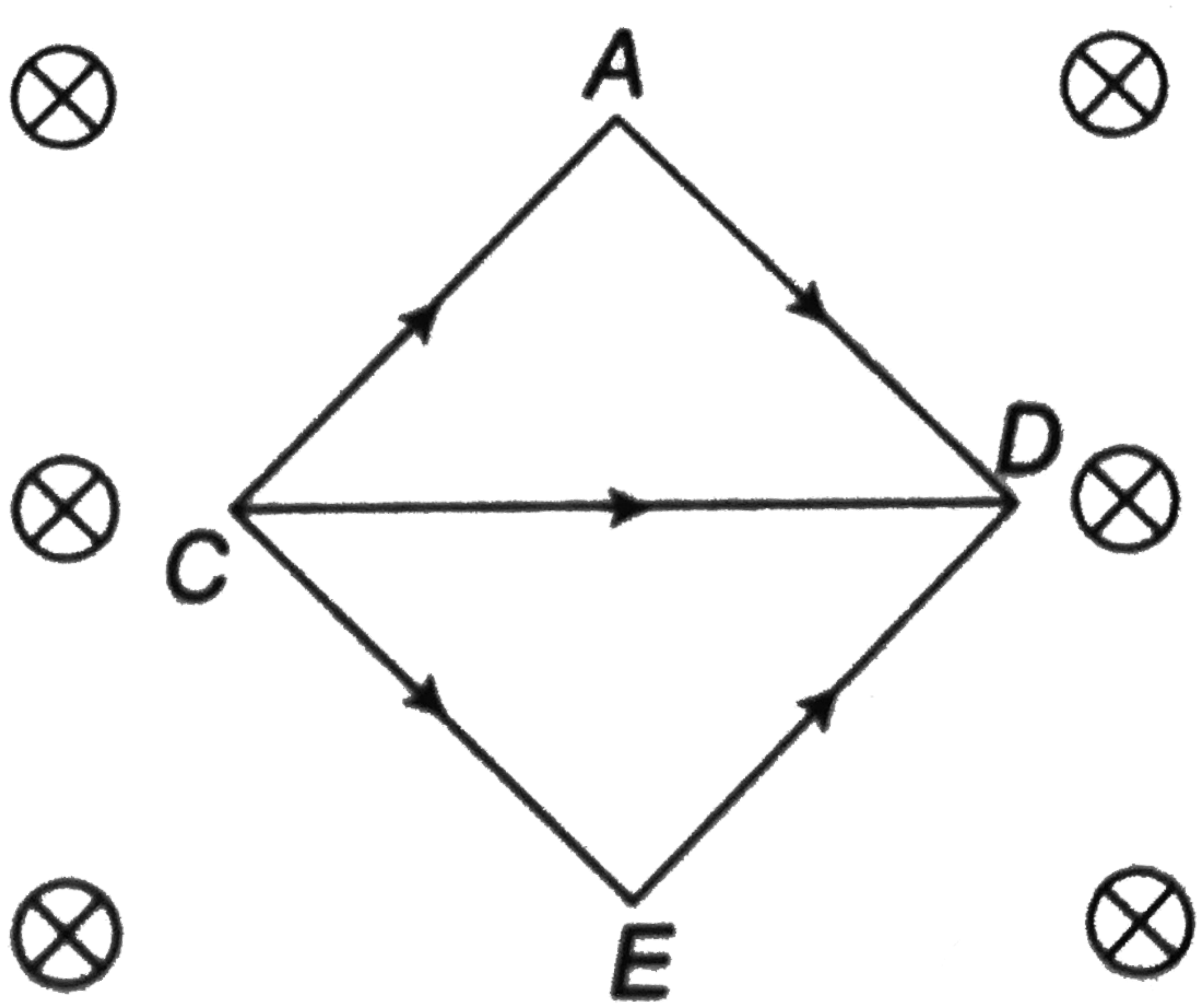
Q-1 - 11965285

Constant current of 1 a flows along three branches of wire frame as shown. The frame is a combination of two equilateral triangles ACD and CDE of side $1m$. It is place in uniform magnetic field $B = 4T$ acting perpendicular to the plane of paper. The magnitude of magnitude force acting on the frame is



(A) $12N$

(B) $24N$

(C) $36N$

(D) zero

CORRECT ANSWER: A

SOLUTION:

Since

$\overrightarrow{F}_{AD} = \overrightarrow{F}_{CD}$

$= \overrightarrow{F}_{CED}$

Hence net force on frame $= 3\overrightarrow{F}_{CD}$

$= 3i\left(\overrightarrow{i} \times \overrightarrow{b}\right) = 3$

$\times 1 \times 1 \times 4$

$F = 12N$

Q-2 - 12229071

An electron is projected with velocity v_0 in a unifrom electric field E perpendicular to the field Again it is projectced with velocity v_0 perpendicular to a unifrom magnetic field $B /$ if r_1 is initial radius of curvature just after entering in the electric field and r_2 is initial radius of curvature just after entering in magnetic field then the ratio r_1 / r_2 is equal to .

(A) $\frac{Bv_0^2}{E}$

(B) $\frac{B}{E}$

(C) $\frac{Ev_0}{B}$

(D) $\frac{Bv_0}{B}$

CORRECT ANSWER: D

SOLUTION:

$$eE = \frac{mV_0^2}{r_1} \Rightarrow r_1$$

$$= \frac{mV_0^2}{eE}$$

$$eV_0B = \frac{mV_0^2}{r_2}$$

$$= \frac{mV_0}{eB} \Rightarrow \frac{r_1}{r_2}$$

$$= \frac{V_0B}{E}$$

.

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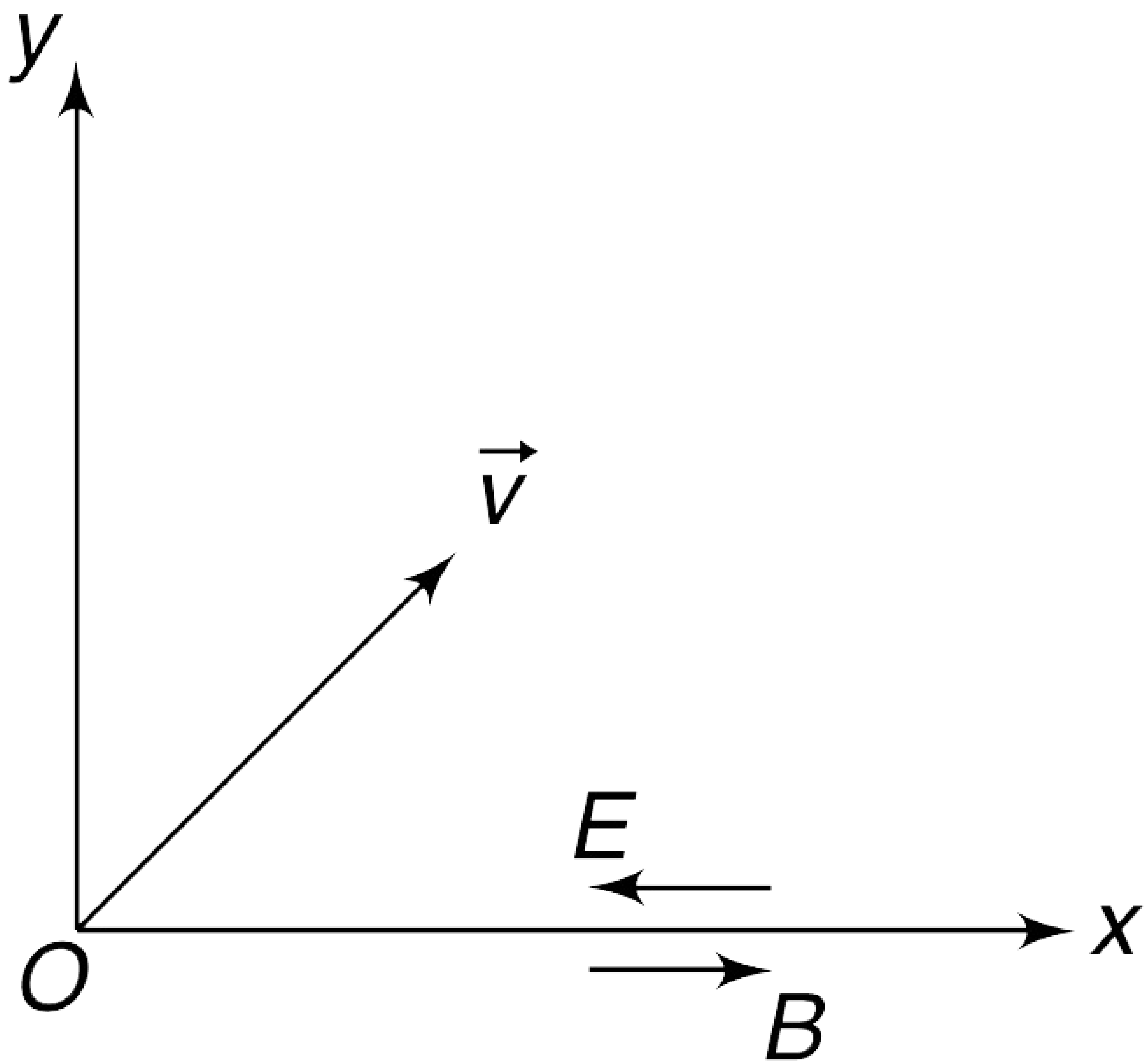
Q-3 - 15086091

A region has a uniform magnetic field B along positive x direction and a uniform electric field E in negative x direction. A positively charged particle is projected from origin with a velocity

$\underset{V}{\longrightarrow} = V_0\hat{i} + V_0\hat{j}$. After some time the velocity of the particle was observed to be$V_0\widehat{J}$ while its x co-ordinate was positive. Write all possible values of $\frac{E}{B}$



CORRECT ANSWER:

$\frac{E}{B}$

$= \frac{V_0}{2PIN}$ WHEREN

$= 1, 2, 3$ � .

Q-4 - 17817343

A charge q is unifomly distrybuted over a nonconducting ring of radius R. The ring is rotated about an axis passing through its centre and perpendicular to the plane of the ring with frequency f. The ratio of electric potential to the magnetic field at the centre of the ring depends on.

(A) $q, f, \text{ and } R$

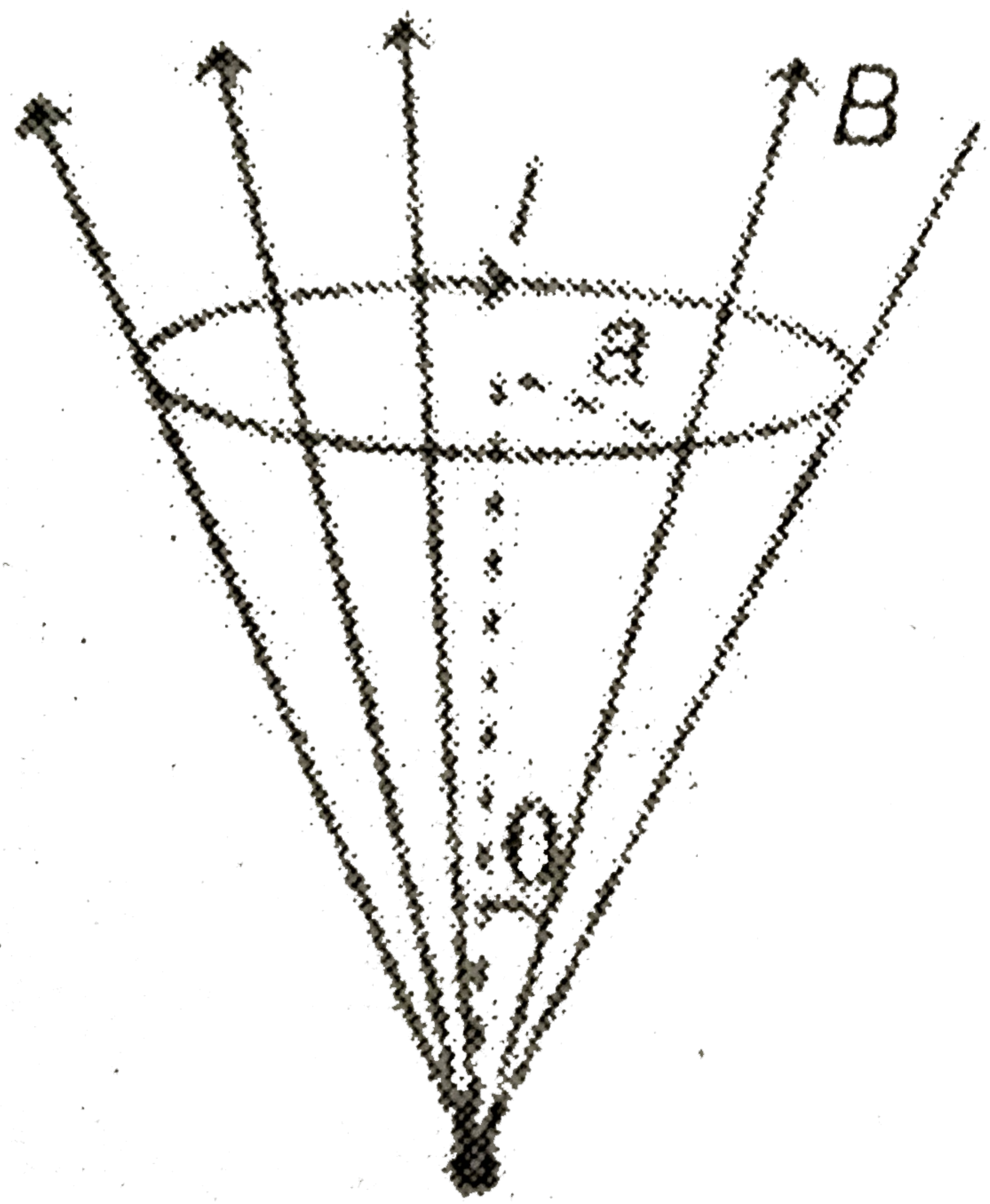
(B) $q \text{ and } fonly$

(C) $f \text{ and } R$

(D) f

CORRECT ANSWER: D

A cicular current loop of radius a is placed in a radial magnetic field B as shown . The net force acting of the loop is :



(A) zero

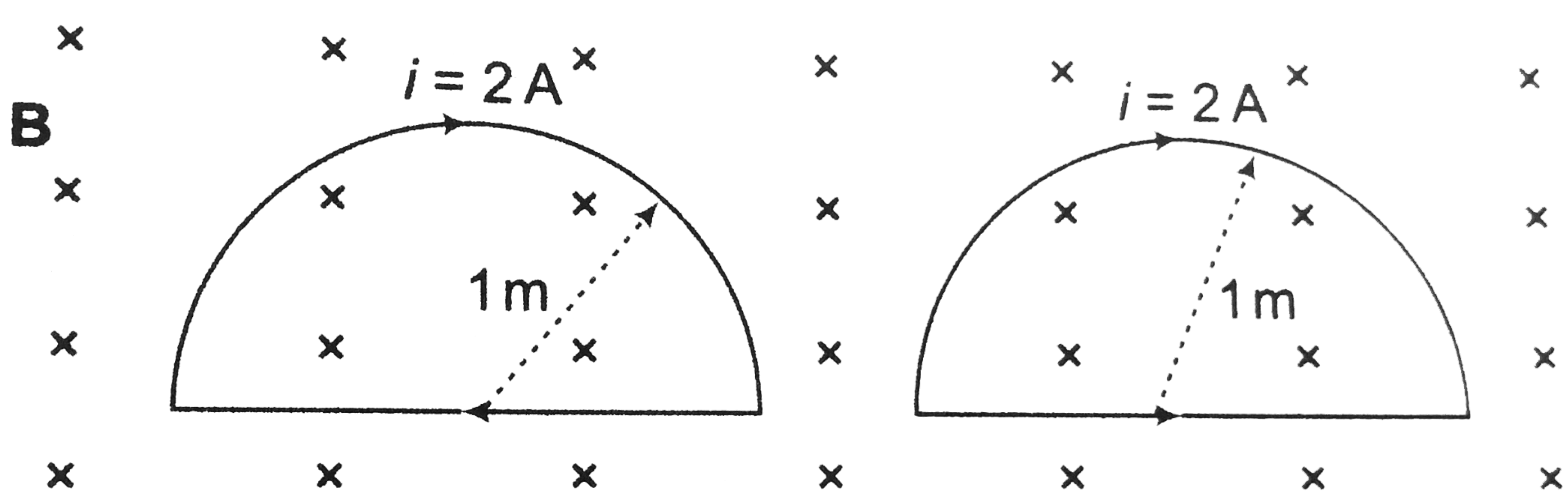
(B) $2\pi BaI\cos\theta$

(C) $2\pi BaI\sin\theta$

CORRECT ANSWER: C

Q-6 - 10967374

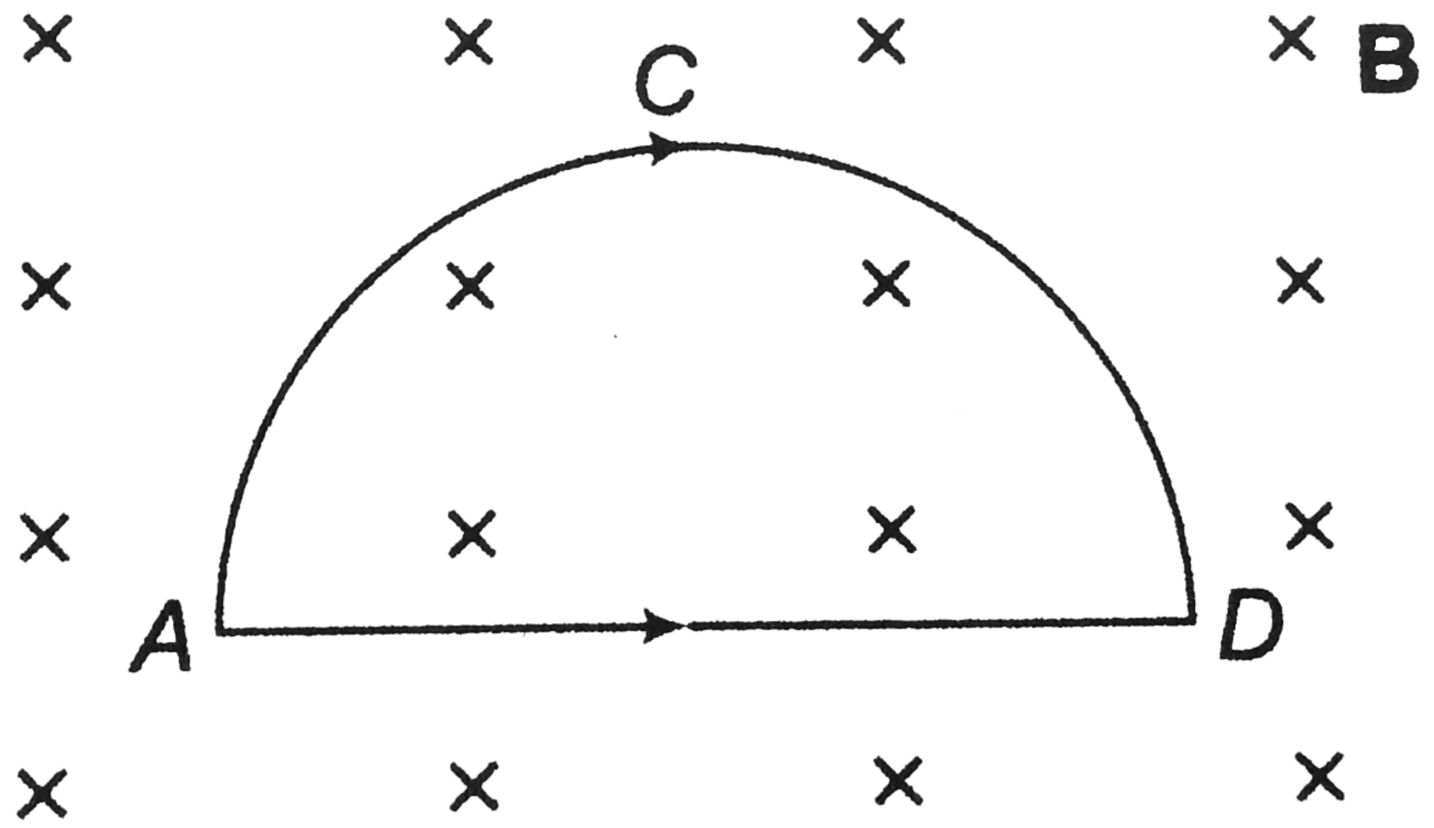
In the figure shown a semicircular wire loop is placed in a uniform magnetic field $B = 1.0T$. The plane of the loop is perpendicular to the magnetic field. Current $i = 2A$ flows in the loop in the directions shown. Find the magnitude of the magnetic force in both the cases a and b. The radius of the loop is 1.0 m



(a) (b)

SOLUTION:

Refer figure a it forms a closed loop and the current completes the loop. Therefore, net force on the loop in uniform field should be zero.



Refer figure b. In this case although it forms a closed loop, but current does not complete the loop. Hence, net force is not zero.

$$F_{ACD} = F_{AD}$$

$$\therefore F_{l\infty p} = F_{ACD}$$

$$+ F_{AD} = 2F_{AD}$$

$$\therefore |F_{l\infty p}| = 2|F_{AD}|$$

$2ilB\sin\theta[l=2r$
$=2.0m]$

$=(2)(2)(2)(1$
$)\sin 90^{=}8N$

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Q-7 - 17817351

The figure shows a long striaght wire of a circular cross-section (radius a) carrying steady current I.The current I is unifromly distributed across this distance $a/2$ and 2a from axis is

(A) $2:1$

(B) $1:2$

(C) $4:1$

(D) $1:1$

CORRECT ANSWER: D

Q-8 - 12011386

A long straight solid metal rod of radius $4cm$ carries a current $2A$, uniformly distributed over its circular cross-section. Find the magnetic field induction at a distance $3cm$ from the axis of the wire.

SOLUTION:

The point P is lying inside the rod at a perpendicular distance $r(= 3cm)$ from the axis of the wire. Draw a circular closed path of radius r with centre on the axis of rod such that the point P lies on this closed path.

Current enclosed by the closed path

$$I' = \frac{I}{\pi R^2} \times \pi r^2$$

$$= \frac{Ir^2}{R^2}$$

The magnetic field produced due to current flowing in the rod at every point over the closed path is tangential to it and is equal in magnitude at all the points of the path.

Line integral of $\overrightarrow{B}$ over the closed path is

$$\oint \overrightarrow{B}.d\overrightarrow{l} = \mu_0 I'$$

or $B2\pi r = \mu_0 \dfrac{Ir^2}{R^2}$ or

$$B = \frac{\mu_0 I r^2}{2\pi r R^2} = \frac{\mu_{02} I r}{4\pi R^2}$$

$$= \frac{10^{-7} \times 2 \times 2 \times 3 \times 10^{-2}}{\left(4 \times 10^{-2}\right)^2}$$

$$= 7 \cdot 5 \times 10^{-6} T$$

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Q-9 - 17817356

Every iron atom in a ferromagnetic domain has a magnetic dipole moment equal to $9.27 \times 10^{-24} Am^2$. A ferromagetic domain in iron has the shape of a cube of side $1 \mu m$. The maximum dipole moment occurs when all the dipoles are alligned. The molar mass of uiron is 55 g and its specific gravity is 7.9 .The magnetisation of the domain is .

(A) $8.0 \times 10^{5} A/m$

(B) $8.0 \times 10^{8} A/m$

(C) $8.0 \times 10^{11} A/m$

(D) $8.0 \times 10^{14} A/m$

CORRECT ANSWER: A

Q-10 - 13656817

The torque acting on a magnetic dipole of moment P_m when placed in a magnetic field is

(A) $P_m B$

(B) $\overrightarrow{P_m} \times \overrightarrow{B}$

(C) $\overrightarrow{P_m} . \overrightarrow{B}$

(D) P_m / B

CORRECT ANSWER: 2

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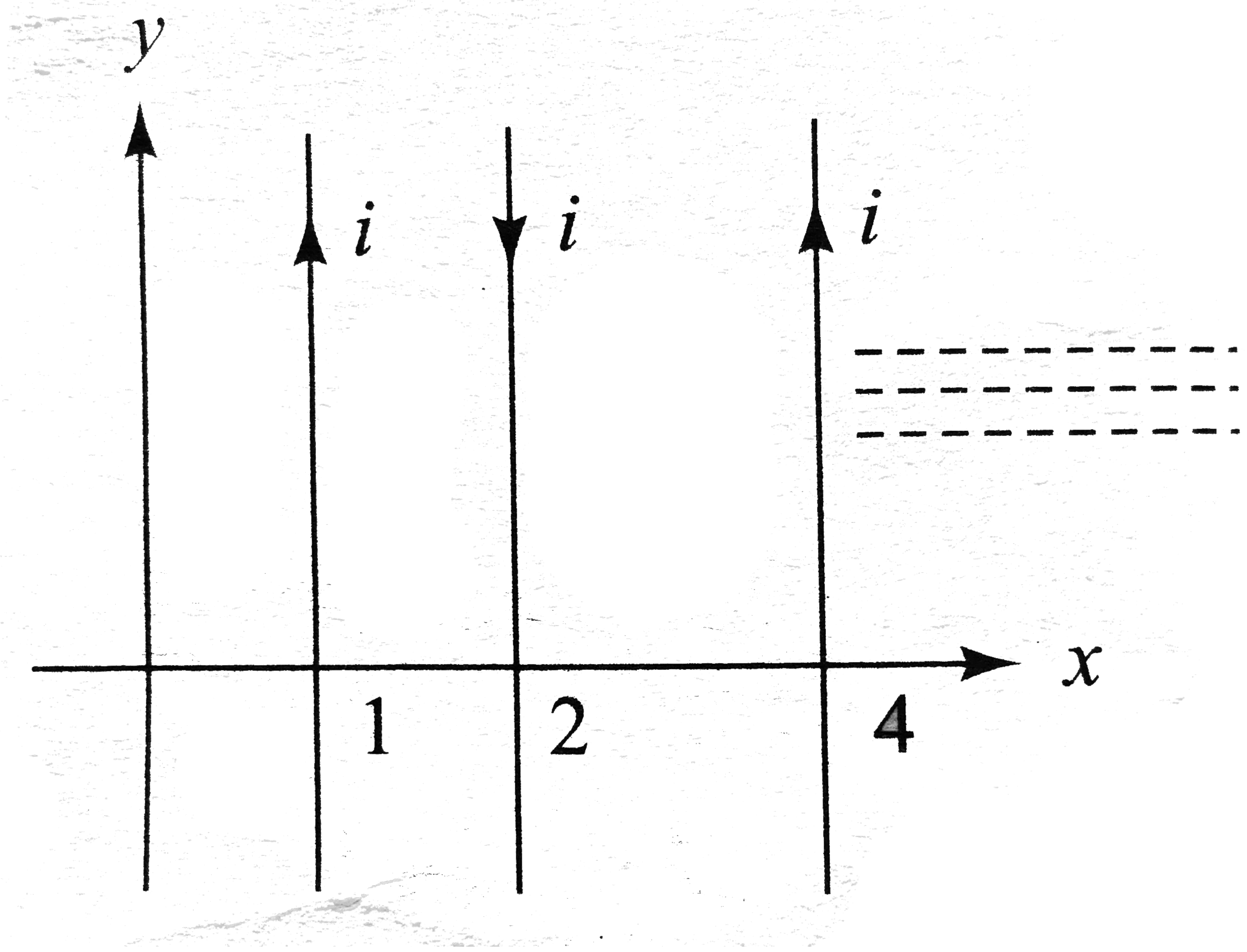
Q-11 - 11314224

Equal currents $i = 1$ A are flowing through the wires parallel to y-axis located at

$x = +1m, x = +2m, x = +4m$

and so on...., etc. but in opposite directions as shown in Fig The magnetic field (in tesla) at origin would be



(A) $-1.33 \times 10^{-7}\hat{k}$

(B) $1.33 \times 10^{-7}\hat{k}$

(C) $2.67 \times 10^{-7}\hat{k}$

(D) $-2.67 \times 10^{-7}\hat{k}$

CORRECT ANSWER: B

SOLUTION:

(b)

$$\vec{B} = \frac{\mu_0}{2\pi}\left[\left(\frac{1}{1}+\frac{1}{4}+\frac{1}{16}+....\right)\hat{k} - \left(\frac{1}{2}+\frac{1}{8}+....\right)\hat{k}\right]$$

$$= \frac{\mu_0}{4\pi}\left[\left(\frac{1}{1-\frac{1}{4}}\right)\hat{k} - \frac{1}{2}\left(\frac{1}{1-\frac{1}{4}}\right)\hat{k}\right]$$

$$= \frac{2}{3}\frac{\mu_0}{2\pi}\hat{k} = \left(\frac{2}{3}\times 2\times 10^{-7}\right)\hat{k} = 1.33\times 10^{-7}\hat{k}$$

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Q-12 - 13656880

Magnetic induction at the centre of a circular loop of area π square meter is 0.1 tesla . The magnetic moment of the loop is (μ_0 is permeability of air)

(A) $\dfrac{0.1\pi}{\mu_0}$

(B) $\dfrac{0.2\pi}{\mu_0}$

(C) $\dfrac{0.3\pi}{\mu_0}$

(D) $\dfrac{0.4\pi}{\mu_0}$

CORRECT ANSWER: 2

SOLUTION:

$M = inA$ and $i = \dfrac{q}{T}$

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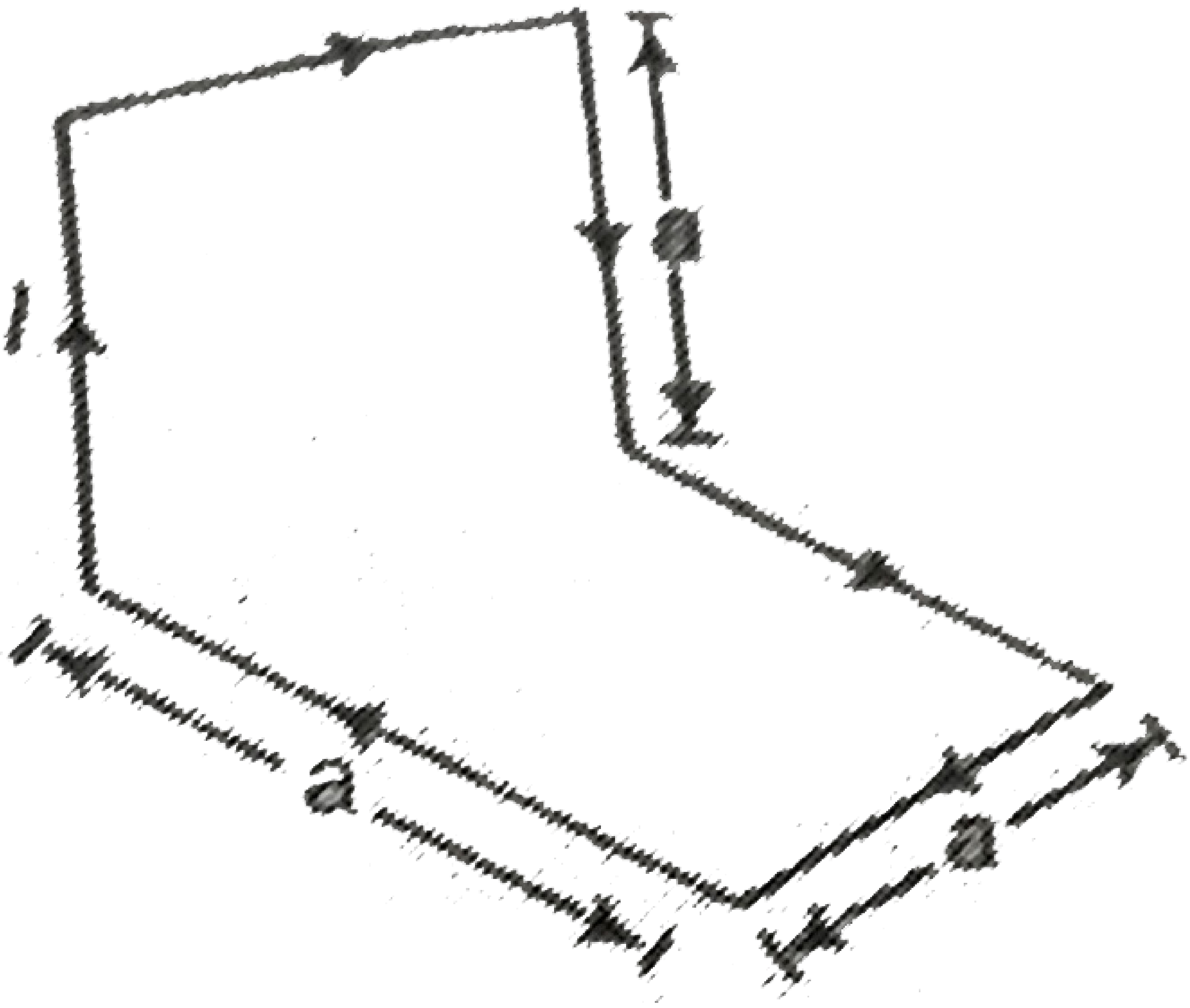
The magnitude of magnetic moment of the current loop in the figure is



(A) Ia^2

(B) $\sqrt{2}Ia^2$

(C) zero

(D) none of the above

CORRECT ANSWER: B

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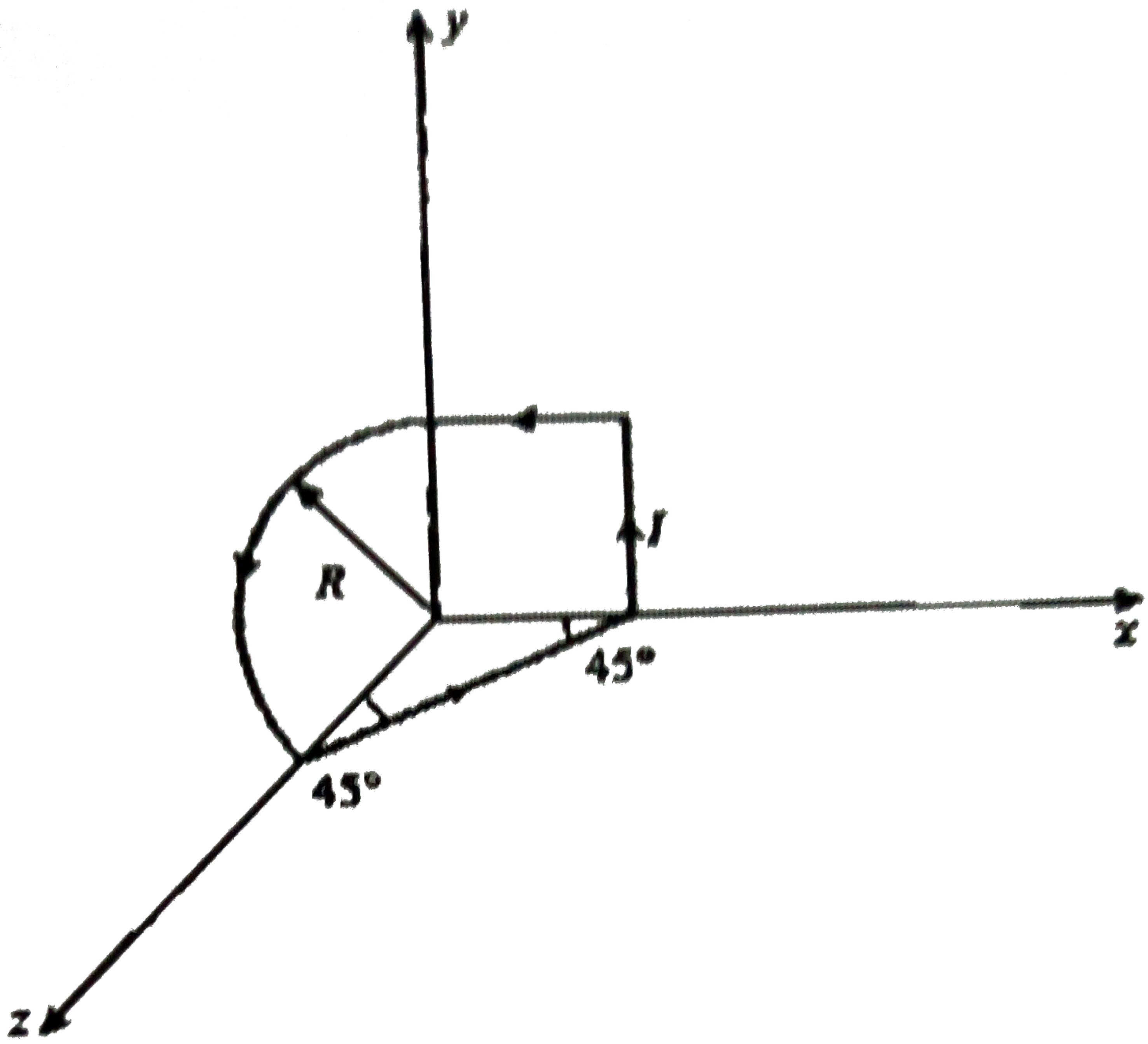
Q-14 - 17090594

Find the magnetic moment of the current carrying loop shown in figure.



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Q-15 - 13657011

A circular coil of 100 turns and effective diameter $20cm$ carries a current of $0.5A$. It is to be turned in a magnetic field of $B = 2.0T$ from a position in which the normal to the plane of the coil makes an angle θ equals to zero to one in which θ equals to 180. Thw work required in this process is

(A) πJ

(B) $2\pi J$

(C) $4\pi J$

(D) $8\pi J$

CORRECT ANSWER: 2

SOLUTION:

$$w = MB(1 - \cos\theta)$$

Q-16 - 19037279

Two long straight parallel conductors are separated by a distance of 5 cm and carrying current 20 A. what work per unit length of a conductor must be done to increases the separation between conductors to 10 cm, if the current flows in the same direction ?

(A) $8 \times 10^{-5} \log_e 2$

(B) $\log_e 2$

(C) $10^{-7} \log_e 2$

(D) none of these

CORRECT ANSWER: A

SOLUTION:

The force per unit length is

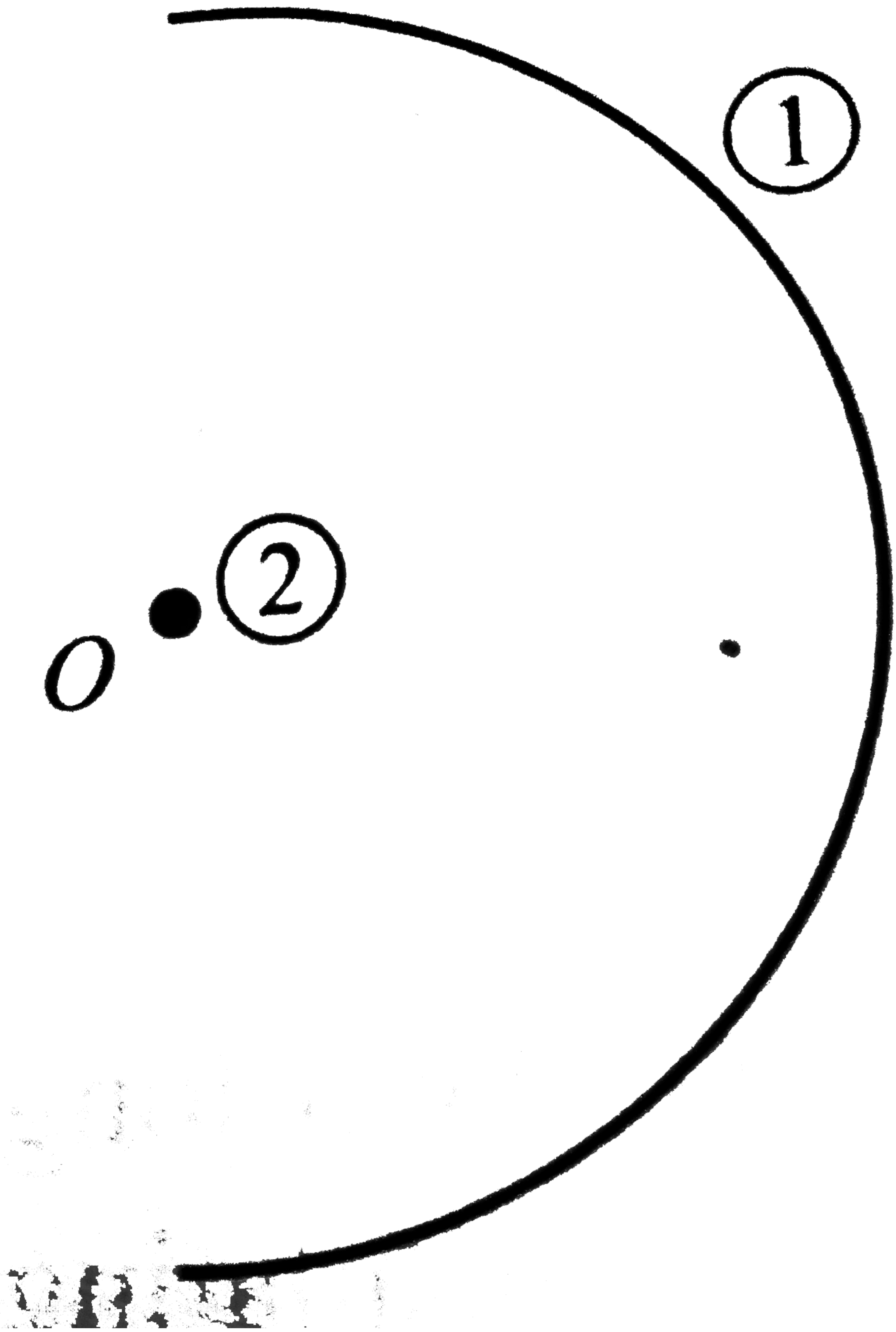
$$F_0 = \frac{\mu_0 l_1 l_2}{2\pi} \int_{5 \times 10^{-2}}^{10 \times 10^{-2}} \frac{dr}{r}$$

$$= \frac{\mu_0 l_1 l_2}{2\pi} \ln 2 = 2 \times 10^{-7} \times 20 \times 20 \ln 2$$

$$= 8 \times 10^{-5} \ln 2 = 8 \times 10^{-5} \log_e 2$$

Q-17 - 11314186

A direct current I flows in a long straight conductor whose cross section has the form of a thin halr-ring of radius R. The same current flows in the opposite direction along a thin conductor located on the axis of the first conductor. Find the magnetic induction froce between the given conductors reduced to a unit of



their length.

CORRECT ANSWER: $\frac{F}{L} = \frac{MU_0 I^2}{PI^2 R}$

SOLUTION:

Let us first hadn magnetic field at O due

to '1'.

$$dB = \frac{\mu_0 dI}{2\pi R}$$

where $dI = \frac{IRd\theta}{\pi R} = \frac{I}{\pi} d\theta$

$$\Rightarrow dB = \frac{\mu_0}{2\pi R} \frac{I}{\pi} d\theta$$

Net field will be along ON:

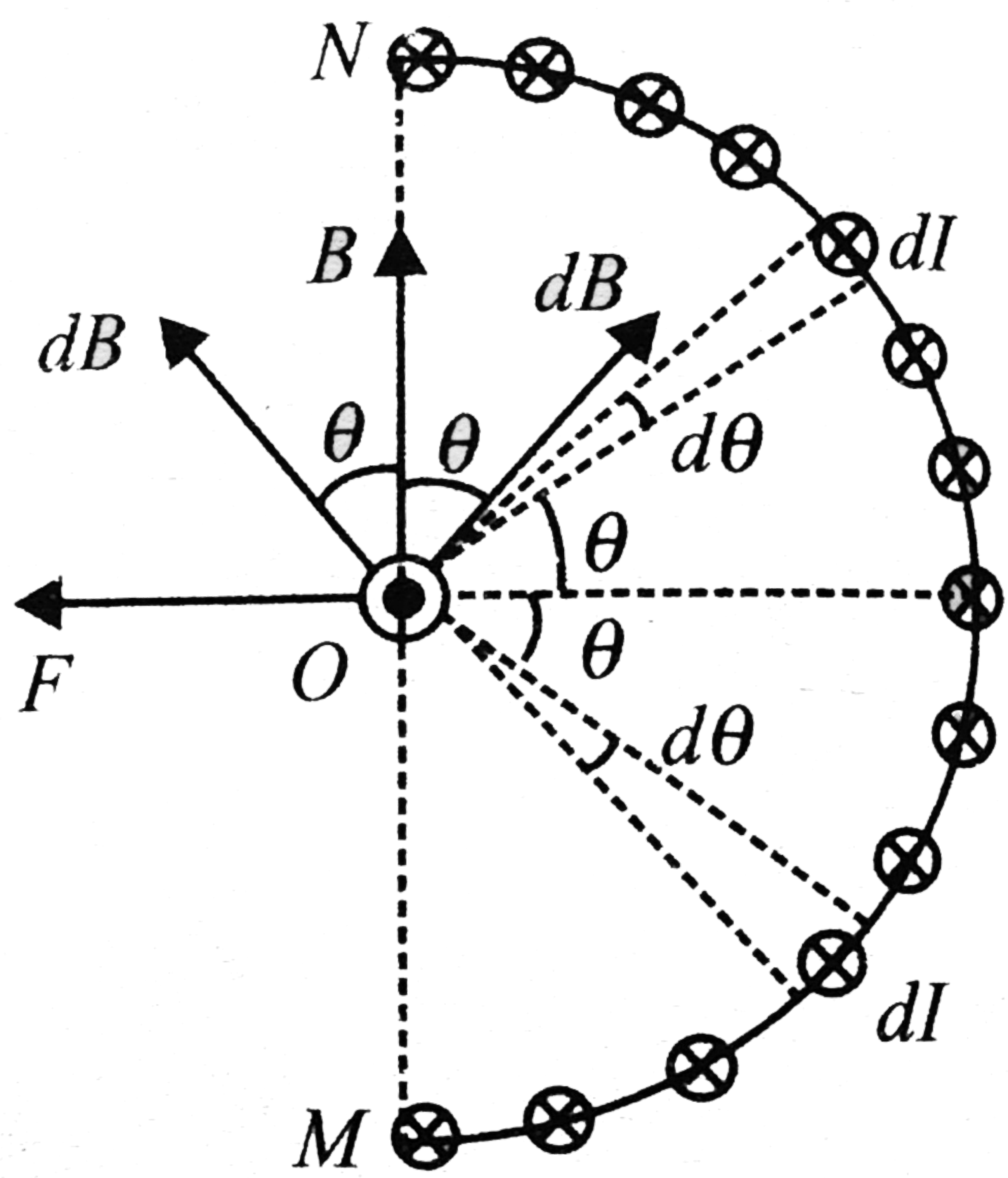
$$B = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} dB \cos\theta =$$

$$\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{\mu_0 I}{2\pi^2 R} \cos\theta d\theta$$

$$= \frac{\mu_0 I}{\pi^2 R}$$

$$F = BIl = \frac{\mu_0 I^2}{\pi^2 R} I$$

$$\Rightarrow \frac{F}{l} = \frac{\mu_0 I^2}{\pi^2 R}$$



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Q-18 - 19037280

A narrow beam of protons and deutrons, each having the same momentum, enters a region of uniform magnetic field directed perpendicular to their direction of momentum. The ratio of the radii of the circular paths described by them is

(A) $1:2$

(B) $1:1$

(C) $2:1$

(D) $1:3$

CORRECT ANSWER: B

SOLUTION:

Since, the radius of circular path of a charged particle in magnetic field is $r = \frac{mv}{qB} = \frac{p}{qB}$

Now, the raduis of circular path of charged particle of given momentum p and magnetic field B is given by $r \propto \frac{1}{q}$ But charge on both charged particles, protons and deutrons, is same. therefore,

$$\frac{r_p}{r_D} = \frac{q_D}{q_p} = \frac{1}{1}$$

Q-19 - 14154797

An electron beam moving with a speed of $2.5 \times 10^7 ms^{-1}$ enters into the magnetic field $4 \times 10^{-3} Wb/m^2$ directed perpendicular to its direction of motion. Find the intensity of the electron moves undeflected .

SOLUTION:

When electron goes undefelected, force due to electric field is equal and opposite to force due to magnetic filed i.e.,

$$Ee = Bev$$

$B \times \; =^{-3} Wb/m^2$ and $V = 2.5 \times 10^7 ms^{-1}$

$$E = Bv = 4 \times 10^{-3} \times 2.5 \times 10^7 = 10^5 V/m$$

Q-20 - 11967883

In a magnetic field of $0.05T$, area of a coil changes from $101cm^2$ to $100m^2$ without changing the resistance which is `2Omega. The amount of charge that flow during this period is

(A) 2.5×10^{-6} coulomb

(B) 2×10^{-6} coulomb

(C) 10^{-6} coulomb

(D) 8×10^{-6} coulomb

CORRECT ANSWER: A

SOLUTION:

$\varphi = BA$

$\Rightarrow$ change in flux

$d\varphi = B.\, dA$
$= 0.05(101$
$- 100)10^{-4}0.10^{-6}Wb$

.

Now, charge

$$dQ = \frac{d\varphi}{R}$$
$$= \frac{5 \times 10^{-6}}{2} = 2.5$$
$$\times 10^{-6}C$$

.

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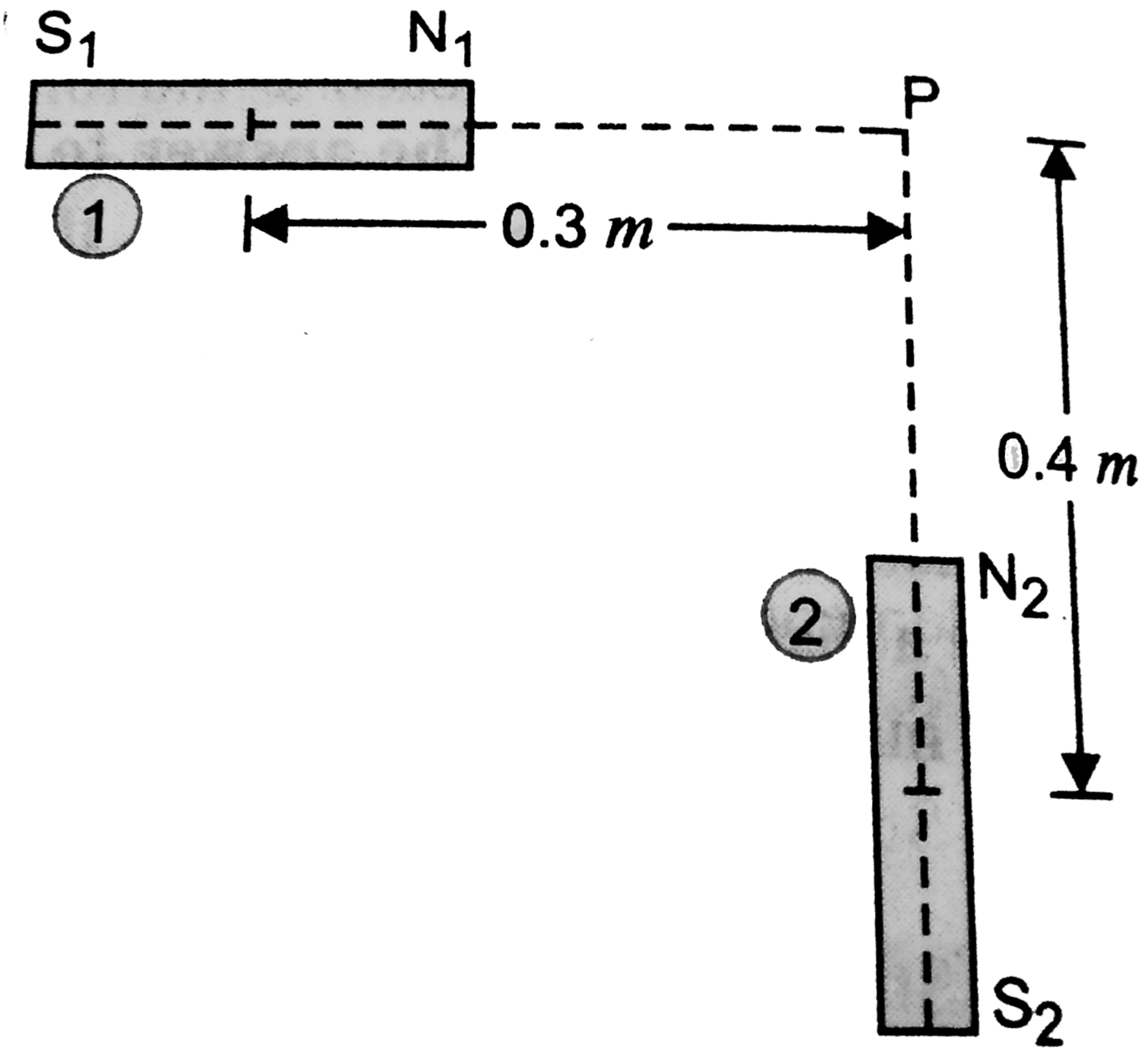
Q-21 - 12012606

Two short magnets (1) and (2) of magnetic moments $2Am^2$ and $5Am^2$ respectively are placed along two lines drawn at 90 to each other as shown in figure. At the point of intersection of their axes, the magnitude of magnetic field is $n \times 10^{-5}T$. What is n?



CORRECT ANSWER: (2)

SOLUTION:

Here, $M_1 = 2Am^2$, $d_1 = 0 \cdot 3m$

$M_2 = 5Am^2$, $d_2 = 0 \cdot 4m$

The point of intersection P lies on axial line of the two magnets, figure.

$$\therefore B_1 = \frac{\mu_0}{4\pi} \times \frac{2M_1}{d_1^3}$$

$$= 10^{-7} \times \frac{2 \times 2}{(0 \cdot 3)^3}$$

$= 1 \cdot 48 \times 10^{-5} T$ along $S_1 N_1$

$$B_2 = \frac{\mu_0}{4\pi} \times \frac{2M_2}{d_2^3}$$

$$= 10^{-7} \times \frac{2 \times 5}{(0 \cdot 4)^3}$$

$= 1 \cdot 56 \times 10^{-5} T$ along $S_2 N_2$

As B_1 and B_2 are perpendicular to each other, therefore

resultant magnetic field at P is

$$B = \sqrt{B_1^2 + B_2^2}$$

$$= \sqrt{\left(1 \cdot 48 \times 10^{-5}\right)^2 + \left(1 \cdot 56 \times 10^{-5}\right)^2}$$

$$= 2 \cdot 15 \times 10^{-5} T$$

$$= n \times 10^{-5} T$$

where $n = 2 \cdot 15$, which can be taken as 2

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Q-22 - 17088132

Two magnetic dipoles of moments 0.108 and $0.122 Am^2$ are placed along two lines drawn on the table at right angles to each other. Find the intensity at the point of intersection of their axes, their centres being 0.3 and 0.4m, respectively from the point of intersection.

CORRECT ANSWER: $10^{-6} T$

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Q-23 - 12012084

A short bar magnet of moment $0 \cdot 32 JT^{-1}$ is placed in a uniform external magnetic field of $0 \cdot 15T$, if the bar is free to rotate in the plane of the field, which orientations would correspond to its, (i) stable and (ii) unstable equilibrium? What is the potential energy of the magnet in each case?

SOLUTION:

Here, $M = 0 \cdot 32JT^{-1}, B = 0 \cdot 15T$

(i) In stable equilibrium, the bar magnet is aligned along the magnetic fiel, i.e. $\theta = 0$

Potential Energy

$= \quad - MB\cos 0^{=} \quad - 0$

$\cdot 32 \times 0 \cdot 15 \times 0 =$

$- 4 \cdot 8 \times 10^{-2}J$

(ii) In unstable equilibrium, the magnet is so oriented that magnetic moment is at 180 to the magnetic field i.e.

$\theta = 180$

Potential energy=

$-MB\cos 180^{=} - 0$

$\cdot 32 \times 0 \cdot 15(-1)$

$= 4 \cdot 8 \times 10^{-2} J$

.

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Q-24 - 13166656

An iron rod is subjected to cycles of magnetisation at the rate of $50Hz$. Given the density of the rod is $8 \times 10^{3} kg/m^{3}$ and specific heat is $0.11 \times 10^{-3} cal \times kgC$. The rise in temperature per minute, if the area enclosed by the $B-H$ loop corresponds to energy of $10^{-2} J$ is (Assume there is no radiation losses)

(A) $78^{\circ} C$

(B) $88^{\circ} C$

(C) $8.1^{\circ} C$

(D) none of these

CORRECT ANSWER: C

SOLUTION:

$$50 \times 60 \times 10^{-2} = dx \times 0.11 \times 10^{-3} \times 4.2 \times \Delta t$$

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Q-25 - 12011577

The susceptibility of magnetisium at $300K$ is $1 \cdot 2 \times 10^{-5}$. At what temperature will the susceptibility be equal to $1 \cdot 44 \times 10^{-5}$?

SOLUTION:

As $\chi_m = \dfrac{C}{T}$

$$\therefore \frac{\chi_m}{\chi'_m} = \frac{T'}{T}$$

or $T' = \dfrac{\chi_m}{\chi'_m} \times T$

$$= \frac{1 \cdot 2 \times 10^{-5}}{1 \cdot 44 \times 10^{-5}} \times 300 = 250K$$

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Q-26 - 10967392

A magnetic needle performs 20 oscillations per minute in a horizontal plane. If the angle of dip be 30 , then how many oscillation per minute will this needle perform in vertical, north south plane and in vertical east -west plane?

SOLUTION:

In horizontal plane the magnetic needle oscillates in horizontal component H.

$$\therefore T = 2\pi \sqrt{(MH)}$$

In the vertical north-south plane (magnetic meridian) the needle oscillates in the total earth's magnetic field B_e

and in vertical east -west plane (plane perpendicular to the magnetic meridian) it oscillates only in earth's vertical component V. If its time period be T_1 and T_2, then

$T_1 = 2\pi\sqrt{\frac{I}{MB_3}}$ and $T_2 = 2\pi\sqrt{\frac{I}{MV}}$

From above equations, we can find

$\frac{T_1^2}{T^2} = \frac{H}{B_e}$ or $\frac{n_1^2}{n^2} = \frac{B_e}{H}$

Similarly, $\frac{n_2^2}{n^2} = \frac{V}{H}$

Further,

$$\frac{B_e}{H} = \sec\theta$$

$$= \frac{\sec 30^{=}2}{\sqrt{3}}$$

and

$$\frac{V}{H} = \tan\theta$$

$$= \frac{\tan 30^{=}1}{\sqrt{3}}$$

$$\therefore n_1^2 = (n)^2 \left(\frac{B_e}{H}\right)$$

$$= (20)^2 \left(\frac{2}{\sqrt{3}}\right)$$

or

$n_1 = 21.5 oscillation /$
$\min$

and

$$n_2^2 = (n)^2 \left(\frac{V}{H}\right)$$

$$= (20)^2 \left(\frac{1}{\sqrt{3}}\right)$$

$\therefore n_2$
$= 15.2 oscillation /$
$\min$

Q-27 - 13166477

Two like poles of strengths m_1 and m_2 are at far distance apart. The energy repuired to bring them r_0 distance apart is

(A) $\left(\frac{\mu_0}{4\pi}\frac{m_1 m_2}{r_0}\right)$

(B) $\left(\frac{\mu_0}{8\pi}\frac{m_1 m_2}{r_0}\right)$

(C) $\left(\frac{\mu_0}{16\pi}\frac{m_1 m_2}{r_0}\right)$

(D) $\left(\frac{\mu_0}{2\pi}\frac{m_1 m_2}{r_0}\right)$

CORRECT ANSWER: A

Q-28 - 13166564

Two magnetic poles of pole strength $324 milliamp. m.$ and $400 milliampm$ are kept at a distance of $10 cm$ in air. The null point will be at a distance of cm, on the line joining the two poles, from the weak pole if they are like poles.

(A) 4.73

(B) 5

(C) 6.2

(D) 5.27

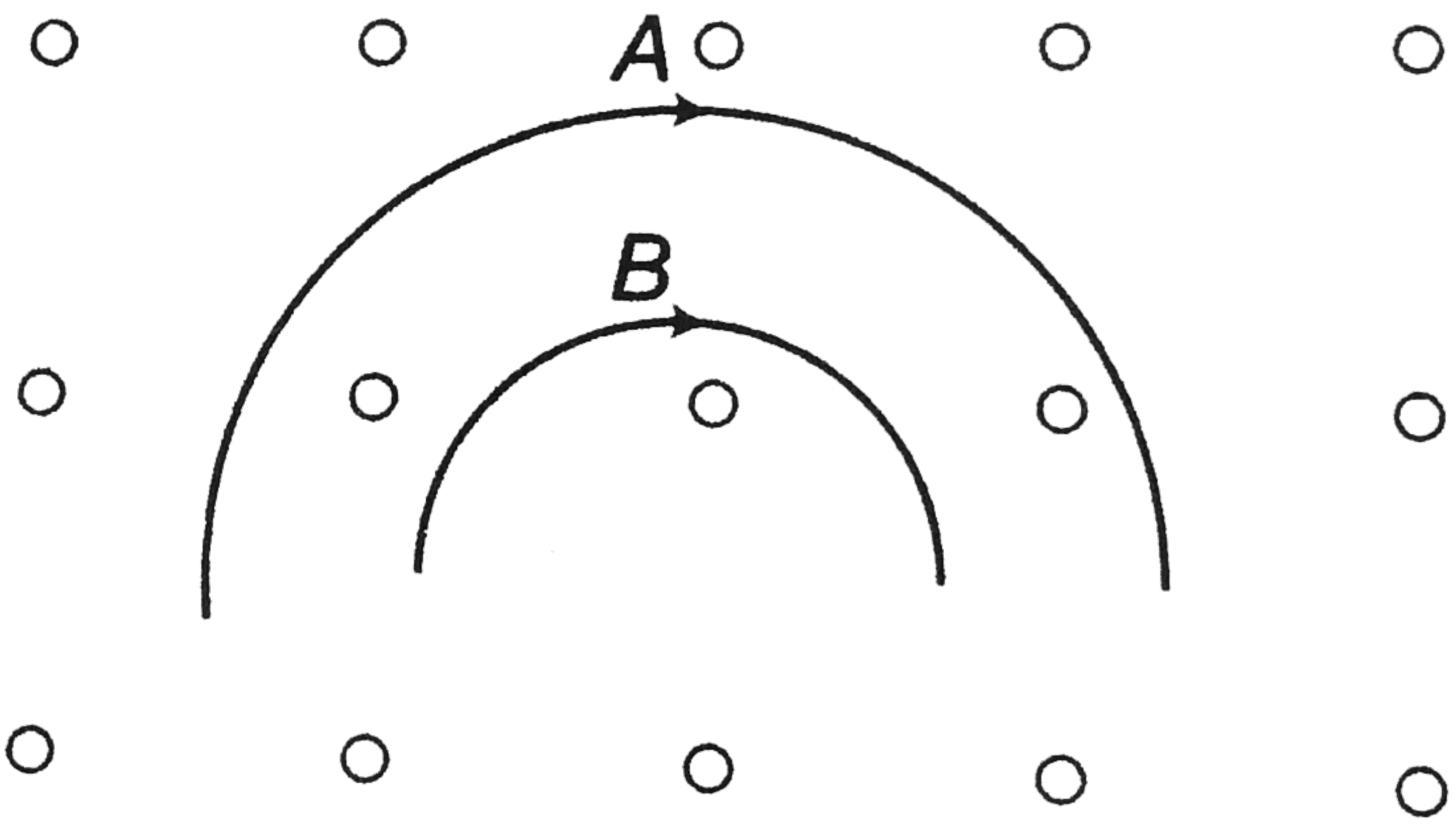
CORRECT ANSWER: A

SOLUTION:

$$\frac{m^1}{x^2} = \frac{m_2}{(d-x)^2}$$

Q-29 - 10967369

Two particles A and B of masses m_A and m_B respectively and having the same charge are moving ina plane. A uniform magnetic field exists perependicular to this plane. The speeds of the particles are v_A and v_B respectively and the trajectories are as shown in the figure. Then,



(A) $m_A v_A < m_B v_B$

(B) $m_A v_A > m_B v_B$

(C) $m_A < m_B$ and $v_A < v_B$

(D) $m_A = m_B$ and $v_A = v_B$

SOLUTION:

Radius of the circle $= \frac{mv}{Bq}$

or $radius \propto mv$ if B and q are same.

$(Radius)_A$

$> (Radius)_B$

$m_V V_A > m_B v_B$

$\therefore$ correct option is b

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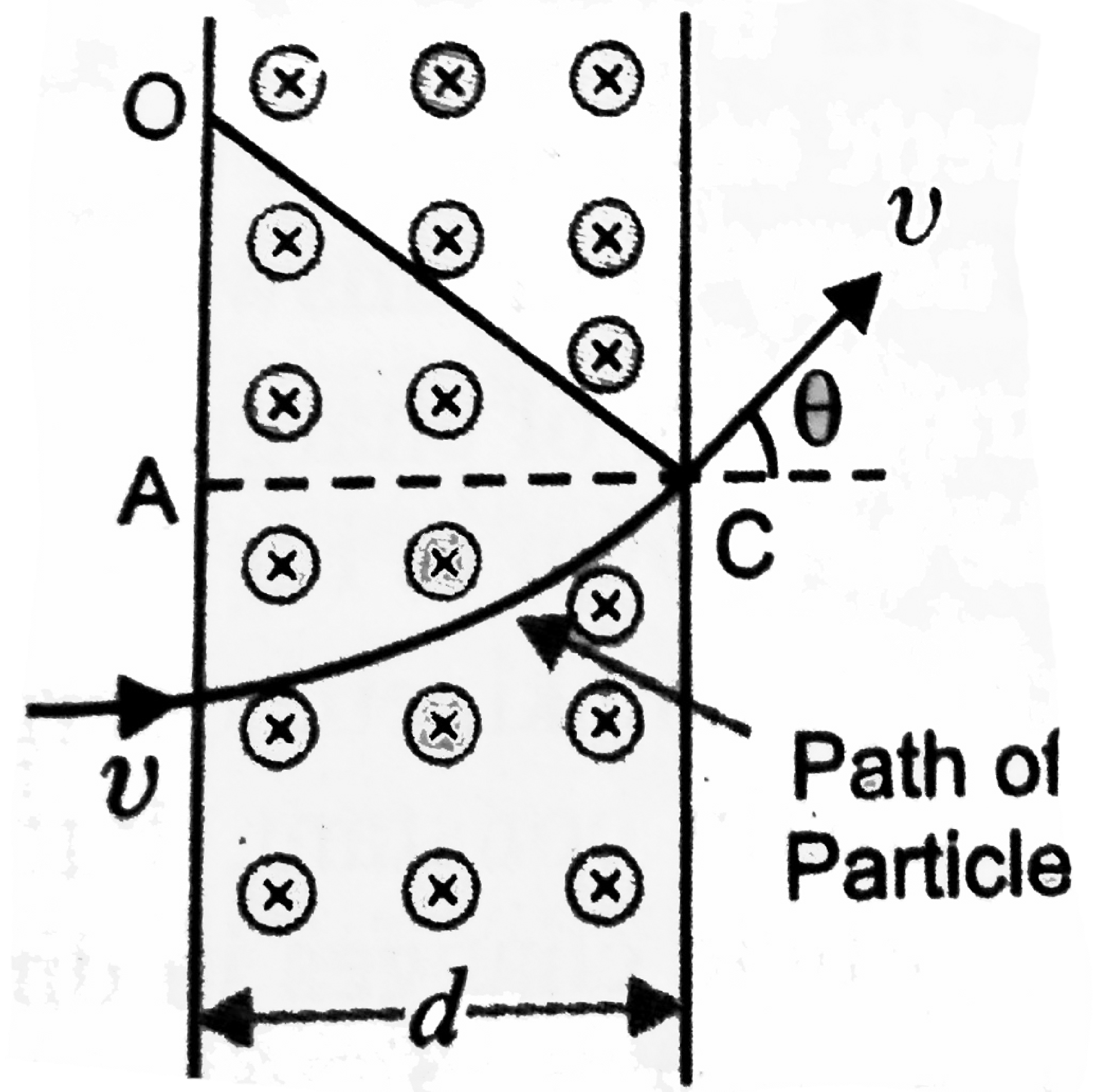
Q-30 - 12011864

A proton and an alpha particle are projected in a perpendicular magnetic field B which exists in a region of width d, figure. Find the ratio of the sines of angles of deviation suffered by the proton and the alpha particle if before entering the magnetic field both the particles (i) have the same momentum (ii) have the same kinetic energy.



SOLUTION:

If m_p, m_α are the masses of proton and α-particle then

$m_\alpha = 4m_p$.

If q_p, q_α are the charges of proton and α-particle.

then $q_\alpha = 2q_p$.

When a charged particle describes a circular path in the magnetic field, then radius of the path is

$$r = \frac{mv}{Bq} = \frac{p}{Bq}$$

$$= \frac{\sqrt{2mK}}{Bq}$$

where p is momentum and K is the kinetic energy of the particle. From figure, it is clear that θ is the angle of deviation (i.e., angle between direction of final velocity and initial velocity) of the charged particle on leaving the magnetic field.

In ΔOAC ,

$$\sin\theta = \frac{d}{r} = \frac{Bqd}{mv}$$

$$= \frac{Bqd}{p} = \frac{Bqd}{\sqrt{2mK}}$$

Case (i). When $p_\alpha = p_p$ then $\sin\theta \propto q$

$$\therefore \frac{\sin\theta_p}{\sin\theta_\alpha} = \frac{q_p}{q_\alpha} = \frac{1}{2}$$

Case (ii). When $K_\alpha = K_p$, then $\sin\theta \propto \frac{q}{\sqrt{m}}$

$$\frac{\sin\theta_p}{\sin\theta_q} = \frac{q_p}{q_\alpha} \times \sqrt{\frac{m_\alpha}{m_p}}$$

$$= \frac{1}{2} \times \sqrt{\frac{4}{1}} = 1$$

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Q-31 - 11965212

Mixed He^+ and O^{2+} ions (mass of He^+=4 amu and that of $O^{2+} = 16$ amu) beam passes a region of constant perpendicular magnetic field. If kinetic energy of all the ions is same then

(A) He^+ ions will be deflected more than those of O^{2+}

(B) He^+ ions will be be deflected less than those of O^{2+}

(C) All the ions will be deflected equally

(D) No ions will be deflected

CORRECT ANSWER: C

SOLUTION:

$$r = \frac{\sqrt{2mK}}{qB} \Rightarrow r$$

$$\propto \frac{\sqrt{m}}{q} \Rightarrow \frac{r_{He^{+}}}{r_{o^{++}}}$$

$$= \sqrt{\frac{m_{He^{+}}}{m_{O^{++}}}} \times \frac{q_{O^{++}}}{q_{He^{++}}}$$

$\sqrt{\frac{4}{16}} \times \frac{2}{1} = \frac{1}{1}$. Then will deflect equally.

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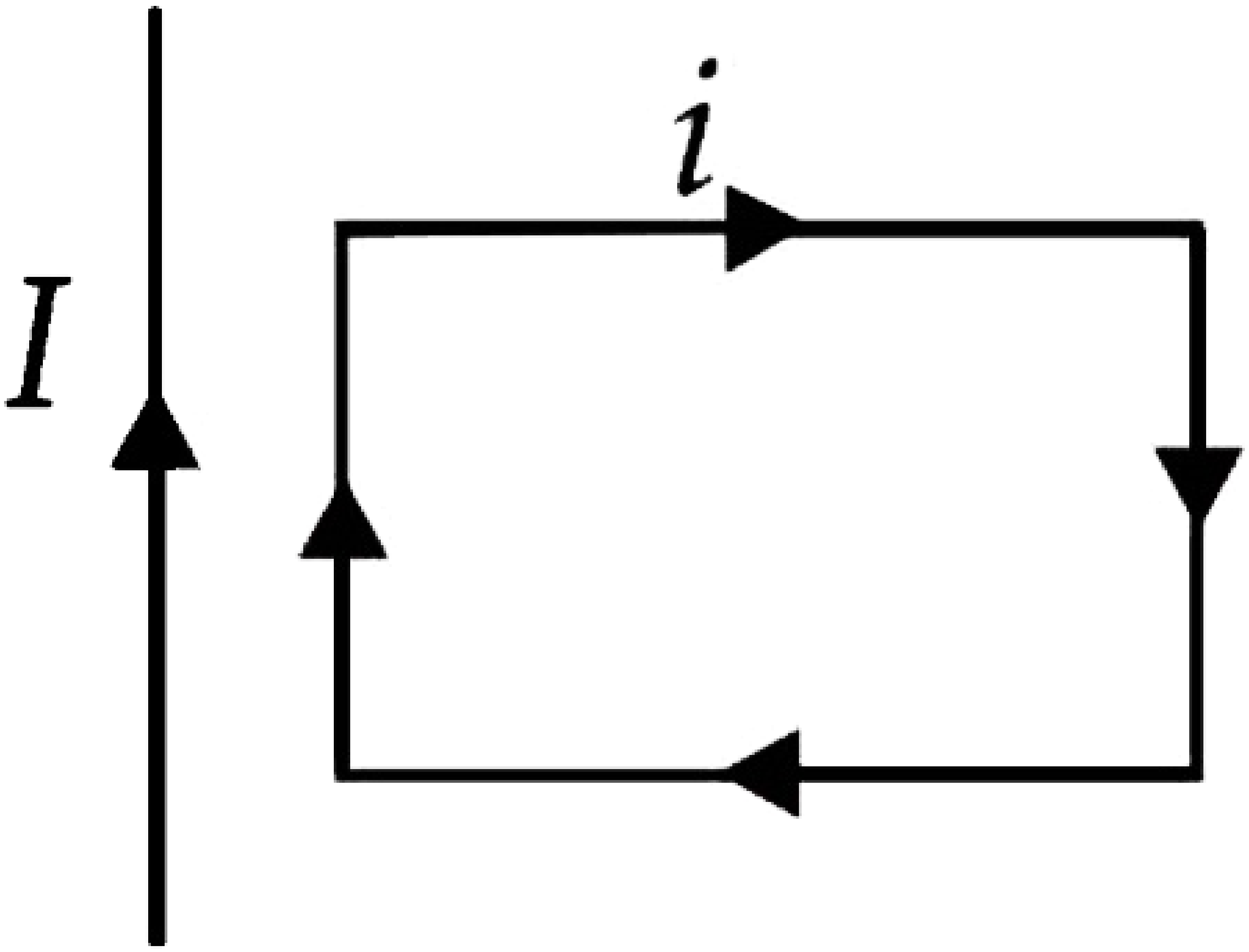
Q-32 - 10059892

A rectangular loop carrying a current i is situated near a long straight wire such that the wire is parallel to one of the sides of the loop and is in the plane of the loop . If steady current I is established in the wire as shown in the figure ,



(A) rotate about an axis parallel to the wire

(B) move away from the wire

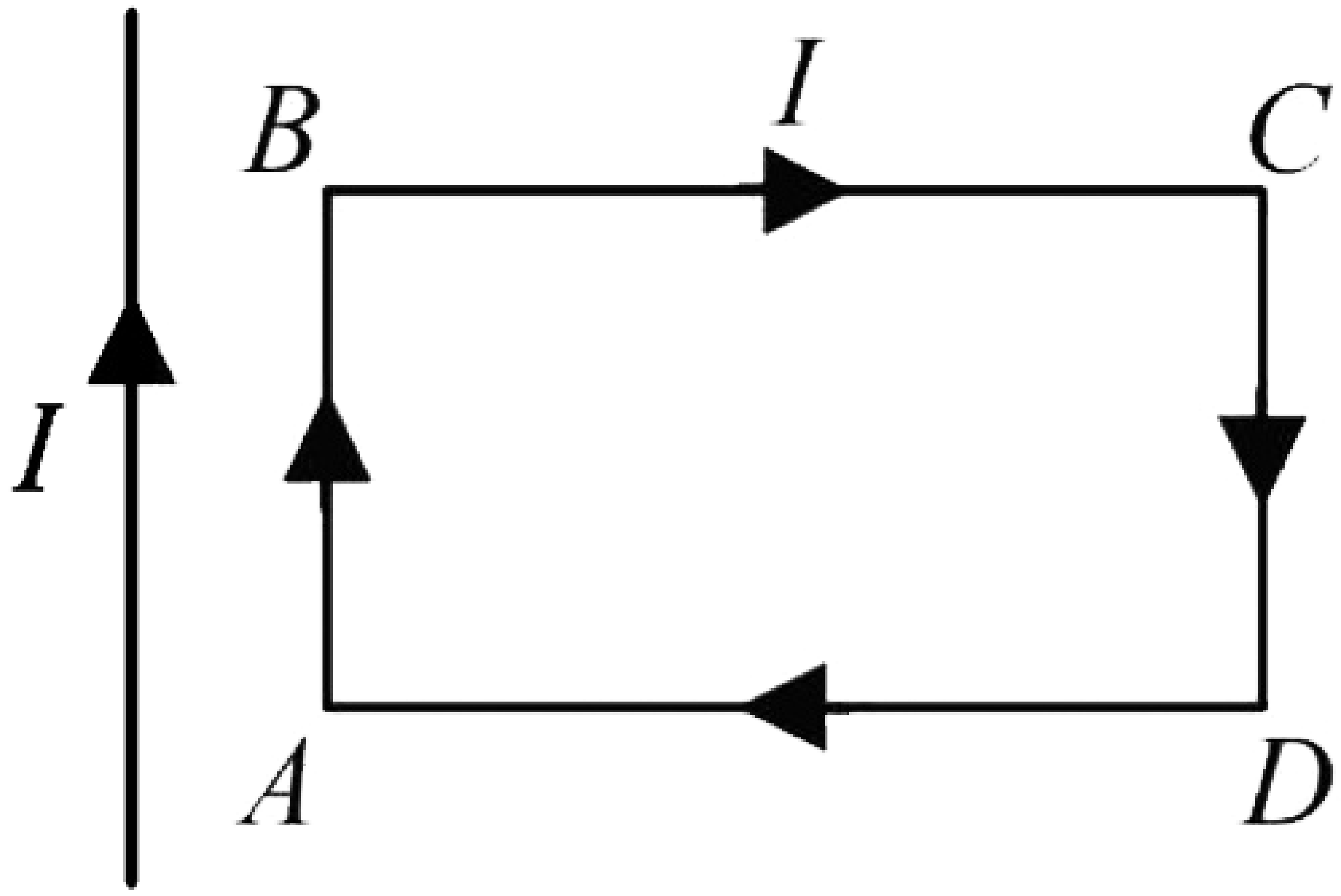
(C) move towards the wire

(D) remain stationary

CORRECT ANSWER: C

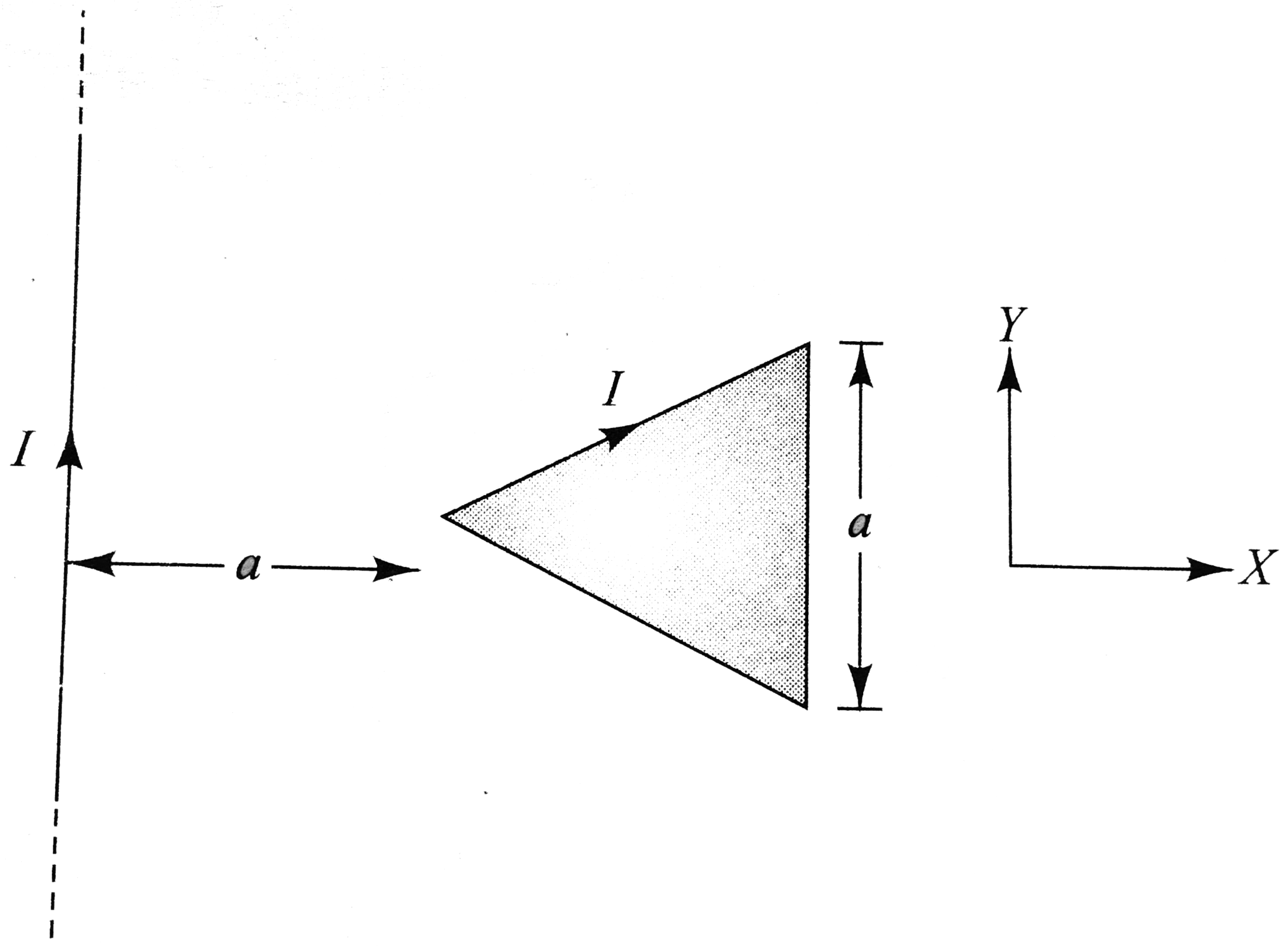
SOLUTION:

AB part of the rectangular loop will get attracted to the long straight wire as the currents are parallel and in the same direction whereas CD part will be repelled . But since this force $F \propto \frac{1}{r}$ where r is the distance between the wires . Therefore, there will be a net attractive force on the rectangular loop. Force on BC is equal and opposite to that on AD.



Q-33 - 11314247

An equilateral triangular loop is kept near to a current carrying long wire as shown fig. under the action of magnetic force alone, the loop



(A) must move along positive of negative X-axis

(B) must move in XY plane and not along X- or Y-axis

(C) does not move

(D) moves but which way we cannot predict

CORRECT ANSWER: A

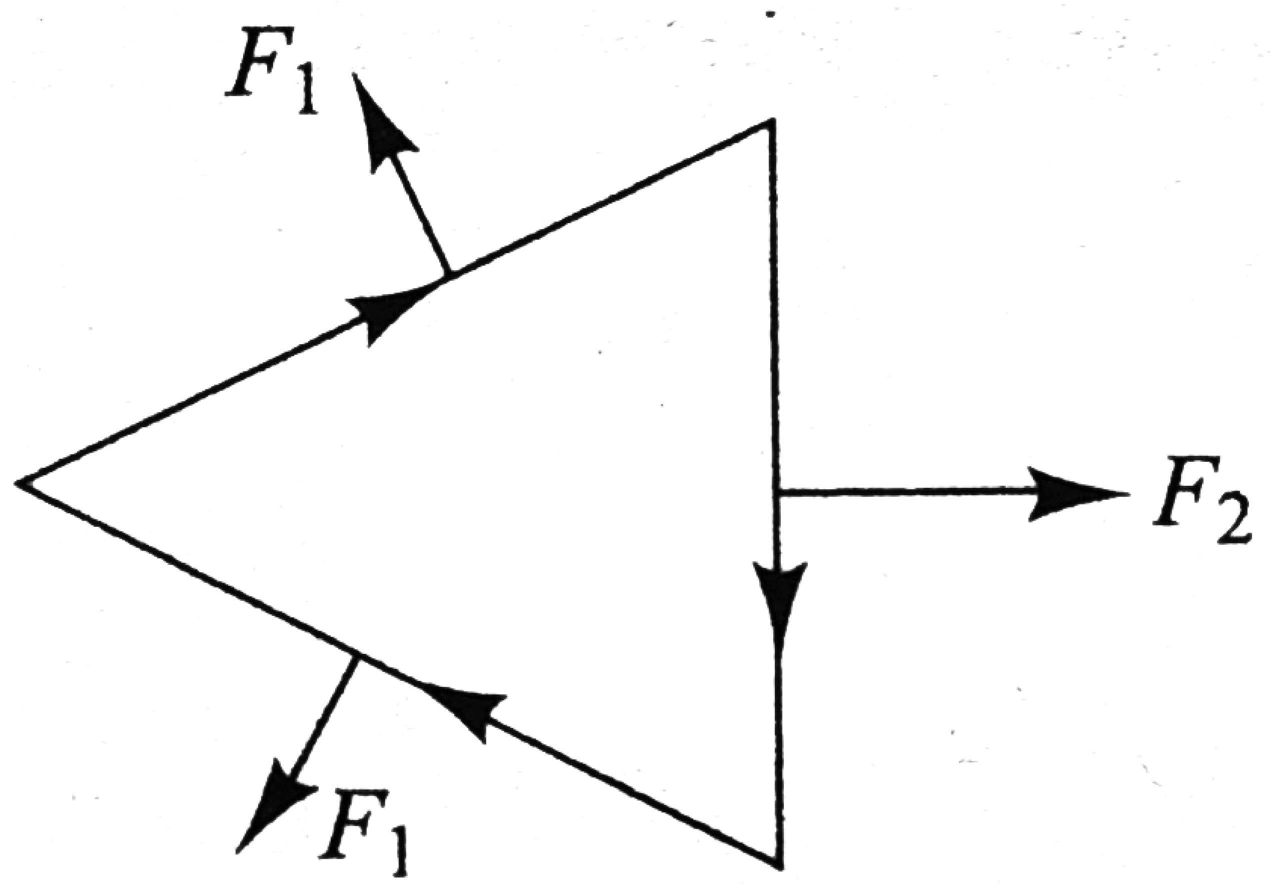
SOLUTION:

(a) The net force acting on the loop would be along X-axis (to

determine whether it is along +ve or -ve X-axis,

calculation

has to be carried out) as shown in Fig.



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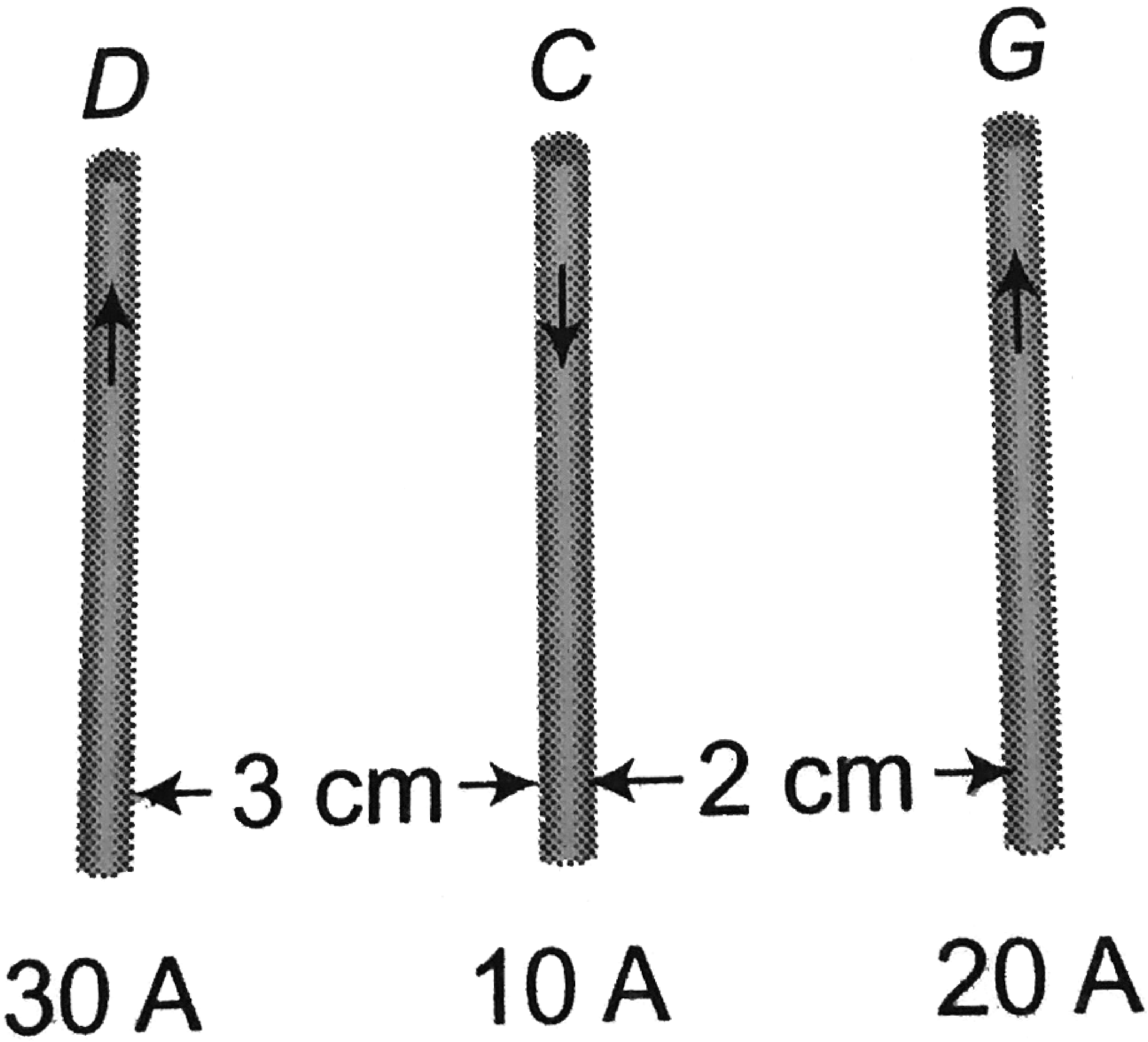
Q-34 - 11965266

Three long, straight parallel wires carrying current, are arranged as

shown in figure. The force experienced by a $25 cm$ length of wire C

is



(A) $10^{-3} N$

(B) $2.5 \times 10^{-3} N$

(C) Zero

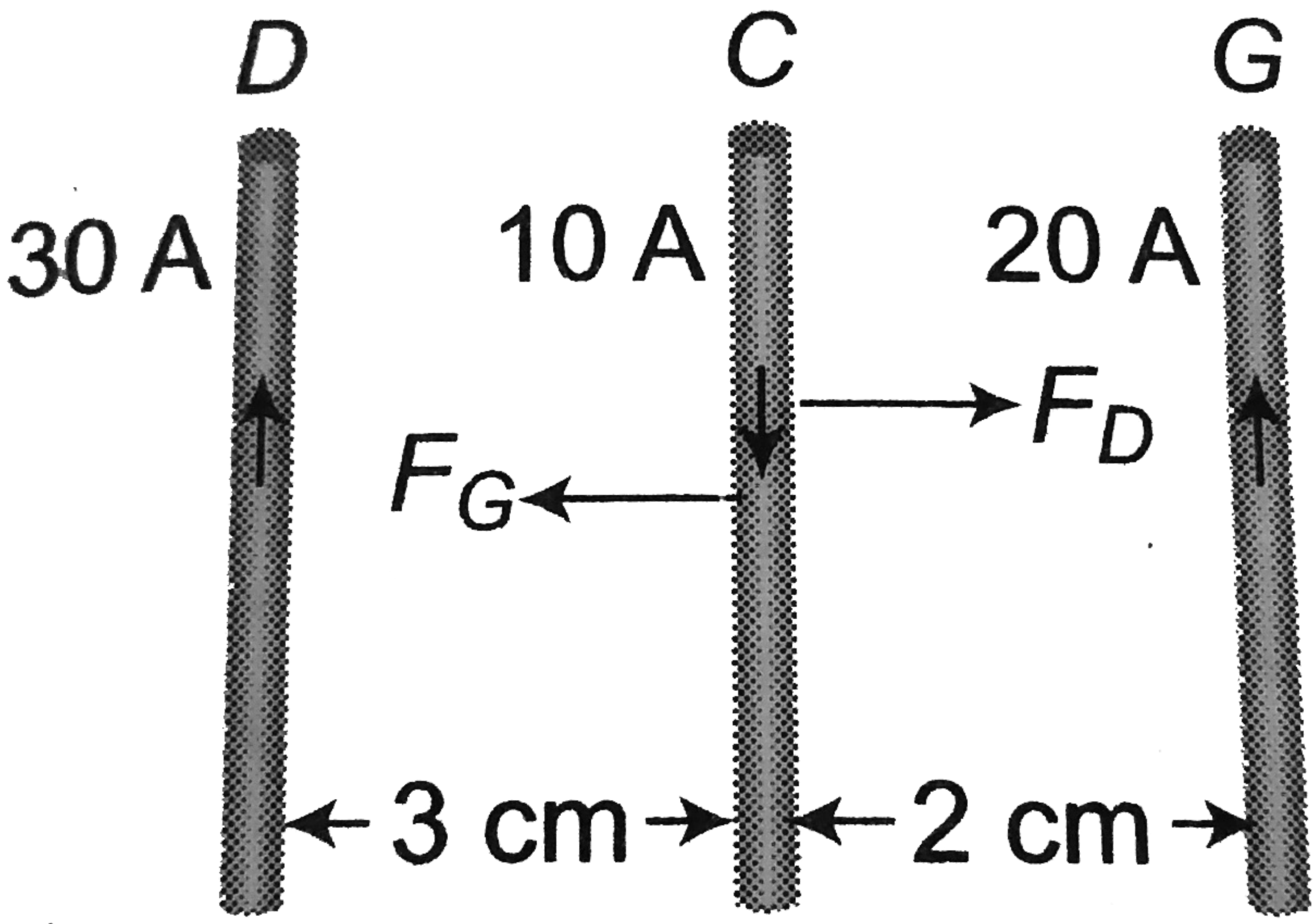
(D) $1.5 \times 10^{-3} N$

CORRECT ANSWER: C

SOLUTION:

Force on wire C due to wire D

$$F_D = 10^{-7} \times \frac{2 \times 30 \times 10}{2 \times 10^{-2}} \times 25 \times 10^{-2} = 5 \times 10^{-4} N$$



Force on wire C due to wire G

$$F_G = 10^{-7} \times \frac{2 \times 20 \times 10}{2 \times 10^{-2}} \times 25 \times 10^{-2} = 5 \times 10^{-4} N$$

(Towards left)

$\Rightarrow$ Net force on wire C is $F_{\text{net}} = F_D - F_G = 0$

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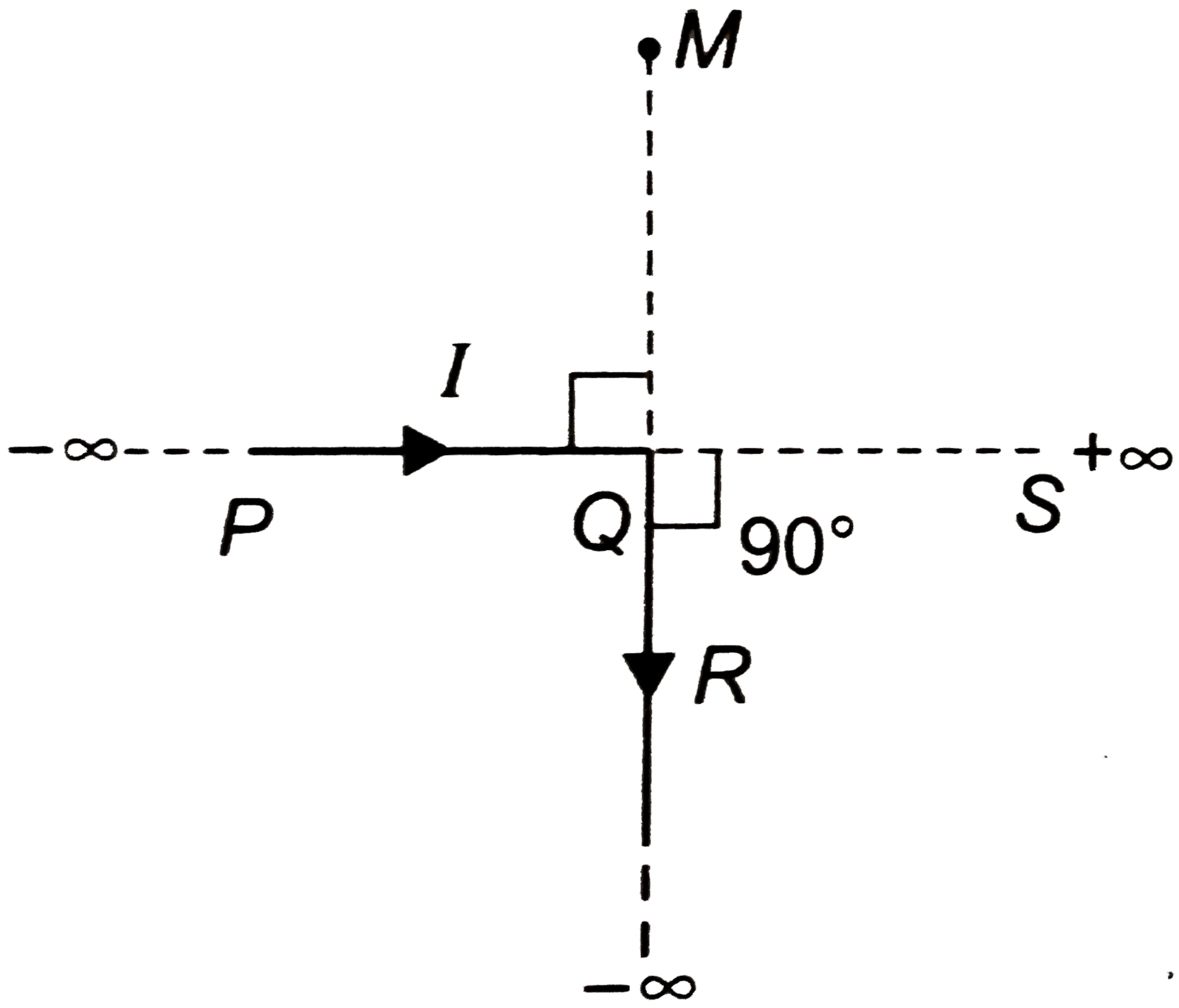
Q-35 - 13652515

An infinetely long conductor PQR is bent to from a right angle as shown. A current I flows through PQR. The magnetic field due to this current at the point M is H_1.Now, another infinitely long straight conductor QS is connected at Q so that the current is $I/2$ in QR as well as in QS, the current in PQ remaining unchanged. The magnetic field at M is now H_z, the ratio H_1/H_2 is given by



(A) $\frac{1}{2}$

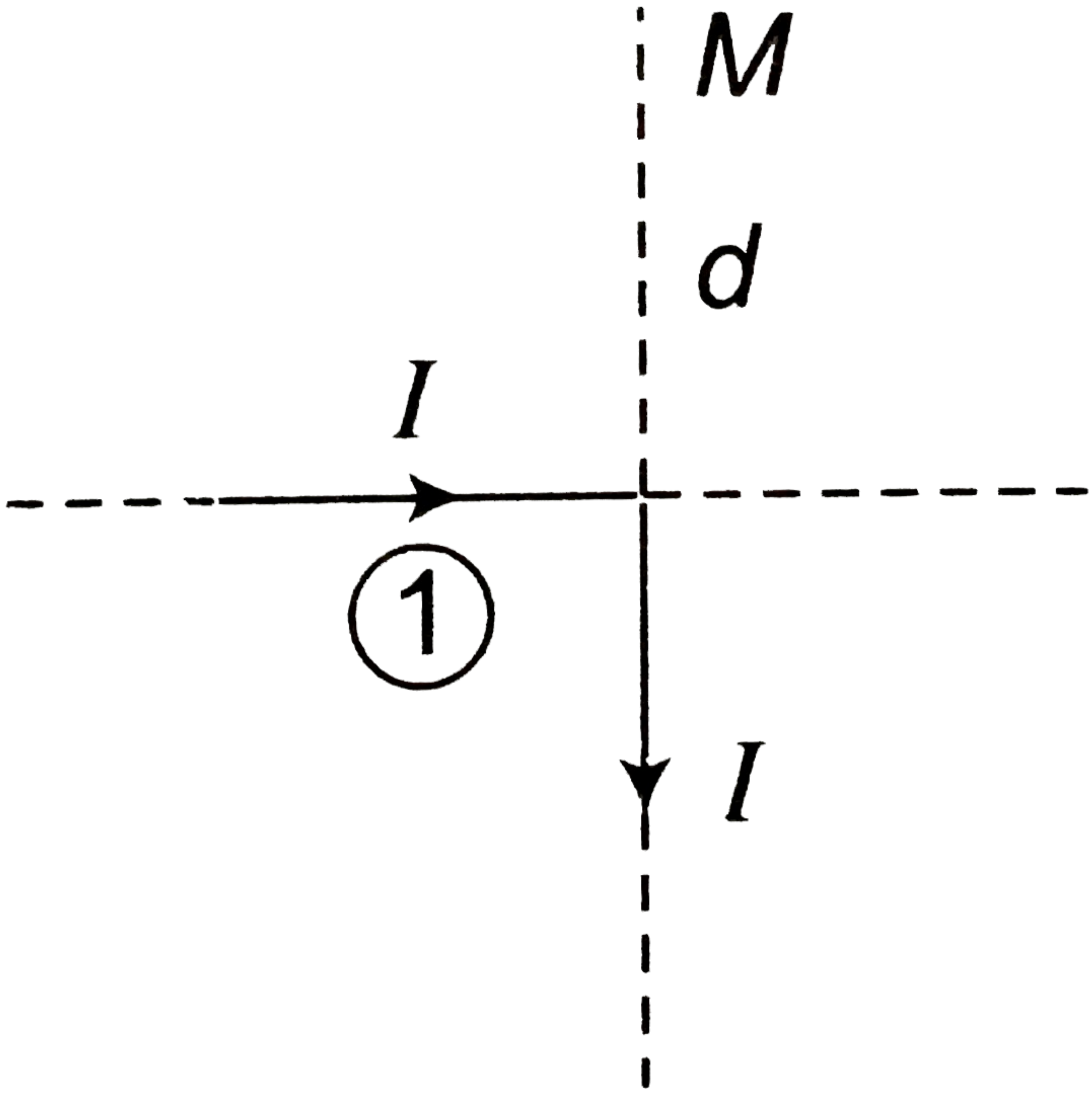
(B) 1

(C) $\frac{2}{3}$

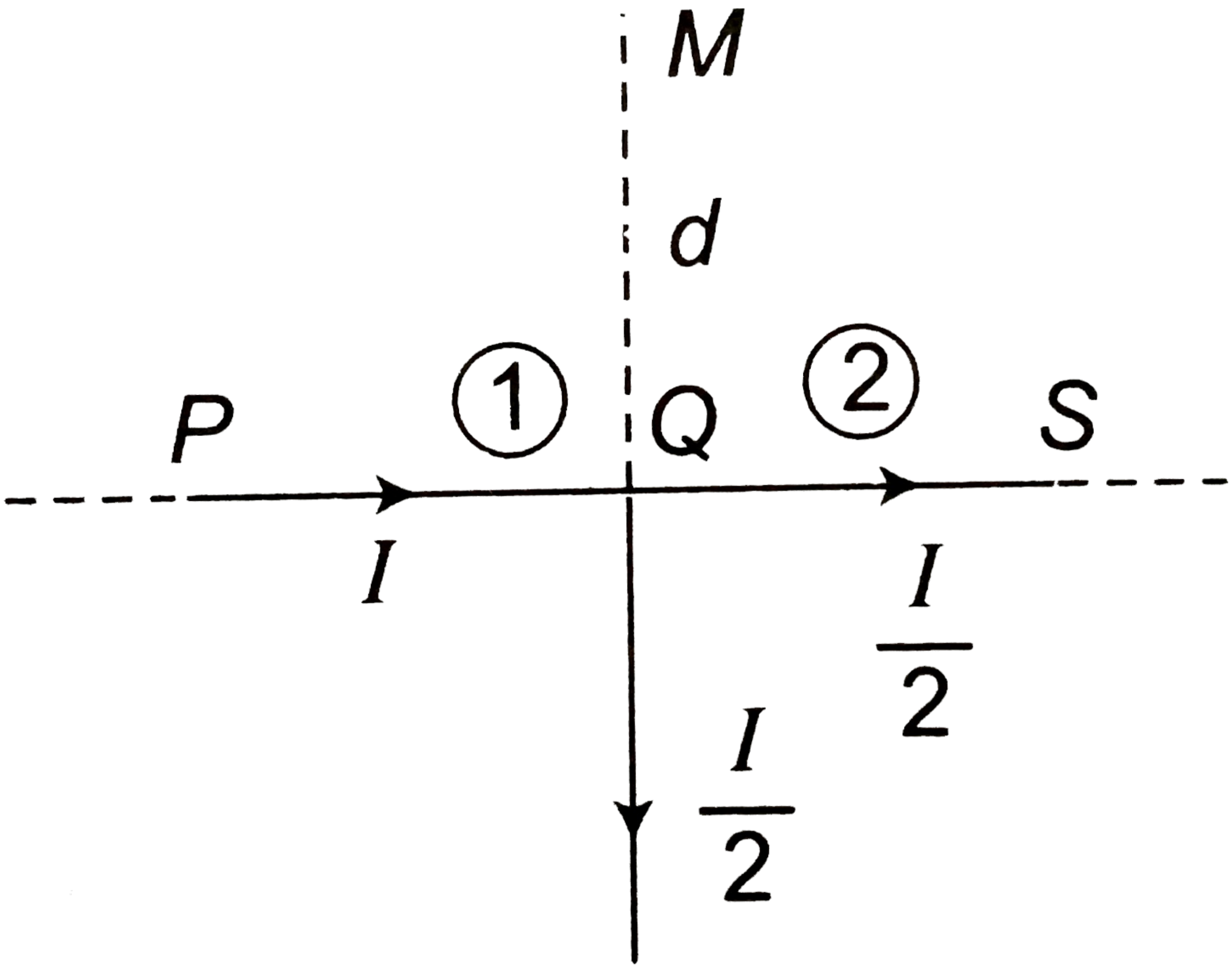
(D) 2

CORRECT ANSWER: C

SOLUTION:



$$H_1 = \frac{\mu_0 I}{4\pi d}$$



At M:

Due to PQ, $B_1 = \frac{\mu_0 I}{4\pi d}$

Due to QS, $B_2 = \frac{\mu_0 I / 2}{4\pi d}$

$$H_2 = B_1 + B_2$$

$$= \frac{3}{2}\frac{\mu_0 I}{4\pi d}$$

$$\frac{H_1}{H_2} = \frac{2}{3}$$

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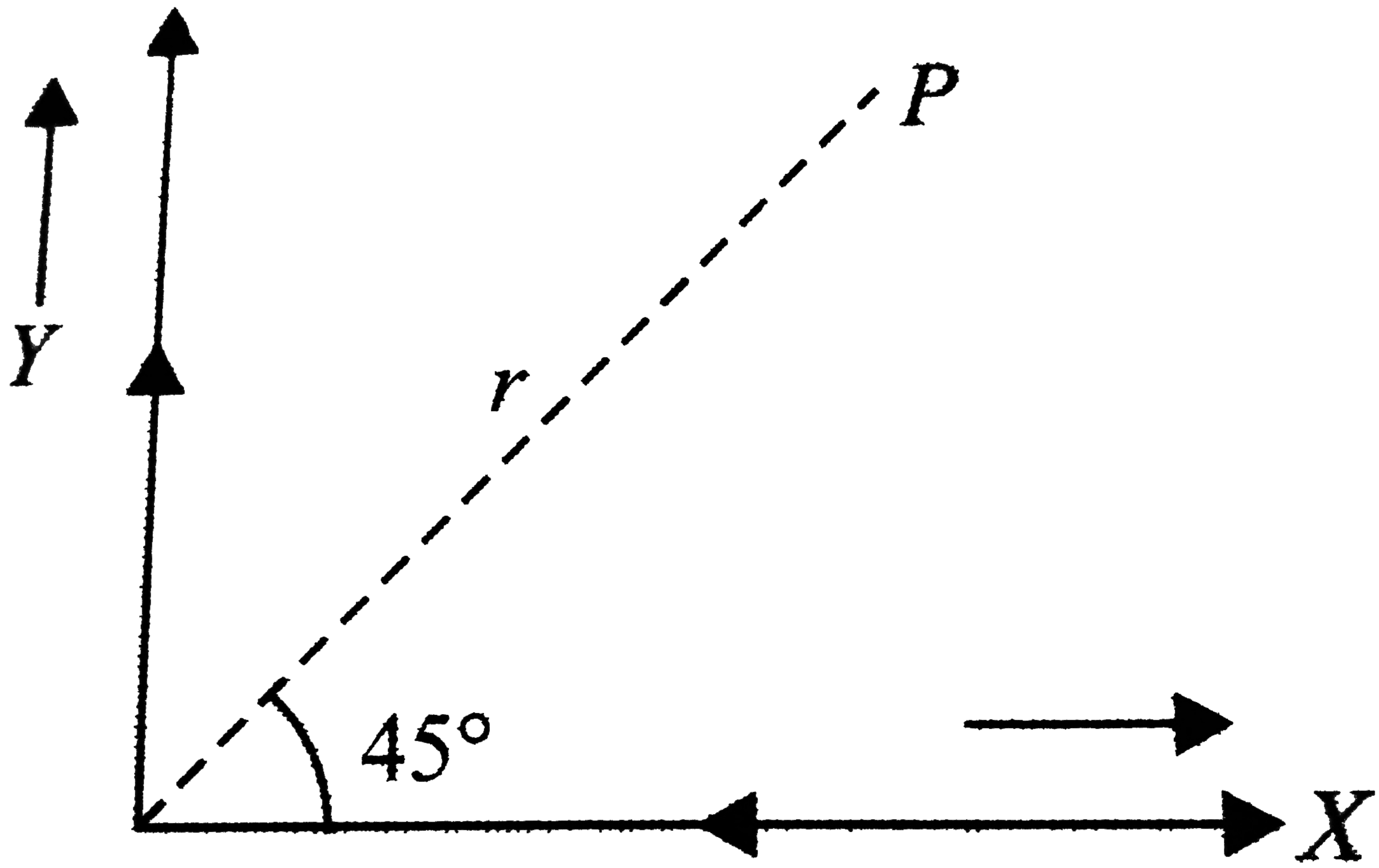
Q-36 - 11314156

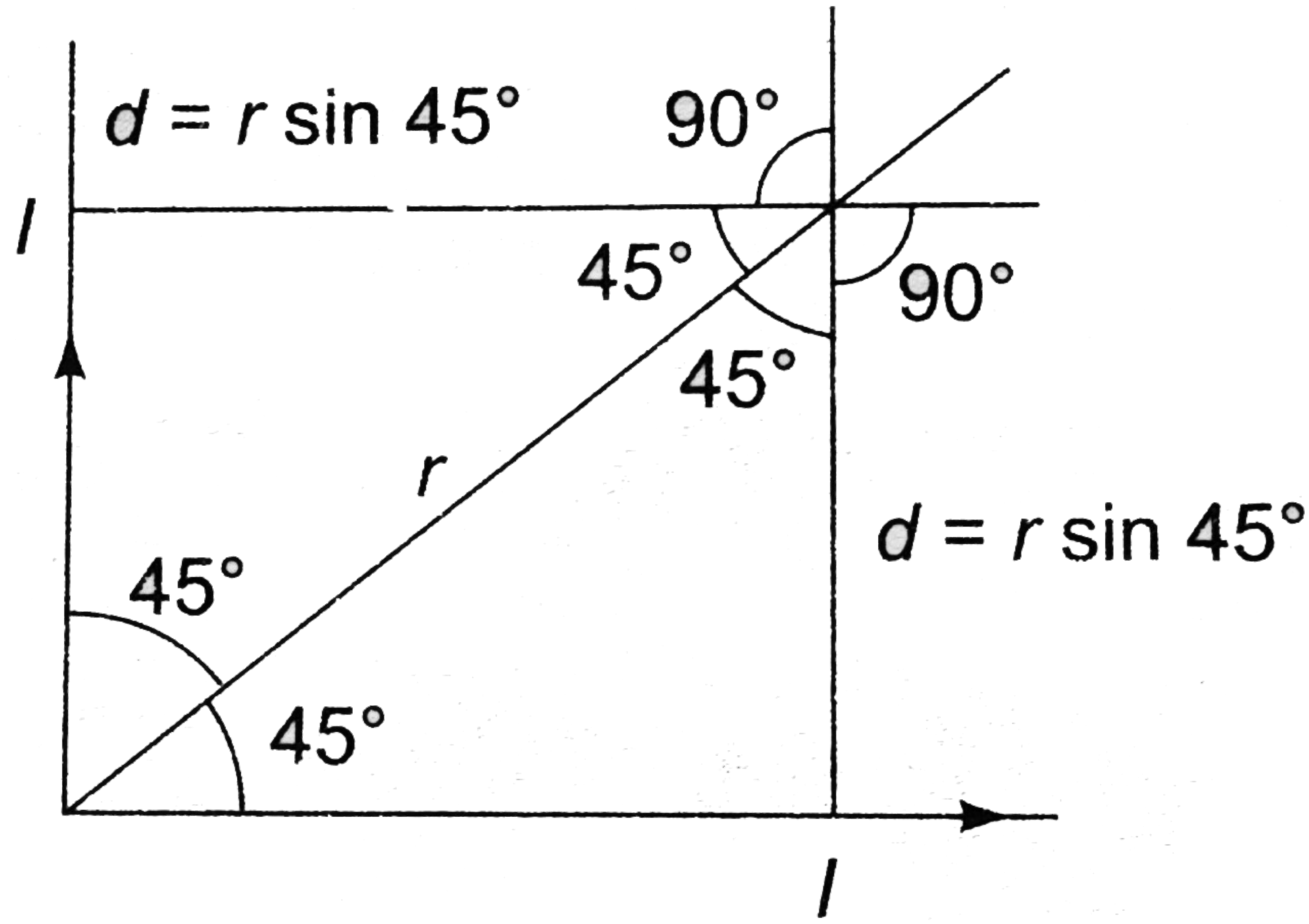
Current I flows through a long conducting wire bent at right angle as shown in Fig. Find the magnetic field at point P on the right angle bisector of the angle XOY at distance r form O.



CORRECT ANSWER: N//A

SOLUTION:

$$B = \frac{\mu_0}{4\pi}\frac{I}{d}(\sin\theta_1 + \sin\theta_2)$$



here, $d = r\frac{\sin 45^{=} r}{\sqrt{2}}$

$B = 2$

$\times \frac{\mu_0}{4\pi}\frac{I}{\left(\frac{r}{\sqrt{2}}\right)}$

$\left(\sin 45^{+} \sin 90^{\square}\right)$

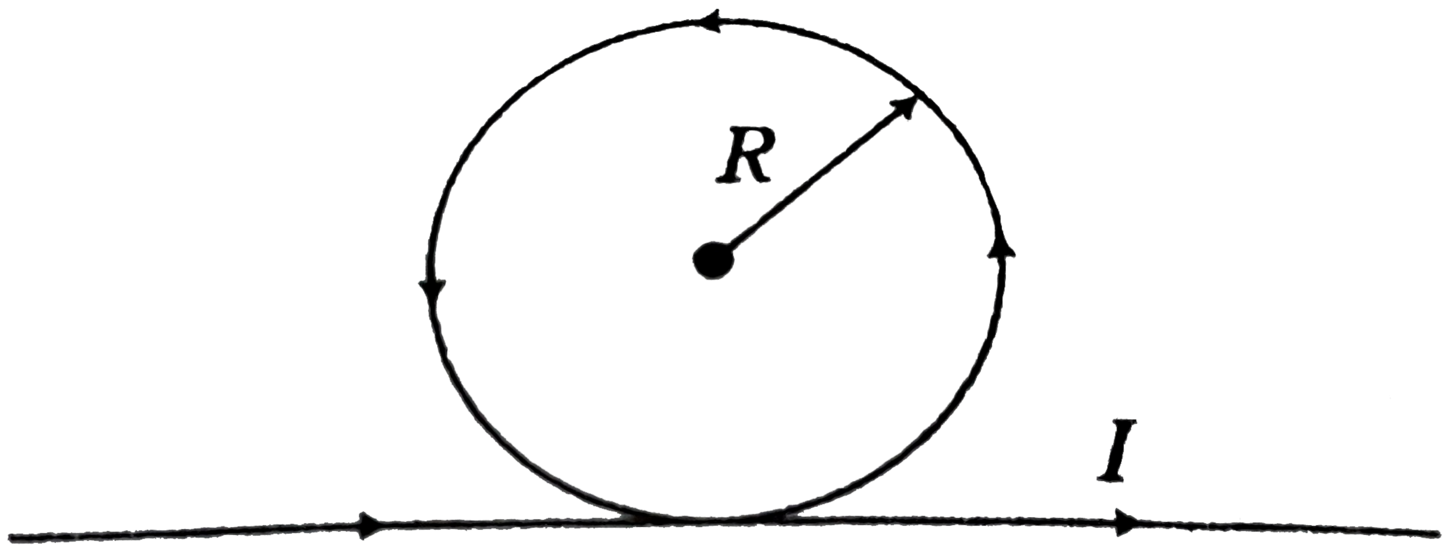
$= 2\sqrt{2}\frac{\mu_0}{4\pi}\frac{I}{r}\left(\frac{1}{\sqrt{2}}\right.$

$\left.+ 1\right) = \frac{\mu_0}{2\pi}\frac{I}{r}(\sqrt{2}$

$+ 1)$

Q-37 - 18249603

An infinitely long conductor is bent into a circle as shown in figure. It carries a current I ampere and the radius of loop is R metre. The magnetic induction at the centre of loop is



(A) $\frac{\mu_0 2I}{4\pi R}(\pi+1)$

(B) $\frac{\mu_0 2I}{4\pi R}(\pi-1)$

(C) $\frac{\mu_0 I}{8\pi R}(\pi+1)$

(D) zero

CORRECT ANSWER: A

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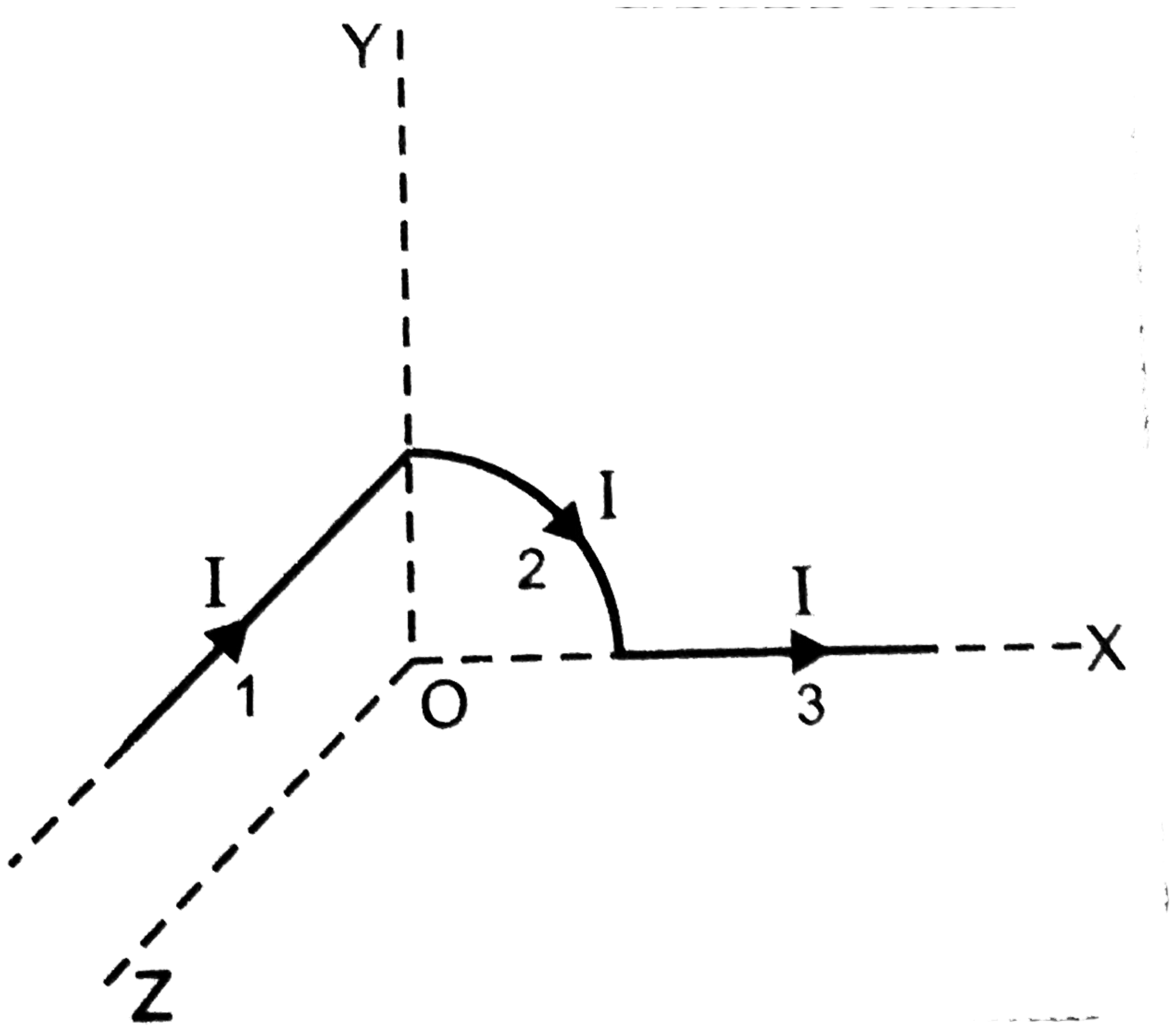
Q-38 - 12012139

Find the magnitude of the magnetic field at the origin O due to very long conductor carrying current I of the shape as shown in figure.



SOLUTION:

Total magnetic field at O is

$$\vec{B}_0 = \vec{B}_1 + \vec{B}_3$$
$$= \frac{\mu_0}{4\pi}\frac{I}{r}\left(-\hat{i}\right)$$
$$+ \frac{\mu_0}{4\pi}\frac{I}{r}\left(\frac{\pi}{2}\right)\left(-\hat{k}\right)$$
$$+ 0(\because B_3 = 0)$$

$$= -\frac{\mu_0}{4\pi}\frac{I}{r}\left[\hat{i} + \frac{\pi\hat{k}}{2}\right]$$
$$= -\frac{\mu_0 I}{4r}\left[\frac{\hat{i}}{\pi} + \frac{\hat{k}}{2}\right]$$

Q-39 - 13076423

An electron is moving with speed $2 \times 10^5 m/s$ along the positive x-direction in the presence of magnetic induction $\vec{B} = \left(\hat{i} + 4\hat{j} - 3\hat{k}\right)T$. The magnitude of the force experienced by the electron in

$N\left(e = 1.6 \times 10^{-19} C\right)\left(\overrightarrow{F}\right.$

$\left.= q\left(\overrightarrow{v} \times \overrightarrow{B}\right)\right)$

(A) 18×10^{13}

(B) 28×10^{-13}

(C) 1.6×10^{-13}

(D) 73×10^{-13}

CORRECT ANSWER: C

SOLUTION:

$$\overrightarrow{F} = e\left(\overrightarrow{V} \times \overrightarrow{B}\right)$$

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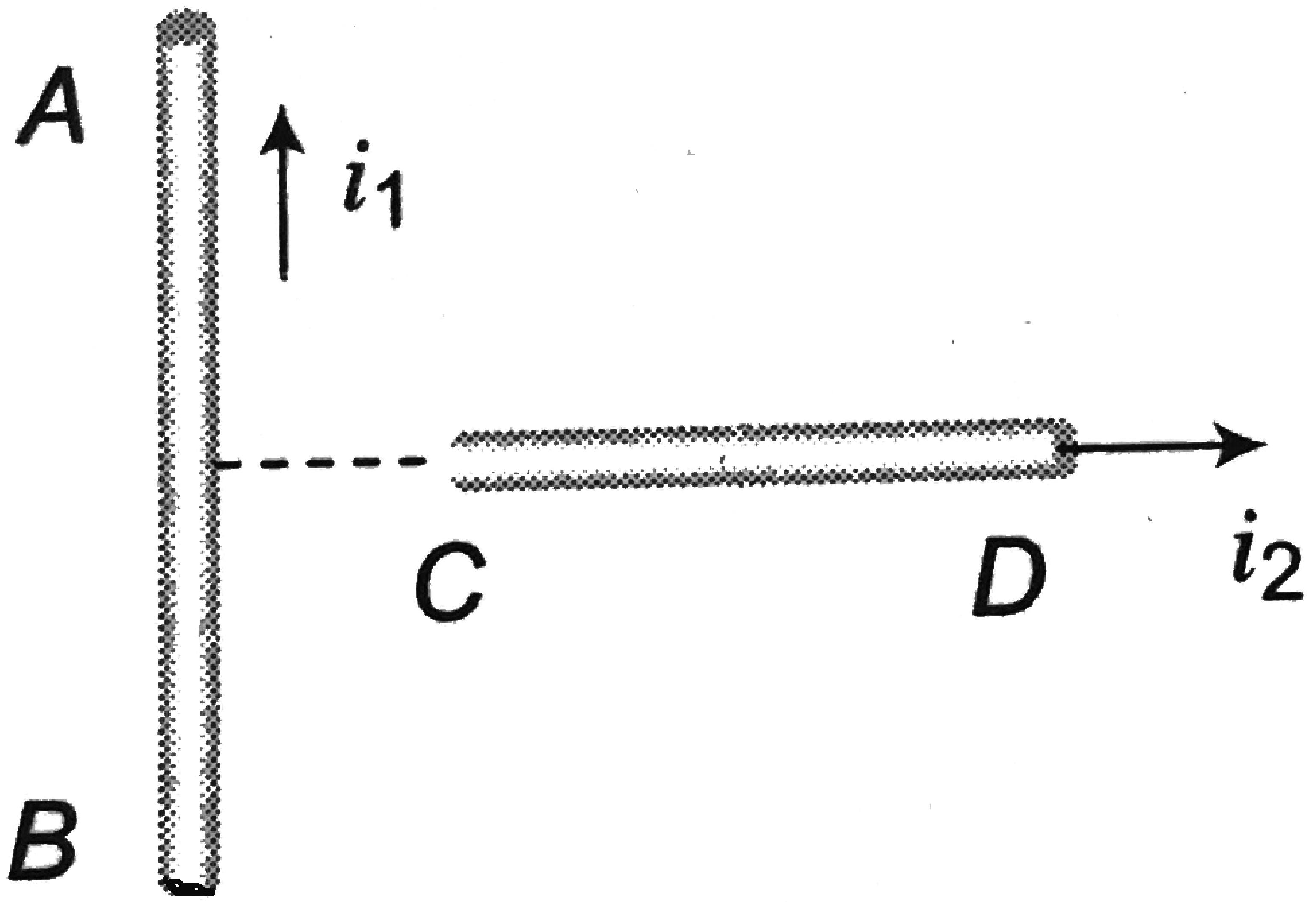
Q-40 - 11965242

An infinitely long, straight conductor AB is fixed and a current is passed through it. Another movable straight wire CD of finite length and carrying current is held perpendicular to it and released. Neglect weight of the wire



(A) The rod CD will move upwards parallel to itself

(B) The rod CD will move downward parallel to itself

(C) The rodCD will move upward and turn clockwise at the same time

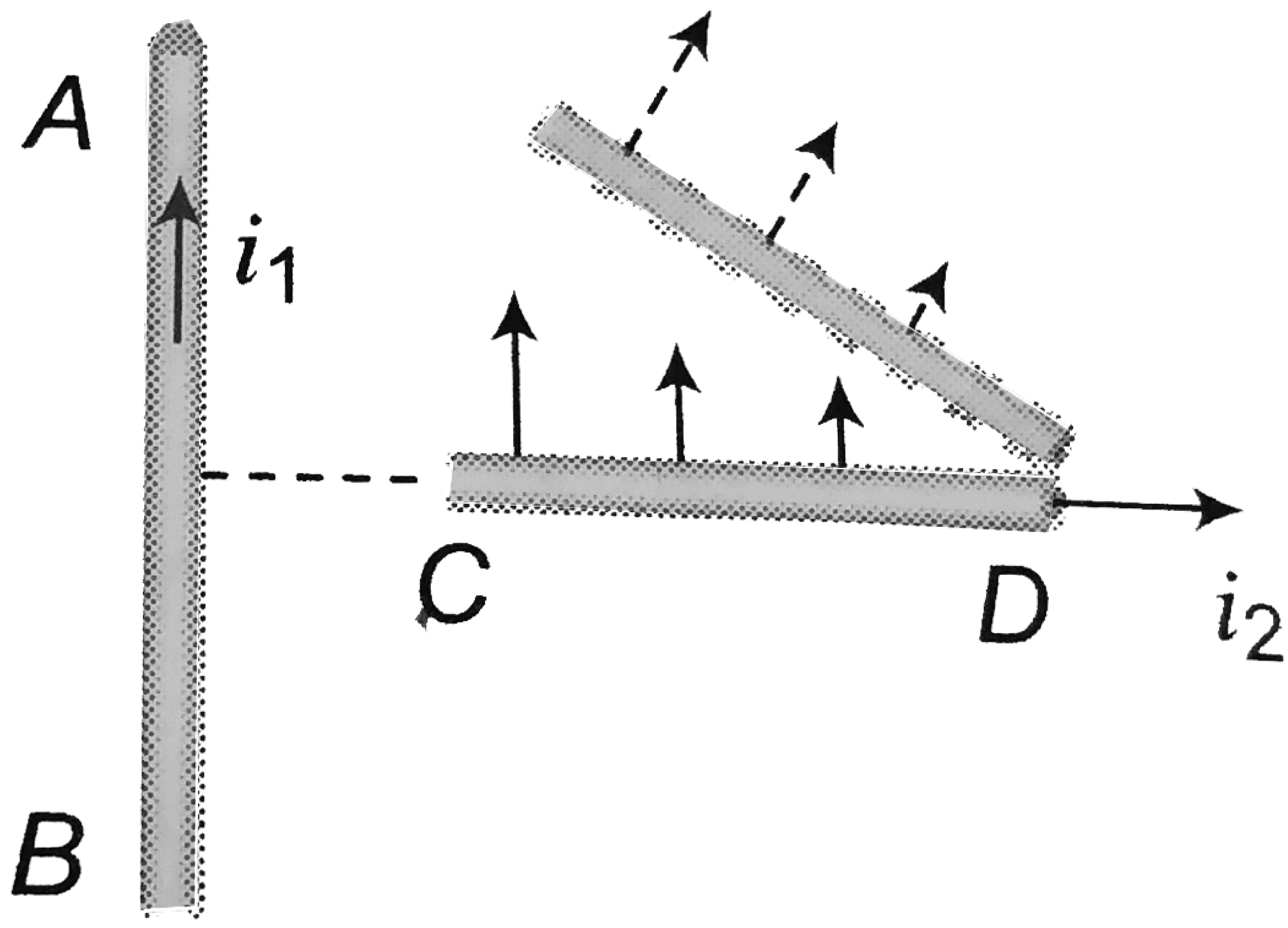
(D) The rod CD will move upward and turn anticlockwise at the same time

---

CORRECT ANSWER: C

SOLUTION:

since the force on the rod CD is non-uniform it will experience force and torque. From the left hand side it can be seen that the force will be upward and torque is clockwise



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Q-41 - 14797112

A particle with charge q, moving with a momentum p, enters a uniform magnetic field normally. The magnetic field has magnitude B and is confined to a region of width d, where $d < \dfrac{p}{Bq}$, The particle is deflected by an angle q in crossing the field. Then

(A) $\sin\theta = \dfrac{Bqd}{p}$

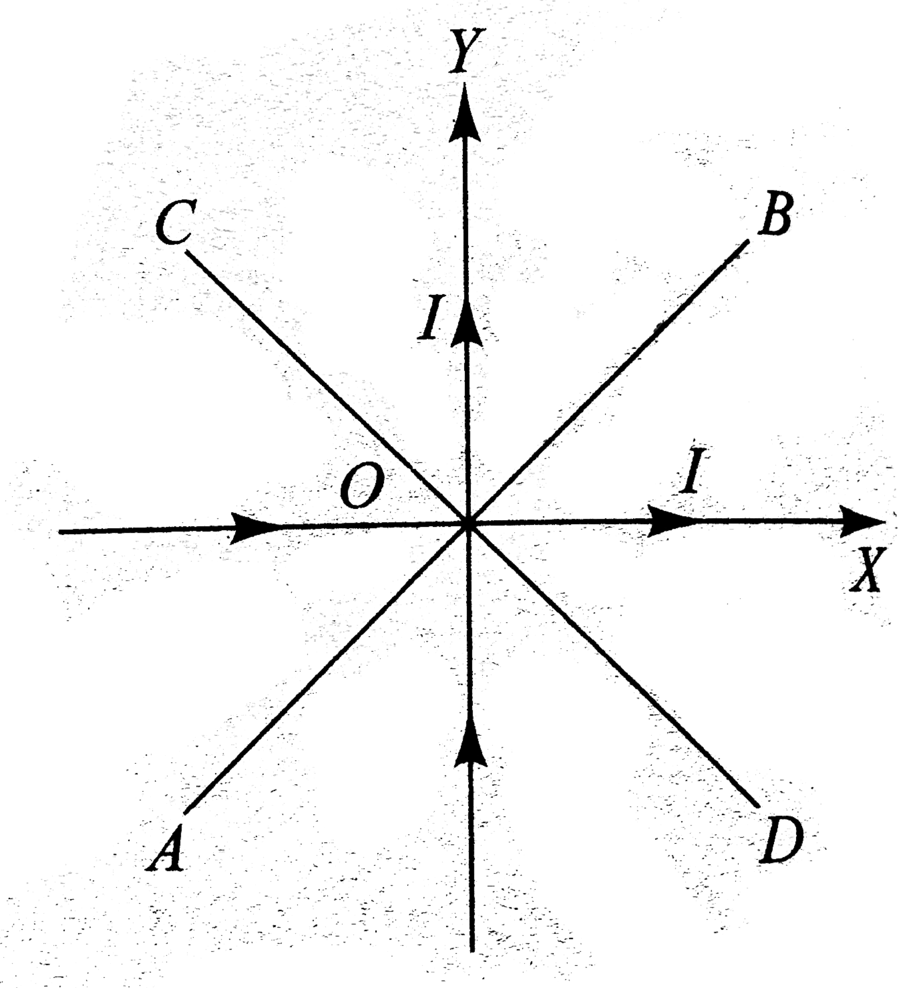
(B) $\sin\theta = \dfrac{p}{Bqd}$

(C) $\sin\theta = \dfrac{Bp}{qd}$

(D) $\sin\theta = \dfrac{pd}{Bq}$

Q-42 - 11314192

Two very thin metallic wires placed along X- and Y-axes carry equal currents as shown in Fig. AB and CD are lines at 45 with the axes. The magnetic field will be zero on the line



(A) AB

(B) CD

(C) segment OB only of line AB

(D) segment OC only of line CD.

CORRECT ANSWER: A

SOLUTION:

(a) All points on AB are equidistant from the two wires.

So,

magnetic field are equal and opposite. Thus, they cancel out.

Q-43 - 11965604

Assertion: A current I flows I flows along the length of an infinitely long stragh and thin walled pipe. Then the magnetic field at any point inside the pipe is zero.

Reason: $\oint \overrightarrow{B} . d \overrightarrow{l} = \mu I$

(A) If both the assertion and reason are true and reason is a true explantion of the assertion.

(B) If both the assertion and reason are true but the reason is not the correct explantion of the assertion.

(C) If the assertion is true but reason false

(D) If both the assertion and reason are false.

CORRECT ANSWER: A

SOLUTION:

Here, both asseration and reason are correct and reason is the correct explanation fo assertion.

Q-44 - 10059955

A magnetic needle lying parallel to a magnetic field requires $W units$ of work to turn it through 60. The torque needed to maintain the needle in this position will be

(A) $\sqrt{3}W$

(B) W

(C) $\frac{\sqrt{3}}{2}W$

(D) $2W$

CORRECT ANSWER: A

SOLUTION:

W
$= MB(\cos\theta_1 - \cos\theta_2$
$)MB\left(\cos\theta 0\right.$
$\left.- \cos\theta 60^0\right) = MB\left(1\right.$
$\left.- \frac{1}{2}\right) = \frac{MB}{2}$

$\therefore$
$\tau = MB\sin\theta$
$= MB\sin 60$
$= \sqrt{3}\frac{MB}{2} = \sqrt{3W}$

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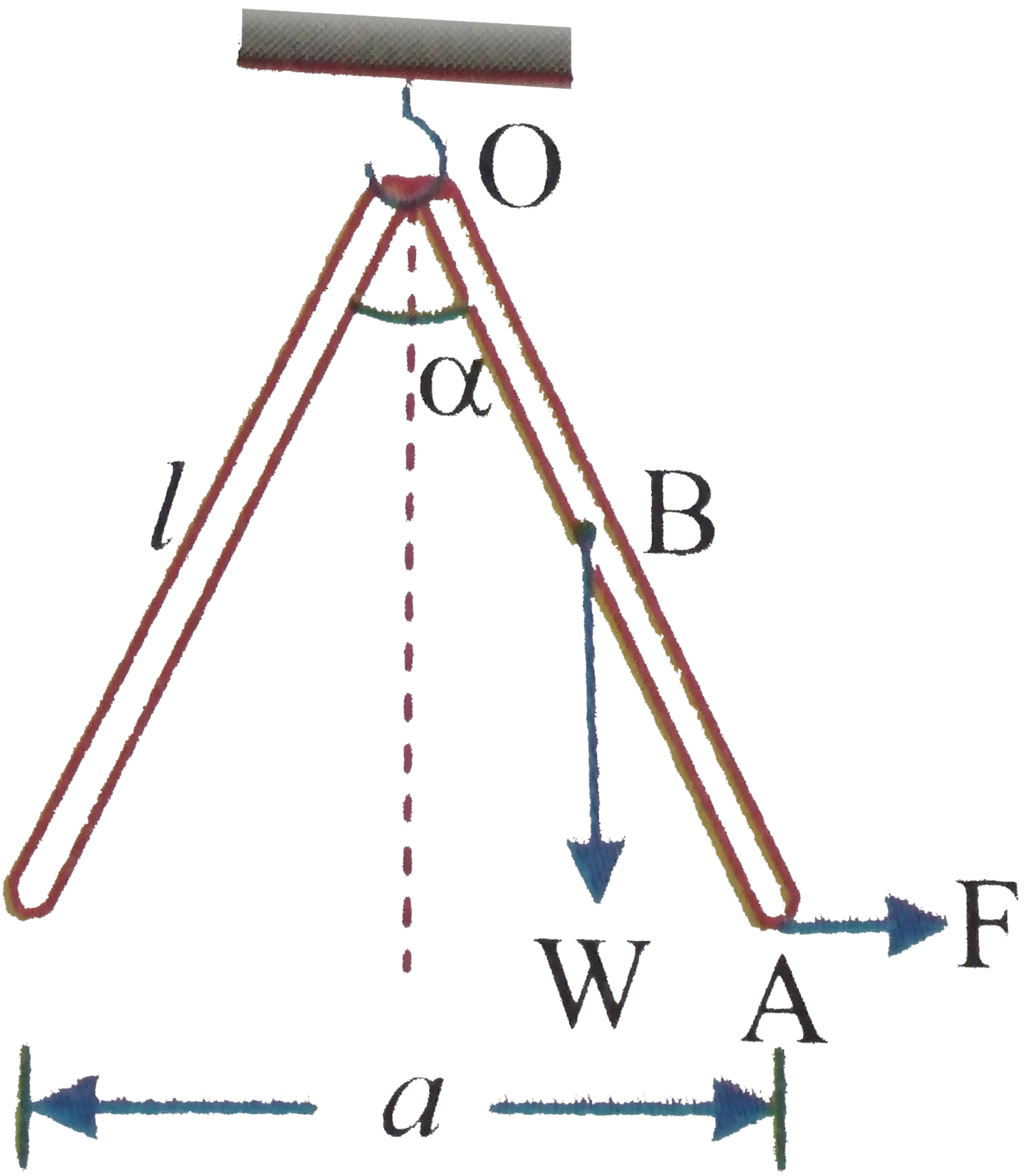
Q-45 - 13166663

Two long equally magnetized needles are freely suspended by their like poles form a hooks shown in figure. The length of each needle is lcm and the weight is W. in equillibrium the needles make an angle α with each other. The magnetic pole strength is concentrated at the ends of needles. The magnetic pole strength of the needles is



(A)

$l \sin\left(\frac{\alpha}{2}\right)\sqrt{2W \tan\left(\frac{\alpha}{2}\right)}$

(B)

$$2l \sin\left(\frac{\alpha}{2}\right)\sqrt{2W \tan\left(\frac{\alpha}{2}\right)}$$

(C)

$$3l \sin\left(\frac{\alpha}{2}\right)\sqrt{2W \tan\left(\frac{\alpha}{2}\right)}$$

(D)

$$4l \sin\left(\frac{\alpha}{2}\right)\sqrt{2W \tan\left(\frac{\alpha}{2}\right)}$$

CORRECT ANSWER: A

SOLUTION:

Let us consider one of the needles. It will be acted by the weight W, which acts through the centre of gravity B and the replusive force between the poles $F = \frac{m^2}{a^2}$

acted through the point A. For the needle to be in equilibrium the sum of the moments of forces acting on the needle should be equal to zero, i.e.,

$$W\frac{l}{2}\sin\left(\frac{\alpha}{2}\right)$$
$$=Fl\cos\left(\frac{\alpha}{2}\right)$$

Hence $F=\frac{m^2}{a^2}$, where $a=2l\sin\left(\frac{\alpha}{2}\right)$

Thus

$$\frac{W}{2}\sin\left(\frac{\alpha}{2}\right)$$
$$=m^2\frac{\cos\left(\frac{\alpha}{2}\right)}{4l^2\sin^2\left(\frac{\alpha}{2}\right)}$$

$$m$$
$$=l\sin\left(\frac{\alpha}{2}\right)\sqrt{2W\tan\left(\frac{\alpha}{2}\right)}$$

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Q-46 - 12012395

Vertical component of earth's magnetic field at a place is $\sqrt{3}$ times its horizontal component. If total intensity of earth's magnetic field at the place is $0 \cdot 4 Gauss$, find (i) angle of dip (ii) horizontal component of earth's magnetic field.

CORRECT ANSWER: 60°; $0 \cdot 2G$

SOLUTION:

$$V = \sqrt{3}H, R = 0 \cdot 4G, \delta = ?\ H = ?$$

$$\tan\delta = \frac{V}{H} = \frac{\sqrt{3}H}{H}$$

$$= \sqrt{3}$$

$$\therefore \Delta = 60$$

$$H = R\cos\delta = 0$$

$$\cdot 4\cos 60^{=} 0 \cdot 4 \times \frac{1}{2}$$

$$= 0 \cdot 2G$$

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Q-47 - 17959798

A jet plane is moving at a speed of $1000 kmh^{-1}$. What is the potential difference across the ends of its wings 20 m long. Given total intensity of earth's magnetic field is 3.5×10^{-4} tesla and angle of dip at the place is 30.

CORRECT ANSWER: 0.97 VOLT

Q-48 - 11967592

The time period of oscillation of a magnet in a vibration magnetometer is 1.5 seconds. The time period of oscillation of another of another magnet similar in size, shap and mass but having one-fourth magnetic moment than that of first magnet, oscillating at same place will be

(A) 0.75 sec

(B) 1.5 sec

(C) 3 sec

(D) 6 sec

CORRECT ANSWER: C

SOLUTION:

$$T \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{T_1}{T_2}$$

$$= \sqrt{\frac{M_2}{M_1}} \Rightarrow \frac{1.5}{T_2}$$

$$= \sqrt{\frac{M_1 / 4}{M_1}} = \frac{1}{2}$$

$$\Rightarrow T_2 = 3 \sec$$

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Q-49 - 12011501

Two short magnets having magnetic moments in the ratio $8:1$, when placed on opposite sides of a deflection magnetometer produce no deflection. If distance of stronger magnet from the centre of deflection magnetometer is $6cm$, what is the distance of weaker manget from the centre?

SOLUTION:

Here,

$$\frac{M_1}{M_2} = \frac{8}{1}, d_1 = 6cm d_2$$

$$= ?$$

For short magnets, In the null method

$$\frac{M_1}{M_2}\left(\frac{d_1}{d_2}\right)^3 = \frac{8}{1}$$

$$= (2)^3$$

$$\therefore \frac{d_1}{d_2} = 2, d_2 = \frac{d_1}{2}$$
$$= \frac{6}{2} = 3cm$$

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Q-50 - 11967481

Two identcal magnetic dipole of magnetic moment $1.0A - m^2$ each, placed at a separation of 2 m with their axis perpendicular to each other. The resultant magnetic field at a point midway between the dipole is

(A) $5 \times 10^{-7}T$

(B) $\sqrt{5} \times 10^{-7}T$

(C) $10^{-7}T$

(D) None of these

CORRECT ANSWER: B

SOLUTION:

With respect to 1^{st} magnet, P lies in end side-on position

$$\therefore B_1 = \frac{\mu_0}{4\pi}\left(\frac{2M}{d^3}\right) \text{ (RHS)}$$

With respect to 2^{nd} magnet. P lies in broad side on

position.

$$\therefore B_2 = \frac{\mu_0}{4\pi}\left(\frac{M}{d^3}\right) \text{ (Upward)}$$

$$B_1 = 10^{-7} \times \frac{2 \times 1}{1}$$

$$= 2 \times 10^{-7} T, B_2$$

$$= \frac{B_1}{2} = 10^{-7} T$$

As B_1 and B_2 are mutually perpendicular, hence the resultant magnetic field

$$B_R = \sqrt{B_1^2 + B_2^2}$$

$$= \sqrt{(2 \times 10^{-7})^2 + (10^{-7})^2}$$

$$= \sqrt{5} \times 10^{-7} T$$

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Q-51 - 14928457

A bar magnet of magnetic moment M is placed at right angles to a magnetic induction B. If a force F is experienced by each pole of the magnet, the length of the magnet will be

(A) F/MB

(B) MB//F`

(C) BF/M

(D) MF//B`

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Q-52 - 11965201

A proton of mass $1.67 \times 10^{-27} kg$ and charge $1.6 \times 10^{-19} c$ is projected with a speed of $2 \times 10^{6} m/s$ at an angle of 60 to the x-axis. If a uniform magnetic field of 0.104 Tesla is applied along Y-axis, the path of proton is

(A) A circle of radius = 0.2m and time period $\pi \times 10^{-7} s$

(B) A circle of radius=0.1m and time period

$2\pi \times 10^{-7} s$

(C) A helix of radius=0.1m and time period $2\pi \times 10^{-7} s$

(D) A helix of radius = 0.2m and time period

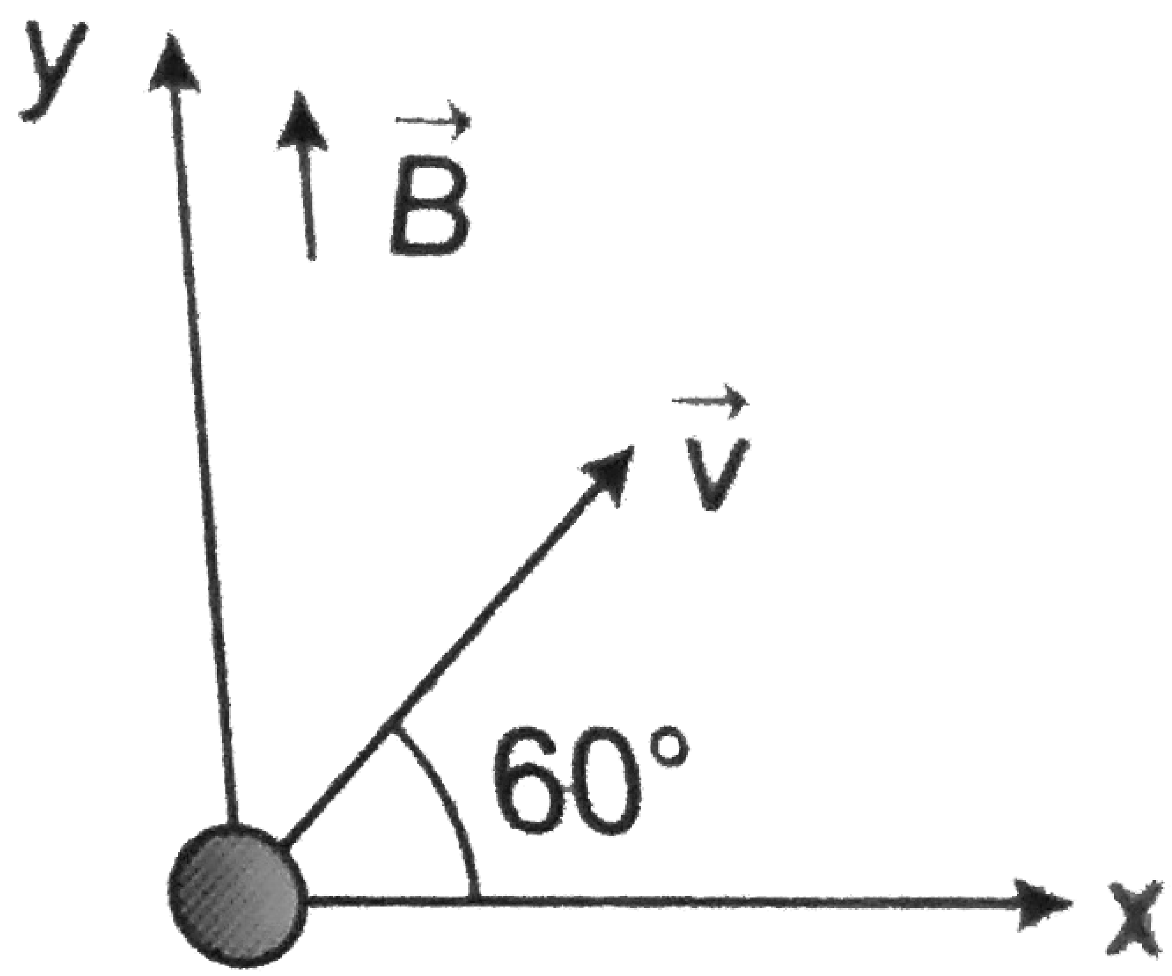
$4\pi \times 10^{-7} s$

CORRECT ANSWER: C

SOLUTION:

path of the proton will be a helix of radius $r = \frac{mv\sin\theta}{qB}$

(where $theata$=Angle between $\vec{B}$ and $\vec{v}$)



$$\Rightarrow r = \frac{1.67 \times 10^{-27} \times 2 \times 10^{6} \times \sin 30}{1.6 \times 10^{-19} \times 0.104}$$

$$= 0.1m$$

Time period

$$T = \frac{2\pi m}{qB}$$

$$= \frac{2\pi \times 1.67 \times 10^{-27}}{1.6 \times 10^{-19} \times 0.104}$$

$$= 2\pi \times 10^{-7} \text{sec}$$

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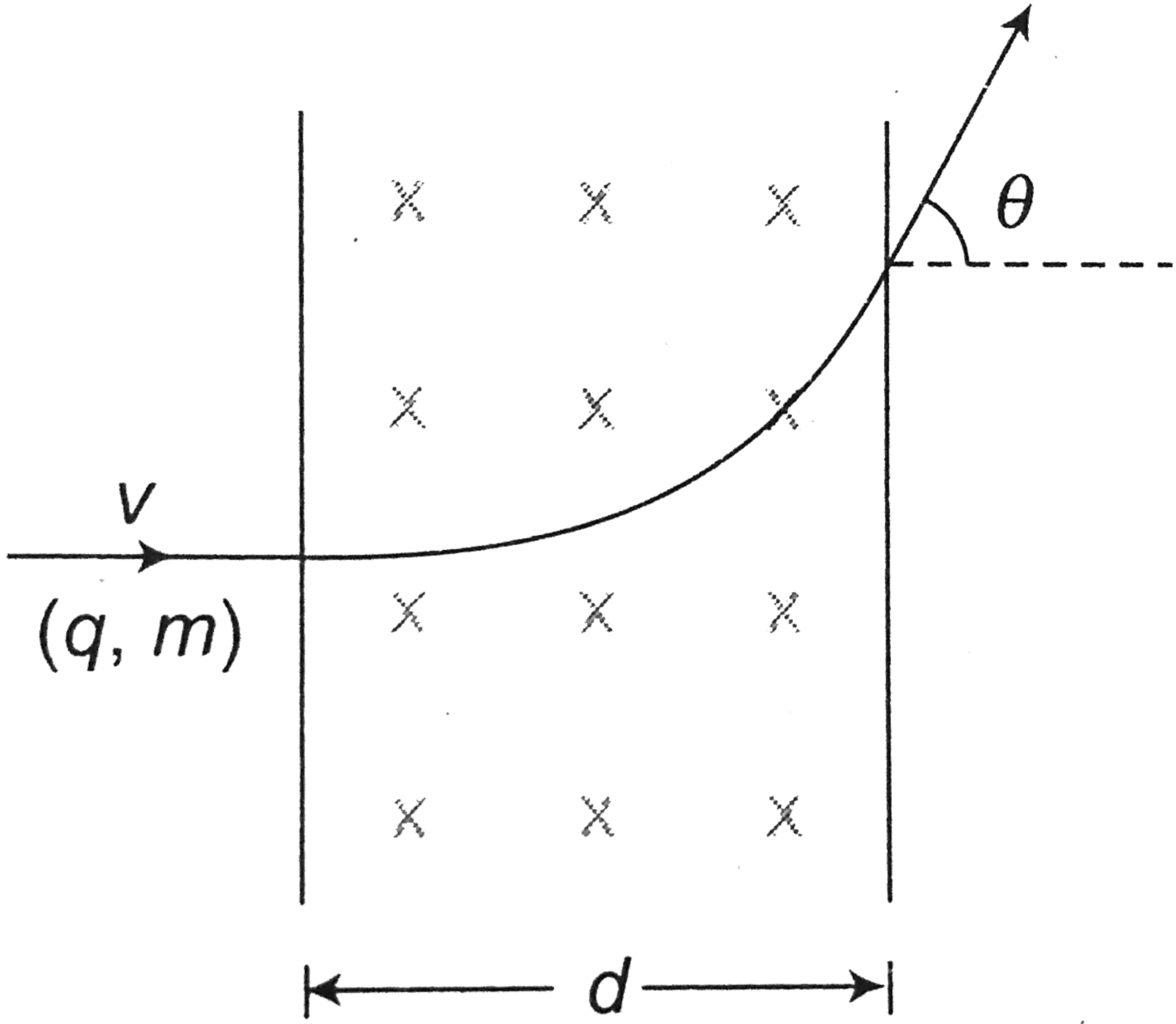
Q-53 - 13397010

A charged particle (q, m) enters perpendicular in a uniform magnetic field B and comes out field as shown. The angle of deviation θ time taken by particle to cross magnetic field will be



(A) $\sin^{-1}. \frac{Bqd}{mv}, \frac{m\theta}{Bq}$

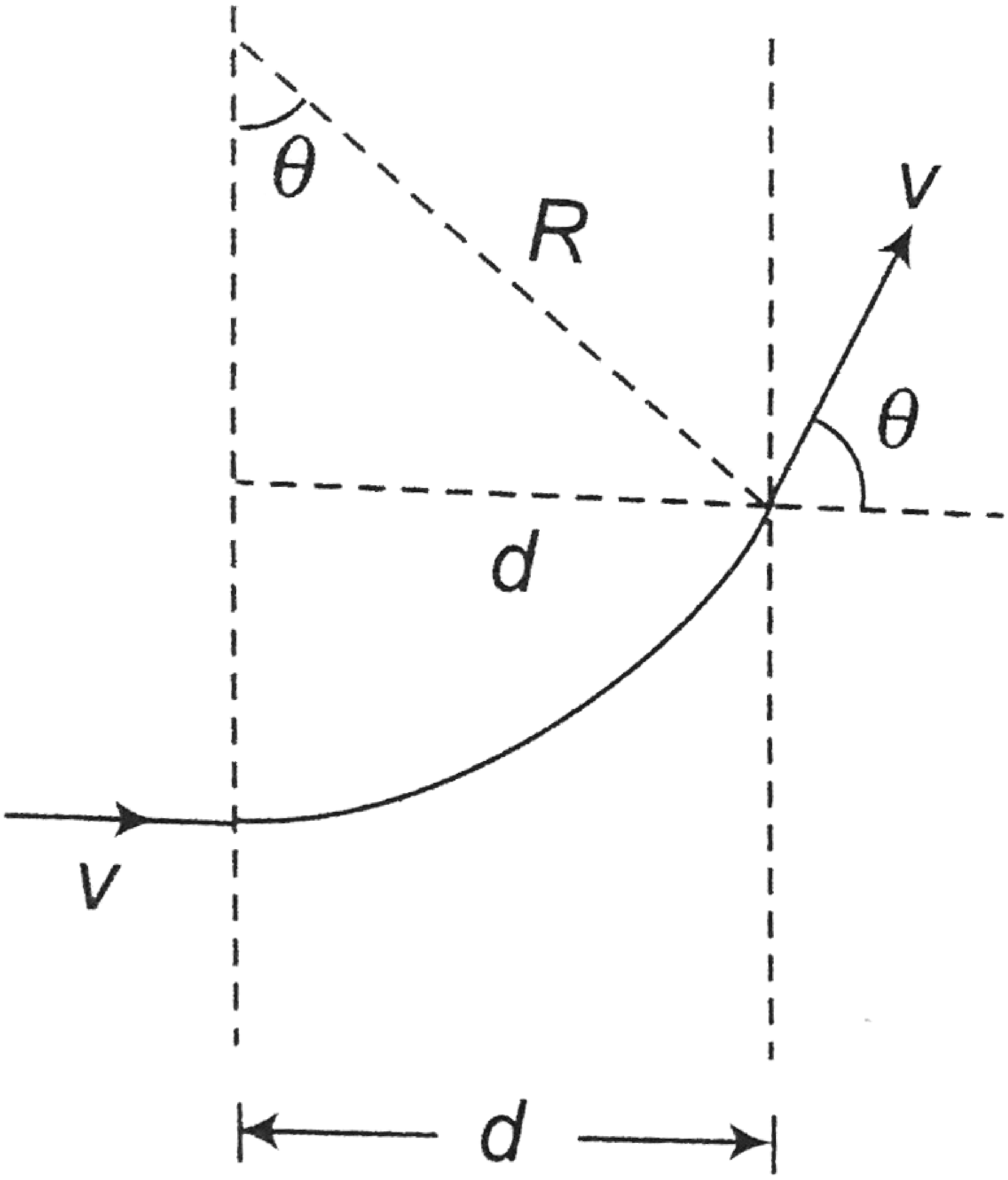
(B) $\sin^{-1}. \frac{Bqv}{md}, \frac{m\theta}{Bq}$

(C) $\cos^{-1}. \frac{Bqd}{mv}, \frac{m\theta}{Bq}$

(D) $\cos^{-1}. \frac{Bqv}{md}, \frac{m\theta}{Bq}$

CORRECT ANSWER: A

SOLUTION:



$$\sin\theta = \frac{d}{R} = \frac{d}{mv/Bq}$$

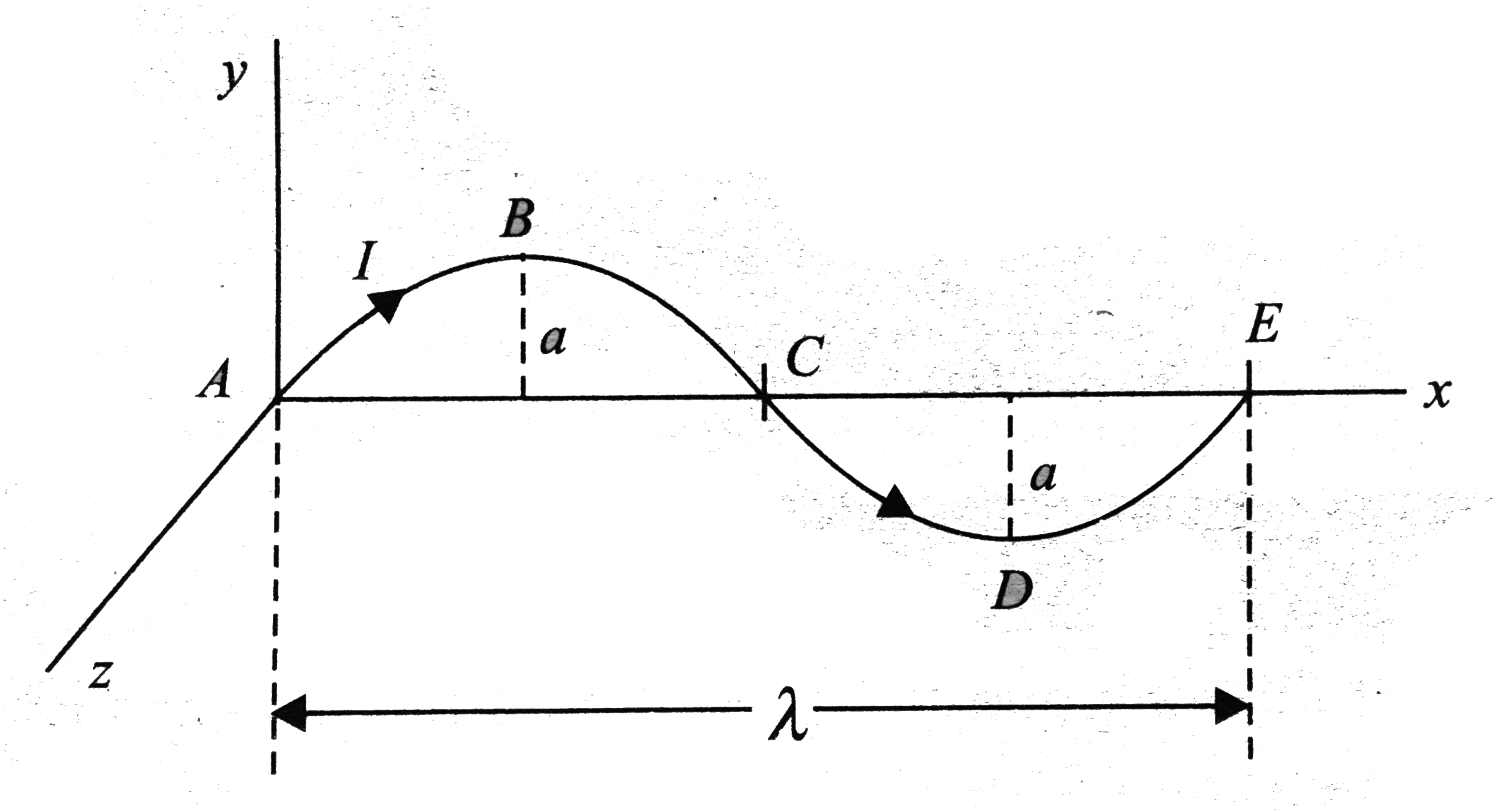
$$= \frac{Bqd}{mv}$$

$$\theta = \sin^{-1}\left(\frac{Bqd}{mv}\right)$$

$$t = \frac{2\pi m}{Bq} \cdot \frac{\theta}{2\pi} = \frac{m\theta}{Bq}$$

Q-54 - 11313980

A conductor ABCDE, shaped as shown, carries current I. It is placed in the x-y plane with the end A and E on the x-axis. A uniform magnetic field of magnitude B exists in the region. The force acting on it will be



(A) zero, if B is in the x-direction

(B) λBI in the z-direction, if B is in the y-direction

(C) λBI in the negative y-direction,if B is in the z-direction

(D) $\lambda a B I$, if B is in the x-direction

CORRECT ANSWER: (A,B,C)

SOLUTION:

To find the Ampere's force on a conductor of any shape,

replace

the conductor by an imagninary straight conductor

joining the

two ends of the given conductor. So, if B is in x-direction,

then

the imaginary staright conductor will be along the field

and the

force acting on it will be zero. If B is in y direction, then

the force

will be $\lambda B I$ acting along the x direction. Similarly, if B is in the

z direction, then the force will be λBI, acting along the

negative

y direction.

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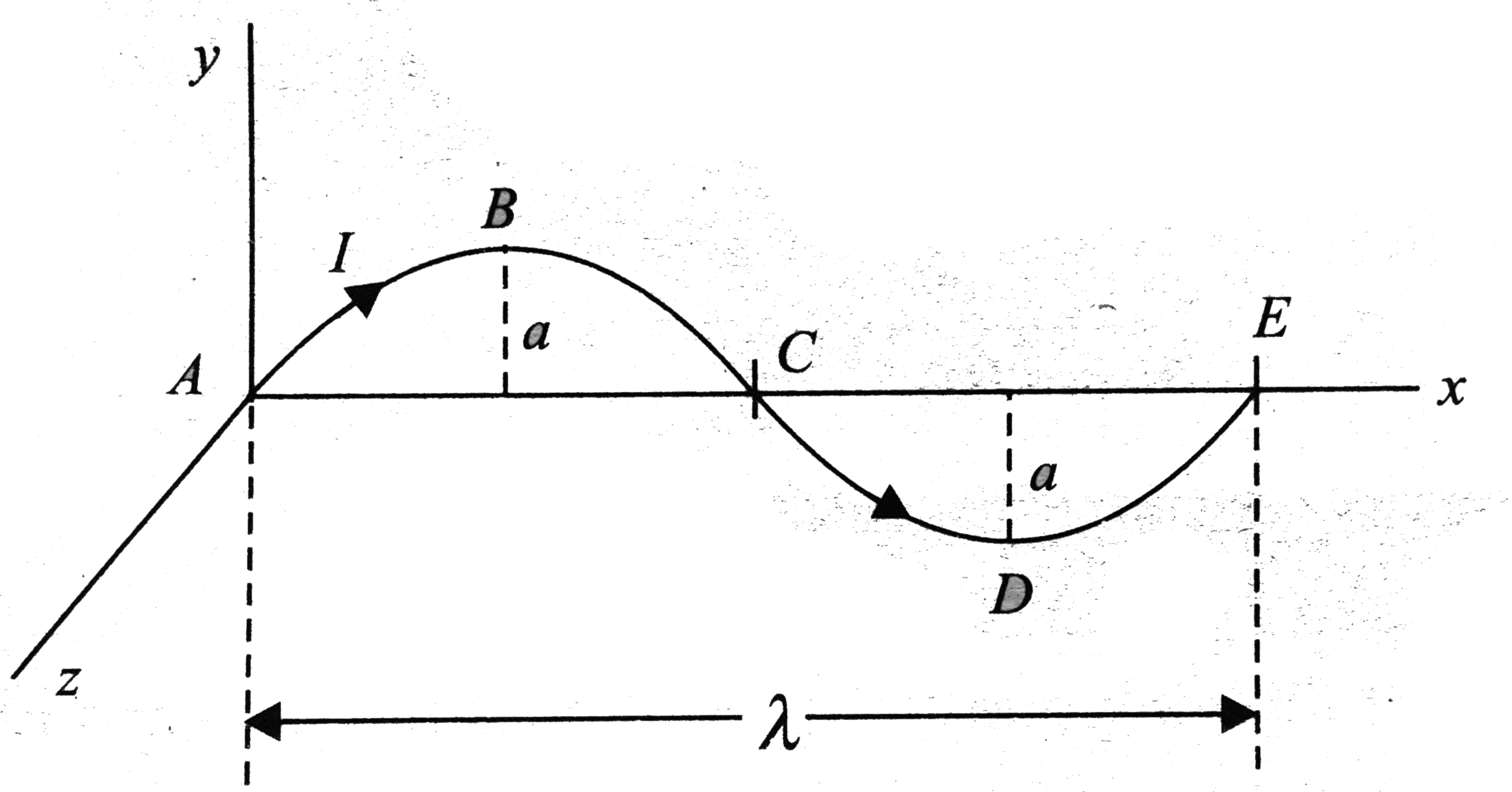
Q-55 - 11313980

A conductor ABCDE, shaped as shown, carries current I. It is placed in the x-y plane with the end A and E on the x-axis. A uniform magnetic field of magnitude B exists in the region. The force acting on it will be



(A) zero, if B is in the x-direction

(B) λBI in the z-direction, if B is in the y-direction

(C) λBI in the negative y-direction,if B is in the z-direction

(D) λaBI, if B is in the x-direction

CORRECT ANSWER: (A,B,C)

SOLUTION:

To find the Ampere's force on a conductor of any shape, replace

the conductor by an imagninary straight conductor joining the

two ends of the given conductor. So, if B is in x-direction, then

the imaginary staright conductor will be along the field and the

force acting on it will be zero. If B is in y direction, then

the force

will be λBI acting along the x direction. Similarly, if B is

in the

z direction, then the force will be λBI, acting along the

negative

y direction.

Q-56 - 13396943

A particle having mass m and charge q is released from the origin

in a region in which electric field and megnetic field are given by

$\overrightarrow{B} = -B_0\hat{j}$ and $\overrightarrow{E} = \overrightarrow{E}_0\hat{k}$. Find the speed of the particle as a

function of its z-coordinate.

CORRECT ANSWER: N/A

SOLUTION:

The magnetic force changes direction of velocity and not its magnitude. The electric force definitely changes velocity, either magnitude or both magnitude and direction. Work is done only by electric force

Let particle be displaced along z-axis by z

Work done by electric force

$$W = \left(qE_0\hat{k}\right).\left(z\hat{k}\right)$$

$$= qE_0z$$

Work done by work energy theorem

$$W = \Delta K$$

$$qE_0z = \frac{1}{2}mv^2 - 0$$

$$v = \sqrt{\frac{2qE_0z}{m}}$$

Note: Magnetic force rotates the particle in plane $\perp^{ar}$

to $\overrightarrow{B}$ axis.

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Q-57 - 14160443

A charge particle is projected in a region of magnetic field and electric field if mass if mass of charged particle is m a its speed charges from V_0 to $2V_0[W_E =$ work done by electric field $W_B =$ work done by magnetic field] which statement is incorrect.?

(A) $W_B = \frac{1}{2}mv_0^2$

(B) $W_B + W_E = \frac{3}{2}mv_0^2$

(C) $W_E = \frac{3}{2}mv_0^2$

(D) $W_E - W_B = \frac{3}{2}mv_0^2$

CORRECT ANSWER: A

SOLUTION:

$$W_B = 0$$
$$W_E = \Delta KE, W_B$$
$$+ W_E = \Delta KE$$

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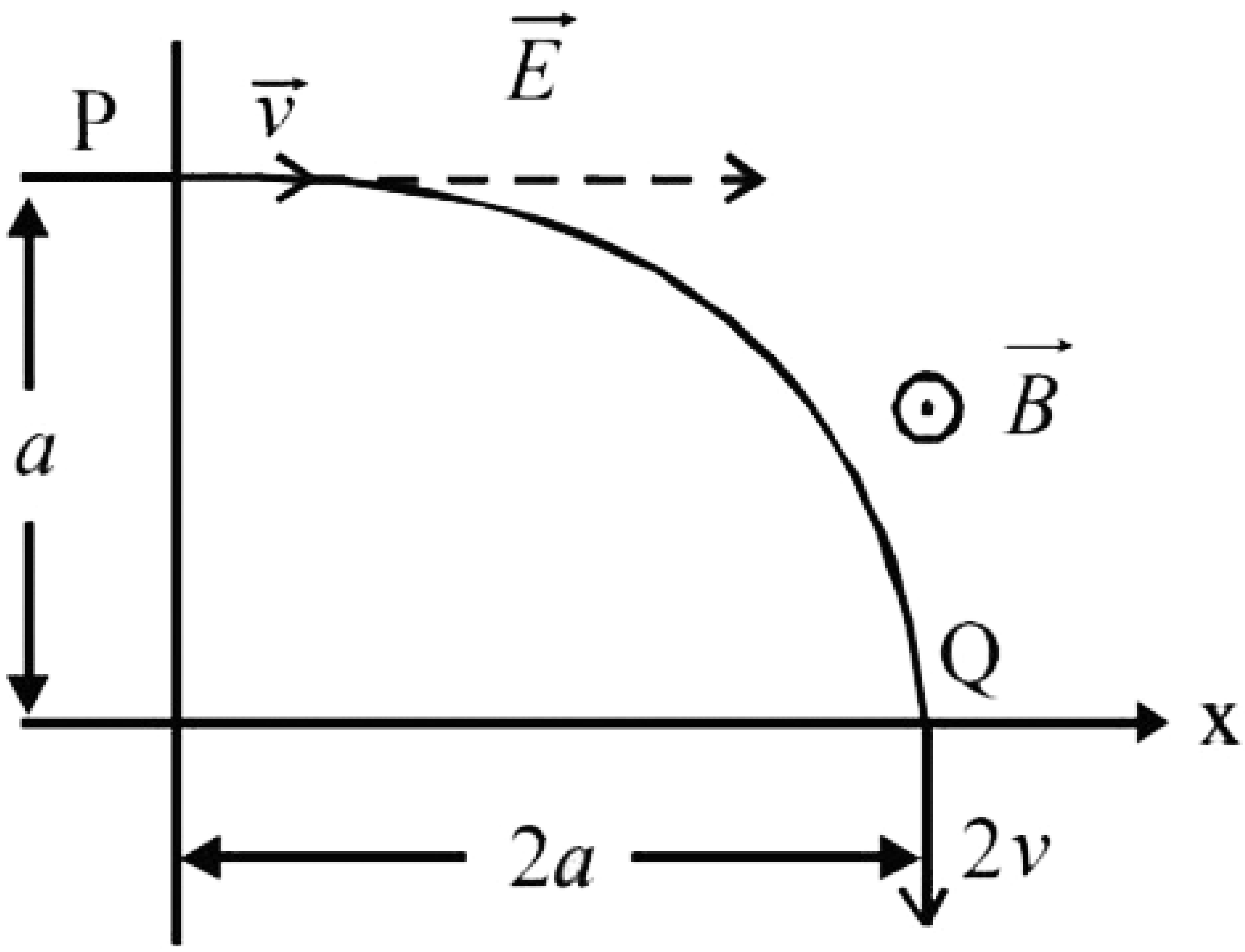
Q-58 - 10059896

A particle of charge $+q$ and mass m moving under the influence of a uniform electric field $E\hat{i}$ and uniform magnetic field $B\hat{k}$ follows a trajectory from $P \rightarrow Q$ as shown in fig. The velocities at P and Q are $v\hat{i}$ and $-2v\hat{j}$. which of the following statement(s) is/are correct ?



(A) $E = \frac{3}{4}\left[\frac{mv^2}{qa}\right]$

(B) Rate of work done by the electric field at P is
$\frac{3}{4}\left[\frac{mv^3}{a}\right]$

(C) Rate of work done by the electric field at p is zero

(D) Rate of work done by the electric field at Q is zero

CORRECT ANSWER: A::B::D

SOLUTION:

Considering the activity from $P \rightarrow Q$ (Horizontal)

$u_1 = v, v_1 = 2v, s_1$
$= 2a, A = A$

rArr $4v^2 - v^2 = 2A(2a)$

rArr $A = \frac{3v^2}{4a}$

Force acting in the horizontal direction is

$F = q^E = mA$

rArr

$E = \frac{mA}{q}$

$= \frac{3}{4}\left[\frac{mv^2}{qa}\right]$

Rate of doing work A P

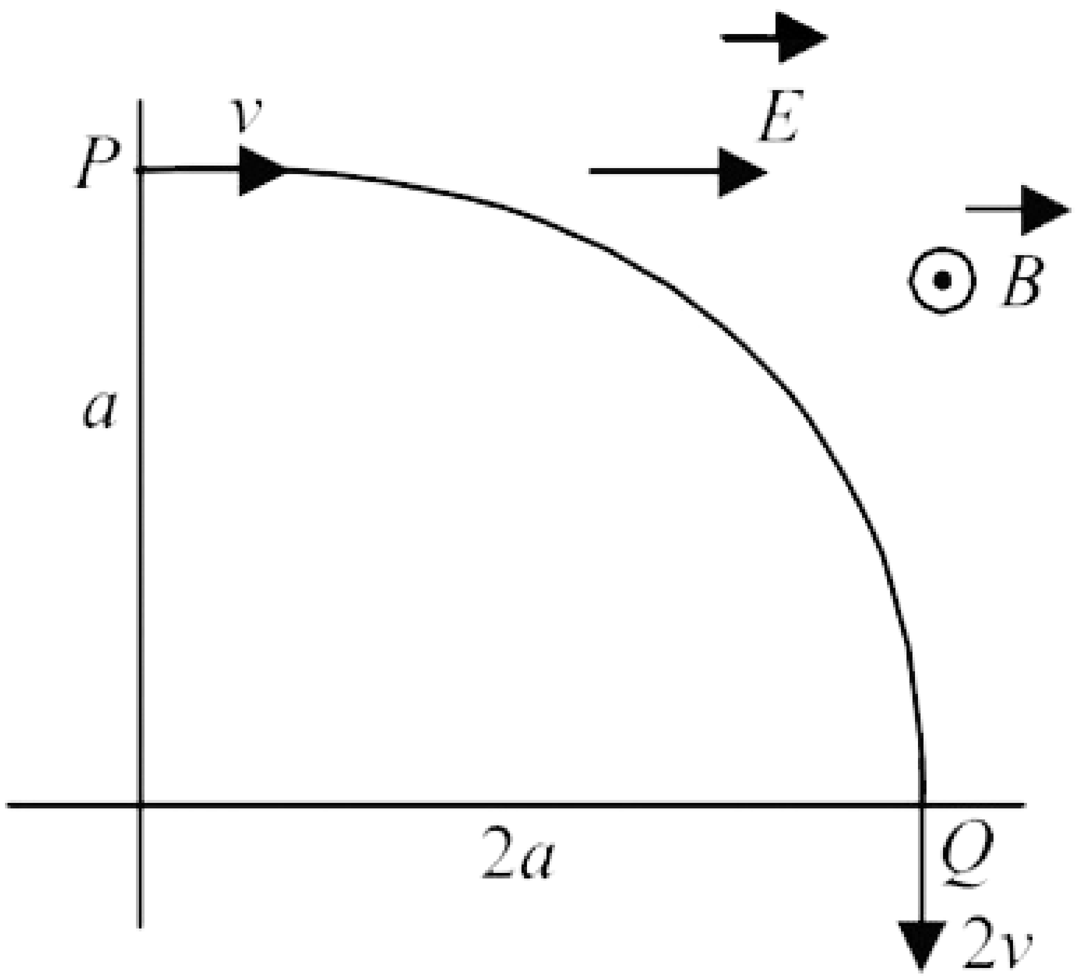
power

$= F \times v = mA \times v$

$= \frac{3}{4}\left[\left(m\frac{v^3}{a}\right]\right.$

Rate of doing work by the magnetic field is throughout zero. The rate of doing work by eletric field is zero at Q .

Because at Q , the angle between force due to electric field and displacement is zero .



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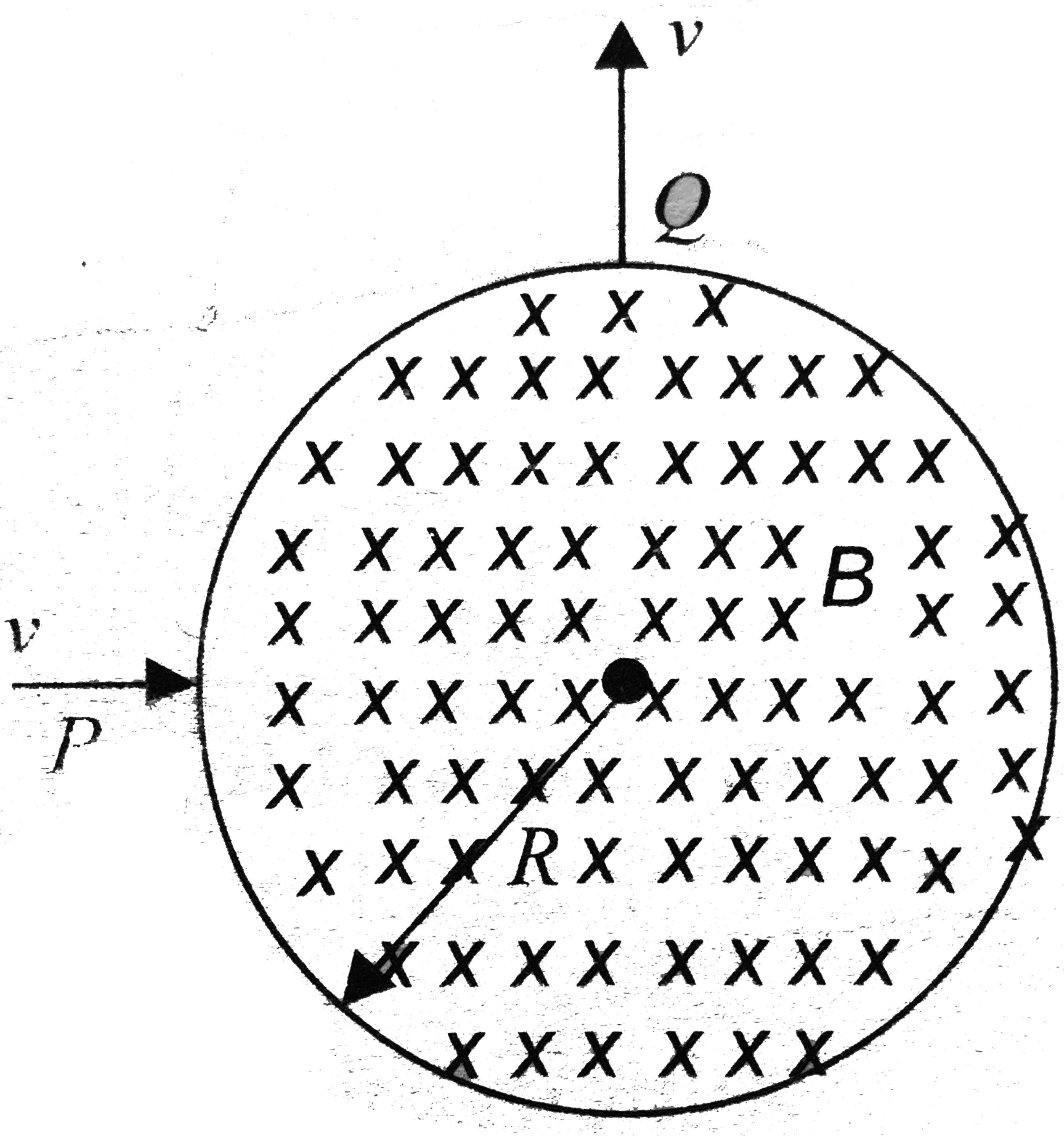
Q-59 - 11313990

A particle of charge q and mass m enters normally (at point P) in a region of magnetic field with speed v. It comes out noramally from Q after time T as shown in Fig. The magnetic field B is present only in the region of radius R and is uniform. Initial and final velocities are along radial direction and they are perpendicular to each other. For this to happen, which of the following expression (s) is are correct?



(A) $B = \dfrac{mv}{qR}$

(B) $T = \dfrac{\pi R}{2v}$

(C) $T = \dfrac{\pi m}{2qB}$

(D) None of these

CORRECT ANSWER: (A,B,C)

SOLUTION:

The particle will move along an arc which

is part of a circle of radius: $r = \frac{mv}{Bq}$

From Fig. we can see that r=R

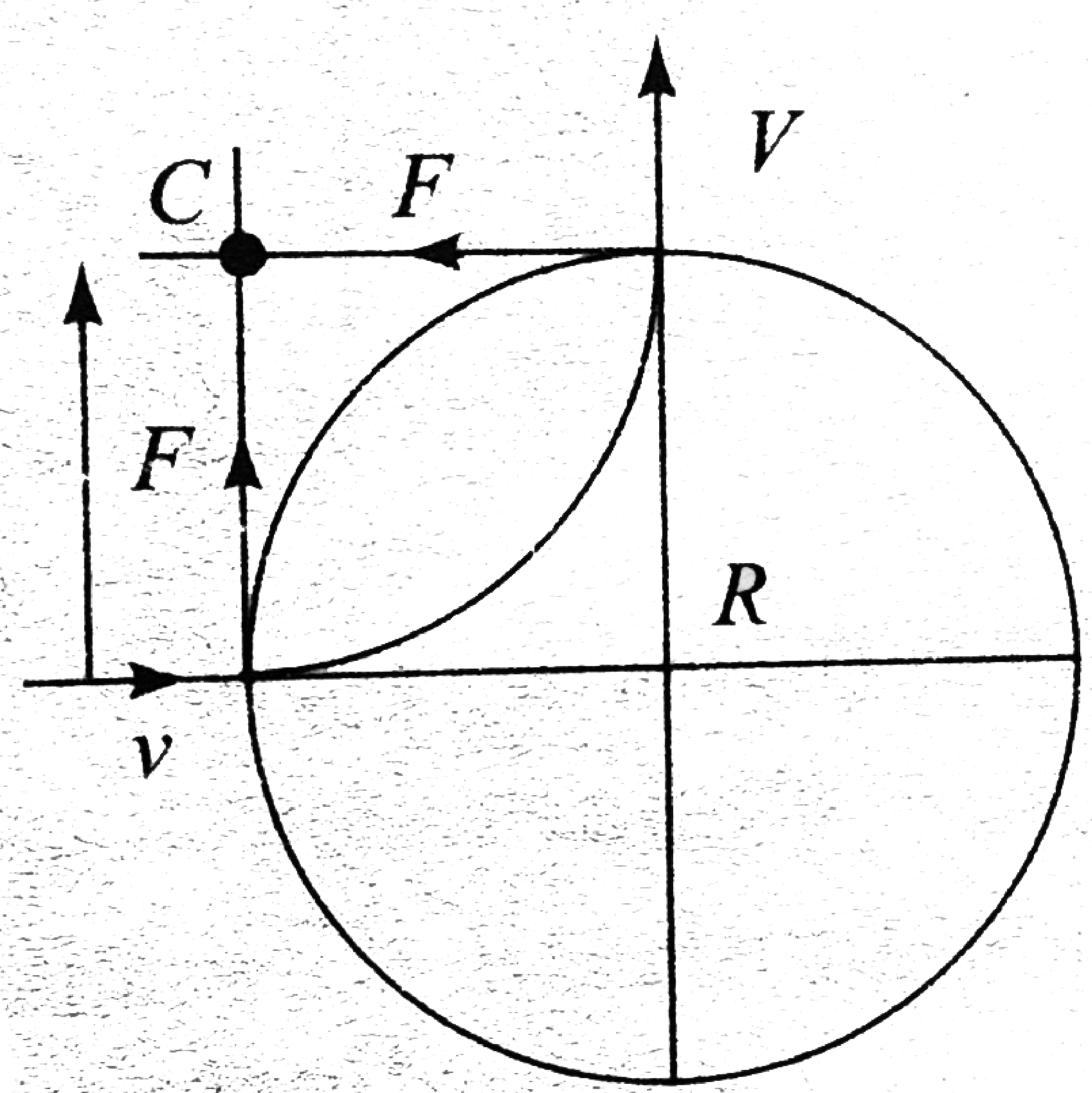
$$\therefore R = \frac{mv}{Bq}$$

$$T = \frac{pr/2}{v} = \frac{\pi r}{2v}$$

$$= \frac{\pi R}{2v}\left(\because r = R\right.$$

$$\left. = \frac{mv}{qB}\right)$$

$$\therefore T = \frac{\pi m}{2Bq}$$


V
C
F
F
R
v