JEE MAIN-2021 DATE:20-07-2021 (SHIFT-2)| PAPER-1-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: $K.E. \Rightarrow K = \frac{P^2}{2m}$

$P \propto \sqrt{K}$

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

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

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

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

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

$R = 5\Omega$

$L = 2H$

$C = 0.5mF, V = 250V$

Then find power in circuit?

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

Ans: 4

Sol: As circuit is in resonance. Thus

$X_L = X_C$

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

$P = i_{rms}^2 R$

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

3. A wheel rotating with an angular speed of 600 rpm is given an constant angular acceleration of $1800 rpm^2$ for 10 sec. Number of revolutions revolved by wheel is:

(1) 125 (2) 100 (3) 75 (4) 50

Ans: 1

Sol: $\omega_0 = 600 rpm$

$\alpha = 1800 rpm^2$

$t = 10\sec = 1/6 \min ute$

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

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

$= 100 + 25 = 125$ revolution.

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

(1) 45^0 (2) 90^0 (3) 135^0 (4) 150^0

Ans: 2

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

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

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

Thus, $\theta = 90^0$

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 $= Pt$

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

$V \propto \sqrt{t}$

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

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

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

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

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

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

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

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

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

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

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 chosen 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: $M \propto T^x C^y h^z$

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

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

On comparing powers

$z = 1 \ldots.(1)$

$x - y - z = 0 \ldots(2)$

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

$y + 2 \times 1 = 0$

$y = -2$

$x - (-2) - 1 = 0$

$x = -1$

$M \propto T^{-1}C^{-2}h^{1}$

$[M] \propto [T^{-1}C^{-2}h]$

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: $C_V = \frac{fR}{2}$

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

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

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

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

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) $5^{2/3}$

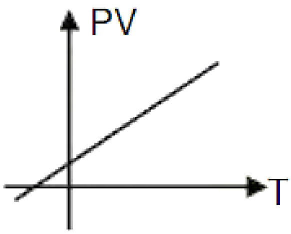
Ans: 3

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

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

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.

(1)


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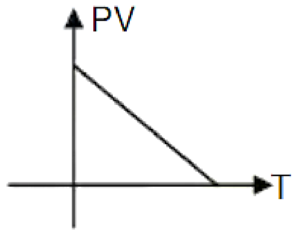

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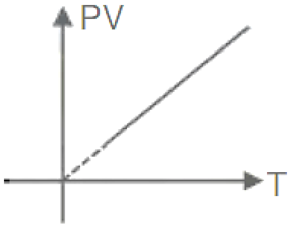

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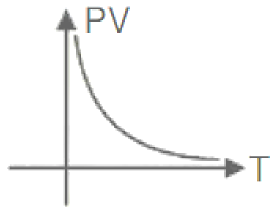


Ans: 3

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 ½ times of its translation kinetic energy. They body should be?

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

Ans: 1

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

As $v = R\omega$ (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 $\vec{E} \times \vec{B}$.

Unit vector in direction $\vec{E} \times \vec{B} \Rightarrow \dfrac{\vec{E} \times \vec{B}}{\left|\vec{E} \times \vec{B}\right|}$

$$\Rightarrow \frac{E_0\hat{i} \times B_0\hat{k}}{E_0 B_0 \sin 90}$$

$$\Rightarrow \hat{i} \times \hat{k}$$

$$\Rightarrow -\hat{j}$$

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

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

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

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

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

Ans: 3

Sol: $T \propto R^{3/5}$

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

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

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: 1

Sol: Suppose length of escalator=L

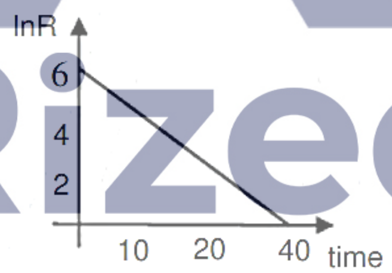
Speed of man wrt escalator $= \frac{L}{t_1}$

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

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

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

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: $KE=hv-W$

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

For first case

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

For second case

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

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 45^0 of magnetic meridian angle of dip is 30^0 then find the angle of dip in vertical plane at 45^0?

(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 45^0 from magnetic meridian, angle of dip=30^0

$\tan 30^0 = \frac{V}{H\cos 45^0} \Rightarrow \frac{1}{\sqrt{3}} = \frac{V}{H\cos 45^0}$

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

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

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

22. A sodium lamp in space was emitting waves of wavelength $2880\,\overset{0}{A}$. When observed from a planet, its wavelength was recorded $2880\,\overset{0}{A}$. Find the speed of planet?

(1) $4.25\times10^5 m/s$ (2) $6.25\times10^5 m/s$ (3) $2.75\times10^5 m/s$ (4) $3.75\times10^5 m/s$

Ans: 2

Sol: $\frac{V_{rel}}{C} = \frac{\Delta\lambda}{\lambda}$

$V_{rel} = \frac{6}{2880}\times3\times10^8$

$= 6.25\times10^5 m/s$

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

(1) $\frac{2mc\lambda^2}{n}$ (2) $\frac{2h}{mc}$ (3) $\frac{h}{mc}$ (4) $\frac{2}{3}\frac{mc\lambda^2}{h}$

Ans: 1

Sol: De-broglie wavelength

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

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

$\therefore$ Kinetic energy of electron $\Rightarrow E = \frac{P^2}{2m_e} = \frac{h^2}{2m_e\lambda_B^2}$

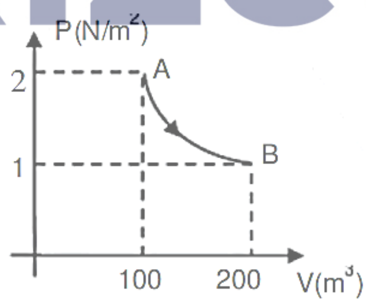
For cut-off wavelength of emitted X-ray

$$E = \frac{hc}{\lambda}$$

$$\Rightarrow \frac{h^2}{2m_e\lambda_B^2} = \frac{hc}{\lambda}$$

$\Rightarrow \lambda = \frac{2m_ec\lambda_B^2}{h} = \frac{2mc\lambda^2}{h}$ 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: $W_{isothermal} = P_1V_1 \ln \frac{V_2}{V_1}$

$$V_1 = 100m^3$$

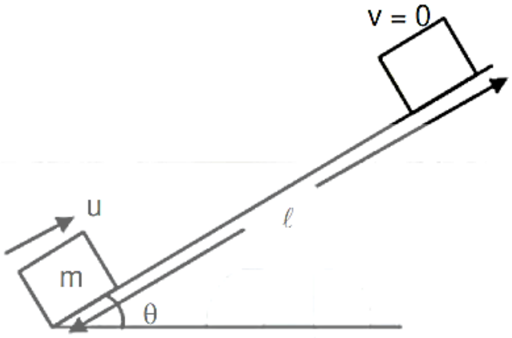
$$V_2 = 200m^3$$

$$P_1 = 2N/m^2$$

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

$$= 200 \ln 2 \text{ Joule}$$

25. A block is projected upto a rough plane of inclination 30^0. If time of ascending is half the time for descending and the coefficient of friction is $\mu = \frac{3}{5\sqrt{n}}$. Then $n = \ldots$



Ans: 3

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

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

From Equation (1) & (2)

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

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

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

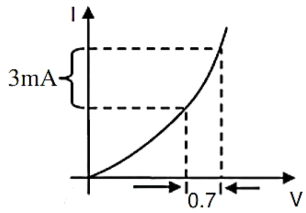
$$\Rightarrow \frac{1}{2}\sqrt{\frac{1-\sqrt{3}\mu}{1+\sqrt{3}\mu}}$$

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

$$\Rightarrow 5\sqrt{3}\mu = 3$$

$$\Rightarrow \mu = \frac{3}{5\sqrt{3}}$$

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 $=\frac{\Delta V}{\Delta I}$

$$=\frac{0.7}{3mA}=233.33\Omega$$

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

(1) $0.061\overset{0}{A}$ (2) $0.011\overset{0}{A}$ (3) $0.021\overset{0}{A}$ (4) $0.161\overset{0}{A}$

Ans: 1

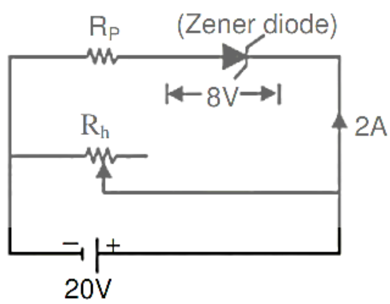
Sol: $\lambda_B=\frac{h}{P}$

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

$$=\frac{12.27}{\sqrt{V}}\overset{0}{A}$$

$$=\frac{12.27}{\sqrt{40\times103}}\overset{0}{A}=0.061\overset{0}{A}$$

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



(1) 4Ω (2) 6Ω (3) 3Ω (4) 5Ω

Ans: 2

Sol: Applying KVL

$$20-8-2R_P=0$$

$$R_P=6\Omega$$

29. Two starts 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) $2\pi\sqrt{\frac{(r_1-r_2)^3}{G(m_1+m_2)}}$

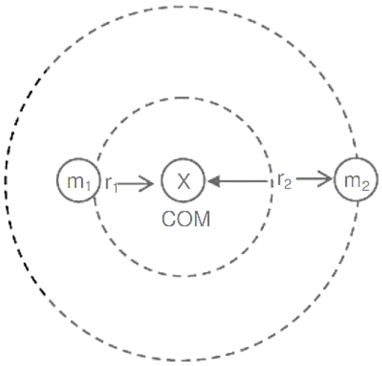
(2) $2\pi\sqrt{\frac{(r_1+r_2)^3}{G(m_1+m_2)}}$

(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

$$\frac{Gm_1m_2}{(r_1+r_2)^2}=m_1r_1\omega^2=m_1\times\frac{m_2(r_1+r_2)}{m_1+m_2}\omega^2$$

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

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

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