PART: PHYSICS

Ans. (2)

Sol. \[ K.E. = K = \frac{p^2}{2m} \]
\[ P = \sqrt{K} \]
\[ P_2 = \frac{K_2}{P_2} = \frac{4K}{P_2} \]
2. A PFC circuit is in its resonance condition. Its circuit components have value
\[ R = 5 \Omega, \quad L = 2H \]
\[ P_1 = V_1 I_1 = V K \]
\[ \Rightarrow P_1 = K \]
\[ \Rightarrow P_2 = \frac{P_1}{P_3} = \frac{2}{3} \]
\[ \Rightarrow \frac{P_2 - P_3}{P_3} = \left( \frac{2}{3} - 1 \right) \times 100\% = (2 - 1) \times 100 = 100\% \]
\[ \Rightarrow \frac{\Delta P}{P_3} = 100\% \]

(a) 5kW
(b) 10kW
(c) 12kW
(d) 12.5kW

Ans. (d)

Solution:
As circuit is in resonance. Thus
\[ X_L = X_C \]
\[ V = R \omega \sin \theta = V \sin \theta = \frac{V}{R} \]
\[ P = \frac{V^2}{R} \]
\[ P = \frac{250 \times 250}{250} = 12500 \text{ J}/6 = 12.5 \text{ kW} \]

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:

(a) 125
(b) 100
(c) 75
(d) 50

Ans. (a)

Solution:
\[ \omega_0 = 600 \text{ rpm} \]
\[ \alpha = 1800 \text{ rpm}² \]
\[ t = 10 \text{ sec} = 1/6 \text{ minute} \]
\[ \theta = \omega_0 t + \frac{1}{2} \alpha t^2 \]
\[ \theta = 100 \text{ rev} + 25 \text{ rev} = 125 \text{ rev} \]

4. \[ |\mathbf{P} - \mathbf{Q}| = |\mathbf{P} + \mathbf{Q}| \neq |\mathbf{P} - \mathbf{Q}| \quad \text{Find angle between } \mathbf{P} \text{ & } \mathbf{Q} \]

(a) 45°
(b) 60°
(c) 135°
(d) 150°

Ans. (b)

Solution:
\[ |\mathbf{P} + \mathbf{Q}| = |\mathbf{P} - \mathbf{Q}| \]
\[ |\mathbf{P}|^2 + |\mathbf{Q}|^2 + 2 |\mathbf{P}| |\mathbf{Q}| \cos \theta = |\mathbf{P}|^2 - 2 |\mathbf{P}| |\mathbf{Q}| \cos \theta \]
\[ \Rightarrow \theta = 90° \]

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

(a) \( S^{1/2} \)
(b) \( S^{3/2} \)
(c) \( S^{2/3} \)
(d) \( S^1 \)

Ans. (a)

Solution:
Energy supply = \( P_t \)
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?

\[
\begin{align*}
(1) & \quad \frac{L_1 - L_2 - T_2}{T_1 - T_2} \\
(2) & \quad \frac{L_2 - L_1 - T_2}{T_2 - T_1} \\
(3) & \quad \frac{L_2 - L_1 - T_1}{T_2 - T_1} \\
(4) & \quad \frac{L_2 - L_1 - T_1}{T_2 - T_1}
\end{align*}
\]

Ans. (3)

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

\[
\begin{align*}
(1) & \quad [M] = [T^{-1} C^{-2} h] \\
(2) & \quad [M] = [T^{-1} C^{-1} h] \\
(3) & \quad [M] = [T^{-1} C^{-2} h^2] \\
(4) & \quad [M] = [T^{-1} C^{-1} h^2]
\end{align*}
\]

Ans. (1)

Sol. \( M \times T^{-1} C^{-2} h^2 \)
8. Find relation between $\gamma$ (adiabatic constant) and degree of freedom ($i$)
   
   (1) $i = \frac{2}{\gamma - 1}$  
   (2) $i = \frac{\gamma}{\gamma - 1}$  
   (3) $i = \frac{\gamma - 1}{2}$  
   (4) $i = \frac{\gamma - 1}{\gamma}$

   Ans. (1)

   Sol. 
   
   $C_v = \frac{\gamma R}{2}$

   $\gamma = 1 + \frac{2}{i}$

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

   (1) $2^{1/3}$  
   (2) $2^{2/3}$  
   (3) $2^{1/2}$  
   (4) $2^{1/1}$

   Ans. (3)

   Sol. 
   
   $R_f = 2^{1/3}$

   Now
   
   $U_{\text{bigger}} = \frac{S \times 4 \pi R_f^2}{2}$
   $U_{\text{smaller}} = \frac{S \times 4 \pi r^2}{2}$

   $\frac{U_{\text{bigger}}}{U_{\text{smaller}}} = 2^{2/3}$

   Therefore, PV vs T graph is a 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)

\[ 1 \times 1 = \frac{1}{2} \times \frac{1}{2} \]

Thus, solid cylinder.

12. Magnetic susceptibility of material is 499 & \( \chi_0 = 4 \pi \times 10^{-7} \). 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 \( \hat{E} = E_0 \hat{j} \) and magnetic field is represented by \( \hat{B} = B_0 \hat{k} \). What is the unit vector along the direction of propagation of electromagnetic wave?

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

Ans. (3)

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

\[ \hat{E} \times \hat{B} = \frac{E_0 B_0 \hat{\imath} \times \hat{k}}{50} \]

\[ \hat{\imath} \times \hat{k} = \hat{j} \]

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14. Two satellites of mass \( M_1 \) and \( M_2 \) are revolving around a planet of mass \( M \) in radius \( R_1 \) and \( R_2 \) respectively. Then?

   (1) \( T_1 > T_2 \) if \( R_1 > R_2 \)   (2) \( T_1 > T_2 \) if \( M_1 > M_2 \)

   (3) \( T_1 = T_2 \) if \( M_1 = M_2 \)   (4) \( T_1 > T_2 \) if \( R_1 < R_2 \)

Ans. (1)

Sol. \( T = \sqrt{\frac{GM}{R^3}} \)

\[ \frac{T_1}{T_2} = \left( \frac{R_2}{R_1} \right)^{3/2} \]
15. If N₀ active nuclei become \( \frac{N_0}{16} \) in 80 days. Find half life of nuclei?

Sol. \[ N_0 \rightarrow N_0 \rightarrow \frac{N_0}{2} \rightarrow \frac{N_0}{4} \rightarrow \frac{N_0}{8} \rightarrow \frac{N_0}{16} \]

\[ 4 \times t \text{ half} = 80 \text{ days} \]
\[ t \text{ half} = 20 \text{ days} \]

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

Ans. 3

Sol. \[ T = \frac{2\pi R^{3/2}}{V} \]
\[ T' = 1.02R^{3/2} \]
\[ \frac{\Delta T}{T} = \frac{3}{2} \frac{\Delta R}{R} = 3\% \]

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 w.r.t escalator = \( \frac{L}{t_1} \)

Speed of escalator = \( \frac{L}{t_2} \)

Speed of man w.r.t ground when escalator is moving = \( \frac{L}{t_1} + \frac{L}{t_2} \)

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

18. For given graph between decay rate & time. Find half life (where \( R = \text{decay rate} \))

An. (2)
time period of oscillation?

\[
\begin{align*}
(1) & \quad 2\pi \sqrt{\frac{x_2^2 - x_1^2}{v^2 - v_1^2}} \\
(2) & \quad 2\pi \sqrt{\frac{x_2^2 - x_1^2}{v^2 - v_1^2}} \\
(3) & \quad 2\pi \sqrt{\frac{x_2^2 - x_1^2}{v^2 - v_1^2}} \\
(4) & \quad 2\pi \sqrt{\frac{x_2^2 - x_1^2}{v^2 - v_1^2}}
\end{align*}
\]

Ans. \(3\)
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24. A gas is undergoing change in state by an isothermal process AB as follows. Work done by gas in process AB is

![Diagram showing isothermal process with coordinates and pressures]

(1) 100 ln2 Joule  (2) – 100 ln2 Joule  (3) 200 ln2 Joule  (4) – 200 ln2 Joule

Ans. (3)

Sol. \[ W_{\text{thermal}} = P_1 V_1 \ln \frac{V_2}{V_1} \]

- \( V_1 = 100 \text{ m}^3 \)
- \( V_2 = 200 \text{ m}^3 \)
- \( P_1 = 2 \text{ N/m}^2 \)

\[ W = 2 \times 100 \ln \frac{200}{100} = 200 \text{ ln2 Joule} \]

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25. A block is projected up the rough plane of inclination 30°. If time of ascending is half the time for descending and the coefficient of friction is \( \mu = \frac{3}{5n} \). Then \( n = \ldots \)
26. I–V characteristic curve of a diode in forward bias is given in fig. Find cut-off dynamic resistance.

![Graph of I-V characteristic curve of a diode in forward bias]

\[ I = \begin{cases} 
3mA & \text{for } V < 0.7 \\
6mA & \text{for } V > 0.7 
\end{cases} \]

**Ans.** (4)

**Sol.** Dynamic resistance is:

\[ R = \frac{\Delta V}{\Delta I} \]

- At 0.7 mA, \[ R = \frac{0.7}{3mA} = 0.2333 \Omega \]

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

\[ \lambda = \frac{h}{p} \]

**Ans.** (1)

**Sol.**

\[ \lambda = \frac{h}{p} = \frac{6.626 \times 10^{-34} \text{ Js}}{910.7 \text{ eV}} = 7.29 \times 10^{-11} \text{ m} = 0.00729 \text{ Å} \]
28. Find value of $R_v$ in given clc? ($V_f = 8V$)

\[ R_v = \frac{20V}{2A} \]

Options:
1. 4Ω
2. 6Ω
3. 8Ω
4. 10Ω

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?

\[ T = \frac{2\pi \sqrt{\frac{(r_1 + r_2)^3}{G(m_1 + m_2)}}}{r_1 + r_2} \]