PHYSICS

NEET and JEE Main 2020 : 45 Days Crash Course

Problem Solving Class

(Magnetic Effects of Current and Magnetism)

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A paramagnetic material is placed in a magnetic field. Consider the following statements;

(a) If the magnetic field is increased, the magnetization is increased.

(b) If the temperature is increased, the magnetization is increased

(A) Both (a) and (b) are true.

(B) (a) is true but (b) is false.

(C) (b) is true but (a) is false.

(D) Both (a) and (b) are false.

Ans [B]

If the magnetic field is increased, the magnetization is increased.

$$\text{Magnetization Intensity } \vec{I} = \frac{\text{Magnetic Moment } (\vec{M})}{\text{Volume}}$$

If the temperature is increased, the magnetization is decreased. Because susceptibility of a paramagnetic substance is inversely proportional to the absolute temperature.

Curie's Law, $\chi_m \propto \frac{1}{T}$

$\chi_m = \frac{\vec{I}}{\vec{H}}$, where $\vec{H} = \frac{\vec{B}}{\mu_0} - \vec{I}$

A long, straight wire carries a current **i**. The magnetizing field intensity **H** is measured at a point ‘P’ close to the wire. A long, cylindrical iron rod is brought close to the wire so that the point ‘P’ is at the centre of the rod. The value of **H** at ‘P’ will

(A) increase many times

(B) decrease many times

(C) remain almost constant

(D) become zero

PQ17S18

Ans [C]

$$\vec{H} = \frac{\vec{B}}{\mu_0} = \frac{1}{4\pi}\frac{i\overrightarrow{dl} \times \vec{r}}{r^3}$$

The value of H doesn't depend on magnetic permeability.

The value of H at P will remain almost constant.

PQ17Q19

The magnetic susceptibility is negative for

(A) paramagnetic materials only

(B) diamagnetic materials only

(C) ferromagnetic materials only

(D) paramagnetic and ferromagnetic materials

Ans [B]

The magnetic susceptibility is negative for diamagnetic materials only.

Magnetic susceptibility is –ve for diamagnetic materials and +ve for ferro and para magnetic materials.

PQ17Q25

Which of the following pairs has quantities of the same dimension ?

(A) magnetic field B and magnetizing field intensity H

(B) magnetic field B and intensity of magnetization I

(C) magnetic field intensity H and intensity of magnetization I

(D) longitudinal strain and magnetic susceptibility

PQ17S25

Ans [C]

$$\vec{H} = \frac{\vec{B}}{\mu_0} - \vec{I}$$

Magnetic field intensity H and intensity of magnetization I are quantities of the same dimension.

Same dimension substances are added and subtracted and after adding & subtracting give the same dimension.

So, dimensions of the Magnetic field intensity H and intensity of magnetization I is same.

Longitudinal strain and Magnetic susceptibility are dimensionless quantities.

PQ17Q41

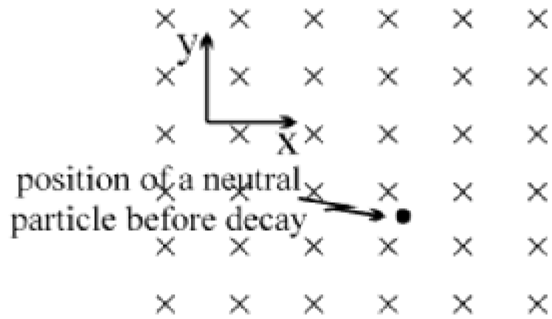
A neutral particle is initially at rest in a uniform magnetic field B as shown in the diagram. The particle then spontaneously decays into two fragments, one with a positive charge +q and mass 3m and the other with a negative charge –q and mass m. Neglecting the interaction between the two charged particles and assuming that the speeds are much less than speed of light, the time after the decay at which the two fragments first meet is [Data : q = 1μC, B = 2π μT, m = 10^{-15} kg Both the charges have initial velocities in x-y plane]

(A) 250 μS

(B) 500 μS

(C) 750 μS

(D) 1000 μS



PQ17S41

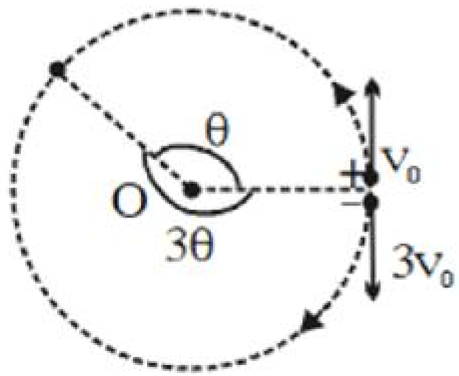
Ans [C]

$r = \frac{p}{qB}$ = same, $T_+ = \frac{2m_+\pi}{qB} = \frac{6\pi m}{qB}$, $T_- = \frac{2\pi m}{qB}$

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

as $T_+ = 3T_-$, They will meet at $\theta = \pi/2$

$q = 1\ \mu C$, $B = 2\pi \mu T$, $m = 10^{-15}$ kg



The time is $= \frac{T_+}{4} = \frac{6\pi m}{4qB} = \frac{6 \times \pi \times 10^{-15}}{4 \times 1 \times 10^{-6} \times 2\pi \times 10^{-6}}$

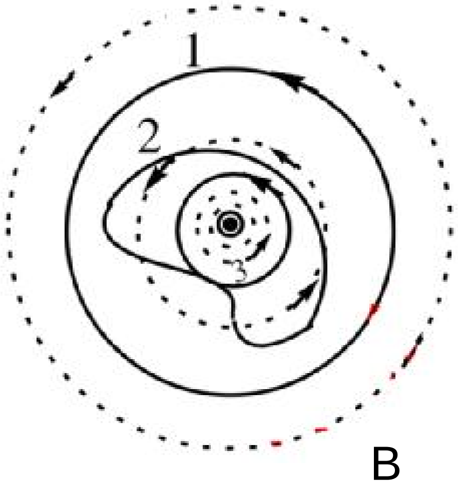
$= 0.75 \times 10^{-3}$ S = 750 μS

Because F_B always points toward the center of the circle, it changes only the direction of v and not its magnitude.

centrifugal force è $\frac{mv^2}{r} = m\frac{d\mathbf{v}}{dt} = q(\mathbf{v} \times \mathbf{B}) \Rightarrow R = \frac{mv}{qB_{\pm}}$

Direction of *centrifugal force along* ($\mathbf{v} \times \mathbf{B}$)

Consider three closed loops drawn using solid line in the magnetic field (magnetic field lines are drawn using dotted line) of an infinite current-carrying wire normal to the plane of paper as shown. If a , b and c represent the values of line integrals of the magnetic field along the paths 1, 2 and 3 respectively, then



(A) a > b > c

(B) a = c > b

(C) a = b =c

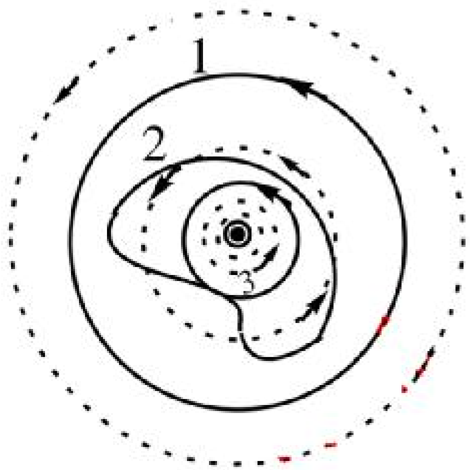
(D) c > b > a

PQ17S43

Ans [C]

$$\oint \vec{B}\, d\vec{l} = \mu_0 I_{enclosed}$$

Ampere's law
$\Sigma B\, \Delta l = \mu_0 I_{enclosed}$



Since $I_{enclosed}$ is same for all loop 1,2,3 magnetic field is same in all.

PQ17Q49

A plastic disc of radius R has a charge q uniformly distributed over its surface. If the disc is rotated with a frequency f about its axis, then the magnetic induction at the center of the disc is given by

(A) $\frac{\mu_0 fq}{R}$

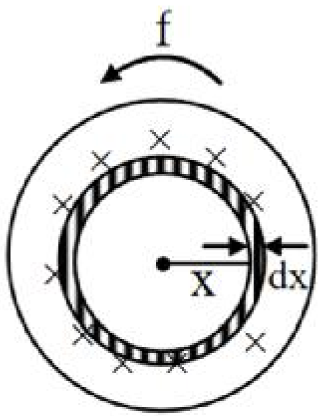
(B) $\frac{\mu_0 fq}{2\pi R}$

(C) $\frac{\mu_0 q}{fR}$

(D) $\frac{\mu_0 f}{qR}$

PQ17S49

Ans [A]



Charge of element at ring $dq = \sigma(2\pi x dx)$

A **charged** particle **moving** without acceleration **produces** an electric as well as a **magnetic field**

$$dB = \frac{\mu_0 dI}{2x} \Rightarrow dB = \frac{\mu_0}{2x}\frac{dq\,\omega}{2\pi}$$

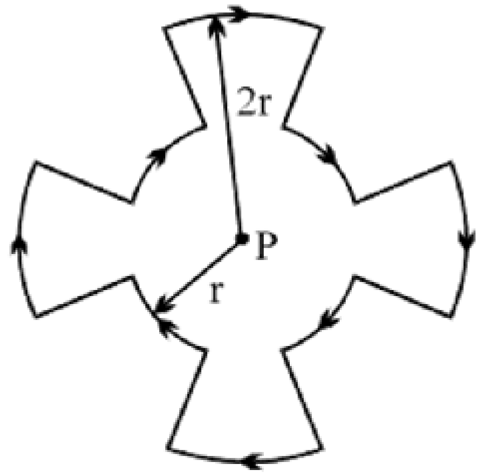
$dI = \frac{dq}{dt}$

$$B = \int dB = \frac{\mu_0 \omega}{4\pi}\int_0^R \frac{\sigma 2\pi x dx}{x}$$

For ring on its center $B = \frac{\mu_0 I}{2r}$

$$B = \frac{\mu_0 \omega \sigma R}{2} = \frac{\mu_0 2\pi f q R}{2\pi R^2} = \frac{\mu_0 q f}{R}$$

A current I flows around a closed path in the horizontal plane of the circle as shown in the figure. The path consists of eight arcs with alternating radii r and 2r. Each segment of arc subtends equal angle at the common center P. The magnetic field produced by current path at point P is $\frac{n\mu_0 I}{8r}$. Value of n is given by



(A) Zero (B) 2

(C) 4 (D) 3

PQ17S50

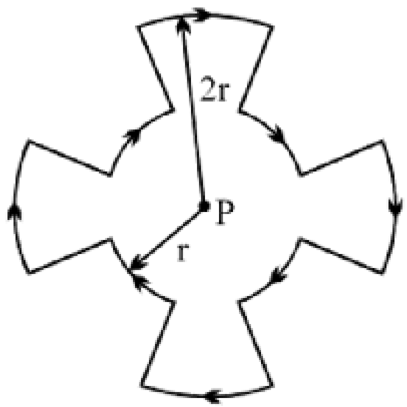
Ans [D]

$$B = \frac{\mu_0}{4\pi}\frac{I}{2r} \times \pi + \frac{\mu_0}{4\pi}\frac{I}{r} \times \pi = \frac{\mu_0 I}{4r}\left[\frac{1}{2}+1\right]$$

$$= \frac{3}{8}\frac{\mu_0 I}{r} \odot$$

For arc on its center B= $\frac{\mu_o I}{2r}\frac{\theta}{2\pi}$

Direction along Id**l** x **r**



The Biot–Savart law is used for computing the resultant magnetic field **B** at position **r** generated by a *steady* current I.

$$\mathbf{B}(\mathbf{r}) = \frac{\mu_0}{4\pi}\int_C \frac{I d\mathbf{l} \times \hat{\mathbf{r}}'}{|\mathbf{r}'|^2}$$

PQ17Q53

A current I flows along the length of an infinitely long, straight, **thin-walled pipe**. Then the magnetic field

(A) At all points inside the pipe is the same, but not zero.

(B) At any point inside the pipe is zero.

(C) Is zero only on the axis of the pipe.

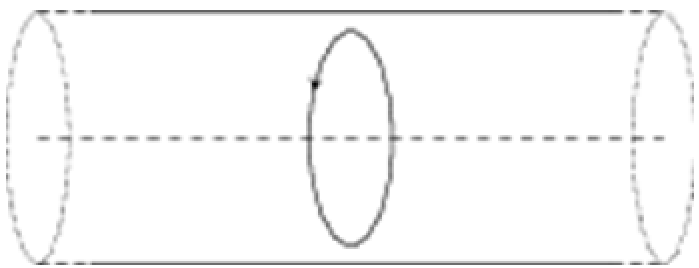
(D) Is different at different points inside the pipe.

Ans [B]

By symmetry, the magnetic field inside the pipe is circumferential. Take a circular loop of radius r with centre along the axis of the pipe. By symmetry, the **magnitude of magnetic field is same throughout the loop**. Since $I_{enc} = 0$, by Ampere's law we get $B = 0$ for all r. Thus, $B = 0$ inside the pipe.

Ampere's Law :-

$\oint \vec{B} \cdot d\vec{l} = B(2\pi r) = \mu_0 I_{enc}$



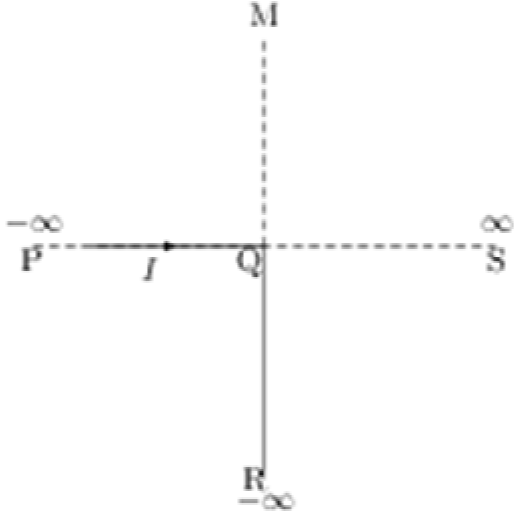
An infinitely long conductor PQR is bent to form a right angle. A current I flows through PQR. The magnetic field due to this current at the point M is B_1. Now, another infinitely long straight conductor QS is connected at Q, so that current is $I/2$ in QR as well as in QS, the current in PQ remaining unchanged. The magnetic field at M is now B_2. The ratio B_1/B_2 is given by

(A) 1/2

(B) 1

(C) 2/3

(D) 2



PQ17S56

Ans [C]

In first case, the field at the point M by part PQ, part QR, and total field are given by

$$B_{PQ} = \frac{\mu_0 I}{4\pi d}(\cos 0 - \cos 90) = \frac{\mu_0 I}{4\pi d},$$

$$B_{PQ} = \frac{\mu_0 I}{4\pi d}(\cos 180 - \cos 90) = 0,$$

$$B_1 = B_{PQ} + B_{QR} = \frac{\mu_0 I}{4\pi d}$$

In second case, the field at M by part PQ and part QR remains same as in first case. The field by part QS and total field are given

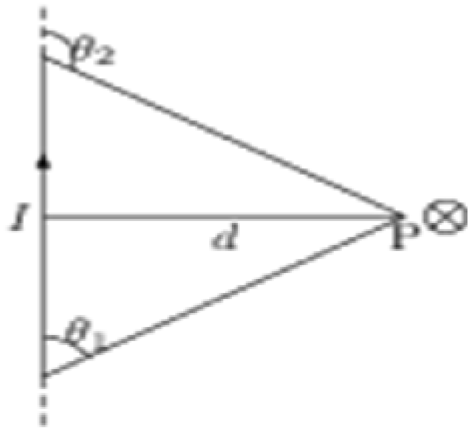
by, $B_{QS} = \frac{\mu_0\left(\frac{I}{2}\right)}{4\pi d}(\cos 90 - \cos 180) = \frac{\mu_0 I}{8\pi d}$,

$$B_2 = B_{PQ} + B_{QR} + B_{QS} = \frac{3}{2}\frac{\mu_0 I}{4\pi d}$$

Magnetic field - current carrying wire:-

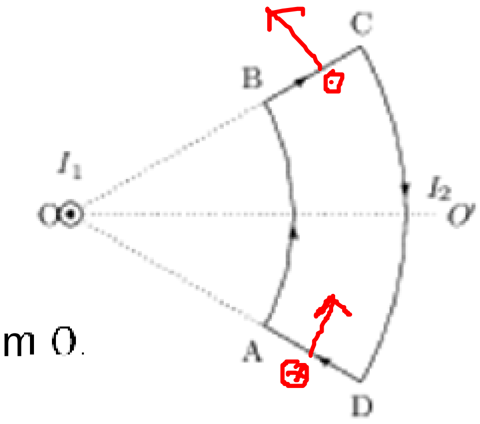
$$B = \frac{\mu_0 I}{4\pi d}(\cos\theta_1 - \cos\theta_2)$$

Magnetic field along the axis of current carrying wire is **zero**



PQ17Q57

An infinitely long wire carrying current I_1 passes through O and is perpendicular to the plane of paper. Another current carrying loop $ABCD$ lies in plane of paper as shown in figure. Which of the following statement(s) is (are) correct?



(A) Net force on the loop is zero.

(B) Net torque on the loop is zero.

(C) Loop will rotate clockwise about axis OO' when seen from O.

(D) Loop will rotate anticlockwise OO' when seen from O'.

PQ17S57

Ans [A]

The magnetic field $\vec{B}$ by the current I_1 is circumferential. For each element $d\vec{l}$ on the branch AB, $\vec{B}$ is parallel to the current direction making the force,

$\vec{F}_{AB} = \int_A^B I_2 \overrightarrow{dl} \times \vec{B} = 0$ For the branch CD, $\vec{B}$ is anti-parallel to $d\vec{l}$.

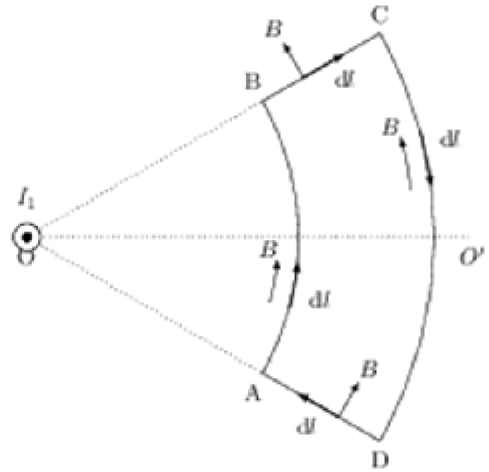
Thus, total force on branch CD is $\vec{F}_{CD} = 0$.

For the branch BC, $\vec{B}$ is perpendicular to $\vec{dl}$, and $\vec{dl} \times \vec{B}$ is coming out of the paper making $\vec{F}_{BC}$ = FBC⊙, where FBC is the magnitude of force. For the branch DA, $\vec{dl} \times \vec{B}$ is going into the paper making $\vec{F}_{DA} = F_{DA} \otimes$, where F_{DA} is the magnitude of force.

By symmetry, $\vec{F}_{BC} = -\vec{F}_{DA}$. Thus, net force acting on ABCDA is zero.

However, there is non-zero clockwise (when looking from O) torque that rotates the loop in clockwise direction because

$$F_{magnetic} = i \int_a^b d\vec{l} \times \vec{B}$$



$\vec{F}_{BC}$ & $\vec{F}_{DA}$ are couple forces

PQ17Q59

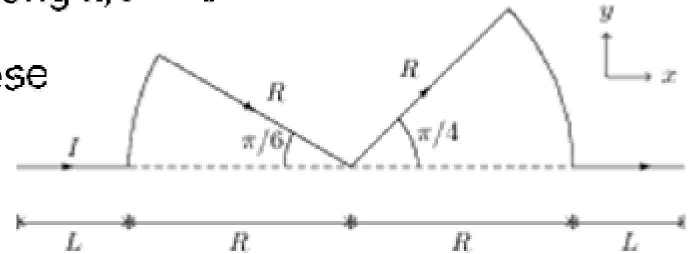
A conductor carrying constant current I is kept in the $x - y$ plane in a uniform magnetic field $\vec{B}$. If F is the magnitude of the total magnetic force acting on the conductor, then the correct statement(s) is (are),

(A) If $\vec{B}$ is along $\hat{z}$, $F \propto (L + R)$

(B) If $\vec{B}$ is along $\hat{x}$, $F = 0$

(C) If $\vec{B}$ is along $\hat{y}$, $F \propto (L + R)$

(D) All of these



PQ17S59

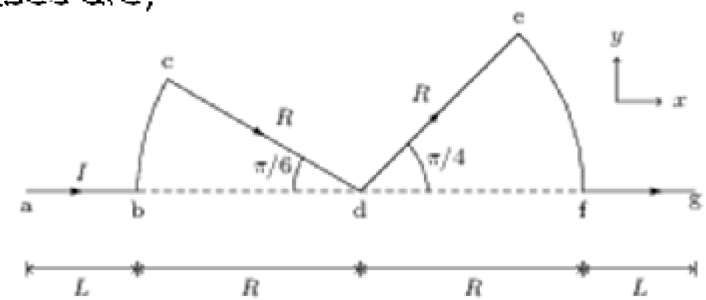
Ans [D]

The force on a conducting element of length $\vec{dl}$ carrying a current I in a magnetic field $\vec{B}$ is given by $d\vec{F} = I\vec{dl} \times \vec{B}$ If the field is uniform, then the total force on the conductor is given by

$$\hat{F} = \int_a^g I\,\vec{dl} \times \vec{B} = I\left(\int_a^g \vec{dl}\right) \times \vec{B} = I\,\overrightarrow{ag} \times \vec{B}$$

Note that $\vec{B}$ is taken out of the integral because it is constant. The vector $\overrightarrow{ag} = 2(L + R)\hat{x}$

The magnetic force on the conductor in the given cases are,



Case (A): $\vec{F} = I(2(L + R)\,\hat{x}) \times (B\hat{z}) = -2IB(L + R)\,\hat{y}$

Case (B): $\vec{F} = I(2(L + R)\,\hat{x}) \times (B\hat{x}) = 0,$

Case (C): $\vec{F} = I(2(L + R)\,\hat{x}) \times (B\hat{y}) = 2IB(L + R)\hat{z}$

Magnetic force on current carrying wire always depends on displacement from start to end of the wire not on its shape.

PQ17Q62

A particle of charge q and mass m moves in a circular orbit of radius r with angular speed ω. The ratio of the magnitude of its magnetic moment to that of its angular momentum depends on

(A) ω and q

(B) ω, q and m

(C) q and m

(D) ω and m

PQ17S62

Ans [C]

The angular momentum of the charge of mass mm moving in a circular orbit of radius r with angular speed ω is given by $L = m\omega r^2$. The charge q takes time $T = 2\pi/\omega$ to complete one rotation. The average current in the loop and its magnetic moment are given by,

M = NiA , L = mωr²

$$i = \frac{q}{T} = \frac{q\omega}{2\pi}, M = i \quad = \frac{q\omega}{2\pi}\pi \quad ^2 = 12q\omega r^2.$$

$\frac{M}{L} = \frac{q}{2m}$ hence it depends only on q, m

Thus, ratio of magnetic moment and angular momentum, $\frac{M}{L} = \frac{q}{2m}$, depends on $q \ a \quad d \ m$. The ratio is independent of dynamics parameters i.e., ω and r. This ratio for an electron (charge e, mass m) defines Bohr Magneton, $\mu \quad = \frac{h}{2\pi}\frac{M}{L} = \frac{eh}{4\pi m_e}$, a physical constant.

A moving coil galvanometer of resistance $100\ \Omega$ is used as an ammeter using a resistance 0.1Ω. The maximum deflection current in the galvanometer is $100\ \mu A$. Find the current in the circuit, so that the ammeter shows maximum deflection,

(A) 100.1 mA

(B) 1000.1 mA

(C) 10.01 mA

(D) 1.01 mA

PQ17S64

Ans [A]

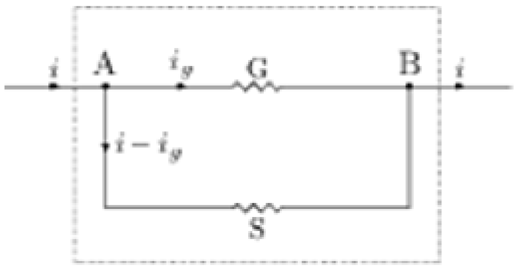
A galvanometer of resistance G is converted to an ammeter by connecting a small shunt resistance S in parallel. Kirchhoff's loop law gives,

$$i_g G - (i - i_g)S = 0, \Rightarrow i = \frac{i_g(G + S)}{S}.$$

Use Kirchhoff's loop law

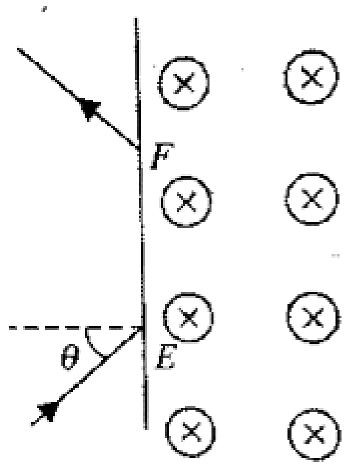
The maximum deflection current of galvanometer sets upper limit on the current measured by this ammeter. Substitute the values to get,

$i = ig(G + S)/S = (100 \times 10^{-6})((100 + 0.1)/0.1)) = 100.1\text{mA}.$



PQ17Q67

How long does the particle stay inside the magnetic field. (T is the time period of one full revolution)



(A) $t = T\left(\dfrac{\pi - 2\theta}{2\pi}\right)$

(B) $t = T\left(\dfrac{2\pi - 3\theta}{6\pi}\right)$

(C) $t = T\left(\dfrac{\pi - 2\theta}{4\pi}\right)$

(D) $t = T\left(\dfrac{\frac{\pi}{2} - \theta}{\pi}\right)$

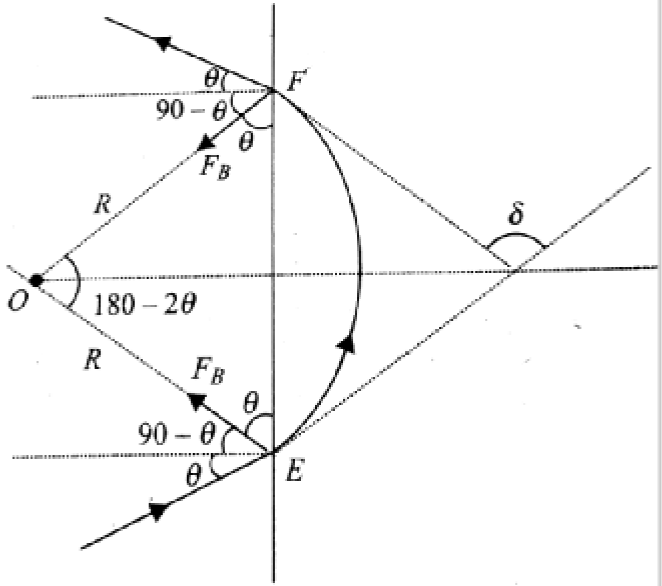
PQ17S67

Ans [A]

The length of the arc traced by the particle, $l = R(\pi - 2\theta)$

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

Time spent in the field, $t = \frac{l}{v} = \frac{R(\pi - 2\theta)}{v} = \frac{m}{Bq}(\pi - 2\theta)$



$$t = \frac{T}{2\pi}(\pi - 2\theta)$$

Time period:

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

This result can be generalized. If ∅ is the angle subtended by the arc traced by the charged particle in the magnetic field, the spent is $t = T\left(\frac{\emptyset}{2\pi}\right)$

PQ17Q77

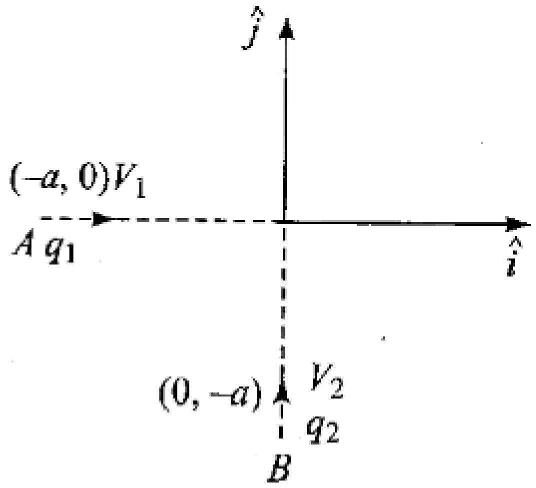
Two positive charges $q_1\ a\ \ d\ q_2$ are moving with velocities $v_1\ a\ \ d\ v_2$ when they are at points A and B, respectively, The magnetic force experienced by charge q_1 due to the other charge q_2 is

(A) $\frac{\mu_0 q_1 q_2 v_1 v_2}{8\sqrt{2}\pi a^2}$

(B) $\frac{\mu_0 q_1 q_2 v_1 v_2}{4\sqrt{2}\pi a^2}$

(C) $\frac{\mu_0 q_1 q_2 v_1 v_2}{2\sqrt{2}\pi a^2}$

(D) $\frac{\mu_0 q_1 q_2 v_1 v_2}{\sqrt{2}\pi a^2}$



Ans [A]

$\vec{r} = -a\hat{i} + a\hat{j}$

Magnetic field at A due to B:

$$\frac{\mu_0}{4\pi} q \frac{\vec{v} \times \vec{r}}{r^3} = \frac{\mu_0 q_2 v_2}{8\sqrt{2}\pi a^2} \hat{k}$$

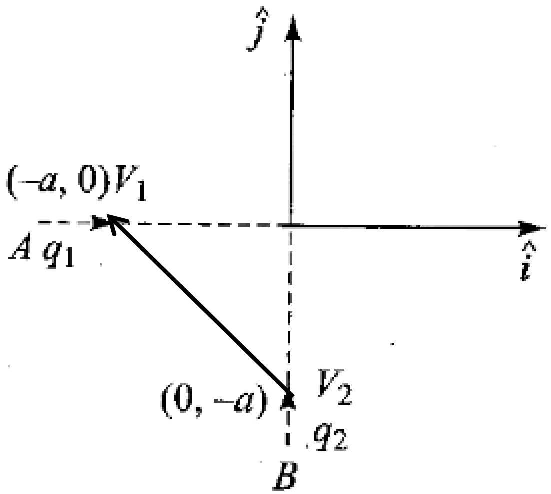
Force on A:

$$\hat{F} = -\frac{\mu_0 q_1 q_2 v_1 v_2}{8\sqrt{2}\pi a^2} \hat{j}$$

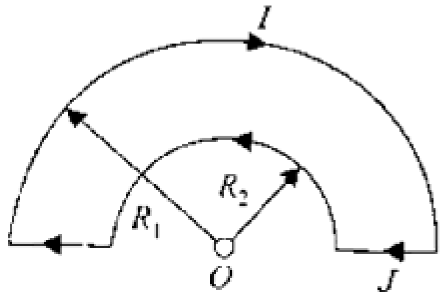
Magnetic field of moving point charge:

$$\vec{B} = \frac{\mu_0}{4\pi} q \frac{\vec{v} \times \vec{r}}{r^3}$$

$$\hat{F} = q(\hat{v} \times \hat{B})$$



Compute the magnitude of magnetic dipole moment of the loop



(A) $\frac{\pi I}{2}(R_1^2 + R_2^2)$

(B) $\frac{\pi I}{2}(R_1^2 - R_2^2)$

(C) $\frac{\pi I}{2}(R_2^2 - R_1^2)$

(D) $\frac{\pi I}{2}(R_1 - R_2)^2$

Ans [B]

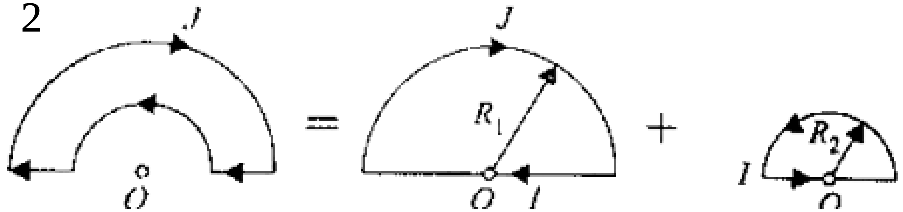
The given loop may be considered as the **superposition of the two loops**,

Magnetic moment of closed loop in a plane:

$M = iA$

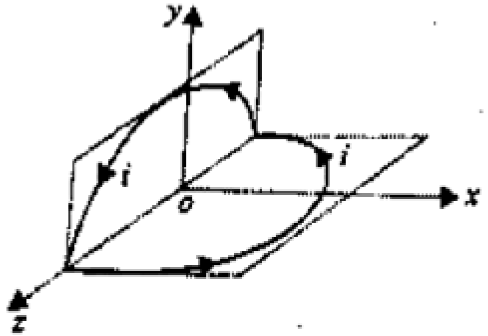
The resultant dipole moment is $M = \frac{\pi R_1^2 I}{2} - \frac{\pi R_2^2 I}{2}$

or $M = \frac{\pi I}{2}(R_1^2 - R_2^2)$ (inward)



PQ17Q80

A circular loop of wire of radius R is bent about its diameter along two mutually perpendicular planes. If the loop carries a current I, then determine its magnetic moment.



(A) $\frac{\pi R^2 I}{2}(\hat{i} + \hat{j})$ (B) $\frac{\pi R^2 I}{2}(\hat{i} - \hat{j})$

(C) $\frac{\pi R^2 I}{4}(\hat{i} + \hat{j})$ (D) $\frac{\pi R^2 I}{4}(-\hat{i} + \hat{j})$

Ans [A]

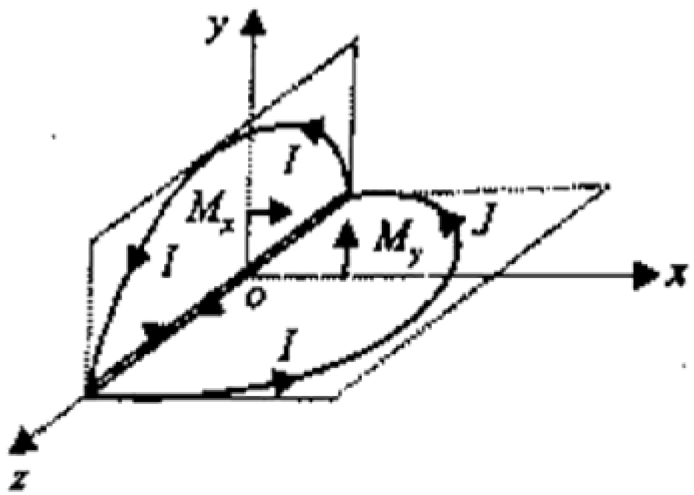
The given loop may be obtained by the superposition of two semicircular loops.

The magnetic moment of the semicircle in the $y - z$ plane is along the $x - axis$ and that in the $x - z$ plane is along the $y - axis$.

$$M = \frac{\pi R^2 I}{2}(\hat{i} + \hat{j})$$

Magnetic moment of closed loop in a plane:

$$M = iA$$



A conductor of length l is placed perpendicular to a horizontal uniform magnetic field B. Suddenly, a certain amount of charge is passed through it, and it is found to jump to a height h. The amount of charge through the conductor is

(A) $\frac{m\sqrt{gh}}{Bl}$

(B) $\frac{m\sqrt{gh}}{2Bl}$

(C) $\frac{m\sqrt{2gh}}{Bl}$

(D) None of these

Ans [C]

Linear impulse = mv

or $F\Delta t = m\sqrt{2gh}$ or $(ilB)\,\Delta t = m\sqrt{2gh}$

But, $i\Delta t = \Delta q$

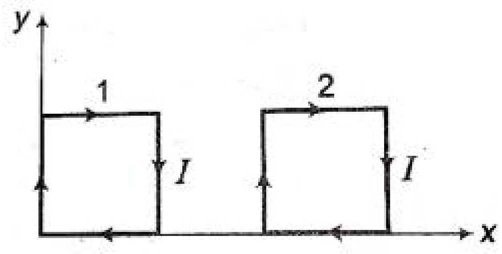
$\therefore (\Delta q)\,(lB) = m\,\sqrt{2gh}$

Hence, $\Delta q = \dfrac{m\sqrt{2gh}}{Bl}$

The impulse on wire due to magnetic field should give the wire a velocity of $\sqrt{2gh}$

PQ17Q86

Magnetic field in a region is given by $B = B_0 x\hat{K}$. Two loops each of side a is placed in this magnetic region in the xy-plane with one of its sides on x-axis. If F_1 is the force on the loop 1 and F_2 be the force on loop 2, then



(A) $F_1 = F_2 = 0$

(B) $F_1 > F_2$

(C) $F_2 > F_1$

(D) $F_1 = F_2 \neq 0$

Ans [D]

Force on the wires parallel to x-axis will be obtained by integration (as $B \propto x$ and x coordinates vary along these wires). But on a loop there are two such wires. Force on them will be equal and opposite. Forces on two wires parallel to y-axis can be obtained directly (without integration) as value of B is same along these wires. But their values will be different (as x-coordinates and therefore B is different).

$F_{net} = \Delta F$ (on two wires)

$= Ia\,(\Delta B) = Ia(B_0)(\Delta x)$

$= Ia\,B_0(a) = IB_0a^2$

This is indecent of x

$\therefore F_1 = F_2 = IBla^2 \neq 0$

Force on the wires parallel to x-axis will cancel out, while net force on wires of the loop ⊥ to x-axis will be equal to $B_0 I(x_2 - x_1) = B_0 Ia$

PQ17Q89

A charge q is uniformly distributed on a non-conducting disc of radius R. It is rotated with an angular speed ω about an axis passing through the centre of mass of the disc and perpendicular to its plane. Find the magnetic moment of the disc.

(A) $\frac{qR^2\omega}{2}$

(B) $\frac{3qR^2\omega}{2}$

(C) $\frac{qR^2\omega}{4}$

(D) $\frac{3qR^2\omega}{8}$

PQ17S89

Ans [C]

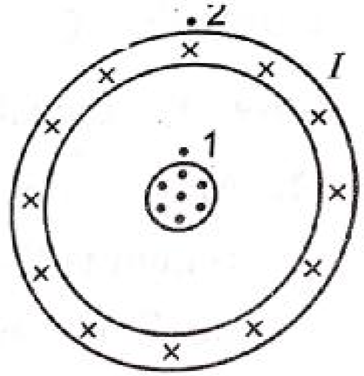
$$\because \frac{M}{L} = \frac{q}{2m}$$

$$\because M = \left(\frac{q}{2m}\right) L = \left(\frac{q}{2m}\right)(I\omega)$$

$$= \left(\frac{q}{2m}\right)\left(\frac{1}{2}mR^2\right)(\omega) = \frac{qR^2\omega}{4}$$

For any charge distribution : Magnetic moment $= \left(\frac{q}{2m}\right)$ (angular momentum)

The figure shows the cross- section of two long coaxial tubes carrying equal currents I in opposite directions. If B_1 and B_2 are magnetic fields at points 1 and 2 as shown in figure then



(A) $B_1 \neq 0; B_2 = 0$

(B) $B_1 = 0; B_2 = 0$

(C) $B_1 \neq 0; B_2 \neq 0$

(D) $B_1 = 0, B_2 \neq 0$

PQ17S90

Ans [A]

At distance r from centre.

$$B_C = \frac{\mu_0}{2\pi}\frac{(I_{in})}{r} \quad \text{(from Ampere's ciruital law)}$$

$$\oint \vec{\ }.\overrightarrow{dl} = \mu_0 I_{in}$$

For path -1, $I_{in} \neq 0$

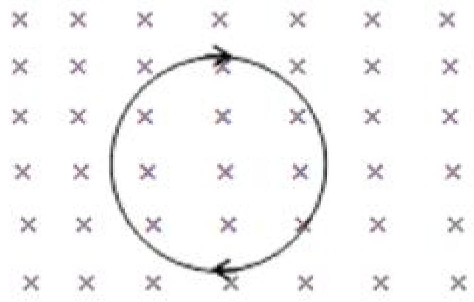
$\therefore \quad B_1 \neq 0$

For path -2, $I_{in} = 0$

$\therefore B_2 = 0$

PQ17Q169

A circular coil carrying current I is placed in a region of uniform magnetic field acting perpendicular to plane of the coil as shown in the figure. Mark correct option –



[IIT-2003]

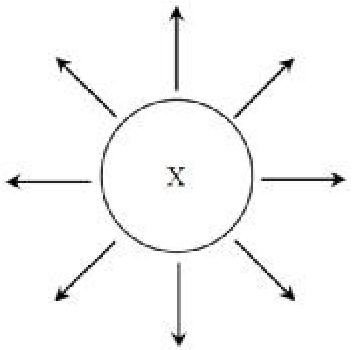
(A) the coil will expand

(B) the coil will contract

(C) the coil will move in positive x-direction

(D) the coil will move in negative x-direction

Ans [A]



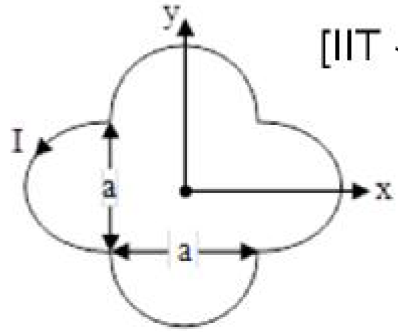
Force due to magnetic field :: $\vec{F} = q\vec{v} \times \vec{B}$

coil will expand.

PQ17Q179

A loop carrying current I lies in the x-y plane as shown in the figure. The unit vector is coming out of the plane of the paper. The magnetic moment of the current loop is -

[IIT -2012]



(A) $a^2I\hat{k}$

(B) $\left(\frac{\pi}{2}+1\right)a^2I\hat{k}$

(C) $-\left(\frac{\pi}{2}+1\right)a^2I\hat{k}$

(D) $(2\pi+1)a^2I\hat{k}$

Ans [B]

$$M = I \times \text{Area of loop } \hat{k}$$

$$= I \times \left[a^2 + \frac{\pi a^2}{4 \times 2} \times 4\right]\hat{k} = I \times a^2\left[\frac{\pi}{2} + 1\right]\hat{k}$$

magnetic moment: $\vec{M} = i\vec{A}$

PQ17Q20

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An Initiative by अमर उजाला

The desirable properties for making permanent magnets are

(A) high retentivity and high coercive force.

(B) high retentivity and low coercive force.

(C) low retentivity and high coercive force.

(D) low retentivity and low coercive force.

PQ17S20

Ans [A]

Permanent magnets have High retentivity and High coercive force and High permeability.

High retentivity is needed so that the magnet is strong.

High coercivity is needed so that the magnetisation is not erased by stray magnetic fields, temperature fluctuations, mechanical damage, etc.

Examples of permanent magnets à Steel, Alnico, Cobalt

PQ17Q21

Electromagnets are made of soft iron because soft iron has

(A) high retentivity and high coercive force.

(B) high retentivity and low coercive force.

(C) low retentivity and high coercive force.

(D) low retentivity and low coercive force.

PQ17S21

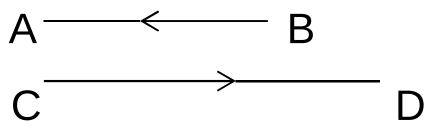
Ans [D]

Electro magnets are made of soft iron because soft iron has Low retentivity and Low coercive force.

Low retentivity will make magnetization zero on switching off the current **à** We can change the magnetization by switching the current on/off.

PQ17Q84

A long horizontal wire AB, which is free to move in a vertical plane and carries a steady current of 20 A, is in equilibrium at a height (h) of 0.1 m over another parallel long wire CD which is fixed in a horizontal plane and carries a steady current of 30 A, as shown in figure. Show that when AB is slightly depressed, it executes simple harmonic. Find the period of oscillations.



(A) 20π

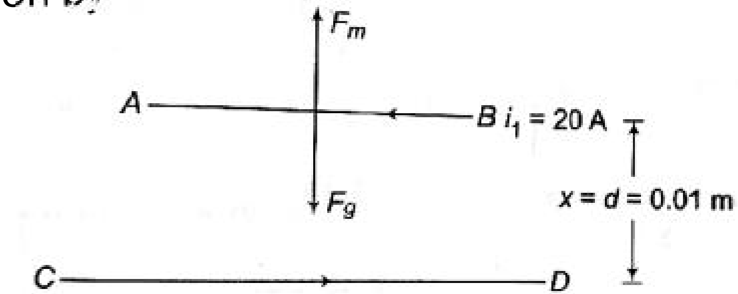
(B) 0.1π

(C) 0.2π

(D) 2π

Ans [C]

Let m be the mass per unit length of wire AB. At a height x above the wire CD. Magnetic force per unit length on wire AB will be given by



$$F_m = \frac{\mu_0}{2\pi}\frac{i_1 i_2}{x} \quad \text{(upwards)} \quad ..(i)$$

Weight per unit length of wire AB is

$$F_g = mg$$

Here, m = mass per unit length of wire AB

At $x = d$, wire is in equilibrium, i.e.

$F_m = F_g$ or

$$\frac{\mu_0}{2\pi}\frac{i_1 i_2}{d} = mg$$

Or

$$\frac{\mu_0}{2\pi}\frac{i_1 i_2}{d^2} = \frac{mg}{d} \quad ...(ii)$$

As $\frac{\mu_0}{2\pi}\frac{i_1 i_2}{d^2} = \frac{mg}{d}$ by (ii)

Now, restoring force when wire is displaced by y (y<<d)

$\frac{\mu_0}{2\pi}\frac{i_1 i_2}{d}$ - $\frac{\mu_0}{2\pi}\frac{i_1 i_2}{(d \quad y)}$ = ma **à** $\frac{- \quad _0}{2\pi}\frac{i_1 i_2 y}{d^2}$ = ma **à** $\frac{- \quad g}{d}$y = ma **à** $\omega = \frac{\sqrt{g}}{\sqrt{d}}$

Calculate restoring force and equate to ma to get a relation of type a = $-\omega^2 y$