PART : PHYSICS

1. If kinetic energy of particle becomes four times, then % change in momentum will be :

(1) 200 (2) 100 (3) 150 (4) 50

Ans. **(2)**

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

$P \propto \sqrt{K}$

$\frac{P_2}{P_1} = \sqrt{\frac{K_2}{K_1}} \Rightarrow \frac{P_2}{P_1} = \sqrt{\frac{4K}{K}}$

$\Rightarrow \quad \frac{P_2}{P_1} = 2$

$\Rightarrow \quad \frac{P_2 - P_1}{P_1}\% = \left(\frac{P_2}{P_1} - 1\right) \times 100 = (2 - 1) \times 100 = 100$

$\Rightarrow \quad \frac{\Delta P}{P_1}\% = 100\%$

2. A RLC circuit is in its resonance condition. Its circuit components have value

$R = 5\Omega$

$L = 2H$

$C = 0.5$ mF, $V = 250V$

Then find power in circuit ?

(1) 6kW (2) 10kW (3) 12kW (4) 12.5kW

Ans. (4)

Sol. As circuit is in resonance. Thus

$X_L = X_C$

$\therefore \quad Z = R$ so $i_{rms} = V/Z = V/R$

$P = i_{rms}^2 R$

$P = \frac{V^2}{R} = \frac{250 \times 250}{5} = 12500$ J/s = 12.5 kW

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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

Ans. (1)

Sol. $\omega = 600$ rpm

$\alpha = 1800$ rpm²

$t = 10$ sec $= 1/6$ minute

$\theta = \omega t + \frac{1}{2}\alpha t^2$

$= 600 \times \frac{10}{60} + \frac{1}{2} \times 1800 \times \frac{1}{36}$

$= 100 + 25 = 125$ revolution.

4. $|\vec{P}| = |\vec{Q}|$, $|\vec{P}+\vec{Q}| = |\vec{P}-\vec{Q}|$. Find angle between $\vec{P}$ & $\vec{Q}$

(1) 45° (2) 90° (3) 135° (4) 150°

Ans. **(2)**

Sol. $|\vec{P}+\vec{Q}| = |\vec{P}-\vec{Q}|$

$|\vec{P}|^2 + |\vec{Q}|^2 + 2|\vec{P}||\vec{Q}|\cos\theta = |\vec{P}|^2 + |\vec{Q}|^2 - 2|\vec{P}||\vec{Q}|\cos\theta$

$|\vec{P}||\vec{Q}|\cos\theta = 0^\circ$

Thus, $\theta = 90^\circ$

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

Ans. **(2)**

Sol. Energy supply = Pt

in t sec

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

$$V \propto \sqrt{t}$$

$$\frac{dS}{dt} = C\sqrt{t}$$

$$\int_0^S dS = C\int_0^t t^{1/2}dt$$

$$S = \frac{2Ct^{3/2}}{3}$$

$$t^{3/2} = \frac{3S}{2C}$$

$$t = S^{2/3}\left(\frac{3}{2C}\right)^{2/3}$$

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

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 ?

(1) $\frac{L_1T_1 - L_2T_2}{T_1 - T_2}$ (2) $\frac{L_2T_1 - L_1T_2}{T_2 - T_1}$ (3) $\frac{L_1T_2 - L_2T_1}{T_2 - T_1}$ (4) $\frac{L_1}{T_1} \times \frac{T_2}{L_2}$

Ans. (3)

Sol. Let initial length of rod be L_0 and Area A.

As $\frac{T}{A} = Y\frac{\Delta\ell}{\ell}$

So, $\frac{T_1}{A} = \frac{Y(L_1 - L_0)}{L_0}$

$\frac{T_2}{A} = \frac{Y(L_2 - L_0)}{L_0}$

Dividing

$\frac{T_1}{T_2} = \frac{L_1 - L_0}{L_2 - L_0}$; $T_1L_2 - T_1L_0 = T_2L_1 - T_2L_0$; $L_0 = \frac{L_1T_2 - L_2T_1}{T_2 - T_1}$

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

(1) $[M] = [T^{-1}C^{-2}h]$ (2) $[M] = [T^{-1}C^{2}h]$

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

Ans. (1)

Sol. $M \propto T^xC^yh^z$

$M^0L^0T^0 = T^x[LT^{-1}]^y[ML^2T^{-1}]^z$

$M^1L^0T^0 = T^{x-y-z}L^{y+2z}M^z$

On comparing powers

$z = 1$ ...(1)

$x - y - z = 0$ ...(2)

$y + 2z = 0$ ...(3)

$y + 2 \times 1 = 0$

8. Find relation between γ (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. $C_V = \frac{fR}{2}$

$\Rightarrow \quad C_P = \left(\frac{f}{2} + 1\right)R$

$\Rightarrow \quad \gamma = \frac{C_P}{C_V} = 1 + \frac{2}{f}$

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

$f = \frac{2}{\gamma - 1}$

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

(1) $2^{3/2}$ (2) $3^{2/5}$ (3) $2^{2/3}$ (4) $5^{2/3}$

Ans. (3)

Sol. $2 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$

$\frac{R}{r} = 2^{1/3}$ ...(1)

Now $\frac{U_{bigger}}{U_{smaller}} = \frac{S \times 4\pi R^2}{S \times 4\pi r^2} = \left(\frac{R}{r}\right)^2 = 2^{2/3}$

10. Identify correct graph between PV and T for an ideal gas.

Sol. ... $\frac{3}{}$ ... $\frac{3}{}$ ...

$\frac{R}{r} = 2^{1/3}$ ...(1)

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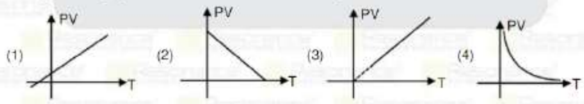


Ans. (3)

Sol. PV = nRT

$\Rightarrow$ PV = CT

Therefore, PV v/s 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

$\frac{1}{2}I\omega^2 = \frac{1}{2} \times \frac{1}{2} mv^2$

as v = Rω (pure rolling

$\frac{1}{2}I\omega^2 = \frac{1}{4}mR^2\omega^2$

$I = \frac{1}{2}mR^2$

Thus, solid cylinder.

12. Magnetic susceptibility of material is 499 & $\mu_0 = 4\pi \times 10^{-7}$. SI unit then find μ_r

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

Ans. (1)

Sol. $\mu_r = 1 + \chi$

$= 1 + 499 = 500$

13. A plane electromagnetic wave travels in free space. Electric field is $\vec{E} = E_0\hat{i}$ and magnetic field is represented by $\vec{B} = B_0\hat{k}$. What is the unit vector along the direction of propagation of electromagnetic wave?

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

Ans. (3)

Sol. Direction of EM wave in given by direction of $\vec{E} \times \vec{B}$

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. $T \propto r^{3/2}$

$$\frac{T_A}{T_B} \propto \left(\frac{R_A}{R_B}\right)^{3/2}$$

15. If N_0 active nuclei becomes $\frac{N_0}{16}$ in 80 days. Find half life of nuclei ?

(1) 40 days
(2) 20 days
(3) 60 days
(4) 30 days

Ans. (2)

Sol. $N_0 \xrightarrow{t_{1/2}} \frac{N_0}{2} \xrightarrow{t_{1/2}} \frac{N}{4} \xrightarrow{t_{1/2}} \frac{N}{8} \xrightarrow{t_{1/2}} \frac{N}{16}$

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

$t_{1/2} = 20$ 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. As $T \propto R^{3/2}$

$T_1 = kR^{3/2}$

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

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 ?

(1) $\frac{t_1 t_2}{t_1 + t_2}$
(2) $\frac{t_1 t_2}{t_1 - t_2}$
(3) $\frac{2t_1 t_2}{t_1 + t_2}$
(4) $\frac{2t_1 t_2}{t_1 - t_2}$

Ans. 3

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

$T_1 = kR^{3/2}$

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

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 ?

(1) $\frac{t_1t_2}{t_1+t_2}$ (2) $\frac{t_1t_2}{t_1-t_2}$ (3) $\frac{2t_1t_2}{t_1+t_2}$ (4) $\frac{2t_1t_2}{t_1-t_2}$

Ans. (1)

Sol. Suppose length of escalator = L

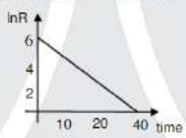
Speed of man wrt escalator = $\frac{L}{t_1}$

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 = $\frac{L}{\frac{L}{t_1} + \frac{L}{t_2}} = \frac{t_1 t_2}{t_1 + t_2}$

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)

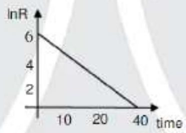
Sol. $R = R_0 e^{-\lambda t}$

$\ln R = \ln R_0 - \lambda t$

slope = $-\lambda = \frac{-6}{40}$

$\lambda = \frac{3}{20}$

ln2 ln2 20



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Ans. (2)

Sol. $R = R_0 e^{-\lambda t}$

$\ln R = \ln R_0 - \lambda t$

slope $= -\lambda = \frac{-6}{40}$

$\lambda = \frac{3}{20}$

$t_{1/2} = \frac{\ln 2}{\lambda} = \frac{\ln 2}{3} \times 20 = \frac{20}{3}\ln 2$

19. The velocities of particle performing SHM at a distance of x_1 & x_2 from mean position are v_1 & v_2 find the 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)

Sol. $v = \omega\sqrt{A^2 - x^2}$

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

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

$$\left(\frac{v_1}{\omega}\right)^2 - \left(\frac{v_2}{\omega}\right)^2 = x_2^2 - x_1^2$$

$$\omega^2 = \frac{v_1^2 - v_2^2}{x_2^2 - x_1^2}$$

$$\omega = \sqrt{\frac{v_1^2 - v_2^2}{x_2^2 - x_1^2}}$$

$$T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$$

20. In photoelectric effect stopping potential is $3V_0$ for incident wave length λ_0 and stopping potential V_0 for incident wavelength $2\lambda_0$. Find threshold wavelength.

(1) $3\lambda_0$ (2) $2\lambda_0$ (3) $4\lambda_0$ (4) $8\lambda_0$

Ans. (3)

Sol. $KE = h\nu - W$

$$eV = \frac{hc}{\lambda} - W$$

For first case

$$e(3V_0) = \frac{hc}{\lambda_0} - W \quad \ldots(i)$$

For second case

$$eV_0 = \frac{hc}{2\lambda_0} - W \quad \ldots(ii)$$

20. In photoelectric effect stopping potential is $3V_0$ for incident wave length λ_0 and stopping potential V_0 for incident wavelength $2\lambda_0$. Find threshold wavelength.

(1) $3\lambda_0$ (2) $2\lambda_0$ (3) $4\lambda_0$ (4) $8\lambda_0$

Ans. (3)

Sol. $KE = h\nu - W$

$$eV = \frac{hc}{\lambda} - W$$

For first case

$$e(3V_0) = \frac{hc}{\lambda_0} - W \quad ...(i)$$

For second case

$$eV_0 = \frac{hc}{2\lambda_0} - W \quad ...(ii)$$

From equation (i) and (ii)

$$W = \frac{hc}{4\lambda_0}$$

For λ_{th}

$$W = \frac{hc}{\lambda_{th}}$$

$$\Rightarrow \frac{hc}{4\lambda_0} = \frac{hc}{\lambda_{th}} \Rightarrow \lambda_{th} = 4\lambda_0$$

21. At 45° of magnetic meridian angle of dip is 30° then find the angle of dip in vertical plane at 45° ?

(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, $\tan\theta = \frac{V}{H}$ ....(i)

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

$$\tan 30° = \frac{V}{H\cos 45°} \Rightarrow \frac{1}{\sqrt{3}} = \frac{V}{H\cos 45°}$$

$$\frac{V}{H} = \frac{1}{\sqrt{6}}$$

$$\tan\theta = \frac{V}{H} \Rightarrow \frac{1}{\sqrt{6}}$$

$$\theta = \tan^{-1}\left(\frac{1}{\sqrt{6}}\right)$$

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

(1) 4.25×10^5 m/s (2) 6.25×10^5 m/s (3) 2.75×10^5 m/s (4) 3.75×10^5 m/s

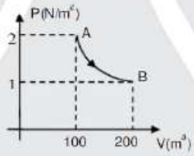
Ans. (2)

Sol. $\frac{v_{rel}}{C} = \frac{\Delta\lambda}{\lambda}$

$$V_{rel} = \frac{6}{2880} \times 3 \times 10^8$$

$\Rightarrow \lambda = \frac{2m_e c\lambda_B^2}{h} = \frac{2mc\lambda^2}{h}$ where $\lambda_B = \lambda$ & $m_e = m$.

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



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

Ans. (3)

Sol. $W_{isothermal} = P_1V_1 \ln\frac{V_2}{V_1}$

$V_1 = 100m^3$

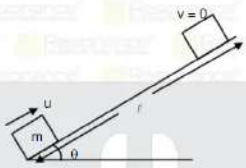
$V_2 = 200m^3$

$P_1 = 2\ N/m^2$

$W = 2 \times 100 \ln\frac{200}{100}$

$= 200 \ln 2$ Joule

25. A block is projected upto a rough plane of inclination 30°. If time of ascending is half the time for descending and the coefficient of friction is $\mu = \frac{3}{5\sqrt{n}}$. Then n =......



Ans. 3

Sol. $S = \frac{1}{2}a_A t_A^2$ .....(1)

$S = \frac{1}{2}a_D t_D^2$ .....(2)

From Equation (1) & (2)

$$\frac{t_A^2}{t_D^2} = \frac{a_D}{a_A}$$

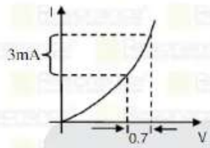
$$\Rightarrow \frac{t_A^2}{t_D^2} = \frac{g\sin\theta - \mu g\cos\theta}{g\sin\theta + \mu g\cos\theta}$$

$$\Rightarrow \frac{t_A}{t_D} = \sqrt{\frac{g\sin\theta - \mu g\cos\theta}{g\sin\theta + \mu g\cos\theta}}$$

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

$$\Rightarrow 1+\sqrt{3}\mu = 4 - 4\sqrt{3}\mu$$

26. I – V characteristic curve of a diode in forward bias is given in fig. find out dynamic resistance -



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

Ans. (4)

Sol. Dynamic resistance = $\frac{\Delta V}{\Delta I}$

$= \frac{0.7}{3mA} = 233.3\Omega$

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. $\lambda_B = \frac{h}{P}$

$= \frac{h}{\sqrt{2meV}}$

$= \frac{12.27}{\sqrt{V}}$ Å

$= \frac{12.27}{\sqrt{40 \times 10^3}}$ Å $= 0.061$Å

28. Find value of R_P in given ckt ? ($V_Z = 8V$)

R_P (Zener diode)

$20 - 8 - 2R_P = 0$

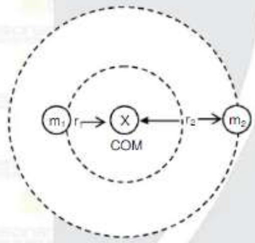
$R_P = 6\Omega$

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 ?

(1) $2\pi\sqrt{\frac{(r_1-r_2)^3}{G(m_1+m_2)}}$ (2) $2\pi\sqrt{\frac{(r_1+r_2)^3}{G(m_1+m_2)}}$ (3) $2\pi\sqrt{\frac{(r_1-r_2)^3}{G(m_1-m_2)}}$ (4) $2\pi\sqrt{\frac{(r_1+r_2)^3}{G(m_1-m_2)}}$

Ans. (2)

Sol.



Let angular velocity will be ω

For mass m_1

$$\frac{Gm_1m_2}{(r_1+r_2)^2} = m_1 r_1 \omega^2 = m_1 \times \frac{m_2(r_1+r_2)}{m_1+m_2}\omega^2$$

$$\omega = \frac{\sqrt{G(m_1+m_2)}}{(r_1+r_2)^{3/2}}$$

$$T = \frac{2\pi}{\omega}$$

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