JEE Main September 2020

Question Paper With Text Solution

6 September| Shift-2

PHYSICS

MATRIX

JEE Main & Advanced | XI-XII Foundation| VI-X Pre-Foundation

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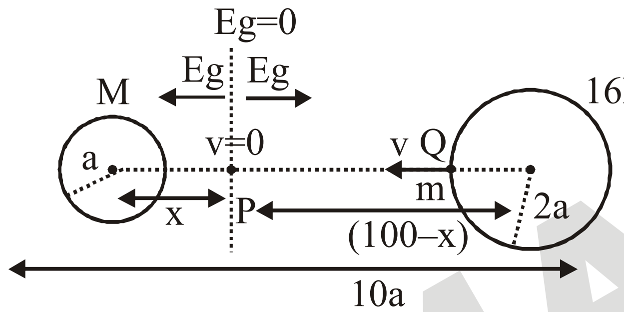
JEE MAIN SEP 2020 | 6TH SEP SHIFT-2

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

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

Ans. (2)

Sol.



to reach smallest planet, mass m has to reach point P. as at point P nett gravitation field intensity is zero. Left to point p, nett gravitational field is towards left and right to point P nett gravitational field is towards right.

At point P, (E_g) due to M = (E_g) due to 16 M

$$\frac{GM}{x^2} = \frac{G16M}{(100-x)^2}$$

x = 2a

Energy conservation two point Q and P

$$-\frac{Gm(16M)}{2a} - \frac{GmM}{8a} + \frac{1}{2}mv^2 = -\frac{G(16M)m}{8a} - \frac{GMm}{2a}$$

$$v = \frac{3}{2}\sqrt{\frac{5GM}{a}}$$

2. A circuit to verify Ohm's law uses ammeter and voltmeter in series or parallel connected correctly to the resistor. In the circuit:

(1) ammmeter is always used in parallel and voltmeter is series

(2) Both ammeter and voltmeter must be connected in parallel

(3) ammeter is always connected in series and voltmeter in parallel

(4) Both, ammeter and voltmeter must be connected in series.

Ans. (3)

Sol. Ammeter is always connected in series and voltmeter in parallel.

3. 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) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for all r

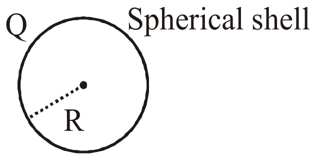
(2) $\frac{1}{4\pi\varepsilon_0}\frac{qQ}{R^2} > F > 0$ for r < R

(3) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{R^2}$ for r < R

(4) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for r > R

Ans. (4)

Sol.



$E = 0, r < R$

$E = \frac{1}{4\pi \in_0}\frac{Q}{R^2}, r \geq R$

as $F = qE$

So, $F = O; R < R$

$F = \frac{1}{4\pi \in_0}\frac{Qq}{R^2}; r \geq R$

4. When a car is at rest, its driver sees rain drops falling on it vertically. When driving the car with speed v, he sees that rain drops are coming at an angle 60° from the horizontal. On further increasing the speed of the car to $(1 + \beta)v$, this angle changes to 45° . The value of β is close to :

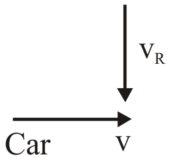
(1) 0.73 (2) 0.37 (3) 0.50 (4) 0.41

Ans. (1)

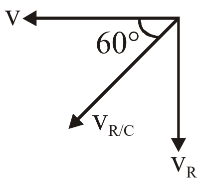
Sol. Initially $\downarrow V_R$ = Velocity of rain

car is at rest $\longrightarrow$ v = 0

When car is moving with speeds v



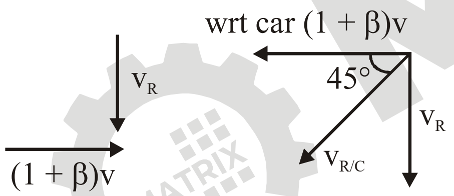
with respect to car.



$$\tan 60° = \frac{v_R}{v}$$

$$\frac{v_R}{v} = \sqrt{3} \qquad ....(1)$$

when car is moving with speed (β + 1)v



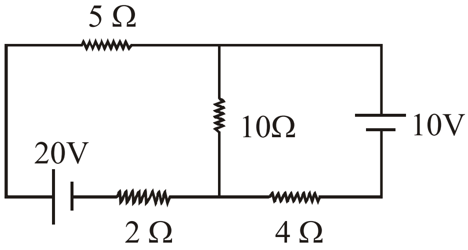
$$\tan 45° = \frac{v_R}{(1+\beta)_v} = 1$$

V_R = (1 + β)v ....(2)

from (1) and (2)

$\sqrt{3}$ v = (1 + β)v

β = 0.73

5. 

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

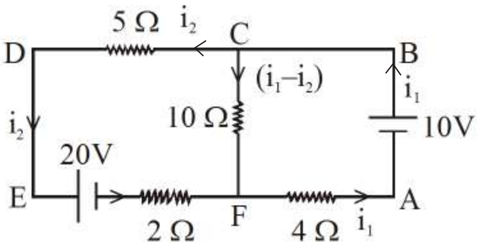
(1) 0.36 A from negative to positive terminal

(2) 0.21 A from positive to negative terminal

(3) 0.42 A from positive to negative terminal

(4) 0.71 A from positive to negative terminal

Ans. (2)

Sol. 

kirchoff's loop law in ABCFA

$10 - 10(i_1 - i_2) - 4i_1 = 0$

$7i_1 - 5i_2 = 5$ ....(1)

kirchoff's loop law in CDEFC

$-5i_2 - 20 - 2i_2 + 10(i_1 - i_2) = 0$

$-17i_2 + 10i_1 = 20$ ....(2)

on solving eq (1) & (2)

$i_1 = -\frac{15}{69} = -0.21$

So currect in battery of 10 V battery is from positive to negative terminal.

6. A fluid is flowing through a horizontal pipe of varying cross-section, with speed υ ms^{-1} at a point where the pressure is P Pascal. At another point where pressure is $\frac{P}{2}$ pascal its speed is V ms^{-1} . If the density of the fluid is ρ kg ms^{-3} and the flow is streamline, then V is equal to :

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

Ans. (2)

Sol. By Belnoull is theolem

$$P_1+\frac{1}{2}\rho v_1^2+\rho g h_1 = p_2+\frac{1}{2}\rho v_2^2+\rho h g_2$$

as pipe is horizontal so $h_1 = h_2 = 0$

so $P+\frac{1}{2}\rho\upsilon^2=\frac{P}{2}+\frac{1}{2}\rho V^2$

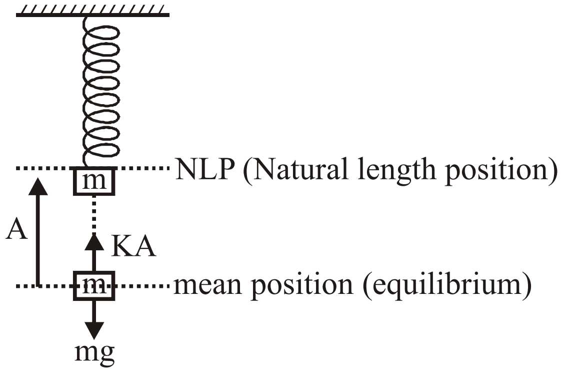
$$v=\sqrt{\frac{P}{\rho}+\upsilon^2}$$

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

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

Ans. (1)

Sol.



$y = y_0 \sin^2 \omega t$

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

Here amplitude is $A = \frac{y_0}{2}$

angular frequency is 2ω.

at mean position

KA = mg

$m(2\omega)^2 \frac{y_0}{2} = mg$

$\omega = \sqrt{\frac{g}{2y_0}}$

8. 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 :

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

Ans (1)

Sol. For double convex (bi – convex) lens

$P = \frac{1}{f} = (\mu - 1)\left(\frac{2}{R}\right)$.......(1)

For plano–convex lens

$1.5P = \frac{1}{f'} = (\mu - 1)\left(\frac{1}{R'}\right)$.......(2)

from (1) and (2)

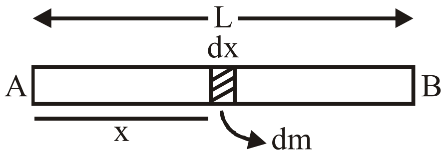
$\frac{1}{1.5} = \frac{2R'}{R} \Rightarrow R' = \frac{R}{3}$

9. The linear mass density of a thin rod AB of length L varies from A to B as $\lambda(x) = \lambda_0\left(1 + \frac{x}{L}\right)$, 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 the rod is :

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

Ans (2)

Sol.



$$dm = \lambda\, dx$$

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

$$M = \int dm = \int_0^L \lambda_0\left(1+\frac{x}{L}\right)dx$$

$$M = \lambda_0\left[x+\frac{x^2}{2L}\right]_0^L$$

$$M = \frac{3\lambda_0 L}{2} \Rightarrow \lambda_0 = \frac{2M}{3L}$$

Moment of inertia of dm about A

$dI = dm\, x^2$

Moment of inertia of rod

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

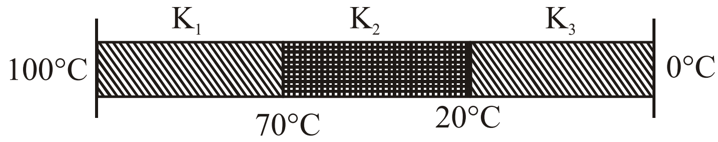
$$I = \lambda_0\left[\frac{x^3}{3}+\frac{x^4}{4L}\right]_0^L$$

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

by putting $\lambda_0 = \dfrac{2M}{3L}$

$$I = \frac{7}{18}ML^2$$

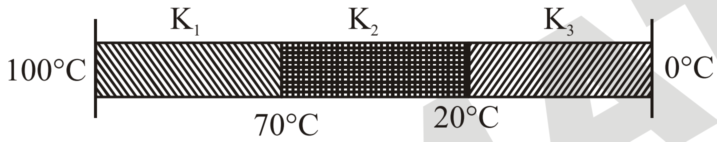
10. Three rods of identical cross-section and lengths are made of three different materials of thermal conductivity K_1, K_2 and K_3, respectively. They are joined together at their ends to make a long rod (see figure). One end of the long rod is maintained at 100°C and the other at 0°C (see figure). If the joints of the rod are at 70°C and 20°C in steady state and there is no loss of energy from the surface of the rod, the correct relationship between K_1, K_2 and K_3 is :



(1) $K_1 > K_2, > K_3$
(2) $K_1 < K_2, < K_3$
(3) $K_1 : K_2 = 5 : 2,\ K_1 : K_3 = 3 : 5$
(4) $K_1 : K_3 = 2 : 3, K_2 : K_3 = 2 : 5$

Ans (4)

Sol.



We know that in steady state rate of heat flow through all the rods will be same as these are arranged in series.

Rate of Heat flow through rod 1 = Rate of Heat flow through rod 2 = Rate of Heat flow through rod 3

$$\frac{k_1A(100-70)}{l} = \frac{k_2A(70-20)}{l} = \frac{k_3A(20-0)}{l}$$

$3k_1 = 5k_2 = 2k_3$

so $k_1 : k_3 = 2 : 3$

$k_2 : k_3 = 2 : 5$

11. 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, 5.45 mm, 5.65 mm. The average of these four readings 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) (5.5375 ± 0.0739)mm
(2) (5.538 ± 0.074)mm
(3) (5.54 ± 0.07)mm
(4) (5.5375 ± 0.0740)mm

Ans (3)

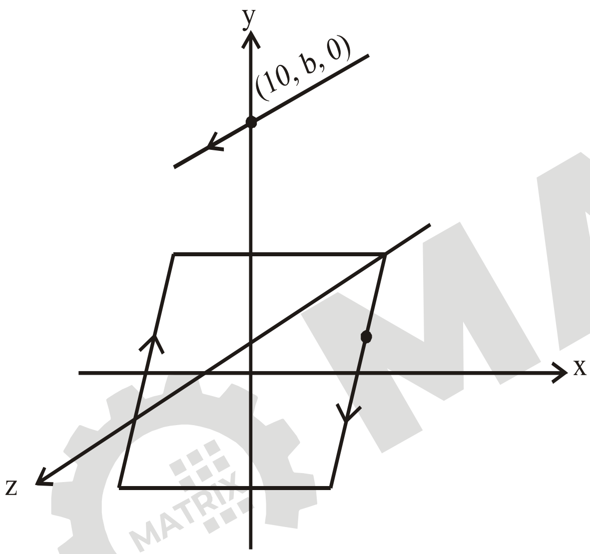
Sol. Average of readings has to have same number of significant digits as of given values. So average value = 5.54 (after round off) and same is applied to deviation = 0.07. So average diameter = (5.54 ± 0.07)mm.

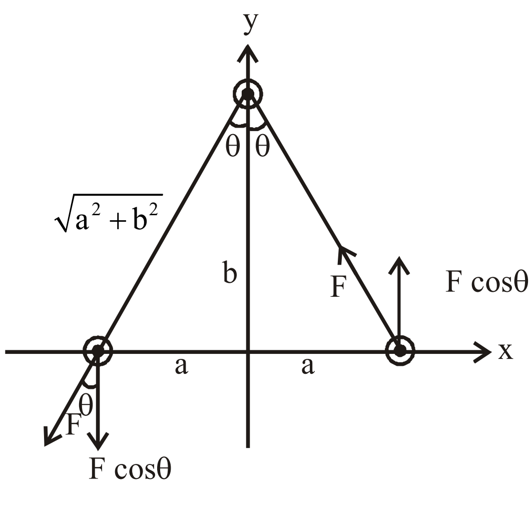
12. A square loop of side 2a and carrying current I is kept in xz plane with its centre at origin. A long wire carrying the same current I is placed parallel to z-axis and passing through point (0, b,0), (b>>a). The magnitude of torque on the loop about z-axis will be :

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

Ans (3)

Sol.





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

$F = BI(2a)$

$\tau = F\cos\theta \times 2a$

$$\tau = \frac{\mu_0 I^2 a}{\pi\sqrt{b^2 + a^2}} \times \frac{b}{\sqrt{b^2 + a^2}} \times 2a$$

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

13. In a dilute gas at pressure P and temperature T, the mean time between sucessive collisions of a molecule varies with T as :

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

Ans (1)

Sol. $\tau \propto \frac{1}{V_{(speed)}}$

$V \propto \sqrt{T}$

$\tau = \frac{1}{\sqrt{T}}$

14. For a plane electromagnetic wave, the magnetic field at a point x and time is

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

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

(speed of light $c = 3 \times 10^8\ ms^{-1}$)

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

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

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

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

Ans (4)

Sol. $\vec{B}(x_1t) = \left[1.2\times10^{-7}\sin\left(0.5\times10^{3}x+1.5\times10^{11}t\right)\hat{k}\right]$ .... (1)

$B_0 = 1.2\times10^{-7}$, $C = 3\times10^{8}\,m/s$

$E_0 = B_0C = 36$

Direction of electromagnetic wave from equation (1) = towards negative x–axis.

We know that direction of EMV is along $\vec{E}\times\vec{B}$.

So direction of electric field will be along negative y–axis.

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

15. Assuming the nitrogen molecule is moving with r.ms. velocity at 400k, the de-Broglie wavelength of nitrogen molecule is close to :

(Given : nitrogen molecule weight : 4.64×10^{-26} kg,

Boltzman constant : 1.38×10^{-23}J/K, planck constant : 6.63×10^{-34}J.s)

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

Ans (2)

Sol. T = 400 K

$\lambda = \frac{h}{P} = \frac{h}{\sqrt{2m(KE)}}$

$KE = \frac{f}{2}KT$

For nitrogen f = 3 (only translational)

$KE = \frac{3}{2}KT$

$m = 4.64\times10^{-26}$ kg

$\lambda = 0.24$ Å

16. Particle A of mass m_1 moving with velocity $\left(\sqrt{3}\hat{i}+\hat{j}\right)ms^{-1}$ 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 $\vec{V}_1 = \left(\hat{i}+\sqrt{3}\hat{j}\right)ms^{-1}$, the angle between $\vec{V}_1$ and $\vec{V}_2$ is :

(1) –45° (2) 105° (3) 60° (4) 15°

Ans (2)

Sol. By applying momentum conservation

$\vec{P}_i = \vec{P}_f$

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

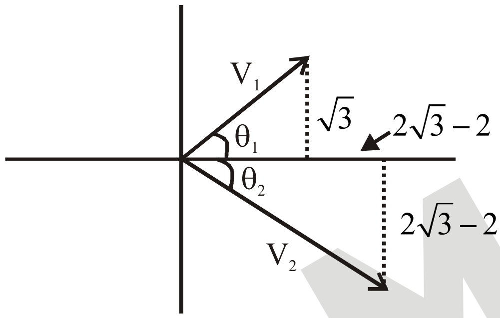
Here $\vec{u_1} = \sqrt{3}\hat{i} + \hat{j}$, $\vec{u_2} = 0$

$\vec{V_1} = \left(\hat{i} + \sqrt{3}\hat{j}\right)$, $m_1 = 2m_2$

$m_1\left(\sqrt{3}\hat{i} + \hat{j}\right) + m_2(0) = m_1\left(\hat{i} + \sqrt{3}\hat{j}\right) + m_2\vec{V}_2$

$2m_2\left(\sqrt{3}\hat{i} + \hat{j}\right) = 2m_2\left(\hat{i} + \sqrt{3}\hat{j}\right) + m_2\vec{V}_2$

$\vec{V}_2 = \left(2\sqrt{3} - 2\right)\hat{i} - \left(2\sqrt{3} - 2\right)\hat{j}$



$\theta_1 = 60°$
$\theta_2 = 45°$
Angle between V_1 & $V_2 = \theta_1 + \theta_2 = 105°$

17. Given the masses of various atomic particles $m_P = 1.0072$ u, $m_n = 1.0087$ u, $m_e = 0.000548$ u, $m_{\bar{\upsilon}} = 9$, $m_d = 2.0141$ u, where p ≡ proton, n ≡ neutron, e ≡ electron, υ ≡ antineutrino and d ≡ deuteron. Which of the following process is allowed by momentum and energy conservation ?

(1) $P \rightarrow n + e^+ + \bar{\upsilon}$

(2) $n + p \rightarrow d + \gamma$

(3) $e^+ + e^- \rightarrow \gamma$

(4) $n + n \rightarrow$ deuterium atom(electron bound to the nucleus)

Ans (2)

Sol. $n + p \rightarrow d + \gamma$
mass of (P + n) = 2.0159 n
mass of d = 2.0141 n
Mass on LHS > Mass on RHS
Mass defect will convert into γ rays.

18. 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 the influence of magnetic field $\vec{B}$. The magnetic moment of this moving particle :

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

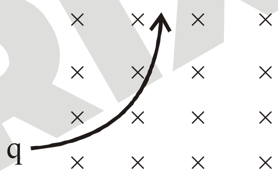
Ans (2)

Sol. $T = \frac{2\pi m}{qB}$ (Time period of change g in magnetic field)

Magnetic moment = IA

$= \left(\frac{q}{T}\right)\pi r^2$

$r = \frac{mv}{qB}$



$$M = \frac{q}{\left(\frac{2\pi m}{qB}\right)} \times \pi\left(\frac{mv}{qB}\right)^2$$

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

Direction of $\vec{M}$ is given by curling fingers of right hand in the direction of current, then extended thumb gives direction of $\vec{M}$. So here $\vec{M}$ will be opposite to $\vec{B}$.

$$\vec{M} = \frac{-mv^2\vec{B}}{2B^2}$$

19. A particle moving in the xy plane experiences a velocity dependent force $\vec{F} = k\left(V_y\hat{i} + V_x\hat{j}\right)$, 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 $\vec{V}\times\vec{a}$ is constant in time

(2) quantity $\vec{V}\cdot\vec{a}$ is constant in time

(3) kinetic energy of particle is constant in time

(4) $\vec{F}$ arises due to a magnetic field

Ans (1)

Sol. $\vec{F} = K\left(V_y\hat{i} + V_x\hat{j}\right)$

$m\vec{a} = K\left(V_y\hat{i} + V_x\hat{j}\right)$

$m\left(\frac{dV_x}{dt}\hat{i} + \frac{dV_y}{dt}\hat{j}\right) = K\left(V_y\hat{i} + V_x\hat{j}\right)$

$\frac{dV_x}{dt} = \frac{k}{m}V_y$ .... (1)

$\frac{dV_y}{dt} = \frac{k}{m}V_x$ .... (2)

$\frac{dV_x}{dV_y} = \frac{V_y}{V_x}$

$V_x dV_x = V_y dV_y$

$\frac{V_x^2}{2} - \frac{V_y^2}{2} = C$ .... (3)

$\vec{V} \times \vec{a} = \left(V_x\hat{i} + V_y\hat{j}\right) \times \frac{k}{m}\left(V_y\hat{i} + V_x\hat{j}\right)$

$\vec{V} \times \vec{a} = \left(V_x^2 - V_y^2\right)\hat{k}$ .... (4)

From (3) & (4)

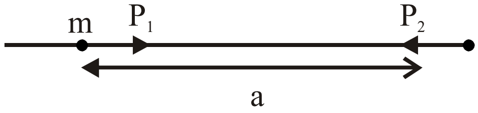
$\boxed{\vec{V} \times \vec{a} = 2C\hat{k}}$ constant

20. Two identical electric point dipoles have dipole 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 apart is :

(1) $\frac{p}{a}\sqrt{\frac{1}{2\pi\varepsilon_0 ma}}$ (2) $\frac{p}{a}\sqrt{\frac{1}{\pi\varepsilon_0 ma}}$ (3) $\frac{p}{a}\sqrt{\frac{2}{\pi\varepsilon_0 ma}}$ (4) $\frac{p}{a}\sqrt{\frac{3}{2\pi\varepsilon_0 ma}}$

Ans (1)

Sol.



$\left|\vec{P}_1\right| = \left|\vec{P}_2\right| = P$

When separation is infinity then potential energy becomes zero.

By energy conservation

$PE_i + KE_i = PE_f + KE_f$

$$\frac{2KP_1P_2}{a^3} + 0 = 0 + 2\left(\frac{1}{2}mv^2\right)$$

$$v = \frac{P}{a}\sqrt{\frac{1}{2\pi\varepsilon_0 ma}}$$

21. In a series LR circuit, power of 400 W is dissipated from a source of 250 V, 50 Hz. 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 the L and R. Taking the value of C as $\left(\frac{n}{3\pi}\right)\mu F$, then value of n is_____.

Ans 400

Sol. $P = \frac{V_{RMS}^2}{Z} \times \cos\phi$,

Here $Z = \sqrt{R^2 + X_L^2}$; For R – L circuit

Given P = 400 watt, V_{RMS} = 250, cosϕ = 0.8.

$$400 = \frac{(250)^2}{Z} \times \frac{R}{Z} \text{ .... (1)}$$

Also $\cos\phi = \frac{R}{Z} = 0.8$ .... (2)

From equation (1) & (2)

$$Z = \frac{(250)^2}{400} \times 0.8 = \frac{625 \times 0.8}{4} = 125$$

$$\frac{R}{Z} = 0.8$$

$$R = 0.8 \times 125 = 100\,\Omega$$

$$Z = \sqrt{R^2 + X_L^2}$$

$X_L = \sqrt{Z^2 - R^2}$

$X_L = \sqrt{(125)^2 - (100)^2}$

$X_L = 75$

For power factor to be one $X_L = X_C$ (in RLC circuit)

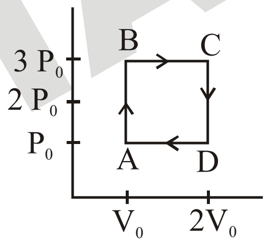
$\frac{1}{\omega_C} = 75$

$\frac{1}{2\pi fC} = 75$ f = 50 Hz

$C = \frac{1}{7500\pi} = \frac{n \times 10^{-6}}{3\pi}$

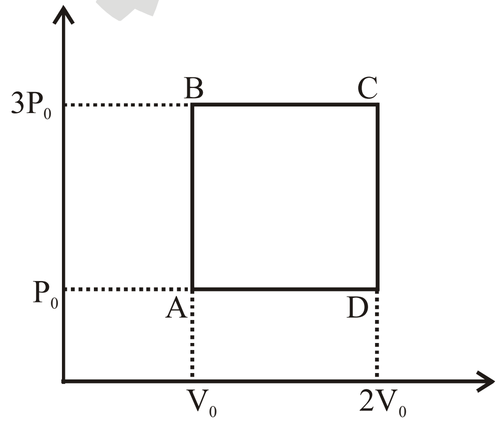
$n = \frac{3 \times 10^6}{7500} = 400$

22. An engine operates by taking a monatomic ideal gas through the cycle shown in the figure. The percentage efficiency of the engine is close to _____.



Ans 19

Sol.



Work done = Area of ABCD = $2P_0V_0$

$T_B = \frac{3P_0V_0}{nR}, T_C = \frac{6P_0V_0}{nR}, T_A = \frac{P_0V_0}{nR}$

Heat supplied in BC = $\Delta Q = nC_p\Delta T = n \times \frac{5}{2}R\left(T_C - T_B\right)$

$$\Delta Q = \frac{15}{2}P_0V_0$$

Heat supplied in AB = $\Delta Q = nC_V\Delta T = n \times \frac{3}{2}R\left(\frac{2P_0V_0}{nR}\right)$

$\Delta Q = 3P_0V_0$

$$\eta = \frac{\text{Work done}}{\text{Heat supplied}} = \frac{2P_0V_0}{\left(\frac{15}{2}+3\right)P_0V_0} \times 100\% = \frac{4}{21} \times 100\% = 19\%$$

23. 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____.

Ans 9

Sol. Given $\Delta x = \lambda$

When $\Delta x = \lambda$, Intensity will be max.

We know that

$$I = 4I_0\cos^2\left(\frac{\Delta\phi}{2}\right)$$

$$\Delta\phi = \frac{2\pi}{\lambda}.\Delta x$$

When $\Delta x = \lambda$,

$$I = 4I_0\cos^2\left(\frac{2\pi}{2\lambda}.\lambda\right) = 4I_0 = K \quad \text{.................. (1)}$$

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

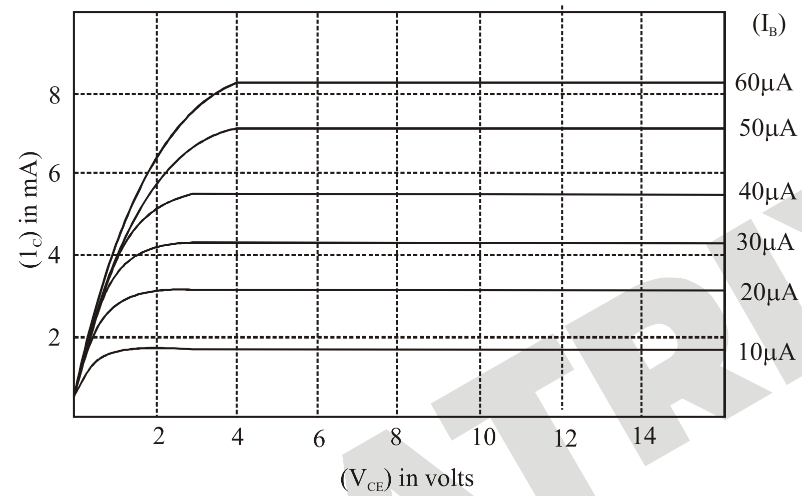
$$I' = 4I_0\cos^2\left(\frac{2\pi}{2\lambda} \times \frac{\lambda}{6}\right)$$

$$\Rightarrow 4I_0 \times \frac{3}{4} = \frac{nK}{12} \quad \text{.................. (2)}$$

From (1) & (2)

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

24. The output characteristics of a transistor is shown in the figure. When V_{CE} is 10V and I_C = 4.0 mA, then value of β_{ac} is _______.



Ans 150

Sol. For V_{CE} = 10 Volt.

From graph

$\Delta I_B = (30 - 20)\ \mu A$

$\Delta I_B = 10\mu A$

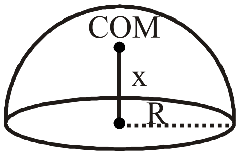
$\Delta I_C = (4.5 - 3)\ mA = 1.5mA$

$$\beta_{ac} = \frac{\Delta I_C}{\Delta I_B} = \frac{1.5mA}{10\mu A} = 150$$

25. The centre of mass of a solid hemisphere of radius 8 cm is x cm from the centre of the flat surface. Then value of x is _____.

Ans 3

Sol.



Solid Hemisphere

R = 8 cm

$$x = \frac{3R}{8}$$

x = 3 cm