscillation.

$\therefore \quad V_f = 3V_i$

$$\omega\sqrt{A'^2 - \left(\frac{2A}{3}\right)^2} = 3 \times \omega\sqrt{A^2 - \left(\frac{2A}{3}\right)^2}$$

$$\left(A'\right)^2 - \frac{4A^2}{9} = 5A^2$$

$$\left(A'\right)^2 = \frac{49A^2}{9}$$

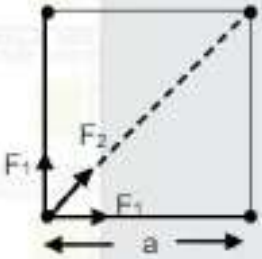
$$A' = \frac{7A}{3}$$

11. Four equal masses m are kept at corners of a square of side a. If magnitude of net gravitational force on any one mass is given by $\left(\frac{2\sqrt{2}+1}{32}\right)\frac{Gm^2}{L^2}$. Find the value of a in terms of L.

(1) a = 2L (2) a = 4L (3) a = 8L (4) a = 16L

Ans. (2)

Sol.



$F_1 = \frac{Gm^2}{a^2}, F_2 = \frac{Gm^2}{2a^2}$

$\vec{F}_{net} = \frac{Gm^2}{a^2}\frac{(2\sqrt{2}+1)}{2} = \left(\frac{2\sqrt{2}+1}{32}\right)\frac{Gm^2}{L^2}$

a = 4L Ans.

12. If a object of volume V is kept in water of density $\rho=10^3$ Kg/m^3 at depth h then percentage change in volume is 0.02% find value of h.(Bulk modulus = 9×10^5 N/m^2)

(1) 3 m (2) 9 m (3) 18 m (4) 12 m

Ans. (3)

Sol. $B = -\frac{\Delta P}{\Delta V/V}$

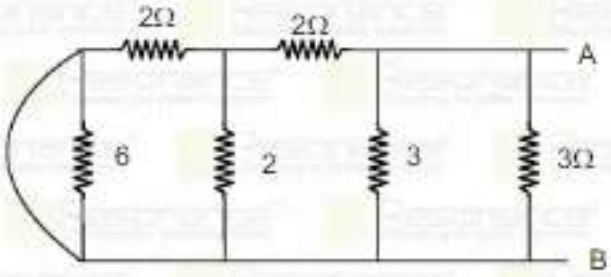
$\Delta P = B\left(-\frac{\Delta V}{V}\right)$

$\Rightarrow h\rho g = 9\times 10^8\left(\frac{0.02}{100}\right)$

$\Rightarrow 10^3\times 10\, h = 18 \times 10^4$

$\Rightarrow h = 18m$

13.



Find equivalent resistance of the circuit between A & B.

(1) 2 Ω (2) 3 Ω (3) 4 Ω (4) 1 Ω

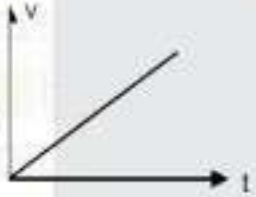
Ans. **(4)**

Sol. 6Ω resistance is shorted

so Req = 1Ω

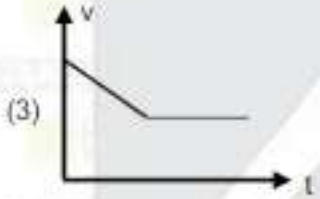
14. A ball is dropped in glycerine. Draw velocity time graph

(1)

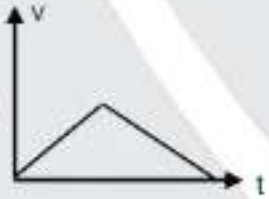


(2)

(3)



(4)



Ans. **(2)**

Sol. Initially ball is at rest later velocity will increase and reaches up to terminal velocity due to viscous force.

15. If the fundamental frequency of closed organ pipe of length ℓ is same as 1st overtone of another open organ pipe of length 60 cm, then find ℓ.

(1) 15 cm (2) 30 cm (3) 45 cm (4) 20 cm

Ans. **(1)**

Sol. $f = \frac{V}{4\ell} = \frac{2V}{2(60)}$

$\Rightarrow \frac{1}{4\ell} = \frac{1}{60}$

$\Rightarrow \ell = 15$ cm

16. An artillery of mass m_1 resting on smooth horizontal ground carries a shell of mass m_2. The artillery fires the shell horizontally. Find the ratio of kinetic energy of artillery and shell just after firing.

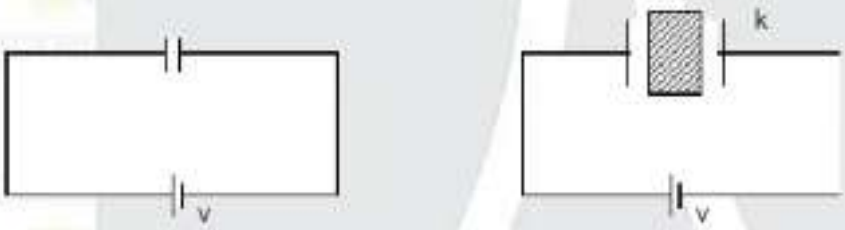
(1) $\frac{m_1}{m_2}$ (2) $\frac{m_2}{m_1}$ (3) $\sqrt{\frac{m_2}{m_1}}$ (4) $\sqrt{\frac{m_1}{m2}}$

Ans. (2)

Sol. $m_1 v_1 = m_2 v_2 \Rightarrow \frac{m_1}{m_2} = \frac{v_2}{v_1}$

$$\frac{K.E_{Ar}}{K.E_{shel}} = \frac{\frac{1}{2}m_1 v_1^2}{\frac{1}{2}m_2 v_2^2} = \frac{m_2}{m_1}$$

17.



Find ratio of energy stored in capacitor in two cases.

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

Ans. (2)

Sol. $E_1 = \frac{1}{2} cv^2$

$E_2 = \frac{1}{2} (kc) v^2$

$\frac{E_1}{E_2} = \frac{1}{k}$

18. If force $F = ax^2 + bt^{1/2}$, where x and t represent the position and time respectively.

Find the dimension of $\frac{b^2}{a}$.

(1) $[M^1 L^1 T^{-2}]$ (2) $[M^2 L^1 T^{-1}]$ (3) $[M^1 L^3 T^{-1}]$ (4) $[M^1 L^3 T^{-3}]$

Ans. (4)

Sol. $F = ax^2 + bt^{1/2}$

$\therefore [F] = [ax^2] = [bt^{1/2}]$

$[M\,L\,T^{-2}] = [aL^2]$ $\quad [a] = [M\,L^{-1}T^{-2}]$

Similarly

If $[F] = [bt^{1/2}]$

$[M\,L\,T^{-2}] = [bT^{1/2}]$ $\quad \Rightarrow [b] = [M\,L\,T^{-5/2}]$

$$\therefore \left[\frac{b^2}{a}\right] = \left[\frac{M^2L^2T^{-5}}{ML^{-1}T^{-2}}\right] = [M\,L^3\,T^{-3}]$$

19. The percentage error in measurement of length & radius of a cylindrical wire is 0.1% each. Find percentage error in measurement of resistance of wire.

(1) 0.5 % (2) 0.2 % (3) 0.3 % (4) 0.05 %

Ans. (3)

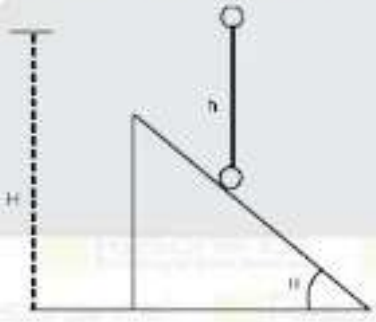
Sol. $R = \frac{\ell\rho}{A} = \frac{\ell\rho}{\pi(r^2)}$

$= \frac{\Delta l}{l} + \frac{2\Delta r}{r}$

$= 0.1\% + 0.2\%$

$= 0.3\%$

20. A ball is dropped from height H above the ground and it strikes an inclined plane after falling through height h. Find ratio $\frac{H}{h}$ so that ball will take maximum time to reach ground.



(1) 1 (2) 3 (3) 2 (4) 5

Ans. (3)

Sol. $t=\sqrt{\frac{2(H-h)}{g}}+\sqrt{\frac{2h}{g}}$

$$\frac{dt}{dh}=\frac{\sqrt{2}}{\sqrt{g}}\left(\frac{1}{2\sqrt{h}}-\frac{1}{2\sqrt{H-h}}\right)=0$$

$$2\sqrt{h}=2\sqrt{H-h}$$

$$h=H-h$$

$$\frac{h}{H}=\frac{1}{2}$$

$$\frac{H}{h}=2$$

21. If ratio of intensity of light from two sources are 1:9 then find the resultant intensity ratio if sources are coherent with phase difference is 60° in one case and incoherent in the other case

(1) 1 : 1 (2) 10 : 13 (3) 13 : 10 (4) 26 : 13

Ans. **(3)**

Sol. $I_{rc}=I_1+I_2+2\sqrt{I_1I_2}\cos\Delta\phi$

$$I_{rc}=I+9I+2\sqrt{9I^2}\times\frac{1}{2}$$

$$I_{rc}=13\,I$$

For Incoherence

$$I_n=I_1+I_2$$

$$I_n=10\,I$$

$$\frac{I_{rc}}{I_n}=\frac{13}{10}$$

22. A plane EM wave has electric field amplitude 50 V/m. Find its average energy density.

($\varepsilon_0 = 8.85\times10^{-12}\,C^2/Nm^2$)

(1) 11.06×10^{-9} J/m^3 (2) 11.06×10^{-8} J/m^3

(3) 11.06×10^{-10} J/m^3 (4) 11.06×10^{-7} J/m^3

Ans. **(1)**

Sol. $(E_A)_E=\frac{1}{2}\varepsilon_0 E_0^2$

$$=\frac{1}{2}\times8.85\times10^{-12}\times50\times50$$

$$=11.06\times10^{-9}\text{ J/m}^3$$

23. In relation b/w time 't' and distance 'x' is $t = ax^2 + bx$. a, b are constant, find acceleration

(1) $\frac{-a}{(2ax+b)^3}$ (2) $\frac{-2a}{(2ax+b)^3}$ (3) $\frac{-2a}{(2ax+b)^2}$ (4) $\frac{-a}{(2ax+b)^2}$

Ans. (2)

Sol. $t = ax^2 + bx$

$$\frac{dt}{dt} = a\frac{dx^2}{dt} + b\frac{dx}{dt} = 2axv + bv$$

$$1 = 2axv + bv$$

$$v = \frac{1}{2ax+b}$$

$$\frac{dv}{dx} = \frac{-2a}{(2ax+b)^2} = -2av^2$$

$$a = v\frac{dv}{dx} = -2av^3 = \frac{-2a}{(2ax+b)^3}$$

24. Find absolute work done to stop the disc rolling on horizontal surface with 0.4 m/s velocity having mass 50 Kg and radius R

(1) 4J (2) 2J (3) 6J (4) 8J

Ans. (3)

Sol. W=K.E of disc

$$W = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{3}{4}mv^2 = 6J$$

25. A parallel plate capacitor with separation between the plates 5mm, is charged by battery. Now if a dielectric slab of thickness 2mm is filled between the plates, charge increases by 25% then find dielectric constant of slab.

(1) 1 (2) 5 (3) 2 (4) 3

Ans. (3)

Sol. $Q_i = CV = \left(\frac{E_0A}{d}\right)V$

$$Q_f = \left(\frac{E_0A}{(d-t)+\frac{t}{k}}\right)V$$

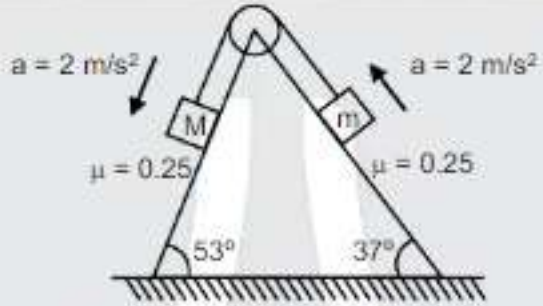
$$\frac{Q_f - Q_i}{Q_i} \times 100 = 25$$

$$\Rightarrow \frac{Q_t}{Q_i} - 1 = \frac{1}{4} \Rightarrow \frac{d}{d - t + \frac{t}{k}} = \frac{5}{4}$$

$$\Rightarrow 4d = 5d - 5t + \frac{5t}{k}$$

$$\Rightarrow k = 2$$

26. Find the value of m if M = 10 kg. All surfaces are rough



(1) 6.5 kg (2) 2.5 kg (3) 7.0 kg (4) 4.5 kg

Ans. **(4)**

Sol. $Mg(\sin 53° - \mu \cos 53°) - T = 2M$

$T - mg(\sin 37° + \mu \cos 37°) = 2m$

$$100\left(\frac{4}{5} - \frac{1}{4} \times \frac{3}{5}\right) - m \times 10\left(\frac{3}{5} + \frac{1}{4} \times \frac{4}{5}\right) = 20 + 2m$$

$80 - 15 - 20 = 2m + 8m$

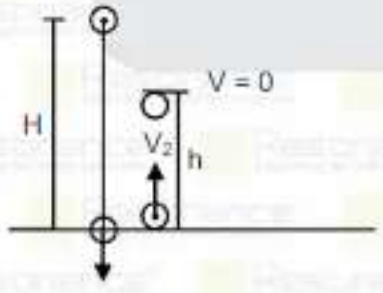
$$m = \frac{45}{10} = 4.5 \text{ kg}$$

27. A ball dropped from height H rebounds up to height h after colliding with horizontal surface. If coefficient of restitution for collision is $e = \frac{1}{2}$ then $\frac{H}{h}$ is :

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

Ans. **(1)**

Sol.



$V_1 =$

$V_2 = eV_1$

$\sqrt{2gh} = e\sqrt{2gH}$

$$h = e^2H = \frac{H}{4}$$

28. Two resistors of equal resistance have thermal coefficient of resistance α_1 & α_2 respectively. If they are connected in series and then in parallel, find α_{eq} for series and parallel combination respectively.

(1) $\alpha_1 + \alpha_2$, $\frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$ (2) $\frac{\alpha_1+\alpha_2}{2}$

(3) $\frac{\alpha_1+\alpha_2}{2}$, $\frac{\alpha_1+\alpha_2}{2}$ (4) $\frac{\alpha_1+\alpha_2}{2}$, $\frac{\alpha_1+\alpha_2}{\alpha_1+\alpha_2}$

Ans. (3)

Sol. In series ($R_1 = R_2 = R$)

$2R(1+\alpha_{eq}\,\Delta t) = R(1+\alpha_1\,\Delta t) + R(1+\alpha_2\,\Delta T)$

$\alpha_{eq} = \frac{\alpha_1+\alpha_2}{2}$

In parallel $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

$= \frac{dR}{R^2} = \frac{-dR_1}{R_1^2} + \frac{-dR_2}{R_2^2}$

$\frac{\alpha R dT}{R^2} = \frac{\alpha_1 R_1 dT}{R_1^2} + \frac{\alpha_2 R_2 dT}{R_2^2}$

$\frac{\alpha}{R} = \frac{\alpha_1}{R_1} + \frac{\alpha_2}{R_2} \rightarrow \alpha = \frac{\alpha_1+\alpha_2}{2}$

29. A circular coil of diameter 0.02 m is kept in an uniform magnetic field which is perpendicular to the plane of the coil. Initial magnetic field is 5000 T after 2 second magnetic field becomes 3000 T. If average value of induced emf in coil is 22 volt, find no. of turns in the coil. $\left(\pi = \frac{22}{7}\right)$.

(1) 70 (2) 50 (3) 30 (4) 100

Ans. (1)

Sol. $\varepsilon = \frac{\Delta\phi}{\Delta t} = \frac{NB_2A - NB_1A}{\Delta t} = \frac{N(B_2 - B_1)A}{\Delta t}$

$\rightarrow 22 = N = \frac{2000 \times \pi \times 0.01 \times 0.01}{2} \rightarrow N = 70$

30. In hydrogen like atom, wavelength of first line of lyman series is λ then wavelength of second line of lyman series shall be ?

(1) $\frac{5}{27}\lambda$ (2) $\frac{5}{32}\lambda$ (3) $\frac{27}{32}\lambda$ (4) $\frac{15}{23}\lambda$

Sol. $\frac{1}{\lambda} = RZ^2\left[\frac{1}{1} - \frac{1}{4}\right]$; $n = 2 \rightarrow 1$

$\frac{1}{\lambda'} = RZ^2\left[\frac{1}{1} - \frac{1}{9}\right]$; $n = 3 \rightarrow 1$

$\frac{\lambda'}{\lambda} = \frac{\frac{3}{4}}{\frac{8}{9}}$

$\lambda' = \frac{27}{32}\lambda$