PART : PHYSICS

1. A drop of radius R is split into 27 drops of equal radius, the work done is 10 J. If the same big drop is split into 64 equal drops the work done is-

(1) 10 J (2) 15 J (3) 20 J (4) $\frac{75}{4}$ J

Ans. (2)

Sol. $27 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$

$r = \frac{R}{3}$

initial surface area = $4\pi R^2$

Final surface area = $4\pi r^2 \times 27$

Change in surface area = $4\pi\,(27r^2 - R^2)$

$$= 4\pi\left(27\left(\frac{R}{3}\right)^2 - R^2\right) = 8\pi R^2$$

Work done by External Agent = $T \times 8\pi R^2 = 10$ ...... (i)

$64 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3 \Rightarrow r = \frac{R}{4}$

change in surface area $= 4\pi(64r^2 - R^2)$

$$= 4\pi\left(64\left(\frac{R}{4}\right)^2 - R^2\right)$$

$$= 12\pi R^2$$

Work done by External Agent = $T \times 12\,\pi R^2 = 12 \times \frac{10}{8} = 15J$

2. A satellite is revolving in a stable circular orbit of radius R and time period is T. If orbital radius of an another satellite is 1.03 R, then the percentage charge in time period of the second satellite as compared to the first will be :

(1) 1.5% (2) 4.5% (3) 7.5% (4) 9%

Ans. (2)

Sol. $T^2 \propto n^3$

$T \propto n^{3/2}$

$\frac{dT}{T} = \frac{3}{2}\frac{dr}{r} = \frac{3}{2} \times 3\% = 4.5\%$

3. In a parallel plate capacitor, the length, width and separation between the plates are respectively $\ell = 5$ cm, b = 3 cm and d = 1 μm. What will be the dimensions of an another capacitor, so that its capacitance becomes 10 times

(1) ℓ = 50 cm, b = 30 cm, d = 10 μm (2) ℓ = 50 cm, b = 10 cm, d = 10 μm

(3) ℓ = 10 cm, b = 30 cm, d = 50 μm (4) ℓ = 40 cm, b = 10 cm, d = 50 μm

Ans. (1)

Sol. $C = \frac{\varepsilon_0 A}{d} = \frac{\varepsilon_0(\ell b)}{d}$

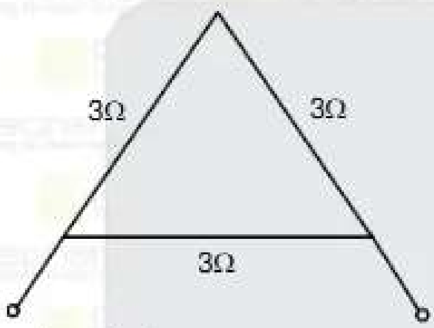
In option (A) $\ell \rightarrow$ 10 times, b → 10 times, b → 10 so C will also be 10 times.

4. Resistance of uniform wire is 9Ω. If it is bent in the form of an equilateral triangle, then equivalent resistance between its two vertices will be :

(1) 1Ω (2) 2Ω (3) 3 Ω (4) 6Ω

Ans. **(2)**

Sol.



$$\frac{1}{R_{eq}} = \frac{1}{3} + \frac{1}{6}$$

$R_{eq} = 2\Omega$

5. A Solid cylinder of mass m and radius r is released from rest at the top of a rough inclined plane making an angle of 45° with the horizontal. Assuming the cylinder rolls without sipping find the acceleration of the axis of the cylinder

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

Ans. **(3)**

Sol. $a = \frac{g\sin\theta}{1 + K^2/R^2}$

$$\frac{K^2}{R^2} = \frac{1}{2}$$

$$\text{Sin}45^\circ = \frac{1}{\sqrt{2}}$$

$$a = \frac{g \times \frac{1}{\sqrt{2}}}{3/2} = \frac{2g}{3\sqrt{2}}$$

6. If $I = I_A \text{Sin}\,\omega t + I_B \text{Cos}\,\omega t$, Then find rms value of current.

(1) $I_{rms} = I_A + I_B$ (2) $I_{rms} = \sqrt{I_A^2 + I_B^2}$ (3) $I_{rms} = \frac{1}{2}\sqrt{I_A^2 + I_B^2}$ (4) $I_{rms} = \sqrt{\frac{I_A^2 + I_B^2}{2}}$

Ans. **(4)**

Sol. $I_{max} = \sqrt{{I_A}^2 + {I_B}^2}$

$I_{rms} = \sqrt{\dfrac{{I_A}^2 + {I_B}^2}{2}}$

7. Work done by a force $F = (\alpha + \beta x^2)$ from $x = 0$ to $x = 1$ is 5J. If $\alpha = 1$, then find value of β.

(1) 4 (2) 8 (3) 12 (4) 16

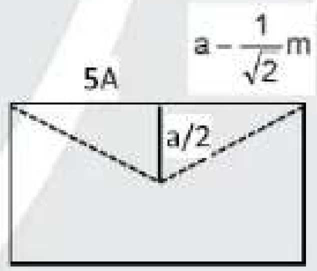
Ans. **(3)**

Sol. $W = \int F dx$

$5 = \alpha x + \beta \dfrac{x^3}{3}\Big|_0^1$

$5 = 1 \times 1 + \dfrac{\beta}{3} \times 1 \Rightarrow \beta = 12$

8. In a square loop of side length $\dfrac{1}{\sqrt{2}}$ m, current of 5 Amp is flowing. Find magnetic field as its centre (in μT).



(1) 3 (2) 9 (3) 11 (4) 8

Ans. **(4)**

Sol. $B_C = \dfrac{\mu_0 i}{\pi l} 2\sqrt{2}$

$= \dfrac{\mu_0 \times 5}{\pi \frac{1}{\sqrt{2}}} \times 2\sqrt{2}$

$= \dfrac{\mu_0}{\pi} \times 20 = \dfrac{4\pi \times 10^{-7} \times 10}{\pi}$

80×10^{-7}

$8 \times 10^{-7} = N \times 10^{-7}$

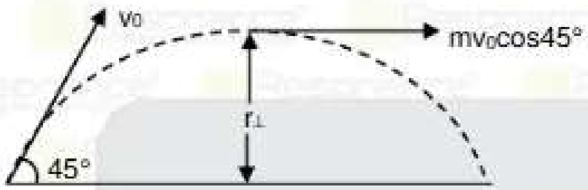
$N = 8$

9. A body projected with initial velocity V_0 at 45° angle in X-Y plane. Angular momentum of the particle at highest point about point of projection is :

(1) $\frac{mV_0^3}{4g}$ (2) $\frac{mV_0^3}{4\sqrt{2}g}$ (3) $\frac{mV_0^2}{4\sqrt{2}g}$ (4) $\frac{mV_0}{2\sqrt{2}g}$

Ans. **(2)**

Sol.



$\vec{L} = \vec{r} \times \vec{p}$

$\vec{L} = mv_0\cos45°$

$L = mvH$

$= m \times v_0\cos45° \times \frac{u^2 \sin^2 45°}{2g}$

$= mv_0 \times \frac{1}{\sqrt{2}} \times \frac{v_0^2}{4g}$

$L = \frac{mv_0^3}{4\sqrt{2}g} \Rightarrow \vec{L} = \frac{mv_0^3}{4\sqrt{2}g}(-\hat{k})$

10. An electron jumps from principle quantum state A to C by releasing photon of wavelength 2000 Å and from state B to C by releasing of photon of wavelength 6000 Å, then find wavelength of photon for transition from A to B.

(1) 2000 Å (2) 3000 Å (3) 4000 Å (4) 8000 Å

Ans. **(2)**

Sol. $E_A - E_C = \frac{hc}{2000}$

$E_B - E_C = \frac{hc}{6000}$

$E_A - E_B = \frac{hc}{\lambda}$

$E_A - E_B = \frac{hc}{2000} - \frac{hc}{6000} = \frac{hc}{\lambda}$

$\Rightarrow \frac{3-1}{6000} = \frac{1}{\lambda}$

$\lambda = \frac{6000}{2} = 3000Å$

11. Initial velocity of an electron is $v_0\hat{i}$ and its initial De-Broglie wavelength is λ_0. A uniform electric field of $\vec{E} = -E_0\hat{k}$ is applied. The De-Broglie wavelength as a function of time will be :-

(1) $\lambda(t) = \lambda_0$

(2) $\lambda(t) = \dfrac{h}{\sqrt{\left(\dfrac{1}{\lambda_0}\right)^2 + \left(\dfrac{eE_0t}{h}\right)^2}}$

(3) $\lambda(t) = \dfrac{1}{\sqrt{\left(\dfrac{1}{\lambda_0}\right)^2 + \left(\dfrac{eE_0t}{h}\right)^2}}$

(4) $\lambda(t) = \dfrac{1}{\sqrt{\left(\dfrac{1}{\lambda_0}\right)^2 + \left(\dfrac{eE_0t}{mh}\right)^2}}$

Ans. **(3)**

Sol. $\lambda_0 = \dfrac{h}{mV_0} \Rightarrow mV_0 = \dfrac{h}{\lambda_0}$

$\vec{V} = \vec{u} + \vec{a}t \Rightarrow \vec{V}(t) = v_0\hat{i} + \dfrac{(-e)(-E_0\hat{k})}{m}t$

$\vec{V} = v_0\hat{i} + \dfrac{eE_0}{m}t\hat{k} \Rightarrow |V| = \sqrt{v_0^2 + \left(\dfrac{eE_0}{m}t\right)^2}$

$\lambda_{ab}(t) = \dfrac{h}{m|V|} = \dfrac{h}{m\sqrt{v_0^2 + \left(\dfrac{eE_0}{m}t\right)^2}} = \dfrac{h}{\sqrt{\left(\dfrac{h}{\lambda_0}\right)^2 + \left(\dfrac{eE_0}{m}t\right)^2}}$

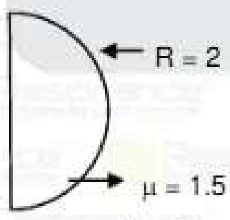
$\lambda_{ab}(t) = \dfrac{1}{\sqrt{\left(\dfrac{1}{\lambda_0}\right)^2 + \left(\dfrac{eE_0t}{h}\right)^2}}$

12. Radius of curvature of a plano convex lens is 2 cm and refractive index is 1.5 has focal length f_1 in air and f_2 in a medium of refractive index 1.2, calculate f_1/f_2

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

Ans. **(2)**

Sol.



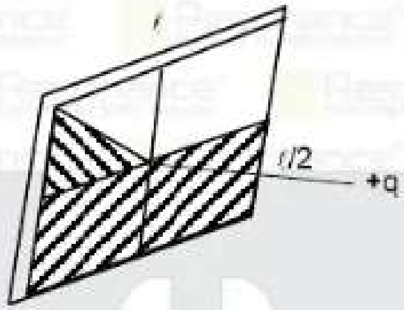
$\dfrac{1}{f_1} = (1.5 - 1) \times \dfrac{1}{2} = \dfrac{1}{4} \Rightarrow f_1 = 4$

$\dfrac{1}{f_2} = \left(\dfrac{1.5}{1.2} - 1\right) \times \dfrac{1}{2} = \dfrac{0.3}{2 \times 1.2} = \dfrac{1}{8}$

$f_2 = 8$

$\dfrac{f_1}{f_2} = \dfrac{4}{8} = \dfrac{1}{2}$

13. A point charge +1C is placed at a distance $\frac{\ell}{2}$ from center of a square surface of side length ℓ. If the flux passing through the shaded region is then $\phi = \frac{5}{x\varepsilon_0}$, then write the value of x



Ans. **48.00**

Sol. flux passing through the complete square surface = $\frac{q}{6\varepsilon_0}$

8 triangular surface .... $\phi = \frac{5}{6\varepsilon_0}$

1 triangular surface .... $\frac{q}{48\varepsilon_0}$

5 triangular surface .... $\phi = \frac{q}{48\varepsilon_0} \times 5$

$$\phi = \frac{5q}{48\varepsilon_0} \text{ where } q = 1C = \frac{5}{48\varepsilon_0} = \frac{5}{x\varepsilon_0}$$

x = 48

14. Find minimum order of maxima of wavelength λ_1 on screen in YDSE where maxima of λ_1 = 480 nm coincide with maxima of λ_2 = 600 nm.

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

Ans. **(1)**

Sol. λ_1 = 480 nm

λ_2 = 600 nm

n_1 = ?

$y = n_1\lambda_1 = n_2\lambda_2$

$\Rightarrow \frac{n_1}{n_2} = \frac{600}{480} = \frac{5}{4}$

n_1 = 5

15. In a process pressure of the gas is directly proportional to temperature then choose correct option

(A) Process is isochoric

(B) Work done in process is zero

(C) Internal energy increases with increase in temperature

(1) A and B are correct (2) A and C are correct

(3) A, B and C are correct (4) B and C are correct

Ans. **(3)**

Sol. $P \propto T$ (volume is constant)

process is isochoric

work = $P\Delta V = 0$

$\Delta U = nC_v\Delta T$

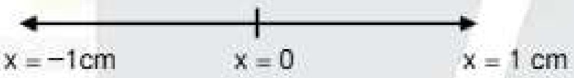
ΔU increase if temperature increase

16. A particle executes SHM with its time period 2 second and has amplitude of 1 cm. What is the ratio of total distance and displacement in 12.5 second :

(1) 25 : 1 (2) 5 : 1 (3) 4 : 5 (4) 3 : 2

Ans. **(1)**

Sol.



12 second + 0.5 second

$$\text{Distance} = \frac{4}{2} \times 12 + \frac{4}{2} \times 0.5$$

$$= 24 + 1 = 25 \text{ cm}$$

Displacement = 1 cm

$$\frac{\text{Distance}}{\text{Displacement}} = \frac{25}{1}$$

17. Find the maximum possible velocity for the given angle of banking θ on a curved road of radius of curvature r having coefficient of friction μ.

(1) $v_{max} = \sqrt{\frac{gr(\mu + \tan\theta)}{(1 - \mu\tan\theta)}}$ (2) $v_{max} = \sqrt{\frac{gr(\mu - \tan\theta)}{(1 - \mu\tan\theta)}}$

(3) $v_{max} = \sqrt{\frac{gr(1 + \tan\theta)}{(1 - \mu\tan\theta)}}$ (4) $v_{max} = \sqrt{\frac{gr(\mu - \tan\theta)}{(1 + \mu\tan\theta)}}$

Ans. **(1)**

18. What is the fractional decrease in focal length of a lens when optical power is increased from 2.5 D to 2.6 D.

(1) 0.05 (2) 0.04 (3) 0.10 (4) 0.25

Ans. **(2)**

Sol. $f = \frac{1}{P}$

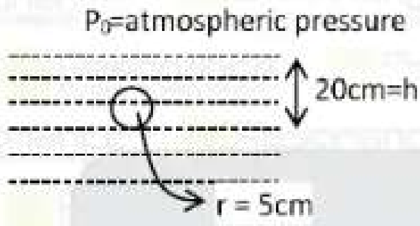
$$\frac{\Delta f}{f} = \frac{\Delta P}{P} = \frac{2.6 - 2.5}{2.5} = \frac{1}{25} = 0.04$$

19. A water bubble is at a depth of 20 cm and radius of bubble is 1 cm. If the inner pressure of the bubble is greater than the atmospheric pressure by 2100 N/m^2 then find the surface tension?

(1) 0.6 (2) 0.5 (3) 0.8 (4) 0.4

Ans. **(2)**

Sol.



$P_{in} - P_0 = 2100$ ..... (i)

$P_{in} - P_0 = \frac{2T}{R} + h\rho g$ ...(ii)

From (i) and (ii)

$2100 = \rho gh + \frac{2T}{R}$

$\frac{2T}{R} = 2100 - \rho gh$

T = 0.5

20. If the distance between two parallel plates of a capacitor is d, A is the area of each plate, and E is the electric field between both the plates. Find the energy stored in capacitor.

(1) $\frac{1}{2}E^2A\epsilon_0 d$ (2) $\frac{1}{4}E^2A\epsilon_0 d$ (3) $\frac{3}{4}E^2A\epsilon_0 d$ (4) $E^2A\epsilon_0 d$

Ans. **(1)**

Sol. Energy density (u) = $\frac{1}{2}\epsilon_0 E^2$

Energy stored = energy density × volume

$= \frac{1}{2}\epsilon_0 E^2 \times (A \times d)$

$= \frac{1}{2}E^2 A \epsilon_0 d$