**PART : PHYSICS**

**Ans. (2)**

**Sol.**  
K.E. $\Rightarrow K = \frac{p^2}{2m}$

$P = \sqrt{K}$

$P_2 = \frac{K_2}{P_2} \sqrt{4K}$
2. A RLC circuit is in its resonance condition. Its circuit components have value
\[ R = 5 \Omega \]
\[ L = 2H \]
\[ \frac{V_1}{V} = 2 \]
\[ \frac{P_2 - P_1}{P_1} = \left( \frac{P_2}{P_1} - 1 \right) \times 100 = 2 - 1 = 100 \]
\[ \frac{\Delta P}{P_1} = 100\% \]

3. A wheel rotating with an angular speed of 600 rpm is given an constant angular acceleration of 1800 rpm² for 10 sec. Number of revolutions revolved by wheel is:
\[ (1) 125 \]
\[ (2) 100 \]
\[ (3) 75 \]
\[ (4) 50 \]

\[ \text{Ans.} (1) \]

4. \[ |\vec{P} - \vec{Q}|, |\vec{P} + \vec{Q}| \] Find angle between \( \vec{P} \) & \( \vec{Q} \)
\[ (1) 45^\circ \]
\[ (2) 90^\circ \]
\[ (3) 135^\circ \]
\[ (4) 150^\circ \]

\[ \text{Ans.} (2) \]

5. A body is moved from rest along straight line by a machine delivering a constant power. Time taken by body to travel a distance \( S \) is proportional to
\[ (1) S^{1/2} \]
\[ (2) S^{3/2} \]
\[ (3) S \]
\[ (4) S^4 \]

\[ \text{Ans.} (2) \]

Sol. Energy supply = Pt
6. A uniform rod of young’s modulus $Y$ is stretched by two tension $T_1$ and $T_2$ such that rods get expanded to length $L_1$ and $L_2$ respectively. Find initial length of rod?

\[ \frac{L_1 - L_2}{T_1 - T_2} = \frac{L_2 - L_1}{T_2 - T_1} = \frac{L_2 - L_1}{T_2 - T_1} \]

Ans. (3)

7. Time $(T)$, velocity $(v)$ and angular momentum $(h)$ are chosen as fundamental quantities instead of mass, length and time. In terms of these, dimension of mass would be:

(1) $[T^{-1}C^{-2}h]$
(2) $[T^{-1}C^{-2}h]$
(3) $[T^{-1}C^{-2}h]$
(4) $[T^{-1}C^{-2}h]$

Ans. (1)
Find relation between $\gamma$ (adiabatic constant) and degree of freedom ($f$)

- $(1) \ f = \frac{2}{\gamma - 1}$
- $(2) \ f = \frac{\gamma}{\gamma - 1}$
- $(3) \ f = \frac{\gamma - 1}{2}$
- $(4) \ f = \frac{\gamma - 1}{\gamma}$

**Ans.** $(1)$

**Sol.**

\[
C_v = \frac{R}{\gamma - 1} f
\]

\[
\Rightarrow \gamma = \frac{C_v(\gamma - 1)}{R} + 1 = \frac{2}{f}
\]

\[
f = \frac{2}{\gamma - 1}
\]

Two identical drops of Hg coalesce to form a bigger drop. Find ratio of surface energy of bigger drop to smaller drop.

- $(1) \ 2^{1/2}$
- $(2) \ 3^{6/5}$
- $(3) \ 2^{1/3}$
- $(4) \ 5^{9/3}$

**Ans.** $(3)$

**Sol.**

\[
\frac{2\pi R_1^2}{3} \quad \frac{2\pi R_2^2}{3}
\]

\[
R \sim 2^{1/3}
\]

Now,

\[
\frac{U_{bigger}}{U_{smaller}} = \frac{S \times 4\pi R^2}{S \times 4\pi r^2} = \frac{R^2}{r^2} = 2^{2/3}
\]

**Ans.** $(3)$

**Sol.**

\[
PV = nRT
\]

Therefore, PV vs T graph is straight line.
11. For a body in pure rolling, its rotational kinetic energy is 1/2 times of its translation kinetic energy. They body should be?

(1) solid cylinder  (2) Ring  (3) solid sphere  (4) Hollow sphere

Ans. (1)

Sol. Given:

\[ \frac{1}{2} I \omega^2 = \frac{1}{2} \frac{1}{2} m v^2 \]

as \( v = R \omega \) (pure rolling)

Thus, solid cylinder.

12. Magnetic susceptibility of material is 499 & \( \chi_m = 4 \times 10^{-7} \). SI unit then find \( \mu \).

(1) 500  (2) 400  (3) 300  (4) 200

Ans. (1)

Sol. \( \mu = 1 + \chi \)

\[ = 1 + 499 = 500 \]

13. A plane electromagnetic wave travels in free space. Electric field is \( \vec{E} = \vec{E}_0 \hat{j} \) and magnetic field is \( \vec{B} = \vec{B}_0 \hat{k} \). What is the unit vector along the direction of propagation of electromagnetic wave?

(1) \( \hat{j} \)  (2) \( \hat{k} \)  (3) \( \hat{z} \)  (4) \( \hat{i} \)

Ans. (3)

Unit vector in direction \( \vec{E} \times \vec{B} \)

\[ \vec{E} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \vec{E}_0 \hat{j} & \vec{0} & \vec{B}_0 \hat{k} \\ \vec{0} & \vec{E}_0 \hat{j} & \vec{0} \end{vmatrix} = (\vec{E}_0 \vec{B}_0 \sin 90) \hat{i} + \hat{j}

\[ j = k \]

14. Two satellites of mass \( M_a \) and \( M_b \) are revolving around a planet of mass \( M \) in radius \( R_a \) and \( R_b \) respectively. Then?

(1) \( T_a > T_b \) if \( R_a > R_b \)

(2) \( T_a > T_b \) if \( M_a > M_b \)

(3) \( T_a > T_b \) if \( M_a > M_b \)

(4) \( T_a > T_b \) if \( R_a < R_b \)

Ans. (1)

Sol.

\[ T \propto \frac{1}{R^{3/2}} \]

\[ \frac{T_a}{T_b} \propto \left( \frac{R_b}{R_a} \right)^{3/2} \]
15. If $N_0$ active nuclei becomes $\frac{N_0}{16}$ in 80 days. Find half-life of nuclei?

Sol.  

$$N_0 = \frac{N_0}{2} \quad N_4 = \frac{N_0}{4} \quad N_8 = \frac{N_0}{8} \quad N_{16} = \frac{N_0}{16}$$

$$4 \times t_{1/2} = 80 \text{ days}$$

$$t_{1/2} = 20 \text{ days}$$

16. A satellite is revolving around a planet in an orbit of radius $R$. Suddenly radius of orbit becomes $1.02 \times R$. Then what will be its change in time period of revolution?

Ans. 3

Sol.  

As $T \propto R^{3/2}$

$$T_1 = kR_1^{3/2}$$

$$T_2 = kR_2^{3/2}$$

$$\frac{\Delta T}{T} = \frac{3}{2} \times \frac{\Delta R}{R} = 3\%$$

17. A person walks up a stationary escalator in the time $t_1$. If he remains stationary on the escalator, then it can take him up in time $t_2$. Determine the time it would take to walk up on the moving escalator?

Ans. (1)

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Sol. Suppose length of escalator = $L$

Speed of man wrt escalator = $\frac{L}{t_1}$

Speed of escalator = $\frac{L}{t_2}$

Speed of man wrt ground when escalator is moving $= \frac{L}{t_1} + \frac{L}{t_2}$

Time taken by the man to walk on the moving escalator $= \frac{L}{t_1} + \frac{L}{t_2} + \frac{t_1 t_2}{t_1 + t_2}$

18. For given graph between decay rate & time. Find half-life (where $R =$ decay rate)

(1) $\frac{10}{3} \ln 2$

(2) $\frac{20}{3} \ln 2$

(3) $\frac{3}{20} \ln 2$

(4) $\frac{20}{3} \ln 2$

Ans. (2)
Sol.
\[ R = R_{\text{max}}^{1/3} \]
\[ \ln R = \ln R_0 - \lambda t \]
\[ \text{slope} = -\lambda = -\frac{6}{40} \]
\[ \lambda = \frac{3}{20} \]
\[ t_{1/2} = \frac{\ln 2}{\lambda} = \frac{\ln 2}{3} - 20 = \frac{20}{3} - \ln 2 \]

**time period of oscillation?**

1. \(2\pi \sqrt{\frac{x_2^2 + x_1^2}{v_1^2 + v_2^2}}\)
2. \(2\pi \sqrt{\frac{x_2^2 - x_1^2}{v_1^2 + v_2^2}}\)
3. \(2\pi \sqrt{\frac{x_2^2 + x_1^2}{v_1^2 - v_2^2}}\)
4. \(2\pi \sqrt{\frac{x_2^2 + x_1^2}{v_1^2 + v_2^2}}\)

**Ans.** (3)

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**Sol.**

\[ v = 0 \sqrt{A^2 - x^2} \]

\[ v_1 = \omega \sqrt{A^2 - x_1^2} \]

\[ v_2 = \omega \sqrt{A^2 - x_2^2} \]

\[ (\frac{v_1}{\omega})^2 - (\frac{v_2}{\omega})^2 = x_2^2 - x_1^2 \]

\[ \phi = \frac{v_2^2 - v_1^2}{x_2^2 - x_1^2} \]

\[ \phi = \frac{v_2^2 - v_1^2}{x_2^2 - x_1^2} \]

\[ T = 2\pi \sqrt{\frac{x_2^2 - x_1^2}{v_1^2 + v_2^2}} \]

**Ans.** (3)

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**Sol.**

KE = \(h\nu - W\)

\[ eV = \frac{h\nu}{\lambda} - W \]

For first case

\[ e(3V_0) = \frac{h\nu}{\lambda} - W \quad (i) \]

For second case

\[ eV_0 = \frac{h\nu}{2\lambda} - W \quad (ii) \]

From equation (i) and (ii)

\[ W = \frac{h\nu}{4\lambda} \]

For \(\lambda\),
(1) \( \tan^{-1} \left( \frac{1}{\sqrt{6}} \right) \)

(2) \( \tan^{-1} \left( \frac{1}{\sqrt{2}} \right) \)

(3) \( \tan^{-1} \left( \frac{1}{\sqrt{4}} \right) \)

(4) \( \tan^{-1} \left( \frac{1}{\sqrt{3}} \right) \)

Ans. (1)

Sol. Let vertical and horizontal component of earth's magnetic field at meridian will be V and H.

Angle of dip, \( \tan \theta = \frac{V}{H} \)

at angle of 45° from magnetic meridian, angle of dip = 30°

\[ \tan 30° = \frac{V}{H \cos 45°} \]

\[ = \frac{1}{\sqrt{3}} \]

\[ \Rightarrow \frac{V}{H} = \frac{1}{\sqrt{3}} \]

\[ \theta = \tan^{-1} \left( \frac{1}{\sqrt{3}} \right) \]

22. A sodium lamp in space was emitting waves of wavelength 2880 Å. When observed from a planet, its wavelength was recorded 2886 Å. Find the speed of planet?

(1) \( 4.25 \times 10^5 \) m/s

(2) \( 6.25 \times 10^5 \) m/s

(3) \( 2.75 \times 10^5 \) m/s

(4) \( 3.75 \times 10^5 \) m/s

Ans. (2)

Sol. \( v_{\text{rel}} = \frac{n_2}{n_1} \lambda_1 \)

\[ v_{\text{rel}} = \frac{6}{2880} \times 3 \times 10^8 \]

\[ = 6.25 \times 10^5 \text{ m/s} \]

23. An electron having de Broglie wavelength is falls on an X-ray tube. The cut off wave length of emitted X-Ray is

(1) \( \frac{2\pi m c^2}{\hbar} \)

(2) \( \frac{2\pi}{mc} \)

(3) \( \frac{h}{mc} \)

(4) \( \frac{2\pi m c^2}{3\hbar} \)

Ans. (1)
24. A gas is undergoing change in state by an isothermal process AB as follows. Work done by gas in process AB is

\[ W = \int_{V_1}^{V_2} P \, dV \]

where \( P \) is the pressure and \( V \) is the volume.

\[ W = P \cdot \Delta V \]

\[ W = P \cdot (V_2 - V_1) \]

\[ W = P \cdot V_2 - P \cdot V_1 \]

\[ W = \Delta P \cdot V_1 \]

(1) 100 ln2 Joule  \hspace{1cm} (2) - 100 ln2 Joule  \hspace{1cm} (3) 200 ln2 Joule  \hspace{1cm} (4) - 200 ln2 Joule

Ans. (3)

Sol. \[ W_{volumetric} = P \cdot V_1 \cdot \ln \left( \frac{V_2}{V_1} \right) \]

\[ V_1 = 100 \text{ m}^3 \]

\[ V_2 = 200 \text{ m}^3 \]

\[ P_1 = 2 \text{ N/m}^2 \]

\[ W = 2 \times 100 \ln \left( \frac{200}{100} \right) \]

\[ W = 200 \ln 2 \text{ Joule} \]
26. \( I - V \) characteristic curve of a diode in forward bias is given in fig. Find out dynamic resistance -

\[
\begin{align*}
3mA & \\
0.7V & \\
0.7 & \\
0.7 & \\
0.7 & \\
0.7 & \\
I & \\
V & \\
\end{align*}
\]

(1) 212.3Ω  
(2) 205.3Ω  
(3) 245.3Ω  
(4) 233.3Ω

**Ans.** (4)

**Sol.** 
Dynamic resistance = \( \frac{\Delta V}{\Delta I} \)

\[
= \frac{0.7}{3mA} = 233.3Ω
\]

27. An electron is accelerated through a voltage of 40 kV. What will be its wavelength?

(1) 0.061Å  
(2) 0.011Å  
(3) 0.021Å  
(4) 0.161Å

**Ans.** (1)

**Sol.** \( \lambda = \frac{h}{p} \)
28. Find value of Rs in given ckt? (V2 = 8V)

\[
\begin{align*}
\sqrt{2} \text{meV} \\
= \sqrt{12.27} \frac{\AA}{40 \times 10^3} = 0.061\AA \\
20V \\
R_s & \quad (Zener_diode) \\
& \quad \Rightarrow 8\uparrow \\
& \quad 2\downarrow \\
& \quad \Rightarrow \quad R_s \\
(1) \quad 4\Omega & \quad (2) \quad 6\Omega \\
(3) \quad 3\Omega & \quad (4) \quad 5\Omega
\end{align*}
\]

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Ans. (2)
Sol. Applying KVL

\[20 - 8 - 2R_s = 0\]

\[R_s = 6\Omega\]

29. Two stars of masses \(m_1\) and \(m_2\) are in mutual interaction and revolving in orbits of radii \(r_1\) and \(r_2\) respectively. Time period of revolution for this system will be

\[T = \frac{2\pi}{\omega}
\]

\[
\omega = \sqrt{\frac{GM}{r^3}}
\]

\[T = 2\pi \sqrt{\frac{(r_1 + r_2)^3}{GM}}
\]

\[T = 2\pi \sqrt{\frac{(r_1 + r_2)^3}{GM}}
\]
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