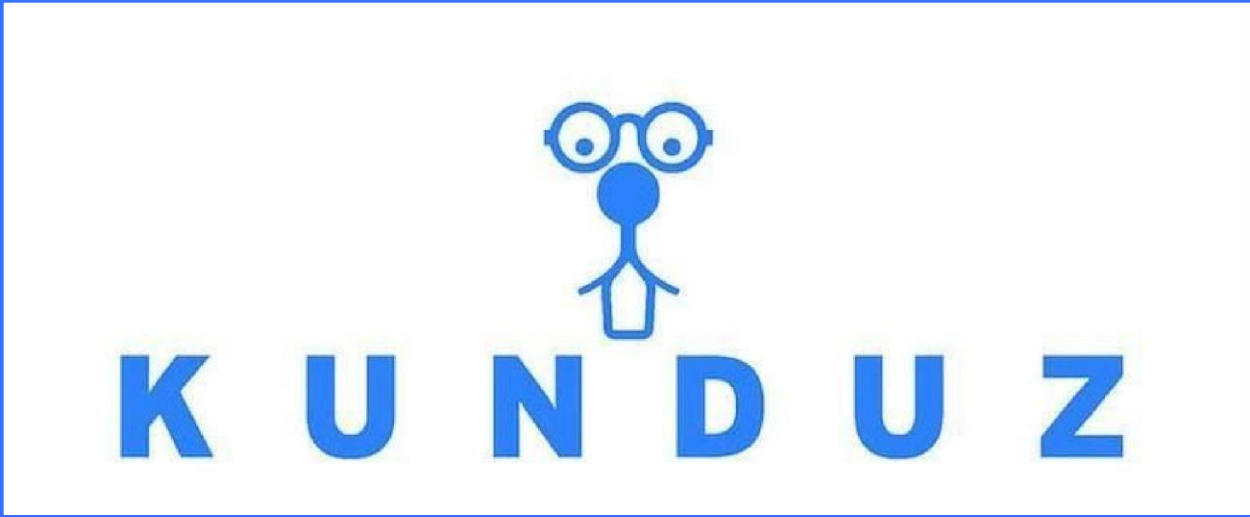


JEE Mains 6th September 2020 shift 2 Physics solutions prepared by KUNDUZ tutors

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Question number

Question and Answers

1

Q1. A charged particle going around in a circle can be considered to be a current loop. A particle of mass m carrying charge q is moving in a plane with speed v under influence of magnetic field $\vec{B}$. The magnetic moment of this moving particle is:

(1) $\frac{mv^2\vec{B}}{B^2}$ (2) $\frac{mv^2\vec{B}}{2B^2}$ (3) $-\frac{mv^2\vec{B}}{2B^2}$ (4) $\frac{mv^2\vec{B}}{2\pi B^2}$

Sol) Given, speed = v

$\Rightarrow$ time taken for one revolution $= \frac{2\pi R}{v}$

$\Rightarrow t = \frac{2\pi R}{v}$

$\Rightarrow$ current $= \frac{q}{t} = \frac{qv}{2\pi R} = I$

Magnetic moment $= m = IA$

$\Rightarrow M = \frac{qv}{2\pi R} \times \pi R^2 = \frac{qvR}{2}$

Also $R = \frac{mv}{qB}$ $\Rightarrow M = \frac{qv}{2} \times \frac{mv}{qB}$

$\Rightarrow M = \frac{mv^2}{2B}$

$\Rightarrow \vec{M} = \frac{mv^2}{2B}(-\hat{B}) = \boxed{-\frac{mv^2\vec{B}}{2B^2}}$

Thus, option 3 is correct.

2

Q2. Particle A of mass m_1 with velocity $(\sqrt{3}\hat{i}+\hat{j})\,ms^{-1}$ collides with another particle B of mass m_2 which is at rest initially. Let $\vec{v}_1$ and $\vec{v}_2$ be the velocities of particles A and B after collision respectively. If $m_1 = 2m_2$ and after collision $\vec{v}_1 = (\hat{i}+\sqrt{3}\hat{j})\,m/s$, the angle between $\vec{v}_1$ and $\vec{v}_2$ is:

(1) 105° (2) 15° (3) −45° (4) 60°

sol> By conservation of momentum:

$$m_1\vec{u_1} + m_2\vec{u_2} = m_1\vec{v_1} + m_2\vec{v_2}$$

$$\Rightarrow m_1(\sqrt{3}\hat{i}+\hat{j}) + 0 = m_1(\hat{i}+\sqrt{3}\hat{j}) + \frac{m_1}{2}\vec{v_2}$$

$$\Rightarrow \vec{v_2} = 2\left[(\sqrt{3}-1)\hat{i} + (1-\sqrt{3})\hat{j}\right]$$

$$\Rightarrow \vec{v_2} = 2(\sqrt{3}-1)(\hat{i}-\hat{j})$$

$$\Rightarrow \text{Total angle} = \tan^{-1}\left(\frac{\sqrt{3}}{1}\right) + \tan^{-1}\left(\frac{1}{1}\right)$$

$$= 60^\circ + 45^\circ$$

$$= \boxed{105^\circ}$$

Thus, option 1 is correct.

3

Q3. A square loop of side $2a$ and carrying current I is kept in xz plane with its centre at origin. A long wire carrying the same current I is placed parallel to z-axis and passing through point $(0, b, 0)$, $(b >> a)$. The magnitude of torque on the loop about z-axis will be:

(1) $\frac{2\mu_0 I^2 a^2}{\pi b}$ (2) $\frac{2\mu_0 I^2 a^2 b}{\pi(a^2+b^2)}$ (3) $\frac{\mu_0 I^2 a^2}{2\pi(a^2+b^2)}$ (4) $\frac{\mu_0 I^2 a^2 b}{2\pi(a^2+b^2)}$

Sol) Distance of long wire from sides of loop =

$$= \sqrt{a^2+b^2}$$

$$\Rightarrow B = \frac{\mu_0 I}{2\pi\sqrt{a^2+b^2}}$$

$$\tau = IAB\cos(\theta) = I \times (2a)^2 \times \frac{\mu_0 I}{2\pi\sqrt{a^2+b^2}} \times \frac{b}{\sqrt{a^2+b^2}}$$

$$\Rightarrow \boxed{\tau = \frac{2\mu_0 I^2 a^2 b}{\pi(a^2+b^2)}}$$

Thus, option 2 is correct.

4

Q4 Two identical electric hamts dipoles moments $\vec{p}_1 = p\hat{i}$ and $\vec{p}_2 = -p\hat{i}$ and are held on the x-axis at distance 'a' from each other. When released, they move along the x-axis with the direction of their dipole moments remaining unchanged. If the mass of each dipole is 'm', their speed when they are infinitely far aharts is:

(1) $\frac{p}{a}\sqrt{\frac{3}{2\pi\epsilon_0 ma}}$ (2) $\frac{p}{a}\sqrt{\frac{1}{2\pi\epsilon_0 ma}}$

(3) $\frac{p}{a}\sqrt{\frac{1}{\pi\epsilon_0 ma}}$ (4) $\frac{p}{a}\sqrt{\frac{2}{\pi\epsilon_0 ma}}$

Sol> Let the speed of dipoles be v at infinity

$\Rightarrow U = K E$

$\Rightarrow -\frac{2Kp_1 p_2 \cos(\theta)}{a^3} = \frac{1}{2}mv^2 \times 2$

here θ = angle between $\vec{p_1}$ and $\vec{p_2}$ = 180°

$\Rightarrow \frac{2Kp^2}{a^3} = mv^2 \Rightarrow v = \sqrt{\frac{2K}{ma}}\ \frac{p}{a}$

$\Rightarrow v = \frac{p}{a}\sqrt{\frac{1}{2\pi\epsilon_0 ma}}$

Thus, option 2 is correct.

5

Q5 For a plane electromagnetic wave, the magnetic field at a point x and time t is:

$\vec{B}(x,t) = [1.2\times10^{-7} \sin(0.5\times10^{3}x + 1.5\times10^{11}t)\hat{k}]\,T.$

The instantaneous electric field $\vec{E}$ corresponding to $\vec{B}$ is:

(1) $\vec{E}.(x,t) = [36\sin(1\times10^{3}x + 0.5\times10^{11}t)\hat{j}]\ \frac{V}{m}$

(2) $\vec{E}.(x,t) = [36\sin(0.5\times10^{3}x + 1.5\times10^{11}t)\hat{k}]\ \frac{V}{m}$

(3) $\vec{E}.(x,t) = [36\sin(1\times10^{3}x + 1.5\times10^{11}t)\hat{i}]\ \frac{V}{m}$

(4) $\vec{E}.(x,t) = [-36\sin(0.5\times10^{3}x + 1.5\times10^{11}t)\hat{j}]\ \frac{V}{m}$

Sol: We know that

$\hat{c} = \hat{E} \times \hat{B}$

Given $\hat{c} = -\hat{i}$, $\hat{B} = \hat{k}$

$\Rightarrow$ $\hat{E}$ should be $-\hat{j}$

Also $E_0 = cB_0$

$\Rightarrow E_0 = 3\times10^{8} \times 1.2\times10^{-7} = 36$

$\Rightarrow \vec{E} = -36(\sin(0.5\times10^{3}x + 1.5\times10^{11}t))\hat{j}\ V/m$

Thus, option 4 is correct.

6

86 When a particle of mass m is attached to a vertical spring of spring constant k and released, it motion, is described by $y(t) = y_0 \sin^2 \omega t$, where 'y' is measured from the lower end of upstreched spring. Then ω is:

(1) $\frac{1}{2}\sqrt{\frac{g}{y_0}}$ (2) $\sqrt{\frac{g}{y_0}}$ (3) $\sqrt{\frac{2g}{y_0}}$ (4) $\sqrt{\frac{g}{2y_0}}$

sol) Given $y = y_0 \sin^2(\omega t)$

$\Rightarrow y = \frac{y_0}{2}\left(1 - \cos(2\omega t)\right)$

$\Rightarrow y - \frac{y_0}{2} = -\frac{y_0}{2}\cos(2\omega t)$

$\Rightarrow Y = A\cos(2\omega t)$

$\Rightarrow 2\omega = \sqrt{\frac{k}{m}} \Rightarrow \frac{k}{m} = 4\omega^2$

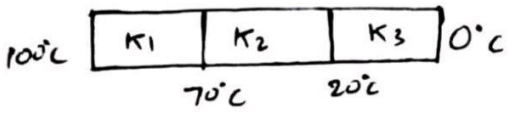
Also maximum displacement $= \frac{2mg}{k}$

$\Rightarrow y_0 = 2g \times \frac{1}{4\omega^2} \Rightarrow \boxed{\omega = \sqrt{\frac{g}{2y_0}}}$

Thus, option 4 is correct.

7

Q 7) Steady state temperature are shown in the diagram. Find ratio of thermal conductivity K_1/K_2, if lengths of all rods are same.



sol) we know that $\dot{Q} = KA\frac{\Delta T}{\Delta l}$

$$\Rightarrow \dot{Q} = \frac{K_1 A(100-70)}{\Delta l}$$

Also $$\dot{Q} = \frac{K_2 A(70-20)}{\Delta l}$$

$$\dot{Q} = \frac{K_3 A(20-0)}{\Delta l}$$

$$\Rightarrow 30K_1 = 50K_2 = 20K_3$$

$$\Rightarrow K_1 : K_3 = \frac{1}{30} : \frac{1}{20}$$

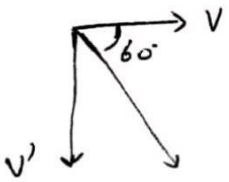
$$\Rightarrow \boxed{K_1 : K_3 = 2:3}$$

8

Q 8) Rain falls vertically when car is at rest. when car moves with speed v, rain appears at 60° with horizontal, when car moves with speed $(\beta+1)v$, rain appears at 45° with the horizontal. Find value of β:

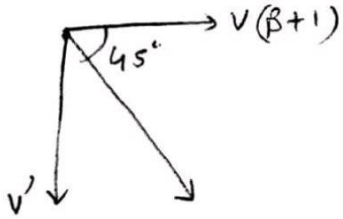
1) 3 2) 0.732 3) 2 4) 0.5

Sol) Rain falls vertical (given).
Let v' be speed of rain.
when car has speed v:



$$\Rightarrow \tan(60^\circ) = \frac{v'}{v} \quad -(1)$$

when car has speed $(\beta+1)v$:



$$\Rightarrow \tan(45^\circ) = \frac{v'}{(\beta+1)v} \quad -(2)$$

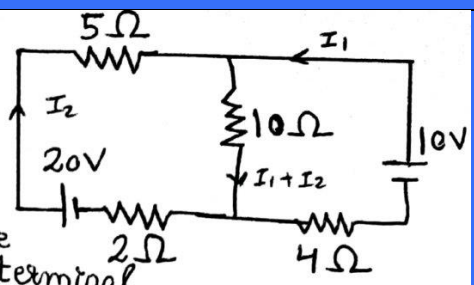
$$\frac{(1)}{(2)} \Rightarrow \frac{\tan(60^\circ)}{\tan(45^\circ)} = \beta+1 \Rightarrow \beta = \sqrt{3}-1$$

$$\Rightarrow \beta = 1.732 - 1 = \boxed{0.732}$$

Thus, option 2 is correct.

9

Q9 In the figure shown, the current in the 10V battery is close to:



(1) 0.42A from positive to negative terminal
(2) 0.71A from positive to negative terminal
(3) 0.36A from negative to positive terminal
(4) 0.21A from positive to negative terminal

Sol> Let the current distribution be as shown in the figure.

=> KVL in left loop:

$$20 - 5I_2 - 10(I_1+I_2) - 2I_2 = 0$$

$$\Rightarrow \quad 17I_2 + 10I_1 = 20 \quad — (1)$$

KVL in right loop:

$$\Rightarrow \quad 10 - 10(I_1+I_2) - 4I_1 = 0$$

$$\Rightarrow \quad 14I_1 + 10I_2 = 10 \Rightarrow 7I_1 + 5I_2 = 5 \quad — (2)$$

$$\Rightarrow \quad \boxed{I_1 = -0.22\ A}, \quad I_2 = 1.3\ A$$

$$\Rightarrow \quad I_1 + I_2 = 1.08\ A$$

Thus, option 4 is correct.

10

Q10. A fluid is flowing through a horizontal pipe of varying cross-section, with v m/s at a point where the pressure is P Pascal. At another point where pressure $\frac{P}{2}$ Pascal its speed is V m/s. If the density of the fluid is ρ kg/m^3 and the flow is streamline, then V is equal to:

(1) $\sqrt{\frac{P}{2\rho}+v^2}$ (2) $\sqrt{\frac{P}{\rho}+v^2}$ (3) $\sqrt{\frac{2P}{\rho}+v^2}$ (4) $\sqrt{\frac{P}{\rho}+v}$

Sol> Using Bernoulli's equation:

$$P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2$$

$$\Rightarrow P + \rho g h_1 + \frac{1}{2}\rho v^2 = \frac{P}{2} + \rho g h_2 + \frac{1}{2}\rho V^2$$

Since both the ends are at same datum.

$$\Rightarrow h_1 = h_2$$

$$\Rightarrow P - \frac{P}{2} + \frac{1}{2}\rho v^2 = \frac{1}{2}\rho V^2$$

$$\Rightarrow \boxed{V = \sqrt{\frac{P}{\rho} + v^2}}$$

Thus, option 2 is correct.

11

Q11 Consider the force F on a charge 'q' due to a uniformly charged spherical shell of radius R carrying charge Q distributed uniformly over it. Which one of the following statements is true for F, if 'q' is placed at distance r from the centre of the shell?

(1) $F = \frac{1}{4\pi\epsilon_0}\frac{Qq}{r^2}$ for all r (2) $F = \frac{1}{4\pi\epsilon_0}\frac{Qq}{R^2}$ for $r < R$

(3) $\frac{1}{4\pi\epsilon_0}\frac{qQ}{R^2} > F > 0$ for $r < R$ (4) $F = \frac{1}{4\pi\epsilon_0}\frac{Qq}{r^2}$ for $r > R$

Sol > We know that electric field inside a hollow shell is zero.

$\Rightarrow F = 0, \quad r < R$

Now, $F = k\frac{Qq}{r^2}$ for $r > R$

$\Rightarrow F = \frac{1}{4\pi\epsilon_0}\frac{Qq}{r^2}, \quad r > R$

Thus, option 4 is correct.

12

Q12 Assuming the nitrogen molecule is moving with r.m.s velocity at 400 K, the de-Broglie wavelength of nitrogen molecule is close to: (Given: nitrogen molecule weight $= 4.64 \times 10^{-26}$ kg, Boltzman constant $= 1.38 \times 10^{-23}$ J/K, Planck's constant $= 6.63 \times 10^{-34}$ J-s)

(1) 0.34 Å (2) 0.44 Å (3) 0.20 Å (4) 0.24 Å

sol) RMS velocity $= v = \sqrt{\frac{3RT}{m}}$

R is Boltzman constant $\Rightarrow p = mv = \sqrt{3mRT}$

$$\Rightarrow \lambda = \frac{h}{p} = \frac{h}{\sqrt{3mRT}} = \frac{6.63 \times 10^{-34}}{\sqrt{3 \times 4.64 \times 10^{-26} \times 1.38 \times 10^{-23} \times 400}}$$

$\Rightarrow \boxed{\lambda = 0.24 \text{ Å}}$

Thus, option 4 is correct.

13

Q13. A particle moving in the xy-plane experiences a velocity dependent force $F = k(v_y \hat{i} + v_x \hat{j})$, where v_x and v_y are the x and y components of its velocity $\vec{v}$. If $\vec{a}$ is the acceleration of the particle, then which of the following statements is true for the particle?

(1) quantity $\vec{v} \cdot \vec{a}$ is a constant in time.
(2) quantity $\vec{v} \times \vec{a}$ is constant in time
(3) $\vec{F}$ arises due to a magnetic field.
(4) kinetic energy of particle is constant in time.

Sol) Given $\vec{F} = k(v_y \hat{i} + v_x \hat{j})$

$$\vec{v} = v_x \hat{i} + v_y \hat{j}$$

$$\Rightarrow \vec{a} = \frac{k}{m}(v_y \hat{i} + v_x \hat{j})$$

$$\vec{v} \times \vec{a} = \frac{k}{m} \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ v_x & v_y & 0 \\ v_y & v_x & 0 \end{vmatrix}$$

$$\Rightarrow \vec{v} \times \vec{a} = \frac{k}{m}\left[\hat{i}(0) - \hat{j}(0) + \hat{k}(v_x^2 - v_y^2)\right]$$

$$\Rightarrow \vec{v} \times \vec{a} = \frac{k}{m}(v_x^2 - v_y^2)\hat{k} = \text{constant.}$$

Thus, option 2 is correct.

14

Q14. A double convex lens has power P and same radii of curvature R of both the surfaces. The radius of curvature of a surface of a plano-convex lens made of the same material with power 1.5 P is:

(A) $\frac{3R}{2}$ (2) $\frac{R}{2}$ (3) $\frac{R}{3}$ (4) $2R$

Sol) By lens makers formula :

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Rightarrow P = (\mu - 1)\left(\frac{1}{R} + \frac{1}{R}\right) = (\mu - 1)\frac{2}{R} \quad -(1)$$

For planoconvex lens:

$$P' = (\mu - 1)\left(\frac{1}{R} - \frac{1}{\infty}\right) = \frac{2(\mu - 1)}{2R} \quad -(2)$$

Given $P' = 1.5P \Rightarrow \frac{P'}{P} = \frac{3}{2}$

$$\Rightarrow \frac{P'}{P} = \frac{R}{2R} \Rightarrow \frac{3}{2} = \frac{R}{2R}$$

$\Rightarrow \boxed{R = R/3}$ Thus, option 3 is correct

15

Q15> Given the masses of various atomic particles, $m_p = 1.00727\,u$, $m_n = 1.00867\,u$, $m_e = 0.00548\,u$ $m_{\bar{\nu}} = 0$, $m_d = 2.01410\,u$, where p is proton n is neutron, e is electron, $\bar{\nu}$ is antineutrino, d is deutron. which of the following processes is allowed by momentum and energy conservation.

1> $n + p \rightarrow d + \gamma$

2> $p \rightarrow n + e^+ + \bar{\nu}$

3> $n + n \rightarrow du$ (electron bound to nucleus)
du is deuterium.

4> $e^+ + e^- \rightarrow \gamma$.

sol> when nutrino or antinutrino is present, momentum isn't conserved.

In deuterium, electrons may consume some energy and we may experience loss of energy.

In option 4, there is no mass on product side, thus no final momentum.

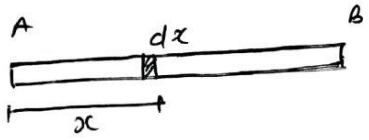
Thus, option 1 is correct.

16

Q16) The linear mass density of a thin rod AB of length L varies from A to B as $\lambda = \lambda_0\left(1+\frac{x}{L}\right)$, where x is the distance from A. If M is the mass of the rod, then its moment of inertia about an axis passing through A and perpendicular to rod:

1) $\frac{5}{12}ML^2$ 2) $\frac{3}{7}ML^2$ 3) $\frac{7}{18}ML^2$ 4) $\frac{2}{5}ML^2$

Sol)



$$dm = \lambda\, dx = \lambda_0\left(1+\frac{x}{L}\right)dx$$

$$\Rightarrow dI = dm\,x^2$$

$$\Rightarrow I = \int_0^L \lambda_0\left(1+\frac{x}{L}\right)x^2\,dx$$

$$= \frac{\lambda_0 L^3}{3} + \frac{\lambda_0}{L}\cdot\frac{L^4}{4} = \lambda_0 L^3\left(\frac{1}{3}+\frac{1}{4}\right)$$

$$\Rightarrow I = \frac{7\lambda_0 L^3}{12}$$

$$\int_0^L dm = M = \lambda_0 L + \frac{\lambda_0 L}{2} = \frac{3\lambda_0 L}{2}$$

$$\Rightarrow I = \frac{7}{12}\times L^3 \times \frac{2M}{3L} = \boxed{\frac{7}{18}ML^2}$$

Thus, option 3 is correct.

17

Q 17) In an electric circuit, ammeter and voltmeter are used to verify ohm's law. which of the following is true.

1) Ammeter connected in series and voltmeter in parallel.
2) Voltmeter connected in series and ammeter in parallel.
3) Both are connected in parallel.
4) Both are connected in series.

Sol) Voltmeter have very high resistance and it takes reading of voltage between two points.
So, it is connected in parallel.

Ammeter has very low resistance and measures current flowing in circuit.
It is connected in series.

Thus, option 1 is correct.

18

Q18> In a dilute gas at pressure P and temperature T the mean time between successive collision of molecule varies with T as:

1> T 2> $\frac{1}{\sqrt{T}}$ 3> $\sqrt{T}$ 4> $\frac{1}{T}$

Sol> We know that,

time constant = τ

$$\tau \propto \frac{1}{V_{rms}}$$

$$\Rightarrow \tau \propto \frac{1}{\sqrt{\frac{3RT}{M}}} \Rightarrow \boxed{\tau \propto \frac{1}{\sqrt{T}}}$$

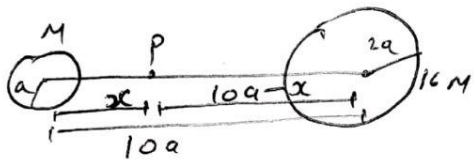
Thus, option 2 is correct.

19

Q19) Two planets have masses M and 16M and their radii are a and 2a. The seperation between the centres of planets are 10a. A body of mass m is fired from surface of larger planet towards the smaller planet along the line joining their centres. For the body to be able to reach at the surface of smaller planet, the minimum speed needed is :

1) $\frac{3}{2}\sqrt{\frac{5GM}{a}}$ 2) $\sqrt{\frac{GM^2}{ma}}$ 3) $2\sqrt{\frac{GM}{a}}$ 4) $4\sqrt{\frac{GM}{a}}$

Sol)



For mass m to reach large planet it just need to cross point P, where gravitational field is zero.

$\Rightarrow \frac{GM}{x^2} = \frac{G\times 16M}{(10a-x)^2}$ $\Rightarrow \frac{10a}{x} - 1 = 4$

$\Rightarrow \boxed{x = 2a}$

$\Rightarrow$ final energy $= -\frac{GMm}{2a} - \frac{G(16M)m}{8a}$

$U_{initial} = -\frac{GMm}{a} - G\frac{16Mm}{(9a)} + \frac{1}{2}mv^2$

$\Rightarrow \frac{mv^2}{2} - \frac{GMm}{a} - \frac{16GMm}{(9a)} = -\frac{GMm}{2a} - \frac{2GMm}{a}$

$\Rightarrow \frac{mv^2}{2} = 5\frac{GM}{18a}m \Rightarrow \boxed{v = \sqrt{\frac{GM\times 5m}{9ma}}} \Rightarrow \boxed{v = \sqrt{\frac{5GM}{9a}}}$

20

Q.20 A student measuring the diameter of a pencil of circular cross-section with the help of a vernier scale records the following four readings 5.50 mm, 5.55 mm, 5.34 mm, 5.65 mm. The average of these four reading is 5.5375 mm and the standard deviation of the data is 0.07395 mm. The average diameter of the pencil should therefore be recorded as:

(1) (5.54 ± 0.07) mm
(2) (5.538 ± 0.074) mm
(3) (5.5375 ± 0.0740) mm
(4) (5.5375 ± 0.0739) mm

Sol> Given, diameter = 5.5375 mm = d

Also Δd = 0.07395 mm

Vernier callipers has least count of 0.01 mm

Thus, Δd, which is measurable is 0.07 mm

And d = 5.54 mm { Rounded off to two decimal places }

Thus, $d = 5.54 \pm 0.07$ mm

Thus, option 1 is correct.

21

Q21. In a series LR circuit, power of 400W is dissipated from a source of 250V, 50Hz. The power factor of the circuit is 0.8. In order to bring the power factor to unity, a capacitor of value C is added in series to L and R. Taking the value of C as $\left(\frac{n}{3\pi}\right)$ μF, then value of n is _____.

Sol>

$$\text{Power factor} = \phi = \frac{R}{Z}$$

$$\Rightarrow 0.8 = \frac{R}{\sqrt{R^2 + X_L^2}} \quad -(1)$$

Let capacitance be C

$$\Rightarrow 1 = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}} \quad -(2)$$

$$\frac{(1)}{(2)} \Rightarrow 0.8^2 = \frac{R^2 + (X_L - X_C)^2}{R^2 + X_L^2}$$

$$\Rightarrow \frac{16}{25} = \frac{R^2 + (X_L - X_C)^2}{R^2 + X_L^2} \quad -(3)$$

$P = 400 = 250 \times i \times 0.8 \Rightarrow i = 2A$

Also $i^2 R = P \Rightarrow R = \frac{400}{2^2} = 100$

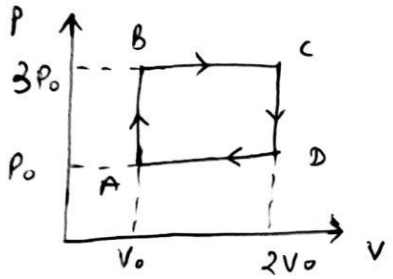
$(1) \Rightarrow X_L = 75\Omega$

$(3) \Rightarrow X_C = 75\Omega \Rightarrow \frac{1}{\omega C} = 75 \Rightarrow C = (75 \times 2\pi \times 50)^{-1}$

$\Rightarrow C = \frac{n \times 10^{-6}}{3\pi} = (7500\pi)^{-1} \Rightarrow n = \frac{3\pi \times 10^6}{7500\pi} = \boxed{400}$

22

Q 22) An engine operates by taking a monoatomic ideal gas through the cycle shown in the figure. The percentage efficiency of the engine is close to :



Sol) Heat is given in AB and BC

For AB, $Q_{in} = nC_V\Delta T$

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

$= \frac{3}{2} P_0 V_0 \times 2$

For BC, $Q_{in} = nC_p\Delta T$

$= n \times \frac{5R}{2} \Delta T = \frac{15}{2} P_0 V_0$

$\Rightarrow Q_{in} = \frac{3}{2} P_0 V_0 \times 2 + \frac{15}{2} P_0 V_0 = \frac{21}{2} P_0 V_0$

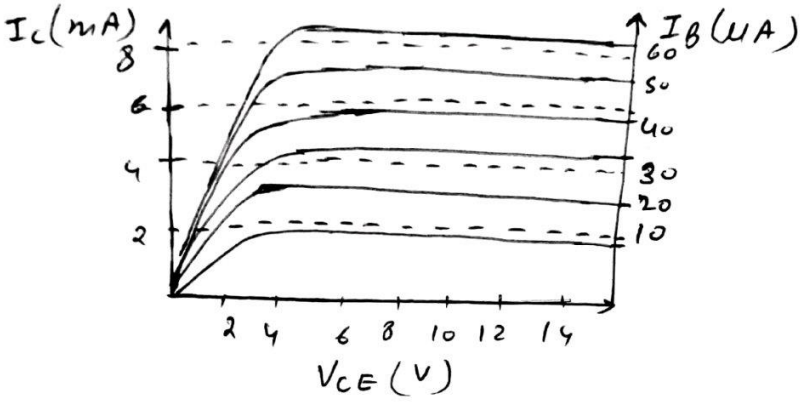
$WD = (2V_0 - V_0)(3P_0 - P_0) = 2P_0 V_0$

$\Rightarrow \eta = \frac{WD}{Q_{in}} \times 100 = \frac{2 P_0 V_0}{\frac{21}{2} P_0 V_0} \times 100 = \frac{400}{21}\%$

$\Rightarrow \boxed{\eta = 19\%}$

23

Q 23) The output characteristic of a transistor is shown in figure. When $V_{CE} = 10V$ and $I_C = 4mA$, then value of β_{ac} is ___



Sol) β = current gain = $\frac{I_C}{I_B}$

Given $I_C = 4mA$

At $V_{CE} = 10V$ and $I_C = 10mA$

$I_B \approx 2606\ \mu A$

$\Rightarrow \beta = \frac{4m}{2606\mu} = \boxed{150}$

24

Q24. A Young's double-slit experiment is performed using monochromatic light of wavelength λ. The intensity of light at a point on the screen, where the path difference is λ, is K units. The intensity of light at a point where the path difference is $\frac{\lambda}{6}$ is given by $\frac{nK}{12}$, where n is an integer. The value of n is ___

Sol> we know that $I = I_0 \cos^2\left(\frac{\phi}{2}\right)$

ϕ is phase difference.

Path difference $= \Delta x = \phi \times \left(\frac{2\pi}{\lambda}\right)^{-1}$

Given $\Delta x = \frac{\lambda}{6}$

$\Rightarrow \phi = \frac{\lambda}{6} \times \frac{2\pi}{\lambda} = \frac{\pi}{3}$

$\Rightarrow I = K \cos^2\left(\frac{\pi}{6}\right) = K \times \left(\frac{\sqrt{3}}{2}\right)^2$

$\Rightarrow I = \frac{3K}{4}$

$\Rightarrow \frac{nK}{12} = \frac{3K}{4} \Rightarrow \boxed{n = 9}$

25

Q 25) Find distance of centre of mass of solid hemisphere of radius 8 cm from centre.

Sol) We know that :

height of hemisphere's COM from flat base $= \frac{3R}{8}$

$\Rightarrow h_{COM} = \frac{3R}{8}$ { $R = 8$ cm (given) }

$\Rightarrow h_{COM} = \frac{3}{8} \times 8 = \boxed{3 \text{ cm}}$

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