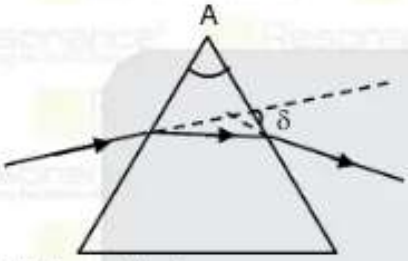
PART : PHYSICS

1. If angle of prism is equals to angle of minimum deviation. Given that $n = \sqrt{3}$, then angle of prism is :

(1) $\frac{\pi}{3}$ (2) $\frac{\pi}{6}$ (3) $\frac{\pi}{12}$ (4) $\frac{\pi}{4}$

Ans. **(1)**

Sol.



We know that

$$n = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

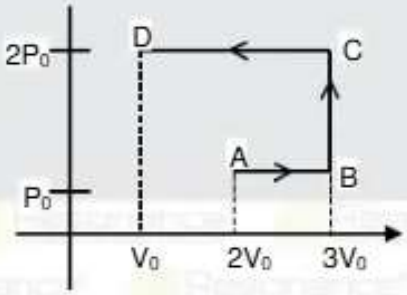
$$\sqrt{3} \Rightarrow \frac{\sin(A)}{\sin(A/2)} = \frac{2\sin A/2\cos A/2}{\sin(A/2)}$$

$$\frac{\sqrt{3}}{2} = \cos(A/2)$$

$$\frac{A}{2} = \frac{\pi}{6}$$

$$A = \frac{\pi}{3}$$

2. Find total work done by gas from A to D?



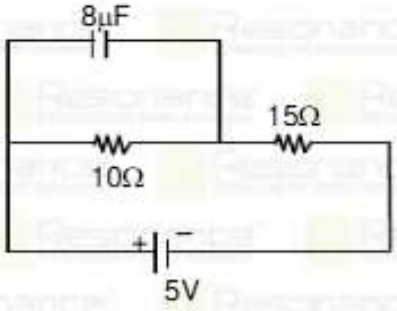
(1) $-3\ P_0V_0$ (2) $3\ P_0V_0$ (3) $2\ P_0V_0$ (4) $5\ P_0V_0$

Ans. **(1)**

So. $W = (P_0 \times V_0) + 0 + 2P_0(-2V_0)$

$W = -3P_0V_0$

3. Find the charge on capacitor in steady state



(1) 8μC (2) 16μC (3) 100μC (4) 16mC

Ans. **(2)**

Sol. Current through $10\Omega \Rightarrow I = \frac{5}{25} = 0.2\,A$

Potential drop across $10\Omega \Rightarrow V = IR = 0.2 \times 10 = 2V$

then charge stored on capacitor

$Q = CV = 8\times 10^{-6} \times 2$

$Q = 16\ \mu C$

4. A satellite is nine times closer to earth compared to moon. Time period of moon is 27 days then time period of satellite is

(1) 3 days (2) 9 days (3) 1 day (4) $3\sqrt{3}$ days

Ans. **(3)**

Sol. $\frac{T_1}{T_2} = \left(\frac{r_1}{r_2}\right)^{3/2}$

$T_1 = T_2\left(\frac{r_1}{r_2}\right)^{3/2}$

$= 27\left(\frac{r_e/9}{r_e}\right)^{3/2}$

$= \frac{27}{9^{3/2}} = \frac{27}{27} = 1$ day

5. In a series LCR circuit, inductance L = 100 μH and capacitance C = 10 nF. The angular frequency of the source when current has maximum amplitude in the circuit is

(1) $\frac{10^4}{2\pi}$ rad/s (2) $\frac{10^5}{2\pi}$ rad/s (3) 10^5 rad/s (4) 10^6 rad/s

Ans. **(4)**

Sol. $\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10^{-4}\times 10^{-8}}} = 10^6$ rad/s

6. A concave mirror has a focal length 'f'in air. What is the focal length of this mirror when it is completely immersed in a liquid of refractive index μ ?

(1) $\frac{f}{\mu-1}$ (2) μF (3) f (4) $\frac{f}{2(\mu-1)}$

Ans. **(3)**

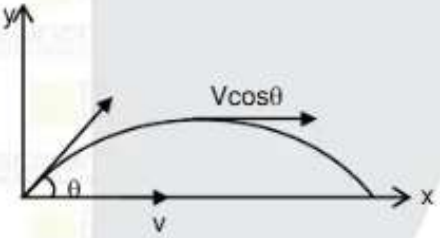
Sol. f (mirror) is independent from μ

7. A particle is projected with kinetic energy K with an angle $\frac{\pi}{3}$ from horizontal, then what will be kinetic energy at its maximum height ?

(1) $\frac{3K}{4}$ (2) $\frac{K}{4}$ (3) 0 (4) K

Ans. **(2)**

Sol.



$(K)_{\text{max height}} = \frac{1}{2} m[v(\cos\theta)]^2$

$= \frac{1}{2} mv^2(\cos 60°)^2$

$K_{min} = \frac{K}{4}$

8. **Statement I :** Graph of frequency f of x-ray & atomic number z of heavy nucleus is straight line, in x-ray emission.

Statement II : Graph of square root of frequency $\sqrt{f}$ of x-ray & atomic number z of heavy nucleus is straight line in x-ray emission.

(1) Statement 1 is correct & statement 2 is correct.
(2) Statement 1 is incorrect & statement 2 is correct.
(3) Statement 1 is correct & statement 2 is incorrect.
(4) Statement 1 is incorrect & statement 2 is incorrect.

Ans. **(2)**

Sol. from Mosley's law

$\sqrt{f} = a(z - b)$

so option (2) is correct.

9. When light of wave length λ is incident on a metal of work function w = 2.14 ev and stopping potential for electron is found to be 2 volt then find wavelength of incident light
[use hc = 1242 ev–nm]
(1) 100 nm (2) 200 nm (3) 300 nm (4) 400 nm

Ans. **(3)**

Sol. $E = K_m + W$

$$\frac{hc}{\lambda} = 2ev + 2.14\ ev$$

$$\lambda = \frac{1242\,ev - nm}{4.14\ ev} = 300\ nm$$

10. The value of E_0 is 9.3 V/m and C is 3×10^8 m/s. Find the value of B_0?
(1) 3.3×10^{-8} T (2) 3.1×10^{-8} T (3) 27.9×10^{-8} T (4) 27.9×10^{8} T

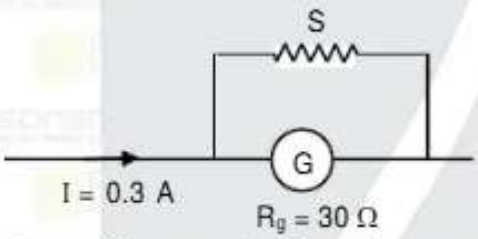
Ans. **(2)**

Sol. $E_0 = 9.3$ V/m $\quad C = 3 \times 10^8$ m/s

$E_0 = C.B_0$

$$B_0 = \frac{E_0}{C} = \frac{9.3\ v/m}{3\times10^8} = 3.1\times10^{-8}\ T$$

11.



For making ammeter of maximum current 0.3 Amp, a shunt is used in parallel with galvanometer of resistance 30 Ω. Maximum galvanometer current is 2 milli ampere. If the value of shunt resistance is $\frac{30}{x}\ \Omega$, what will be the value of x
(1) 149 (2) 298 (3) 300 (4) 49

Ans. **(1)**

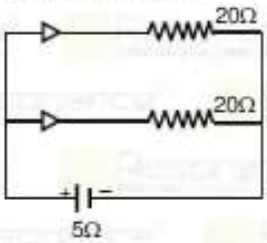
Sol. $I_gR_g = (I - I_g)(s)$

$(2mA)(30) = (300\ mA - 2mA)(s)$

$$s = \frac{30\times2}{298} = \frac{30}{149}\Omega = \frac{30}{x}$$

$x = 149$

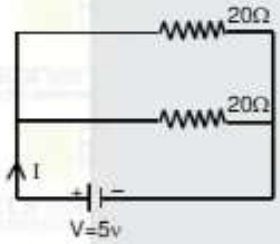
12. Find current through battery. If both diodes are ideal



(1) 0.2 A (2) 0.5 A (3) 0.125 A (4) 12.5 A

Ans. **(2)**

Sol.



$$I = \frac{V}{Req} = \frac{5}{10}$$

$I = 0.5$ A

13. **Statement-1 :** Binding energy is independent of atomic number

Statement-2 : Nuclear Force are long range force

(1) Statement 1 is correct & statement 2 is correct.

(2) Statement 1 is incorrect & statement 2 is correct.

(3) Statement 1 is correct & statement 2 is incorrect.

(4) Statement 1 is incorrect & statement 2 is incorrect.

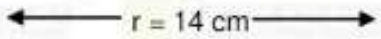
Ans. **(4)**

14. Two charges 7μC and –4μC are placed at (–7, 0, 0) cm and (7, 0, 0) cm. Find the electrostatic potential energy of two charge system? (Given $\epsilon_0 = 8.85 \times 10^{-12}$ C²/Nm²)

(1) 1.6 J (2) 0.9 J (3) 2.5 J (4) 1.8 J

Ans. **(4)**

Sol.



$$E = \frac{kq_1q_2}{r} = \frac{9\times10^9\times7\times10^{-6}\times4\times10^{-6}}{14\times10^{-2}}$$

$E = 1.8$ J

15. If equation of wave travelling in a medium is given by $y = 10\sin(3t + 0.1x)$ then what is the velocity of wave and direction ?

(1) $30\hat{i}$ m/sec (2) $30(-\hat{i})$ m/sec (3) $0.3\ \hat{i}$ m/s (4) $0.3(-\hat{i})$ m/s

Ans. **(2)**

Sol. $V_\omega = \frac{\omega}{k} = \frac{3}{0.1} = 30$ m/sec

direction of wave $= -\hat{i}$

16. A spring has tension 5N at x_1 extension and 7N at x_2 extension. Determine the tension in the spring when extension is $5x_1 - 2x_2$

(1) 11 N (2) 39 N (3) 25 N (4) 12 N

Ans. **(1)**

Sol. $kx_1 = 5$

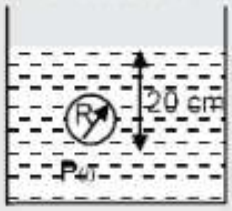
$kx_2 = 7$

$T = k(5x_1 - 2x_2)$

$5kx_1 - 2kx_2$

$= 25 - 14 = 11$ N

17. Find pressure inside the bubble with respect to atmospheric pressure which is 10^5 N/m^2 & density of water $P\omega = 10^{-3}$ kg/cm^3 & surface tension of bubble is 72×10^{-3} N/m (R = 1mm)



(1) 2000 pa (2) 2288 pa (3) 2144 pa (4) 1856 pa

Ans. **(3)**

Sol. $P_{bubble} - P_{atm} = \nu gh + \frac{2T}{R}$

$= \frac{10^{-3}}{10^{-6}} \times 10 \times 20 \times 10^{-2} + \frac{2\times 72}{10^{-3}} \times 10^{-3}$

$= 2 \times 10^3 + 144$

$= 2000 + 144 = 2144$ pa

18. A disc of mass M and radius R is rotating about its axis. If the angle rotated about its axis as a function of time 't' is $\theta = 10t^2 - 8t$, then find the power delivered to the disc at t = 2sec is :

(1) 120 watt (2) 320 watt (3) 220 watt (4) 440 watt

Ans. **(2)**

Sol. $\tau = I\alpha$

$P = \tau \cdot \omega$

$= I\alpha\omega$

$= \frac{MR^2}{2} \cdot \frac{d^2\theta}{dt^2} \cdot \frac{d\theta}{dt}$

$= \frac{MR^2}{2} \cdot (20)(20t - 8)$

$= 10\ MR^2\ (20\ t - 8)$

at t = 2second

$P = 10\ MR^2\ (40 - 8) = 320\ MR^2$ watt

19. In a YDSE experiment slits width are given as D and xD. If ratio of I_{max} and I_{min} is 9 : 4, then find value of x

(1) $\frac{1}{25}$ (2) $\frac{1}{5}$ (3) 25 (4) 5

Ans. **(1)**

Sol. We know that

$I \propto$ width of a slit

So $\frac{I_2}{I_1} = \frac{xD}{D} = x$

$I_2 = xI_1$

now $\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}\right)^2$

$= \left(\frac{1 + \sqrt{\frac{I_2}{I_1}}}{1 - \sqrt{\frac{I_2}{I_1}}}\right)^2$

$= \left(\frac{1+\sqrt{x}}{1-\sqrt{x}}\right)^2 = \frac{9}{4}$

$\Rightarrow \frac{1+\sqrt{x}}{1-\sqrt{x}} = \frac{3}{2}$

$\Rightarrow 2 + 2\sqrt{x} = 3 - 3\sqrt{x}$

$\Rightarrow 5\sqrt{x} = 1$

$\Rightarrow \sqrt{x} = \frac{1}{5}$

$x = \frac{1}{25}$

20. The temperature of a body of mass m and specific heat capacity s is raised slowly from T_1 to T_2. The change is entropy of the system is

(1) $ms\ell n\left(\frac{T_2}{T_1}\right)$ (2) $2ms\ell n\left(\frac{T_2}{T_1}\right)$ (3) $ms\ell n\left(\frac{T_1}{T_2}\right)$ (4) zero

Ans. **(1)**

Sol. $d\delta = \frac{d\theta}{T}$

$\int ds = \int m.s.\frac{dT}{T}$

$\Delta s = ms\ell n\left(\frac{T_2}{T_1}\right)$

21. Match the following.

(A) Magnetic permeability	(P) $[M^1A^{-1}T^{-2}]$
(B) Torsional constant	(Q) $[L^2A^1]$
(C) Magnetic field	(R) $[M^1L^2T^{-2}]$
(D) Magnetic moment	(S) $[M^1L^1A^{-2}T^{-2}]$

(1) A → R; B→S; C→P; D→Q (2) A → S; B→R; C→P; D→Q

(3) A → S; B→R; C→Q; D→P (4) A → S; B→P; C→R; D→Q

Ans. **(2)**

Sol. $M = iA \qquad [L^2A^1]$

$F = i\ell B$

$[B] = \frac{[F]}{[i\ell]} = \frac{M^1L^1T^{-2}}{[A^1L^1]} = M^1A^{-1}T^{-2}$

$\tau = c\theta$

$c = \frac{\tau}{\theta} = [F.d] = [M^1L^2T^{-2}]$

22. A fluid of density ρ flows through a horizontal pipe with a variable cross-section. At two different cross-sections, A and B, the fluid has velocities V_A and V_B, and pressures P_A and P_B respectively. Determine the correct relationship between velocities at these sections.

(1) $V_A - V_B = \frac{\rho}{2\left(P_B^2 - P_A^2\right)}$ (2) $V_A - V_B = \frac{2\left(P_A - P_B\right)}{\rho}$

(3) $V_A^2 - V_B^2 = \frac{2\left(P_B - P_A\right)}{\rho}$ (4) $V_A^2 - V_B^2 = \frac{2\left(P_A - P_B\right)}{\rho}$

Ans. **(3)**

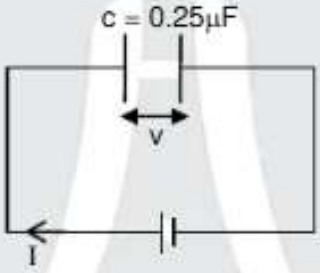
Sol. $P_A + \frac{1}{2}\rho V_A^2 = P_B + \frac{1}{2}\rho V_B^2$ (Using Bernolli's equation)

$$\frac{1}{2}\rho V_A^2 - \frac{1}{2}\rho V_B^2 = P_B - P_A$$

$$\frac{1}{2}\rho(V_A^2 - V_B^2) = P_B - P_A$$

$$V_A^2 - V_B^2 = \frac{2(P_B - P_A)}{\rho}$$

23. Find the rate of change of Voltage $\frac{dv}{dt}$. Given I = 0.25 mA.



(1) 10^{-3} v/s (2) 10^{3} v/s (3) 6.25×10^{-11} (4) 6.25×10^{-9} v/s

Ans. **(2)**

Sol. We know that

$$I = C\frac{dv}{dt}$$

$$\frac{dv}{dt} = \frac{I}{c} = \frac{0.25\times10^{-3}}{0.25\times10^{-6}}$$

$$\frac{dv}{dt} = 10^3 \text{ v/s}$$

24. The energy in a system varies with position and time as $E(x, t) = x^3e^{-\beta t}$ (where $\beta = 0.3$ sec^{-1}). Given that the percentage error in x = 1.2% and that the percentage error in t = 1.6%. Find the maximum percentage error in E at t = 5 sec.

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

Ans. **(3)**

Sol. $E = x^3 e^{-\beta t}$

$$\ell nE = 3\ell nx - \beta t$$

$$\frac{\Delta E}{E} = \frac{3\Delta x}{x} + \beta\Delta t$$

$$\frac{\Delta t}{t} \times 100 = 1.6$$

$$\Delta t \times 100 = 1.6 \times t = 1.6 \times 5 = 8$$

$$\frac{\Delta E}{E} \times 100 = \frac{3\Delta x}{x} \times 100 + \beta(\Delta t \times 100)$$

$$= 3 \times 1.2 + 0.3 \times 8 = 3.6 \times 2.4 = 6\%$$