PART : PHYSICS

1. Determine minimum energy released in balmer series of hydrogen atom.

(1) 3.4 ev (2) 12.09 ev (3) 1.89 ev (4) 10.2 ev

Ans. **(2)**

Sol. For minimum energy

For minimum energy

$\Delta E_{min} = 1.89V$

2. Current flowing in a conductor in given as $I = 3t^2 + 4t^3$. then charge flown through the cross section of conductor from t = 1 sec to t = 2sec will be-

(1) 10 C (2) 11 C (3) 22 C (4) 20 C

Ans. **(3)**

Sol. $I = \frac{dQ}{dt} = 3t^2 + 4t^3$

$$\int dQ = \int_1^2 (3t^2 + 4t^3)dt$$

$$Q = \frac{3t^3}{3} + \frac{4t^4}{4}\Big|_1^2 = (t^3 + t^4)\Big|_1^2$$

$=(8+16) -(1+1)=24-2 = 22$ C

3. Two moles of monoatomic gas and 6 moles of diatomic gas are mixed. Find molar heat capacity for the mixture at constant volume.

(1) $\frac{7}{2}R$ (2) $\frac{11}{2}R$ (3) $\frac{13}{2}R$ (4) $\frac{9}{4}R$

Ans. **(4)**

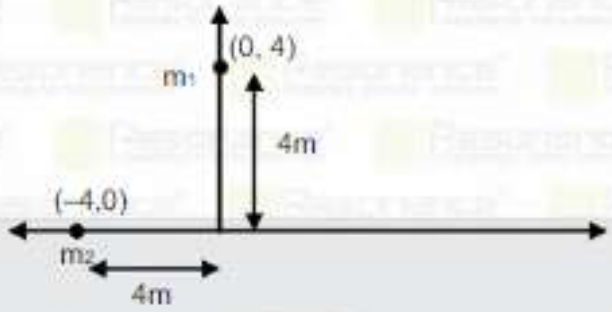
Sol. $C_{v\,mix} = C_{V_{mix}} = \frac{n_1C_{V_1} + n_2C_{V_2}}{n_1 + n_2}$

$n_1 = 2$, $C_{v1} = \frac{3R}{2}$ (monoatomic)

$n_2 = 6$, $C_{v2} = \frac{5R}{2}$ (Diatomic)

$$C_{v\,mix} = \frac{2 \times \frac{3R}{2} + 6 \times \frac{5R}{2}}{8} = \frac{3R + 15R}{8} = \frac{18R}{8} = \frac{9}{4}R$$

4. Two particle each of mass 2 kg are places as shown in x-y plane, if the distance of centre of mass from origin is $\frac{4\sqrt{2}}{x}$. Find x.



(1) 4 (2) 2 (3) 6 (4) 3

Ans. **(2)**

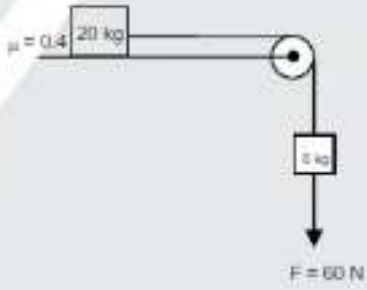
Sol. $\vec{r}_{cm} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2}{m_1 + m_2} = \frac{2(-4\hat{i}) + 2(4\hat{j})}{2+2}$

$\vec{r}_{cm} = -2\hat{i} + 2\hat{j}$

$\left|\vec{r}\right| = \sqrt{(-2)^2 + (2)^2} = 2\sqrt{2} = \frac{4\sqrt{2}}{2}$

$x = 2$

5. Find acceleration of the system if an external force of 60 N is applied on 6 kg block



(1) $\frac{20}{13}$ m/s² (2) 5 m/s² (3) $\frac{30}{17}$ ms² (4) $\frac{10}{6}$ m/s²

Ans. **(1)**

Sol. $a = \frac{\text{Net force along string}}{\text{total mass}}$

$a = \frac{60 + (6\times10) - (20\times10)\times0.4}{20+6}$

$a = \frac{20}{13}$ m/s²

6. Dimension of angular impulse is

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

Ans. **(1)**

Sol. $L = mvr = [MLT^{-1}L] = [ML^2T^{-1}]$

7. Radius of a nucleus of mass number 64 is 4.8 Fermi. Find atomic mass number of nucleus of radius 4 Fermi.

(1) 48 (2) 37 (3) 54 (4) 32

Ans. **(2)**

Sol. Density of nucleus is constant

$$\therefore \frac{\text{mass}}{\text{volume}} = \frac{\text{Atomic number}}{R^3} = \text{constant}$$

$$\therefore \frac{A_1}{R_1^3} = \frac{A_2}{R_2^3}$$

$$\rightarrow \quad A_2 = \left(\frac{R_2}{R_1}\right)^3 A_1$$

$$\rightarrow \quad A_2 = \left(\frac{4}{4.8}\right)^3 64$$

$$\rightarrow \quad A_2 = 37$$

8. **Statement 1 :** Value of Young's modulus increase on increasing temperature.

Statement 2 : Value of Young's modulus decreases on increasing temperature.

(1) Statement –I is true, Statement –II is true

(2) Statement –I is true, Statement –II is False

(3) Statement –I is false, Statement –II is true

(4) Statement –I is False, Statement –II is False

Ans. **(3)**

Sol. Statement-I is false, Statement-II is true

9. If de-broglie wavelength of proton is λ and of alpha particle is 2λ. Find the ratio of their speeds.

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

Ans. **(3)**

Sol. $\lambda = \frac{h}{p}$

$p = \frac{h}{\lambda}$

$\Rightarrow mv = \frac{h}{\lambda}$

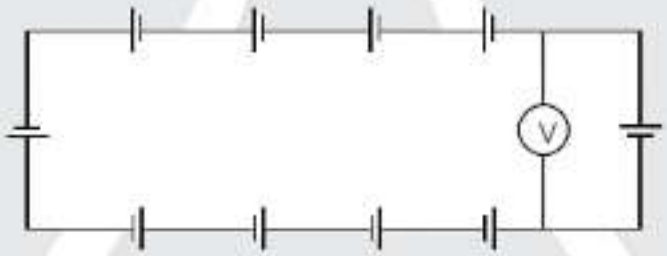
$\Rightarrow v = \frac{h}{m\lambda}$

$\Rightarrow \frac{v_p}{v_\alpha} = \frac{m_\alpha}{m_p} \cdot \frac{\lambda_\alpha}{\lambda_p}$

$\Rightarrow \frac{v_p}{v_\alpha} = \frac{4m}{m} \frac{2\lambda}{\lambda}$

$\Rightarrow \frac{v_p}{v_\alpha} = 8$

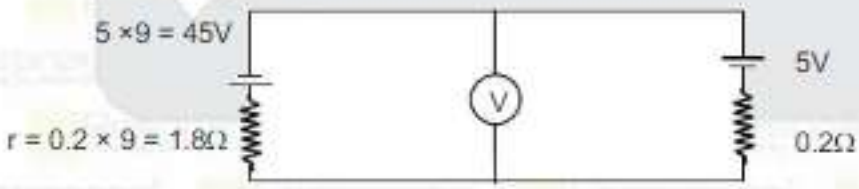
10. All batteries are identical (5v, 0.2Ω) and connected red as shown in the figure. Find the reading of voltmeter.



(1) 40 V (2) 45V (3) 30V (4) 0V

Ans. **(4)**

Sol.



$V = \frac{E_2 r_1 - E_1 r_2}{r_1 + r_2}$

$V = \frac{5 \times 1.8 - 45 \times 0.2}{1.8 + 0.2}$

$V = 0$

11. A gas undergoes a thermodynamic process from state (P_1, V_1, T_1). to state $(P_2V_2T_2)$ For the given process $PV^{\frac{3}{2}} =$ constant find the work done by the gas

(1) $\frac{P_2V_2 - P_1V_1}{2}$ (2) $\frac{P_1V_1 - P_2V_2}{2}$ (3) $2(P_1V_1 - P_2V_2)$ (4) $\frac{3(P_1V_1 - P_2V_2)}{2}$

Ans. (3)

Sol. $PV^{\frac{3}{2}} = c$

Work done $= \frac{P_2V_2 - P_1V_1}{1-x} = \frac{P_2V_2 - P_1V_1}{1-\frac{3}{2}} = 2(P_1V_1 - P_2V_2)$

12. Find focal length of a convex lens if image is 3 times virtually magnified. Distance between object & image is 20 cm

(1) 8 cm (2) 15 cm (3) 10 cm (4) 20 cm

Ans. (2)

Sol. $m = \frac{v}{u} = 3$

$v = 3u$

$v - u = 20$ cm

$2u = 20$ cm $\Rightarrow u = 10$ cm

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \quad = -\frac{1}{3u} = \frac{1}{v} - \frac{2}{3u}$

$f = \frac{3(10)}{2} = 15$ cm

13. Position of a particle moving along x-axis is given by $x = 6t^3 - t^2 - t$, Find the speed of the particle when its acceleration becomes zero.

(1) $-\frac{17}{18}$ m/s (2) $\frac{19}{18}$ m/s (3) $-\frac{19}{18}$ m/s (4) $\frac{17}{18}$ m/s

Ans. (3)

Sol. $x = 6t^3 - t^2 - t$

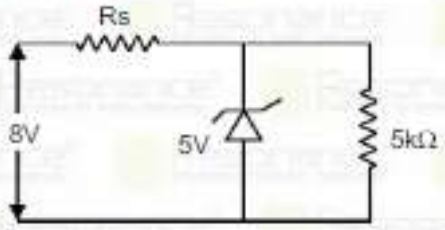
$v = 18t^2 - 2t - 1$

$a = 36t - 2 = 0$

$t = \frac{1}{18}$, $v = 18 \times \frac{1}{18} \times \frac{1}{18} - 2 \times \frac{1}{18} - 1$

$v = -\frac{19}{18}$ m/s

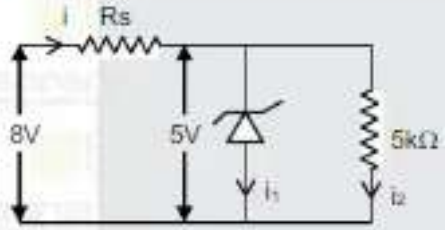
14. Power in zenor diode is 20mW Find value of resistance R_s.



(1) 600 Ω (2) 6000 Ω (3) 300 Ω (4) 3000 Ω

Ans. **(1)**

Sol.



$$i = i_1 + i_2 = \frac{P_1}{V_1} + \frac{V_2}{5k\Omega}$$

$$i = \frac{20}{5}mA + \frac{5}{5}mA$$

$i = 5mA$

$$\therefore Rs = \frac{(8-5)}{5} \times 1000\Omega = 600\Omega$$

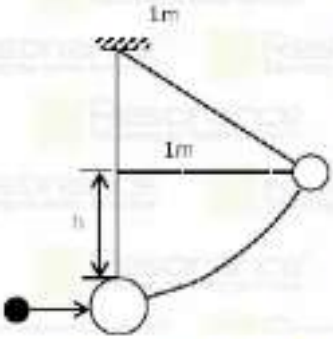
$Rs = 600\Omega$

15. A bullet of mass 10^{-2} Kg moving with speed 2×10^2 m/s hits a ballistic pendulum of length 1m and mass 1 Kg horizontally and gets embedded in it. Find the maximum height achieved by the system. ($g = 9.8$ m/s^2)

(1) 0.48 m (2) 0.196 m (3) 0.98 m (4) 1 m

Ans. **(2)**

Sol.



COLM (conservation & linear momentum)

$10^{-2} \times 2 \times 10^{2} = \left(1+10^{-2}\right) V$

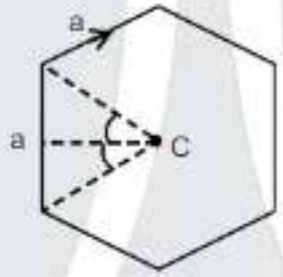
$\Rightarrow V \approx 2$ m/s

By COE

$\frac{1}{2} mv^2 = mgh$

$h = \frac{v^2}{2g} = 0.2$ m

16. Find the magnetic field at the center of current carrying regular hexagon wire of side length 'a' and current i.

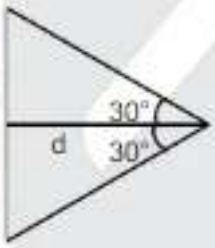


(1) $\frac{\mu_0 i}{\sqrt{3}\pi a}$ (2) $\frac{\sqrt{3}\,\mu_0 i}{2\pi a}$ (3) $\frac{\sqrt{3}\,\mu_0 i}{4\pi a}$ (4) $\frac{\sqrt{3}\,\mu_0 i}{\pi a}$

Ans. **(4)**

Sol. $d = a\cos 30°$

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



$B_c = 6 \times \frac{\mu_0 i}{4\pi\left(\frac{\sqrt{3}a}{2}\right)} (\sin 30° + \sin 30°)$

$= 6 \times \frac{\mu_0 i}{4\pi\frac{\sqrt{3}}{2}a} = 6 \times \frac{\mu_0 i}{4\pi\frac{\sqrt{3}}{2}a}\left(2 \times \frac{1}{2}\right)$

$B_c = \frac{\sqrt{3}\,\mu_0 i}{\pi a}$

17. The length of a seconds pendulum if it is placed at a distance 2R from the surface of earth (R = Radius of earth) is $\frac{10}{x\pi^2}$ m . Find x.

(1) 10 (2) 9 (3) 12 (4) 8

Ans. **(2)**

Sol. $T = 2\pi\sqrt{\frac{\ell}{g}}$

$g = \frac{GM}{R^2}$

$g' = \frac{GM}{(R+2R)^2} = \frac{g}{9}$

$T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow 2 = 2\pi\sqrt{\frac{\ell}{g/9}} \Rightarrow \frac{1}{\pi^2} = \frac{9\ell}{g}$

$\ell = \frac{g}{9\pi^2} = \frac{10}{9\pi^2}$

$x = 9$

18. Two identical charged particles of mass density 1.5 g/cm^2 are connected by individual strings of equal length from a common point and the system is placed in air. If angle between the strings does not change when dipped in water. Find the dielectric constant of water.

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

Ans. **(1)**

Sol. $\tan\theta = \frac{Fe}{\rho vg}$

θ is same

$\therefore \frac{Fe}{\rho Vg} = \frac{Fe'}{(\rho-\rho_w)Vg}$

$\Rightarrow \frac{Fe}{(1.5)} = \frac{Fe}{K(1.5-1)}$

$\Rightarrow K = 3$

19. Value of capacitance is changed from C to 4C in an LC circuit. Find the value of new inductance if original induction was L. Resonance frequency remain same.

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

Ans. **(1)**

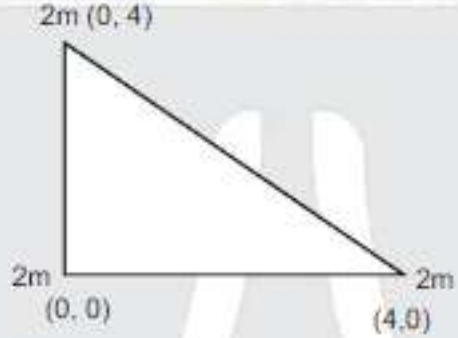
Sol. $W_r = \frac{1}{\sqrt{LC}} = \text{Constant}$

$LC = \text{Constant}$

If $C \to 4C$

Then $L \to \frac{L}{4}$

20. Find the coordinates of centre of mass of following system



(1) $\left(\frac{1}{2},\frac{4}{3}\right)$ (2) $\left(\frac{4}{3},\frac{4}{3}\right)$ (3) $\left(\frac{4}{3},\frac{5}{3}\right)$ (4) $\left(\frac{2}{3},\frac{2}{3}\right)$

Ans. **(2)**

Sol. $X_{com} = \frac{(2m).0 + (2m)(4) + (2m)(0)}{2m + 2m + 2m}$

$= \frac{8m}{6m} = \frac{4}{3}$

$Y_{com} = \frac{2m.0 + 2m.0 + 2m.4}{6m} = \frac{8m}{6m} = \frac{4}{3}$

at com $\left(\frac{4}{3},\frac{4}{3}\right)$ Ans.

21. A particle is performing horizontal circular motion of radius R with constant speed V. Its time period is T. Another particle is projected with same speed at an angle θ such that its maximum height is 2R. Find the value of θ. ($g = \pi^2$)

(1) $\frac{1}{2}\cos^{-1}\left(1-\frac{T^2}{R}\right)$ (2) $\frac{1}{2}\sin^{-1}\left(1-\frac{T^2}{R}\right)$

(3) $\frac{1}{2}\sin^{-1}\left(1-\frac{2T^2}{R}\right)$ (4) $\frac{1}{2}\cos^{-1}\left(1-\frac{2T^2}{R}\right)$

Ans. **(4)**

Sol. $T = \frac{2\pi R}{v} \Rightarrow v = \frac{2\pi R}{T}$

$h_{projectile} = \frac{v^2 \sin^2\theta}{2g}$

$2R = \left(\frac{2\pi R}{T}\right)^2 \frac{\sin^2\theta}{2g} = \frac{4\pi^2R^2}{2gT^2} \sin^2\theta$

$\sin^2\theta = \frac{gT^2}{\pi^2 R}$

$\sin^2\theta = \frac{T^2}{R}$

$= \frac{1-\cos 2\theta}{2} = \frac{T^2}{R}$

$\cos 2\theta = 1 - \frac{2T^2}{R}$

$\theta = \frac{1}{2}\cos^{-1}\left(1 - \frac{2T^2}{R}\right)$

22. A vernier calipers device has 10 main scale divisions coinciding with 11 vernier scale divisions each equals 5 mm. The least count of the is :

(1) $\frac{1}{2}$ mm (2) $\frac{1}{22}$ mm (3) $\frac{5}{11}$ mm (4) 0.3 mm

Ans. **(2)**

Sol. $1\ M.S = \frac{5}{10}$ mm

$1\ V.S = \frac{5}{11}$ mm

$L.C. = \frac{5}{10} - \frac{5}{11}$ mm

$L.C. = 5\left(\frac{1}{10\times 11}\right)$

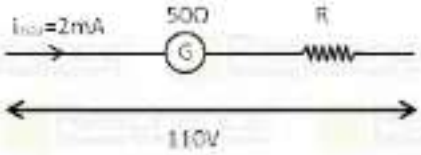
$L.C. = \frac{1}{22}$ mm

23. Resistance of a galvanometer is 50 Ω and full scale deflection current in galvanometer is 2 mA. To design a volt meter of range 110 V, find the resistance to be connected in series with the galvanometer.

(1) 25 KΩ (2) 50 KΩ (3) 55 KΩ (4) 60 KΩ

Ans. **(3)**

Sol.



$i_{max}(R+50) = 110$

$\Rightarrow R+50 = \frac{110}{2\times10^{-3}}$

$\Rightarrow R \approx 55\ K\Omega$

24. In single slit diffraction wavelength of light used is $\lambda = 6000A°$

If Slit width is 0.1 mm and convex lens of focal length 20 cm is used to collect the diffracted light.

Then find the width of central maxima.

(1) 2.2 mm (2) 2.8 mm (3) 2.4 mm (4) 3.4 mm

Ans. **(3)**

Sol. $\text{width} = 2\frac{f\lambda}{d}$

$= 2\frac{0.2\times6000\times10^{-10}}{0.1\times10^{-3}} = \frac{2.4\times10^{-7}}{10^{-4}}$

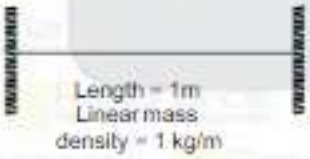
Width = $2.4 \times 10^{-3} = 2.4$ mm

25. Two strings each of length 1 m and linear mass density 1 kg/m are fixed at both ends with tension 6 N in each string. If the tension in one string is changed from 6 N to 52 N, then find the beat frequency. (Both the strings vibrating in fundamental mode)

(1) 2.35 Hz (2) 3.25 Hz (3) 2.75 Hz (4) 5.25 Hz

Ans. **(1)**

Sol.



$f = \frac{1}{2}\sqrt{\frac{T}{\mu}} = \frac{1}{2(1)}\sqrt{\frac{T}{1}} = \frac{\sqrt{T}}{2}$

$f_b = f_1 - f_2 = \frac{\sqrt{T_1}}{2} - \frac{\sqrt{T_2}}{2}$

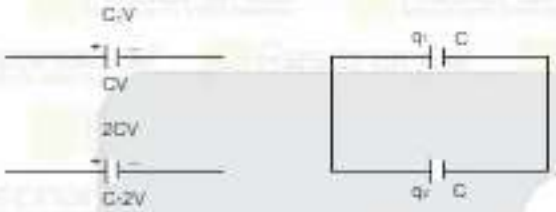
$= \frac{1}{2}\left[\sqrt{52} - \sqrt{6}\right] = \frac{7.2-2.5}{2} = \frac{4.7}{2} = 2.35$ Hz

26. Two capacitor of same capacitance (C) are charged with potential difference V and 2V respectively if these two are connected in such a way that positive terminal of one connected with positive terminal of other and same for negative terminal then find energy loss.

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

Ans. (3)

Sol.



$$\frac{q_1}{C}=\frac{q_2}{C} \Rightarrow q_1=q_2=\frac{CV+2CV}{2}=\frac{3}{2}CV$$

Energy loss $\Delta E=\frac{\Delta q_1^2}{2C}+\frac{\Delta q_2^2}{2C}$

$$\Delta E=\frac{\left(CV-\frac{3}{2}Cv\right)^2}{2C}+\frac{\left(2CV-\frac{3}{2}Cv\right)^2}{2C}$$

$$\Delta E=\frac{1}{8}CV^2+\frac{1}{8}Cv^2$$

$$\Delta E=\frac{1}{4}CV^2$$

27. For measuring resistivity, the relation $R=\frac{\rho\ell}{A}=\frac{\rho\ell}{\pi r^2}$ is used. The percentage error in resistance (R), in length (ℓ) and in radius (r) are given x, y and z respectively. Find percentage error in resistivity ρ.

(1) x + 2y + z (2) 2x + y + z (3) x + y + 2z (4) x + 2z– y

Ans. (3)

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

$$\rho=\frac{\pi r^2 R}{\ell}$$

$$\frac{\Delta\rho}{\rho}\times 100\%=\left(\frac{2\Delta r}{r}\times 100+\frac{\Delta R}{R}\times 100+\frac{\Delta\ell}{\ell}\times 100\right)\%$$

$$\frac{\Delta\rho}{\rho}\times 100\%=2z+x+y$$