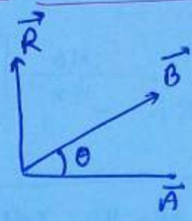
Moving Charges & Magnetism

CH ⇒ MOVING CHARGE AND MAGNETISM

Cross product



$\vec{R} = \vec{A} \times \vec{B} = AB\sin\theta \rightarrow$ [Angle b/w $\vec{A}$ & $\vec{B}$]

↳ $\vec{R}$ must be ⊥r to $\vec{A}$ & $\vec{B}$

$\boxed{\hat{i} \times \hat{i} = \hat{j} \times \hat{j} = \hat{k} \times \hat{k} = 0}$ ⇒ $\hat{i} \times \hat{j} = \hat{k}$, $\hat{k} \times \hat{i} = -\hat{j}$ | $\hat{j} \times \hat{k} = \hat{i}$, $\hat{i} \times \hat{k} = -\hat{j}$ | $\hat{k} \times \hat{i} = \hat{j}$, $\hat{j} \times \hat{i} = -\hat{k}$

$\vec{R} = \vec{A} \times \vec{B}$

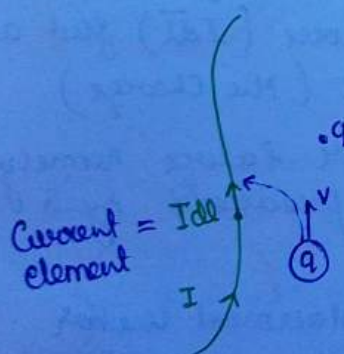
R result — [Represent Result]

1st Vec — [Four finger]

2nd Vect — [Slap 2nd vect]

Biot-Savart law

= [Current = Scalar; Current element $Id\vec{l}$ = Vector] dirn along current.



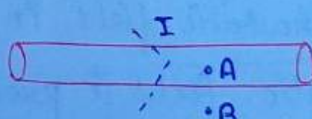
• q (rest) F = 0

$F_{exp} = 0$

F = 0 (Theoretically because E = 0)

F ≠ 0 (Experimentally)

$\boxed{q = 0}$

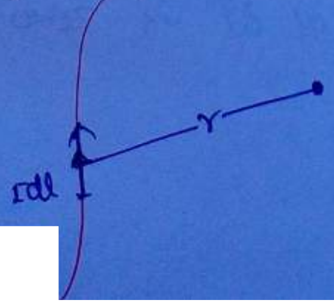


(E_A) inside ≠ 0

(E_B) neutral wire = 0

Magnetic field of Current

= Magnetic field due to a current element Bio Savart law.



$dB \propto \frac{1}{r^2}$ (Inverse square law)

$dB \propto Idl$

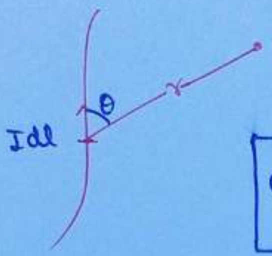
$dB \propto \sin\theta$

$dB = k\frac{Idl\sin\theta}{r^2}$

$$\boxed{dB = \left(\frac{\mu_0}{4\pi}\right)\frac{Idl\sin\theta}{r^2}}$$

Vector form

$\boxed{\text{dimension} = B = MT^{-2}A^{-1}}$



$dB = \frac{\mu_0}{4\pi}\left[\frac{Idl\,\sin\theta}{r^2}\right] = \frac{\mu_0}{4\pi}\frac{(Idl)\,r\,\sin\theta}{r^2 \times r}$

$\boxed{d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\vec{dl}\times\vec{r}}{r^3}}$

$\boxed{dB = \frac{\mu_0}{4\pi}\frac{Idl\,\sin\theta}{r^2}}$

$\boxed{d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\vec{dl}\times\hat{r}}{r^2}}$

Source of magnetic field is $(I\hat{dl}) \to$ is Vector P. Q

dirⁿ of magnetic field ⊥r to the plane of $I\vec{dl}$ and $\vec{r}$

[gravitation field / electric field / magnetic is linear Inside source]

Similarities and difference b/w Biot-Savart law and Coulomb's law →

(i) Both are long range. since both depend inversely on outside square of distance from source to the point of Interest

(ii) The principle of Superposition is applied to both fields

(iii) The magnetic field is linear Inside the source $(I\vec{dl})$ just as the electrostatic field is linear its source (the charge)

(iv) Electrostatic field is produced by a scalar source namely the electric charge the magnetic field is produced by a Vector source $(I\vec{dl})$

(v) The electrostatic field is along the displacement vector joining the source and the field point. the magnetic field is perpendicular to the plane containing displacement vector $\vec{r}$ and current element $I\vec{dl}$ -

(VI) There is angle dependence in the biot savart law which is not present in the electrostatic field. Magnetic field at the point in the direction of $\vec{dl}$ is zero.

$\Rightarrow$ μ_0 (Permeability of free space/air) $= 4\pi \times 10^{-7}$

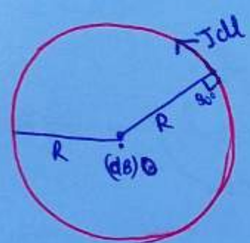
$\Rightarrow$ μ_m (Permeability of medium)

$\Rightarrow$ $\mu_r = \frac{\mu_m}{\mu_0}$ = relative permeability

↳ unitless/dimensionless

$$\boxed{\mu_m = \mu_r \mu_0}$$

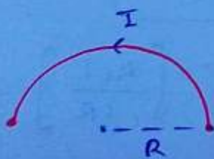
Magnetic field on the Centre of Circular loop



$$dB = \frac{\mu_0}{4\pi} \frac{I\,dl \sin 90^\circ}{R^2}$$

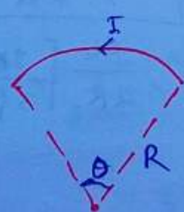
$$\int dB = \frac{\mu_0}{4\pi} \frac{I}{R^2} \int_0^{2\pi R} dl$$

$$\boxed{B = \frac{\mu_0}{\cancel{4\pi}_{2}} \frac{I}{R^{\cancel{2}}} \times (\cancel{2\pi R}) = \frac{\mu_0 I}{2R}}$$



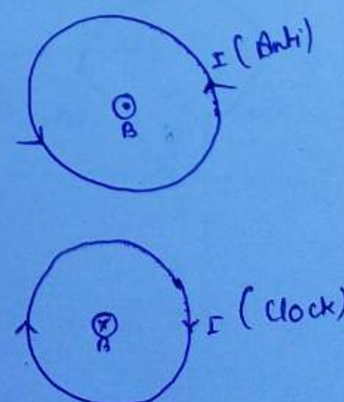
$$B = \frac{\mu_0 I}{4\cancel{\pi R}} (\cancel{\pi R})$$

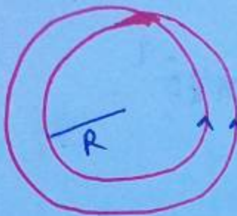
$$\boxed{B = \frac{\mu_0 I}{4R}}$$



$$\boxed{B = \frac{\mu_0}{4\pi} \frac{I}{R^2} (R\theta)}$$

direction



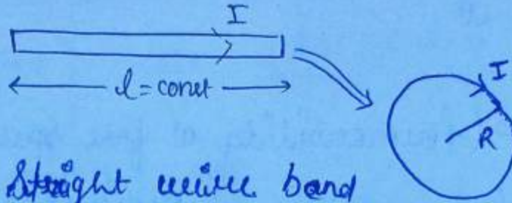


$B = \left(\frac{\mu_0 I}{2R}\right) \cdot 2$

$B = n\left[\frac{\mu_0 I}{2R}\right]$

No. of loop.

Q



Straight wire bend into 1 Circular loop = $B_0 = \frac{\mu_0 I}{2R}$ — ①

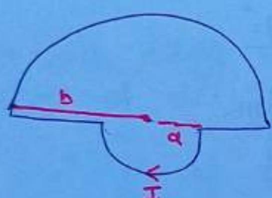
Straight wire bend into 2 Circular loop

$4\pi r = l$

$r = \frac{l}{4\pi}$

$B = 2\left[\frac{\mu_0 I}{2r}\right] = \frac{\mu I 4\pi}{l} = 4B_0$

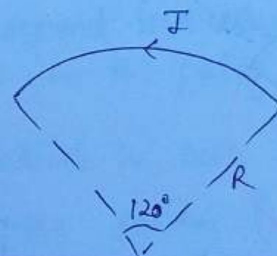
Q



$B_0 = \frac{\mu_0 I}{2b}\left(\frac{\pi}{2\pi}\right)$

$$\boxed{B_0 = \frac{\mu_0 I}{4b} \otimes + \frac{\mu_0 I}{4a} \otimes}$$

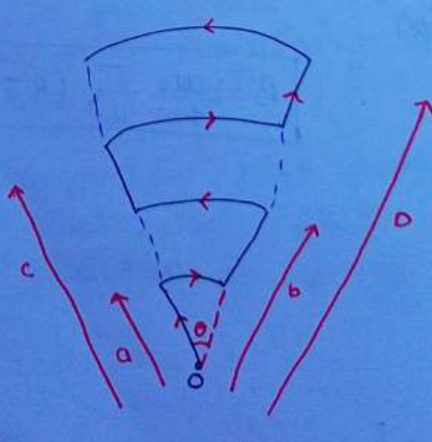
Q



$$\boxed{B_0 = \frac{\mu_0 I}{2R}\left[\frac{\theta}{2\pi}\right]}$$

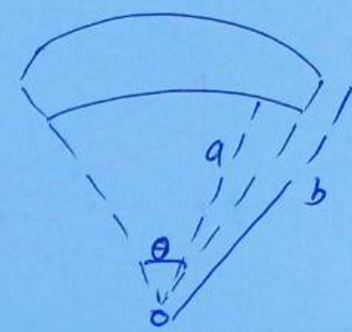
$\frac{\mu_0}{2R}\left[\frac{2\pi}{3(2\pi)}\right] = \left[\frac{\mu_0 I}{6R}\right]$

Q



$B = \frac{\mu_0 I}{2a}\left(\frac{\theta}{2\pi}\right)\otimes + \frac{\mu_0 I}{2b}\left(\frac{\theta}{2\pi}\right)\odot + \frac{\mu_0 I}{2c}\left(\frac{\theta}{2\pi}\right)\otimes + \frac{\mu_0 I}{2D}\left(\frac{\theta}{2\pi}\right)\odot$

Qu The figure below shows a current loop having two circular arcs joined by two radial lines. The magnetic field at O is



① $\frac{\mu_0 i\theta}{2\pi ab}(b-a)$

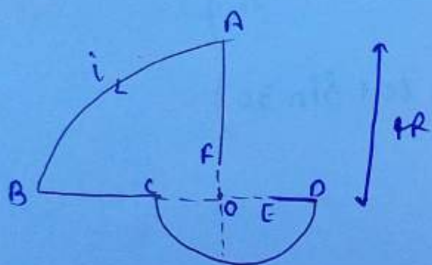
② $\frac{\mu_0 i\theta}{4\pi ab}(b-a)$ ✓

③ zero

④ $\frac{\mu_0 i\theta}{3\pi ab}(b+a)$

$$\boxed{B=\frac{\mu_0 I}{2R}\left(\frac{\theta}{2\pi}\right)}$$

Qu

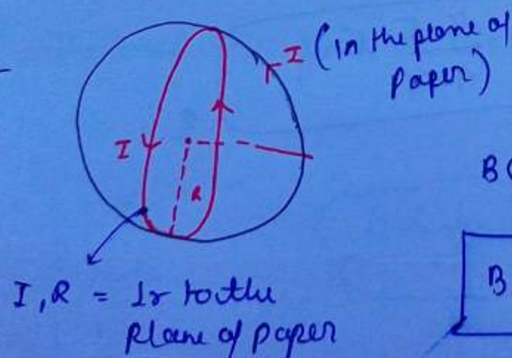


$$B=\frac{\mu_0 I}{2(4R)}\left(\frac{\cancel{\pi}}{2\times 2\cancel{\pi}}\right)+\frac{\mu_0 I}{2(2R)}\times\frac{\pi}{2\cancel{\pi}}+\frac{\mu_0 I}{2R}\left(\frac{1}{4}\right)$$

$$B=\left[\frac{\mu_0 I}{32R}+\frac{\mu_0 I}{8R}+\frac{\mu_0 I}{8R}\right]\odot$$

$$\left[\frac{9\mu_0 I}{32R}\right]$$

Qu

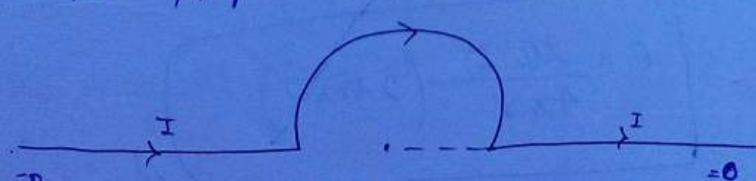


$$B\odot=\frac{\mu_0 I}{2R}$$

$$\boxed{B=\frac{\mu_0 I}{2R}}$$

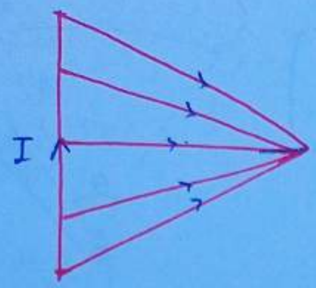
$$\boxed{B_{centre}=\sqrt{2}\left(\frac{\mu_0 I}{2R}\right)}$$

Q

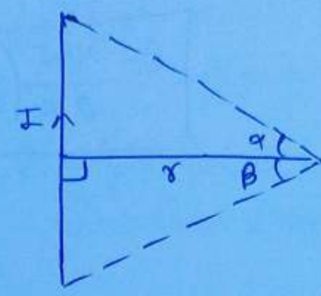


$$\boxed{B=\frac{\mu_0 I}{4R}\ (\times)}$$

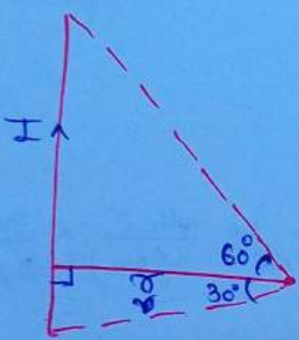
Magnetic field due to finite straight wire



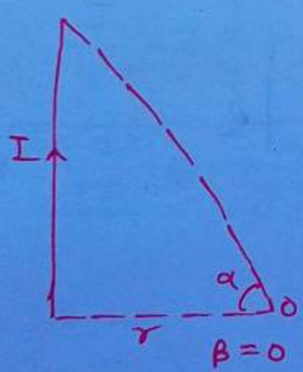
=



$$\boxed{B = \left(\frac{\mu_0}{4\pi}\right)\frac{I}{r_{\perp r}}\left[\sin\alpha + \sin\beta\right]}$$

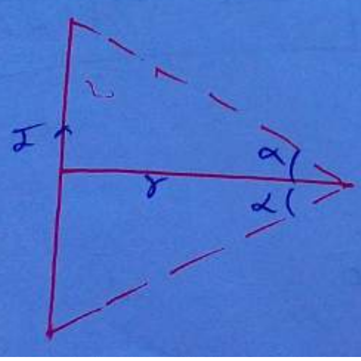


$$B = \frac{\mu_0 I}{4\pi r}\left(\sin 60 + \sin 30\right)$$



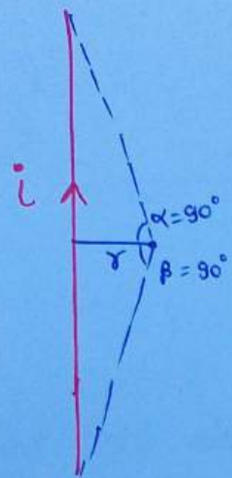
$$B_0 = \frac{\mu_0 I}{4\pi r}\left[\sin\alpha + \sin 30\right]$$

$$\boxed{B_0 = \frac{\mu_0 I}{4\pi r}\sin\alpha}$$



$$\boxed{B = \frac{\mu_0 I}{4\pi r}\left(2\sin\alpha\right)}$$

Infinite wire ka field



$$B = \frac{\mu_0 I}{4\pi r}\left[\sin 90 + \sin 90\right]$$

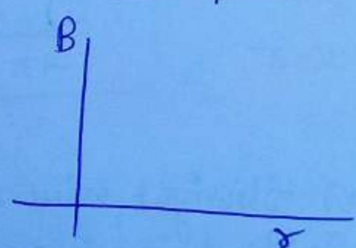
$$\boxed{B = \frac{\mu_0 I}{2\pi r}}$$

$B \propto \frac{1}{r}$

Semiinfinite

$$B = \frac{\mu_0 I}{4\pi R}$$

Graph

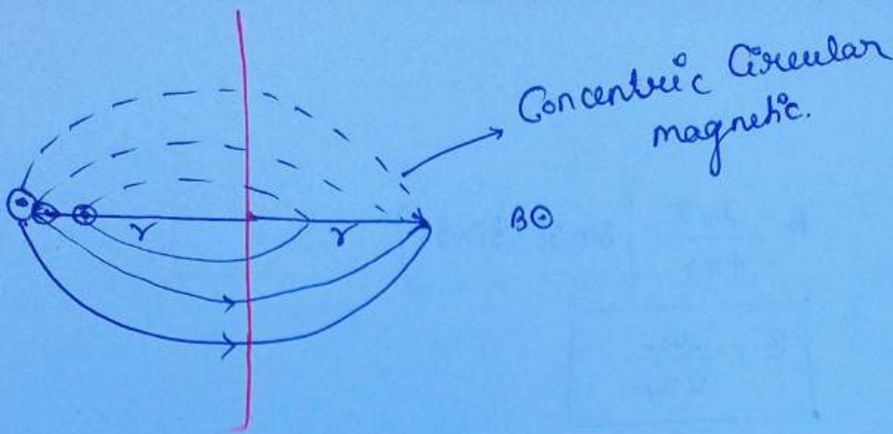


Que The magnetic field at a distance r from a long wire carrying

(1) 0.2 tesla —
0.8 tesla
0.1 tesla

$B \propto \frac{1}{r}$

Que The magnetic field at centre P will be



<u>Que</u> The magnetic field at Centre P will be

① $\frac{\mu_0}{4\pi}$

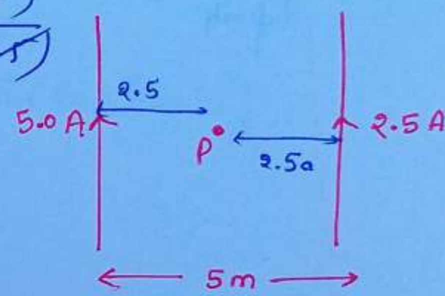
② $\frac{\mu_0}{\pi}$

③ $\frac{\mu_0}{2\pi}$ ✓

④ $4\mu_0\pi$

$$B_1 - B_2 = \frac{\mu_0 \cancel{5}^{2}}{2\pi(\cancel{2.5})} - \frac{\mu_0(\cancel{2.5})}{2\pi(\cancel{2.5})}$$

$$\boxed{B = \frac{\mu_0}{2\pi}}$$



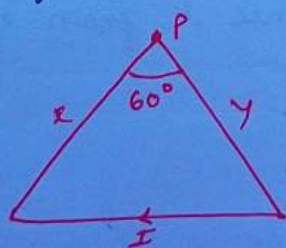
<u>Q</u> A Straight wire of finite length Carrying Current I Subtends and angle of 60° at point P as shown The magnetic field at P is.

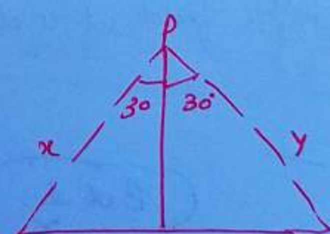
① $\frac{\mu_0 I}{2\sqrt{3}\pi x}$ ✓

② $\frac{\mu_0 I}{2\pi x}$

③ $\frac{\sqrt{3}\mu_0 I}{2\pi x}$

④ $\frac{\mu_0 I}{3\sqrt{3}\pi x}$

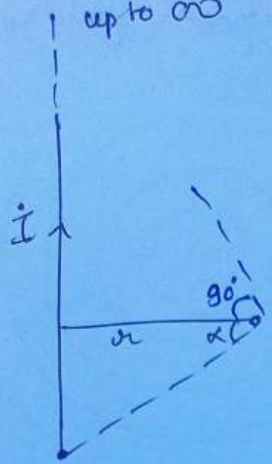




$$\cos 30^\circ = \frac{6x}{2}$$

$$r_{\perp r} = \frac{\sqrt{3}x}{2}$$

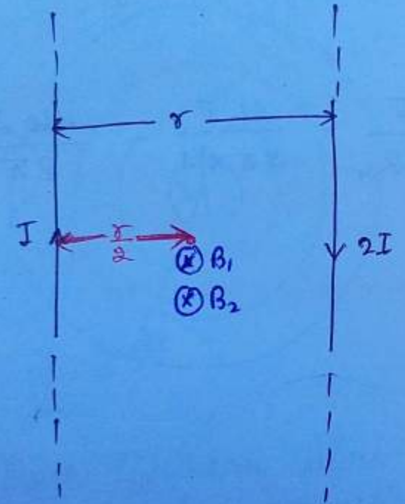
Que up to ∞ semi infinite wire



$$B = \frac{\mu_0}{4\pi}\frac{I}{r}\left[\sin\alpha + \sin 90\right]$$

$$\boxed{B = \frac{\mu_0 I}{4\pi r}\sin\alpha + 1}$$

Que Find field at mid point

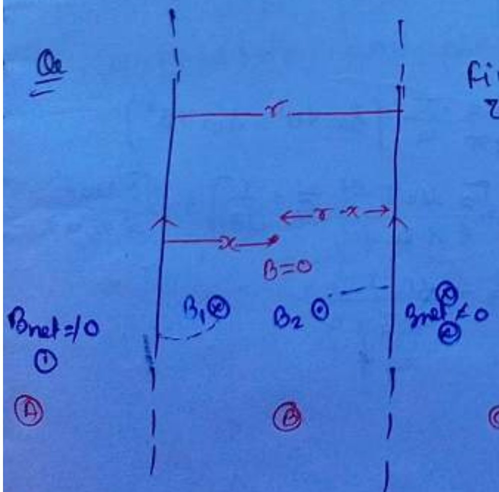


$$B = B_1 + B_2$$

$$\frac{\mu_0 I}{\cancel{2}\pi \frac{r}{\cancel{2}}} + \frac{\mu_0}{\cancel{2}\pi}\frac{2I}{\left(\frac{r}{2}\right)}$$

$$\boxed{\frac{2\mu_0 I}{\pi R}}$$

Que



Find Position where magnetic field will be zero.

$$B = 0$$

$$B_1 = B_2$$

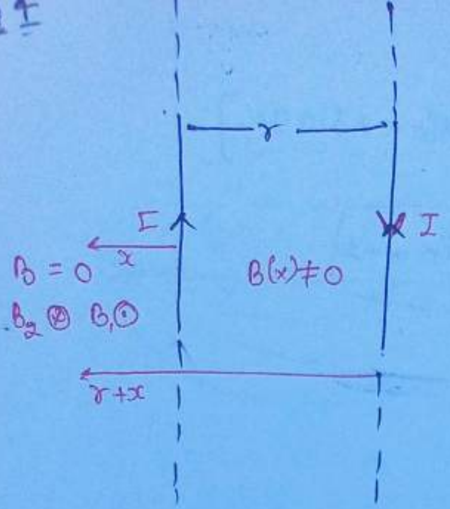
$$\frac{\mu_0 I}{2\pi x} = \frac{\mu_0 n I}{2\pi(r-x)}$$

$$nx = r - x$$

$$x(n+1) = r$$

$$\boxed{x = \frac{r}{n+1}}$$

Qu 1



Find Position where magnetic field will be zero.

$B_1 = B_2$

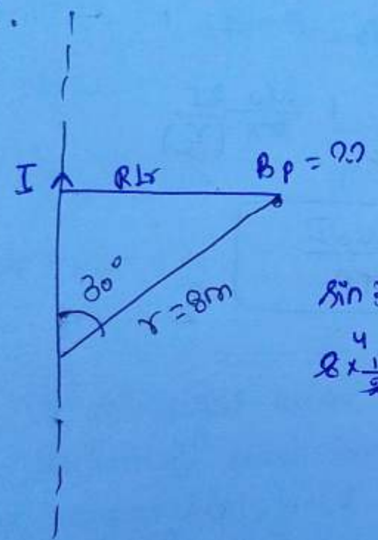
$\frac{\mu_0 I}{2\pi x} = \frac{\mu_0 I n}{2\pi (r+x)}$

$nx = r + x$

$nx - x = r$

$\boxed{x = \frac{r}{n-1}}$

Que Infinite wire as shown in figure. find magnetic field at P.

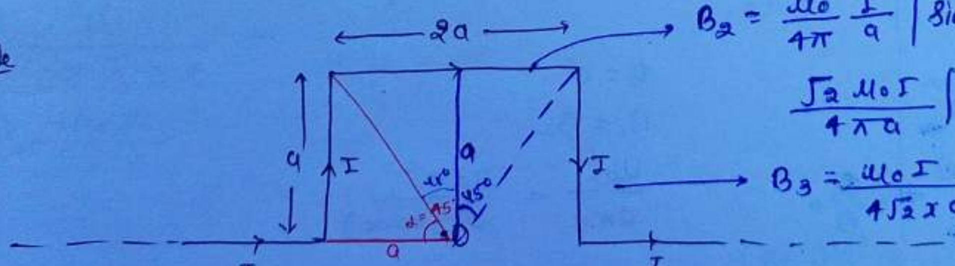


$B = \frac{\mu_0 I}{2\pi R_\perp} = \frac{\mu_0 I}{2\pi \times 4} = \frac{\mu_0 I}{8\pi}$

$\sin 30° = \frac{R_\perp}{8}$

$8 \times \frac{1}{2} = 4$

Q.



$B_2 = \frac{\mu_0}{4\pi}\frac{I}{a}[\sin 45° + \sin 45°]$

$\frac{\sqrt{2}\mu_0 I}{4\pi a}\left[\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}\right] = \frac{\sqrt{2}\mu_0 I}{4\pi a}$

$B_3 = \frac{\mu_0 I}{4\sqrt{2} \times a}$

$B_1 = \frac{\mu_0 I}{4\pi a}[\sin\theta + \sin 45°]$

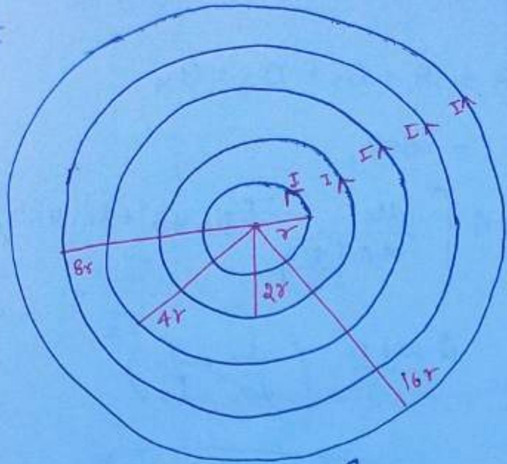
$B_1 = \frac{\mu_0 I}{4\pi a\sqrt{2}}$

$B = \left(\frac{\mu_0 I}{4\sqrt{2}\pi a} + \frac{\mu_0 I}{4\sqrt{2}\pi a}\right) + \frac{\sqrt{2}\mu_0 I}{4\pi a}$

$\frac{2\mu_0 I}{4\sqrt{2}\pi a} + \frac{\sqrt{2}\mu_0 I}{4\pi a}$

$B = \frac{2\sqrt{2}\mu_0 I}{4\pi a}$

Qu 7



Infinite Circular wire

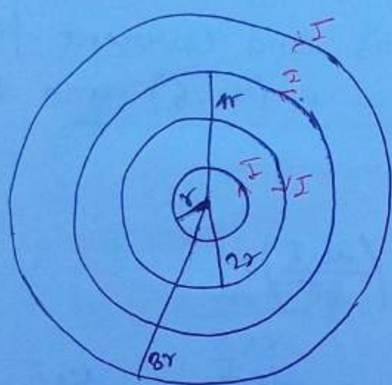
$$B = \frac{\mu_0 I}{2r} + \frac{\mu_0 I}{2(2r)} + \frac{\mu_0 I}{2(4r)} + \frac{\mu_0 I}{2(8r)}$$

$$\frac{\mu_0 I}{2r}\cdot\left(1 + \frac{1}{2} + \frac{1}{2} + \frac{1}{8} + \frac{1}{16}\right)$$

$$\frac{\mu_0 I}{2r}\left[\frac{1}{1-\frac{1}{2}}\right]$$

$$\left[\frac{\mu_0 I}{r}\right]$$ Ans

Qu



(a) zero

(b) $\frac{\mu_0 I}{3r}$ ✓

(c) $\frac{\mu_0 I}{2r}$

(d) $\frac{\mu_0 I}{r}$

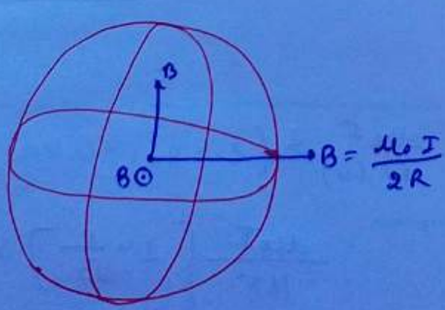
$$B = \frac{\mu_0 I}{2r}\left(1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16}\right)$$

$$\frac{\mu_0 I}{2r}\left(\frac{1}{1+\frac{1}{2}}\right)$$

$$\frac{\cancel{2}}{3}\left(\frac{\mu_0 I}{\cancel{2}r}\right) = \boxed{\frac{\mu_0 I}{3r}}$$ Ans

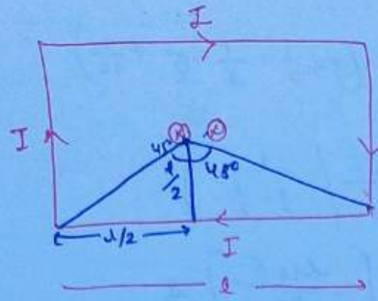
Qu Three circular wire of same radius R having current I then find magnetic field at centre if they are placed concentric and plane perpendicular to each other.

$$B = \frac{\mu_0 I}{2R}\hat{i} + \frac{\mu_0 I}{2R}\hat{j} + \frac{\mu_0 I}{2R}\hat{k}$$



$$B_n = \sqrt{3}\left(\frac{\mu_0 I}{2R}\right)$$

Qu Magnetic field at the Centre of square loop



$B = B_1 + B_2 + B_3 + B_4$

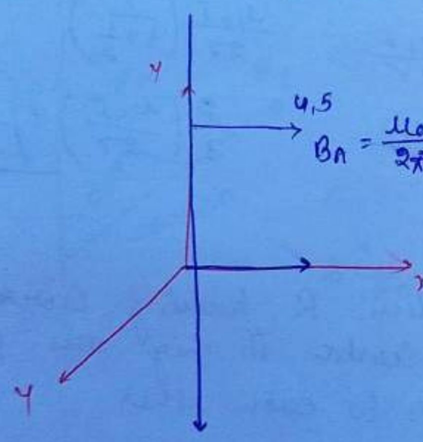
$= 4B_1$

$4\left[\frac{\mu_0 I}{4\pi\left(\frac{l}{2}\right)}\right.\left(\sin 45^\circ + \sin 45^\circ\right)$

$\frac{2\mu_0 I}{\pi l}\left(\frac{1}{\cancel{\sqrt{2}}} + \frac{1}{\sqrt{2}}\right)^{\sqrt{2}}$

$\boxed{\frac{2\sqrt{2}\mu_0 I}{\pi l}}$

Infinite wire is placed along y-axis and current flowing in it is 10A find magnetic field at A (4,5) and B (3,3,4)



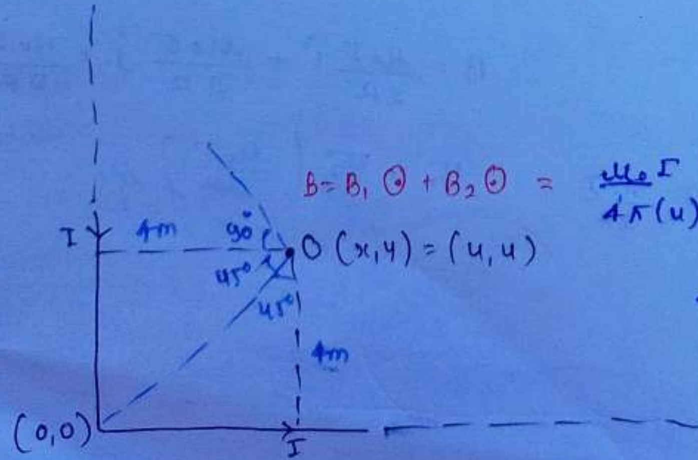
$B_A = \frac{\mu_0 I}{2\pi r} = \left(\frac{\mu_0 I}{2\pi(4)}\right) = \left(\frac{\mu_0 I}{8\pi}\right)T$

$B_B = \frac{\mu_0 I}{2\pi(r)} = \frac{\mu_0 I}{2\pi(5)}$

$\frac{\mu_0 \times 1\cancel{0}}{2\pi \cancel{10}}$

$\boxed{= \frac{\mu_0}{\pi} \text{ Tesla}}$

Qu



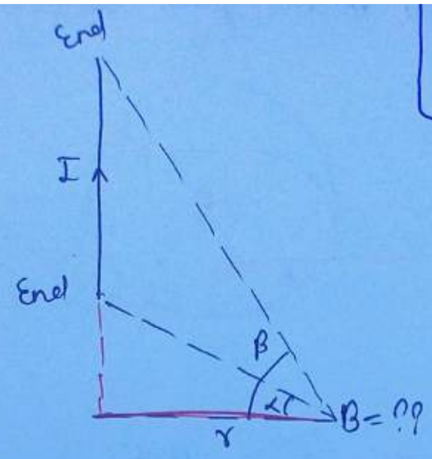
$B = B_1 \odot + B_2 \odot = \frac{\mu_0 I}{4\pi(4)} \times (\sin 90 + \sin 45) \times 2$

$\frac{\mu_0 I}{16\pi}\left[1 + \frac{1}{\sqrt{2}}\right] \times 2$

$\frac{\mu_0 I}{\underset{8}{\cancel{16}}\pi}\left[\frac{1+\sqrt{2}}{\sqrt{2}}\right] \times \cancel{2}$

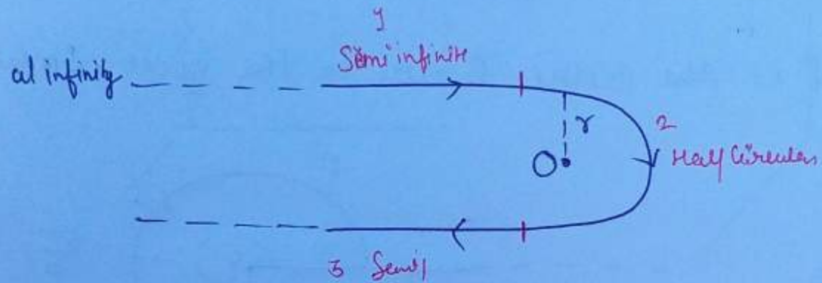
$= \frac{\mu_0 I}{8\sqrt{2}\pi}(1+\sqrt{2})$

Qu



$$\boxed{B = \frac{\mu_0 I}{4\pi r}\left[\sin\beta + \sin\alpha\right]}$$

Qu



$$B_1 = \frac{\mu_0 I}{4\pi r} \otimes$$

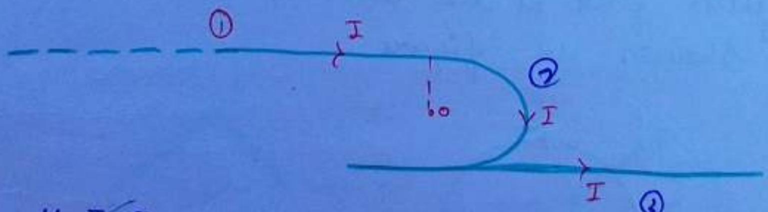
$$B_2 = \frac{\mu_0 I}{4r} (\times)$$

$$B_3 = \frac{\mu_0 I}{4\pi r} (\times)$$

$$B_1 = \frac{\mu_0 I}{2\pi r} + \frac{\mu_0 I}{4r}$$

$$\frac{\mu_0 I}{r}\left(\frac{1}{2\pi} + \frac{1}{4}\right)$$

Qu



$$\cancel{B_1 = \frac{\mu_0 I}{4\pi r}} \otimes$$

X

$$\cancel{B_3 = \frac{\mu_0 I}{4\pi r}} \odot$$

$$\boxed{B_2 = \frac{\mu_0 I}{4r}}$$

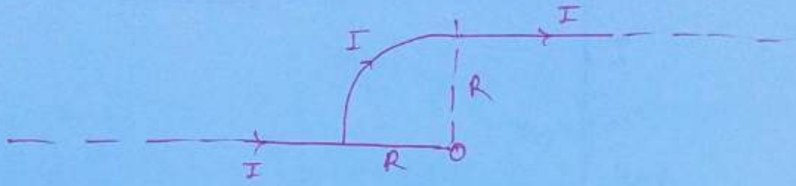
Qu Magnetic field at point O due to the given structure is

(1) $\frac{\mu_0 I}{4\pi a}\cdot\left(\frac{\pi}{2}+1\right) \otimes$

(2) $\frac{\mu_0 I}{4\pi a}\left(\frac{\pi}{2}+1\right) \odot$

(3) $\frac{\mu_0 I}{2\pi a}\left(\pi + 1\right) \otimes$

(4) $\frac{\mu_0 I}{2\pi a}\left(\pi+1\right) \odot$



$B_1 = 0$

$B_2 = \frac{\mu_0 I}{8R} \quad B_3 = \frac{\mu_0 I}{4\pi R}$

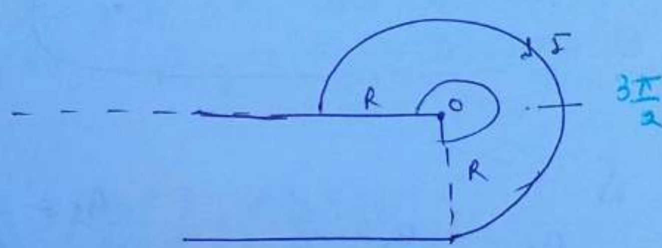
Qu Magnetic field at the Centre O due to the given Structure

(1) $\frac{\mu_0 I}{4R}\left[\frac{3}{2}+\frac{1}{\pi}\right] \odot$

(2) $\frac{\mu_0 I}{2R}\left[3+\frac{1}{\pi}\right] \otimes$

(3) $\frac{\mu_0 I}{4R}\left[\frac{3}{2}+\frac{1}{\pi}\right] \otimes$

(4) $\frac{\mu_0 I}{4R}\left[3+\frac{2}{\pi}\right] \odot$

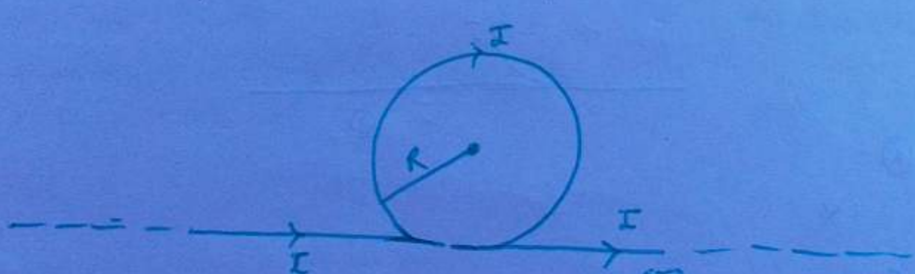


$B_1 = 0$

$B_2 = \frac{\mu_0 I}{2R}\left(\frac{3\cancel{\pi}}{2(2\cancel{\pi})}\right) = \frac{3\mu_0 I}{8R} \otimes$

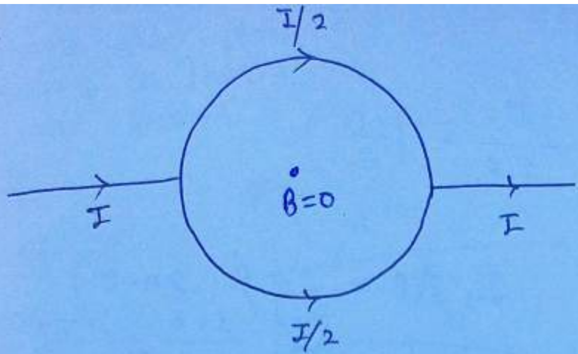
$B_2 = \frac{\mu_0 I}{4\pi R} \otimes$

Qu Find the magnetic field at the centre of the circular loop shown loop shown in figure

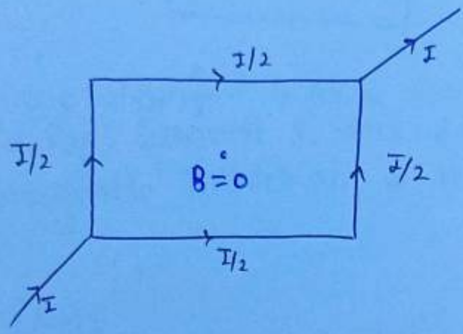


$\boxed{B_1 = \frac{\mu_0 I}{2\pi R} \odot}$

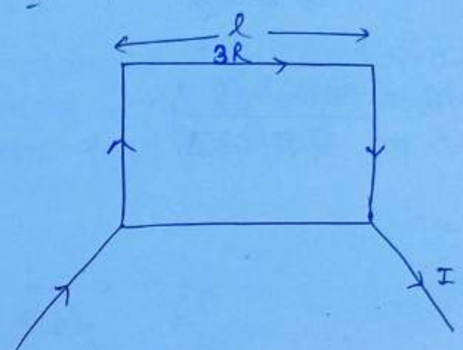
Qu



Qu

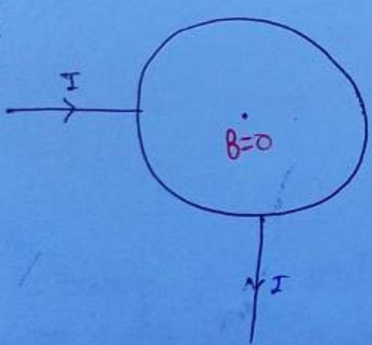


Q Square loop

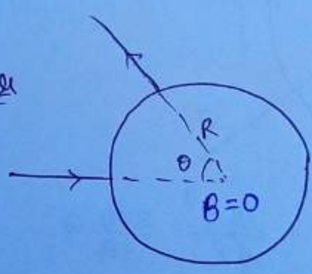


$\boxed{B_{net} = 0}$

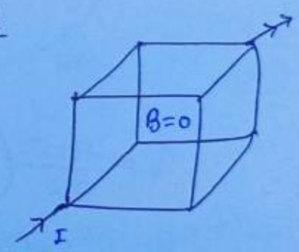
Qu



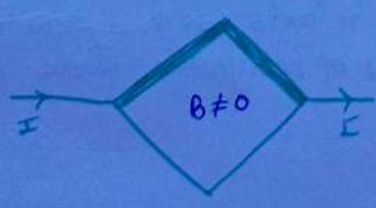
Qu



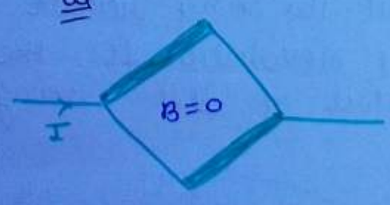
Qu



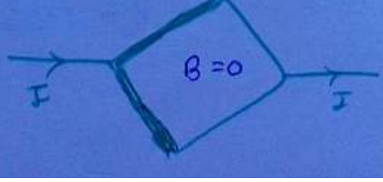
Qu



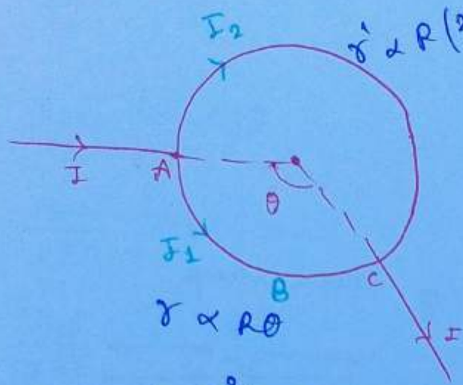
Qu



Qu



Que Find magnetic field due to Arc ABC



$r' \propto R(2\pi-\theta)$ $B = \frac{\mu_0 I_2}{2R}\left(\frac{\theta}{2\pi}\right)$

$r \propto R\theta$

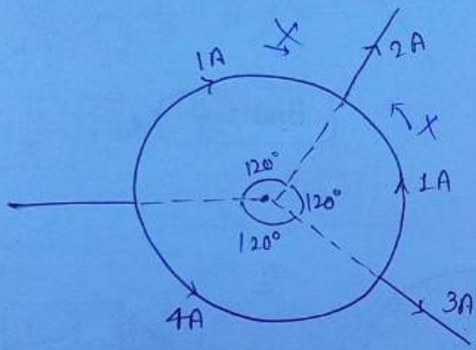
$I_1 R\theta = I_2 R(2\pi-\theta)$

$= \frac{I_1\theta}{(2\pi-\theta)} = I_2$

$\boxed{I_1 + I_2 = I}$

$B = \frac{\mu_0 I_1}{2R}\left(\frac{\theta}{2\pi}\right)$

Que



$\boxed{B_{net} = \frac{2\mu_0}{3R}}$

$B_1 = \frac{\mu_0 I}{2R}\left(\frac{2\pi}{3\times 2\pi}\right) = \frac{\mu_0 4^2}{\frac{6}{3}R} = \frac{2\mu_0}{3R}$ ⊙

$B_2 = \frac{\mu_0 1}{2R}\left(\frac{1}{3}\right)$

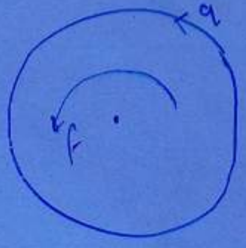
$B_2 = \frac{\mu_0}{6R}$ ⊗

Qu A thin ring of radius R meter has charge q coulomb uniformly spread on it the ring rotate about it axis with a constant frequency f revolution is. The value of magnetic field in tesla at the centre of the ring is.

(1) $\frac{\mu_0 q f}{2\pi R}$

(2) $\frac{\mu_0 q}{2\pi f R}$

(3) $\frac{\mu_0 q}{2 f R}$



$I = \frac{\Delta q}{\Delta t} = qf$

$B = \frac{\mu_0 I}{2R} = \frac{\mu_0 qf}{2R}$

Q. Two similar circular loops of radius R, are lying concentrically with their plane at right angles to each other. The currents flowing in them are I and $I\sqrt{3}$ respectively. The magnetic field at the centre of the coil is.

(1) $\frac{\mu_0 I}{2R}$

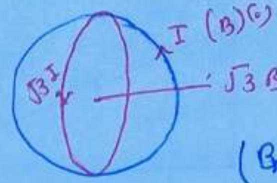
(2) $\frac{\mu_0 I}{R}$ ✓

(3) $\frac{4\mu_0 I}{R}$

(4) $\frac{\sqrt{3}\mu_0 I}{R}$

$\cancel{2}\left(\frac{\mu_0 I}{\cancel{2}R}\right)$

$\boxed{B = \frac{\mu_0 I}{R}}$



$(B_{net}) = \sqrt{B^2 + (\sqrt{3}B)^2}$

$\sqrt{B^2 + 3B^2}$

$\sqrt{4B^2} = \boxed{2B}$

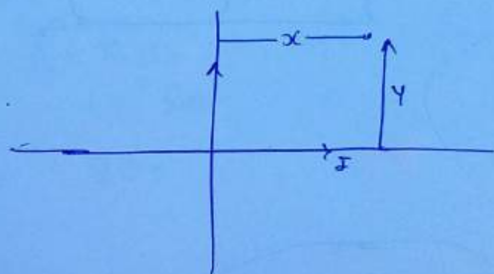
Q. Two long straight wires are placed along x-axis and y-axis. They carry current I_1 and I_2 respectively. The equation of locus of zero magnetic induction in the magnetic field produced by them is

(1) $y = x$

(2) $y = \left(\frac{I_2}{I_1}\right)x$

(3) $y = \left(\frac{I_1}{I_2}\right)x$

(4) $y = (I_1 I_2)x$



Q. Charge of q is uniformly spread on a thin ring of radius R. The ring rotates about its axis with a uniform frequency f Hz. The magnitude of magnetic induction at the centre of the ring is.

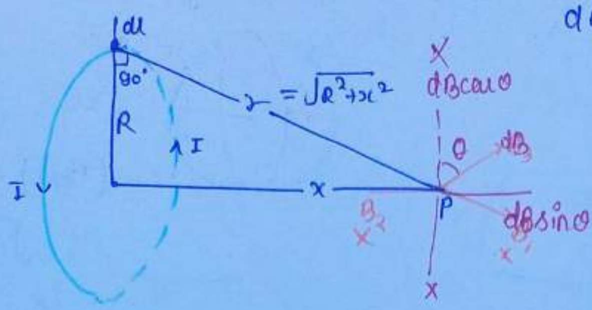
(1) $\frac{\mu_0 q}{2\pi f R}$ ✓

(2) $\frac{\mu_0 q f}{2\pi R}$

(3) $\frac{\mu_0 q f}{2R}$

(4) $\frac{\mu_0 q}{2 f R}$

Magnetic Field on the axis of Circular loop



$$dB = \frac{\mu_0 I dl \sin 90^\circ}{4\pi\left(\sqrt{R^2+x^2}\right)^2}$$

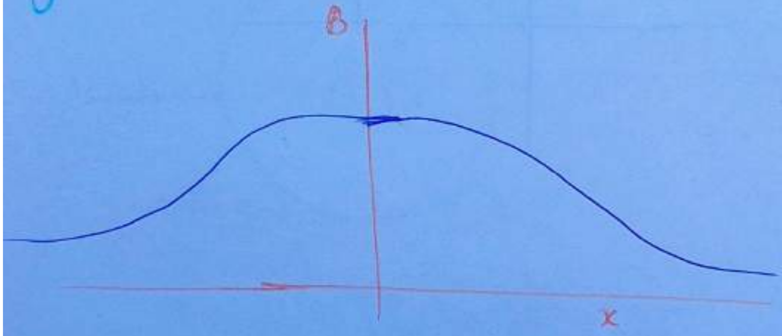
$$= \frac{\mu_0 I dl}{4\pi(R^2+x^2)}$$

$$dB = \frac{\mu_0}{4\pi}\frac{I dl}{(R^2+x^2)}\frac{R}{(R^2+x^2)^{1/2}}$$

$$\int dB = \int \frac{\mu_0 I R \, dl}{4\pi (R^2+x^2)^{3/2}}$$

$$\boxed{B = \frac{\mu_0 I R^2}{2(R^2+x^2)^{3/2}}} = B = \frac{\mu_0 I R}{\cancel{4\pi}_2 (R^2+x^2)^{3/2}}(\cancel{2\pi}R)$$

Graph.



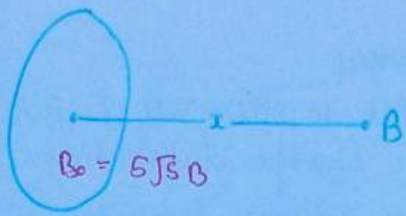
Qu If magnetic field at distance $x = \sqrt{3}R$ on the axis at ring.

$$B = \frac{\mu_0 I R^2}{2\left[R^2+(\sqrt{3}R)^2\right]^{1/2}}$$

$$B = \frac{\mu_0 I R^2}{2(4R^2)^{1/2 \times 3}} = \frac{\mu_0 I R^2}{2(2R)^3} = \frac{\mu_0 I R^2}{2(8 \times R^3)} = \boxed{\frac{\mu_0 I}{16R}}$$ Ans

Qu The magnetic field at the centre of a current carrying circular coil of radius 10cm is $5\sqrt{5}$ time the magnetic field at a point on its axis. the distance of the point from the centre of the coil (in cm) is.

(1) 5 (2) 10 (3) 20 (4) 25



$$\frac{\mu_0 I}{2R} = 5\sqrt{5} \times \frac{\mu_0 I R^2}{2(R^2+x^2)^{3/2}}$$

$$(R^2+x^2)^{3/2} = 5\sqrt{5} R^3$$

$$(R^2+x^2)^3 = (5\sqrt{5}R^3)^2$$

$$= 25 \times 5 R^6$$

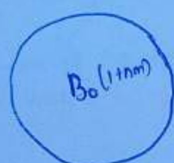
$$(R^2+x^2)^3 = 125 R^6$$

$$(R^2+x^2) = (5 \times R^2)$$

$$x^2 = 4R^2 = \boxed{x = 2R = 20}$$

Qu A circular coil carrying a certain current produce a magnetic field B_0 at its centre. The coil is now rewound so as to have 3 turns and the same current is passed through it. The new magnetic field at the centre is.

① $\frac{B_0}{9}$
② $9B_0$
③ $\frac{B_0}{3}$
④ $3B_0$



$$B = n^2 B_0$$

$$(3)^2 B_0$$

$$9B_0$$

Qu At what distance on the axis, from the centre of a circular current carrying coil of radius r. The magnetic field become $\frac{1}{8}$th of the magnetic field at centre?

① $\sqrt{2}\, r$
② $2^{3/2} r$
③ $\sqrt{3}\, r$
④ $3\sqrt{2}$

$$B = \frac{B_0}{8}$$

$$\frac{\mu_0 I R^2}{2(R^2+x^2)^{3/2}} = \frac{1}{8} \frac{\mu_0 I}{2R}$$

$$8R^3 = (R^2+x^2)^{3/2}$$

$$(8R^3)^{1/3} = (R^2+x^2)^{1/2}$$

$$2R = (R^2+x^2)^{1/2}$$

$$(2R)^2 = (R^2+x^2)$$

$$4R^2 - R^2 = x^2$$

$$x^2 = 3R^2$$

$$\boxed{x = \sqrt{3} R}$$

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Ampere Circuital law

Gauss law

$$\phi = \oint \vec{E} \cdot \vec{ds} = \frac{q_{in}}{\varepsilon_0}$$

Close area Integral

→ It gives electrostatic flux from close surface

⇒ q_{in} — total enclosed charge

E = Electric field due to all the charge are Inside

ds = Area element of gaussion surface

= always valid

= only useful to calculate $\vec{E}$ for Symmetric charge distribution

= gaussian surface symmetric

= Angle B/w $\vec{E}$ & Area Must be 0°, 90°, 180°

$\boxed{E = \text{must be Const}}$

Gauss law $\xrightarrow{\text{Analogue}}$ Ampere Circuital law

---

Ampere Circutal loop

Bond or line mana chahiye

$$= \oint \vec{B} \cdot \vec{dl} = \mu_0 I_{in}$$

Inclosed current by amperian loop.

magnetic field due inside or outside current.

Small length element of Imaginary amperian loop

= Close line Integral

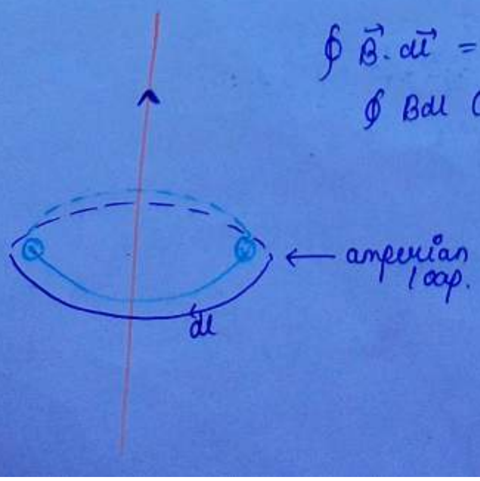
= It does not give magnetic flux

= always valid

= always aplicable

= Not aplicable or useful to Calculate magnetic field

= amperion loop must be passing through Point where $\vec{B}$ have to Calculate.



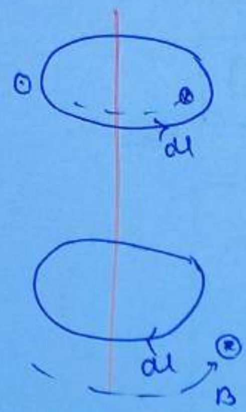
$$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_{in}$$

$$\oint B dl \cos\theta = \mu_0 I_{in}$$

$$\oint B dl \cos 180^\circ = \mu_0 I_{in}$$

$$\boxed{\oint B dl = -\mu_0 I}$$

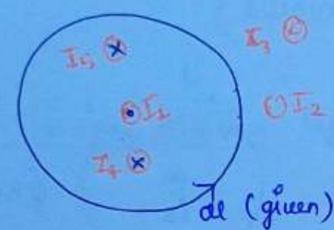
oppo me (−)



$\oint B\,dl = +\mu_0 I$

$\oint B\,dl = -\mu_0 I$

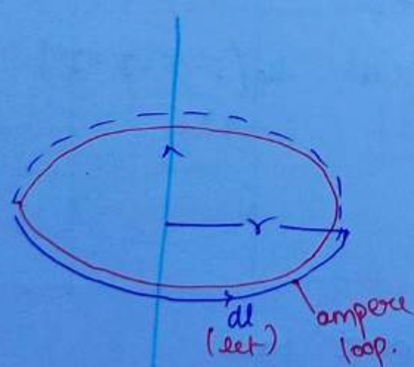
Ex



$\oint B\,dl = (+I_1 - I_4 - I_5)$ Ans

(always included range)

Magnetic field due to magnetic Straight wire

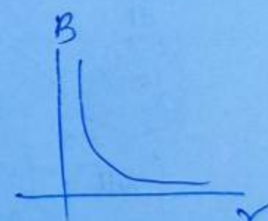


$\oint B\,dl = \mu_0 I$

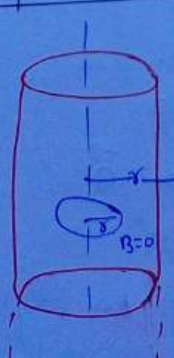
$B \oint dl = \mu_0 I$

$B(2\pi r) = \mu_0 I$

$$\boxed{B = \frac{\mu_0 I}{2\pi r}}$$

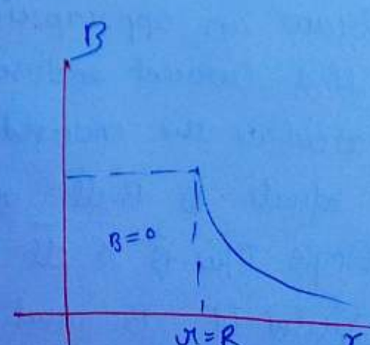


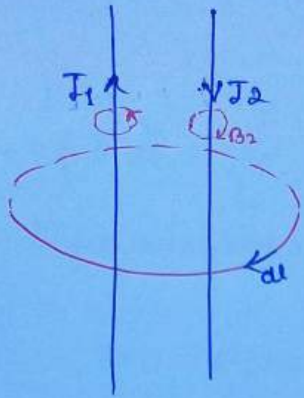
Infinite Hollow Cylinder (magnetic field)



$$\boxed{B = \frac{\mu_0 I}{2\pi r}}$$

$B_{surface} \left(\frac{\mu_0 I}{2\pi R}\right)$





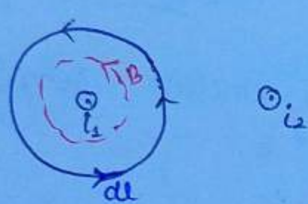
$$\boxed{\oint \vec{B}\cdot d\vec{l} = \mu_0(-I_1 + I_2)}$$

$$= \mu_0(-I_1 + I_2)$$

$$= \mu_0 \cdot (+I_1 - I_2)$$

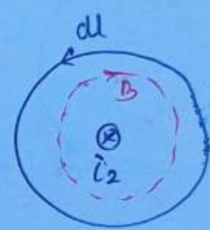
Que Find $\oint \vec{B}\cdot d\vec{l}$ over following loop (direction in which Integration has to be performed is Indicated by arrows)

(i)



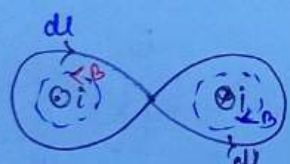
$$\oint \vec{B}\cdot d\vec{l} = +\mu_0 I_1$$

(ii)



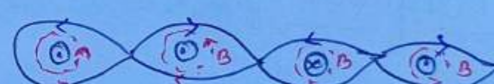
$$\oint B\,dl = -\mu_0 I_2$$

(iii)



$$\oint B\,dl = (-I - I)\mu_0$$
$$-2I\mu_0$$

(iv)



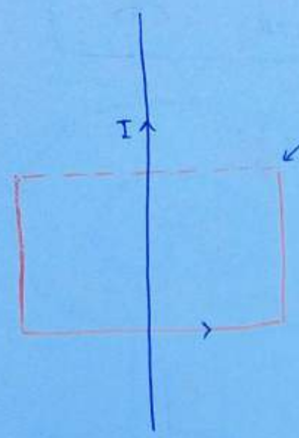
$$\oint B\,dl = \mu_0(\cancel{I} - \cancel{I} - I - I)$$
$$-2I\mu$$

Using Ampere's Circuital Law

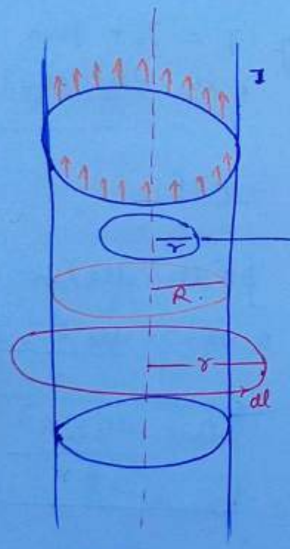
Problem solving strategy for ampere' law

- To apply ampere law to calculate the magnetic field we use the following procedure.
- (i) Draw an appropriate amperian loop
- (ii) Find current enclosed by the amperion loop.
- (iii) calculate the enclosed by the amperian loop
- (iv) Equate $\oint \vec{B}\cdot d\vec{l}$ with $\mu_0 I$ and solve for $\vec{B}$
- (v) Angle B/w $\vec{B}$ & $d\vec{l}$ must be 0, 180° or 90°
- (vi) Value of B must be same at all point on loop.

Magnetic field due to a Straight Infinite Current Carrying wire



Infinite Hollow Cylinder



amperian loop

$\oint \vec{B}\cdot\vec{dl} = \mu_0 I_{in}$

$\boxed{B_{inside} = 0}$

at Surface

$\boxed{B = \frac{\mu_0 I}{2\pi R}}$

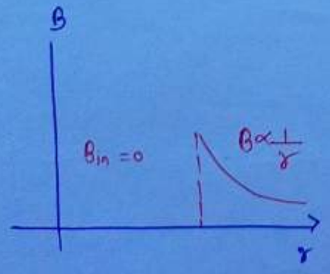
at outside $(r > R)$

$\oint B dl = \mu_0 I_{in}$

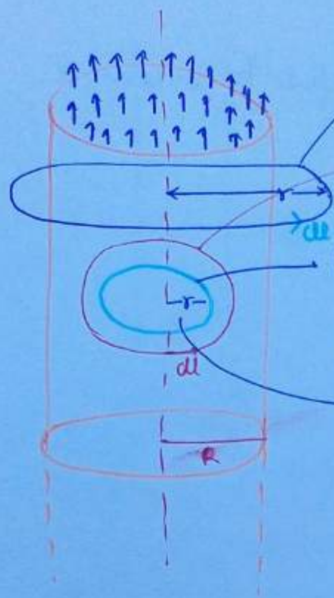
$B \oint dl = \mu_0 I$

$B\, 2\pi r = \mu_0 I$

$\boxed{B = \frac{\mu_0 I}{2\pi r}}$



Infinite Solid Cylinder



outside – $\boxed{B_{out} = \frac{\mu_0 I}{2\pi r}}$ $(r>R)$

$B\oint dl = \mu_0 i_n$

$B(2\pi \cancel{r}) = \mu_0 \frac{I r^{\cancel{2}}}{R^2}$

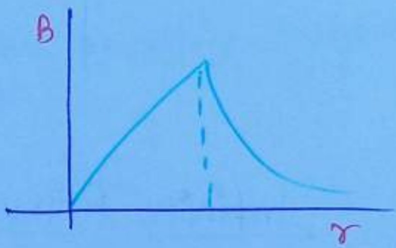
$\boxed{B = \frac{\mu_0 I r}{2\pi R^2}}$

Amperian loop $r<R$ Inside

$\oint B\cdot dl = \mu_0 I_{in}$

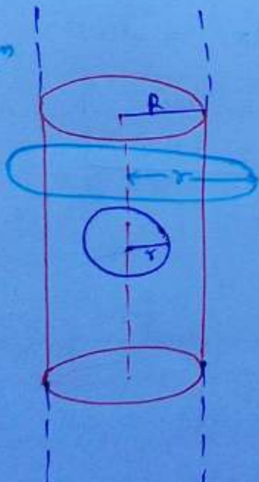
$I_{in} = \frac{I}{\cancel{\pi} R^2} \times \cancel{\pi} r^2$

$\boxed{I_{in} = \frac{I r^2}{R^2}}$



Que Infinite cylinder of Radius R, Current density $J = J_0 r$ then find total current flowing through it where r is distance from axis of cylinder.

Non uniform



$dI = J\,dA$

$\int dI = \int J_0 r (2\pi r\,dr)$

$I = 2J_0\pi \int_0^R r^2 dr$

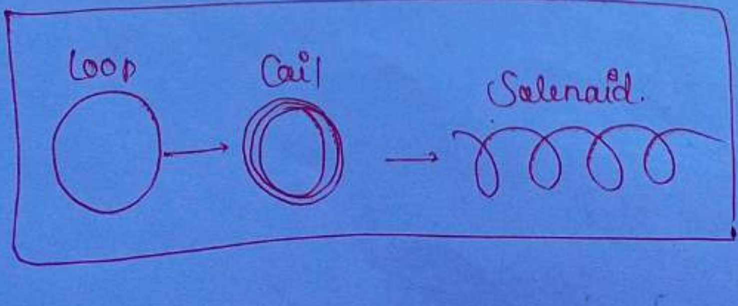
$2J_0\pi \left(\frac{r^3}{3}\right)_0^R = \frac{2J_0\pi R^3}{3}$

$r>R$

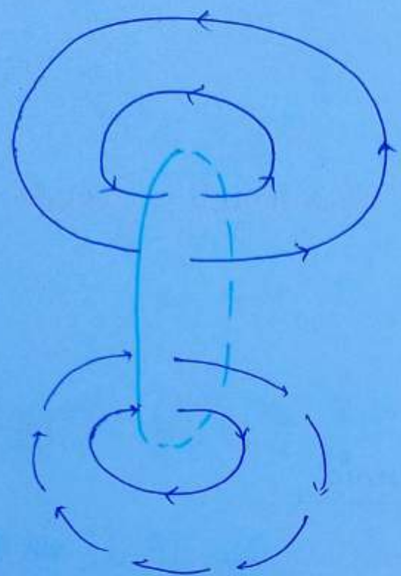
$\oint \vec{B}\,dl = \mu_0 I_{in}$

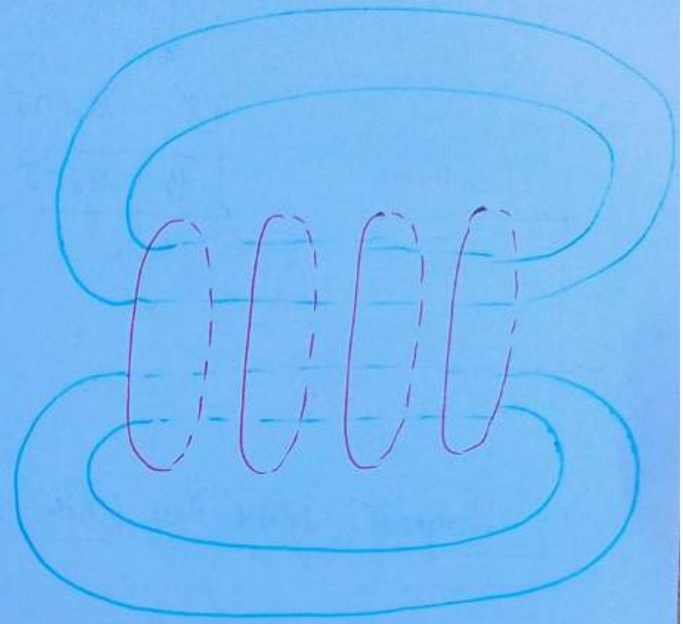
$B\,\cancel{2\pi} r = \frac{\mu_0 \cancel{2} J_0 \cancel{\pi} R^3}{3}$

$\boxed{B = \frac{\mu_0 J_0 R^3}{3r}}$

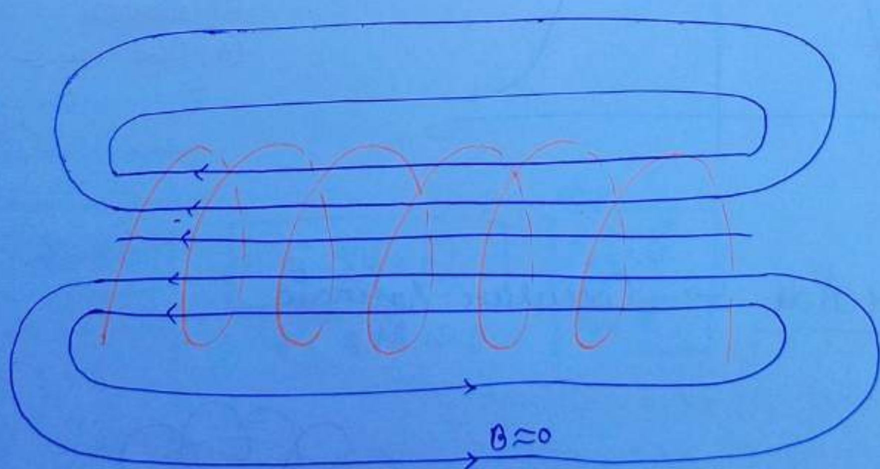


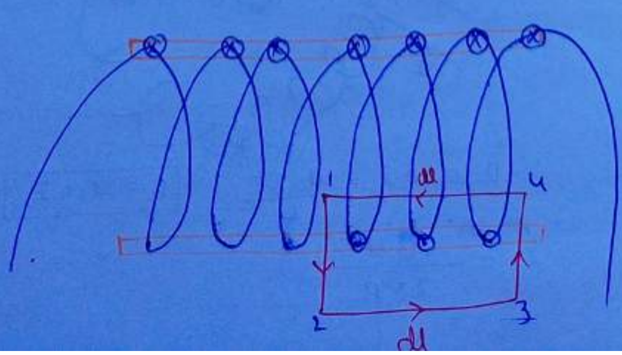
Solenoid ⇒ Loop





Solenoid ⇒





$\frac{N}{L} = n$ = no. of turns per unit length.

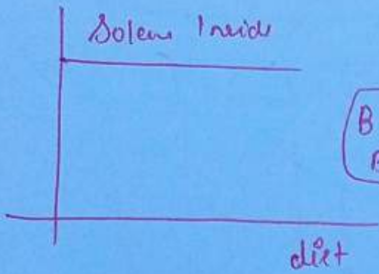
$I_{\text{Incurrent}} = Inl$ in l.

$$\oint B\,dl + \oint B\cdot dl + \oint B\cdot dl + \oint B\cdot dl = \mu_0 I_{in}$$

$$B\int_{41} dl = \mu_0 (I n l)$$

$$B\cancel{l} = \mu_0 n I \cancel{l}$$

$$\boxed{B = \mu_0 n I}$$ → dimensionally correct

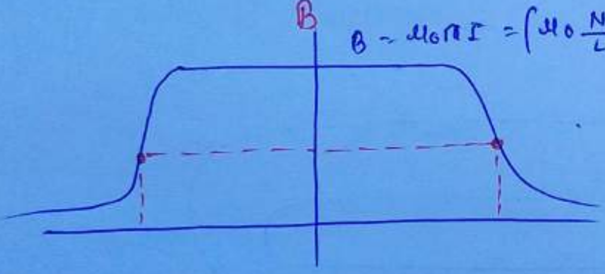


$B \propto n$
$B \propto I$

Magnetic field due finite solenoid

$$B = \frac{\mu_0 n I}{2}\left[\sin\alpha + \sin\beta\right]$$

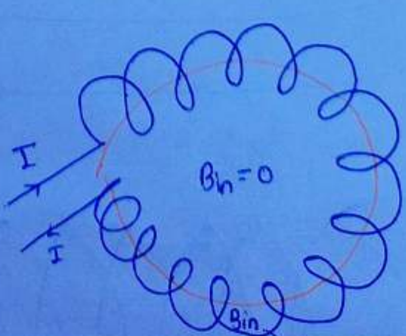
$$B = \mu_0 n I = \left(\mu_0 \frac{N}{L} I\right)$$



Que. If length of solenoid doubled then magnetic field inside solenoid will be ??

(a) Same
(b) Half
(c) doubled
(d) Cant say

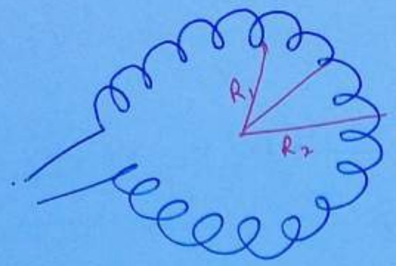
Toroide → Circular solenoid



$\boxed{B = \mu_0 n I}$

$$B = \mu_0 n I = \frac{\mu_0 N I}{L}$$

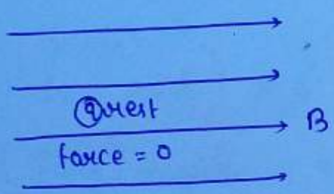
$$= \frac{\mu_0 N I}{2\pi R}$$

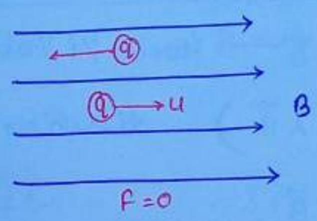


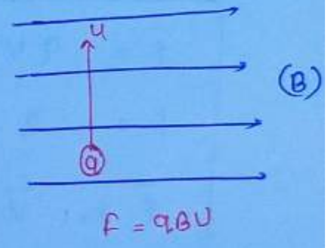
$$\boxed{R_{avg} = \frac{R_1 + R_2}{2}}$$

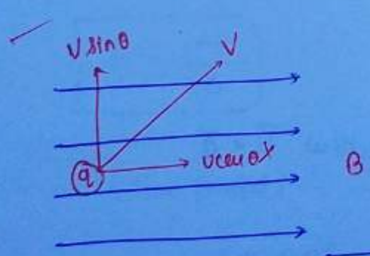
$$B = \mu_0 n I = \frac{\mu_0 N I}{L} = \frac{\mu_0 N I}{2\pi R}$$

Magnetic field on charge







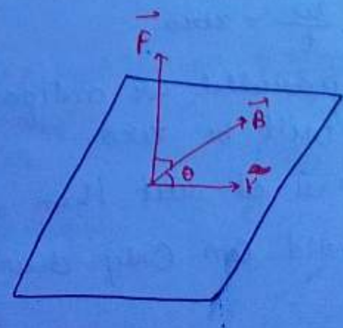


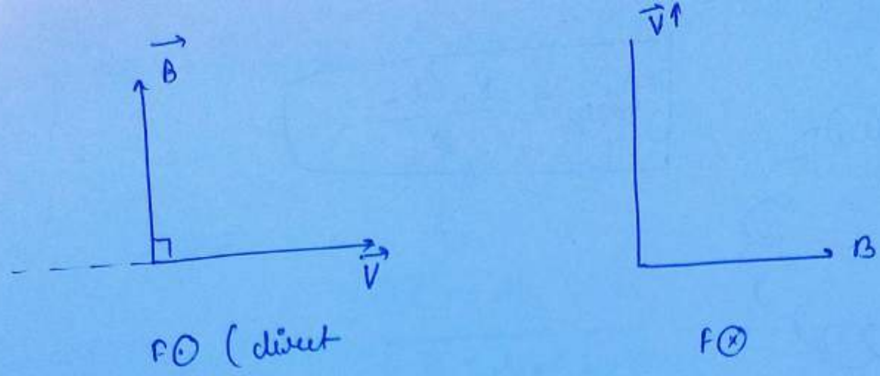
$\boxed{f = qv\sin\theta B}$ $\boxed{\vec{F} = q(\vec{v} \times \vec{B})}$

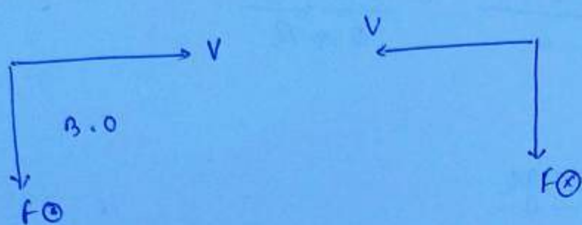
$f = qvB\sin\theta$

$\boxed{F \perp r \cdot \vec{U}}$
$\boxed{F \perp r \cdot \vec{B}}$

$F \propto q$
$F \propto V$
$\propto B$
$F \propto \sin\theta$

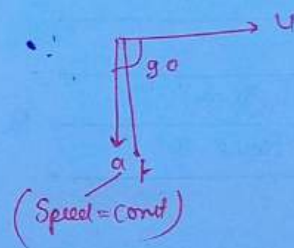






Magnetic force ⇒

$$\boxed{\begin{array}{l} F = qVB \text{ — force ki value} \\ F = q(\vec{V} \times \vec{B}) \text{ — direction} \\ \vec{F} \perp r \ \vec{V} \ \& \ \vec{B} \\ \vec{F}.\vec{V} = 0 \text{ (zero)} \end{array}}$$



$F = q(\vec{V} \times \vec{B}) = qVB \sin\theta$ → Angle b/w $\vec{V} \times \vec{B}$

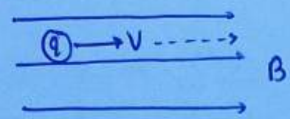
↳ force is always $\perp r$ to $\vec{V}$ & $\vec{B}$

($\vec{B} \perp r\ \vec{a}$)

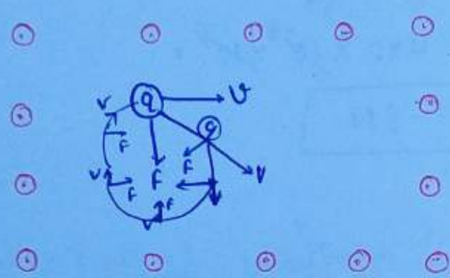
- Speed alway Constant ($\vec{a} \perp r\ \vec{V}$)
- $K.E = $ Const,
- Work $= \Delta K.E = 0$ (zero)
- Power $= \frac{W}{t} =$ zero
- If $\vec{V}$ is parallel or antiparallel to magnetic field then force will be zero.
- If charge is at rest then magnetic force will be zero
- Magnetic field can Only change dir^n of motion of charge particle
- $\vec{F}.\vec{B} = 0$, $\vec{F}.\vec{V} = 0$, $\boxed{\vec{a}.\vec{V} = 0}$

Path of charge particle in magnetic field

(i) Straight line ($\vec{v} \parallel \vec{B}$) → force = 0
$a = 0$
$\vec{v}$ = const



(ii)



magnetic force = Centripetal force

$$qvB \sin 90^\circ = \frac{mv^2}{R}$$

$$\boxed{R = \frac{mv}{qB}}$$

$R \propto m$ $\quad$ $R \propto \frac{1}{q}$
$R \propto V$
$R \propto \frac{1}{B}$

$F = qvB$

$F_c = qvB = \frac{mv^2}{R}$

$(F_{avg})_{\text{magnetic force}} = qvB \dfrac{\sin(\frac{\theta}{2})}{(\theta/2)}$

$\boxed{R = \dfrac{mv}{qB}}$

$T(\text{time period}) = \dfrac{2\pi R}{v}$

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

P.M.A. $\boxed{T = \dfrac{2\pi m}{qB}}$ — does not depend on speed

time taken to complete 2π rad is $= \dfrac{2\pi m}{qB}$
" " " " 1 rad " $= \left[\dfrac{m}{qB}\right]$
" " " " θ angle $= \left(\dfrac{m\theta}{qB}\right)$

$\boxed{f = \dfrac{qB}{2\pi m} = \dfrac{1}{T}}$ — work = 0 (coz speed const)
K.E = const

Qu The magnetic force acting on a charged particle

① 4 N in z direction

② 8 N in y "

③ 8 N in z "

④ 8 N in -z "

$q = -2\mu C$

$B = 2T\ \hat{j}\times$

$V = (2\hat{i} + 3\hat{j}) \times 10^6$

$F = 4 \times 2 \times \cancel{10^{-6}} \times \cancel{10^{6}} =$

$\boxed{F = -8N}$

Q Velocity of charge particle $(2\hat{i} + 3\hat{j})$ and accⁿ $(3\hat{i} - \beta\hat{j})$ in magnetic field then find value of β ??

$\vec{V} \perp r\ \vec{a}$ (Perp ka (·) product zero hota)

$(2\hat{i} + 3\hat{j}) \cdot (3\hat{i} - \beta\hat{j}) = 0$

$6 - 3\beta = 0 \qquad \beta = \frac{6}{3}^{2} = 2$ Ans

Qu Charge q is moving with $V = (3\hat{i} - 2\hat{j})$ and $B = 4\hat{j}$ and $\vec{E} = 2\hat{i}$ then find net force ??

$\vec{F} = q\vec{E} + q(\vec{V} \times \vec{B}) =$

$q(2\hat{i}) + q(12\hat{k})$

$q(2\hat{i} + 12\hat{k})$

Qu A proton (m, e), deutron $(2m, e)$, & α-particle $(4m, 2e)$ are projected with same velocity in magnetic field. then find Ratio of their radius of circular path.

Solⁿ

$= 1 : 2 : 2$

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

$r \propto \frac{m}{q}$

$r_p : r_D : r_\alpha = \frac{\cancel{m}}{\cancel{e}} : \frac{2\cancel{m}}{\cancel{e}} : \frac{4\cancel{m}}{2\cancel{e}}$

Que A proton (m, e), deutron $(2m, e)$ & α-Particle $(4m, 2e)$ are projected with same momentum in magnetic field then find Ratio of their radius of Circular path

$$r \propto \frac{mv}{qB} = r \propto \frac{m}{q}$$

$$r_p : r_D : r_\alpha = \frac{\cancel{m}}{\cancel{e}} : \frac{2\cancel{m}}{\cancel{e}} : \frac{4\cancel{m}}{2\cancel{e}}$$

$$= \boxed{1 : 2 : 2}$$

Que A Proton (m, e), deutron $(2m, e)$ & α-Particle $(4m, 2e)$ are projected with same $(K.E)$ in magnetic field then find Ratio of their radius of Circular Path.

Soln

$$r = \frac{mv}{qB} = \frac{P}{qB} = \frac{\sqrt{2mK.E}}{qB}$$

$$r \propto \frac{\sqrt{m}}{q}$$

$$r_p : r_D : r_\alpha = \frac{\sqrt{\cancel{m}}}{\cancel{e}} : \frac{\sqrt{2\cancel{m}}}{\cancel{e}} : \frac{\sqrt{4\cancel{m}}}{2\cancel{e}} = 1 : \sqrt{2} : 1$$

Qu A Proton (m, e), deutron $(2m, e)$ & α-particle $(4m, 2e)$ are accelerated with same potential and then projected in magnetic field then find ration of their radius of Circular Path

$$r = \frac{\sqrt{2mq\Delta V}}{qB}$$

$$r = \frac{\sqrt{mq}}{q} = \sqrt{\frac{m}{q}}$$

$$r_p : r_D : r_\alpha = \sqrt{\frac{\cancel{m}}{\cancel{e}}} : \sqrt{\frac{2\cancel{m}}{\cancel{e}}} : \sqrt{\frac{4\cancel{m}}{2\cancel{e}}} = 1 : \sqrt{2} : \sqrt{2}$$

Qu A uniform magnetic field at right angle to the direction of motion of electron. as a result, the e^- moves in a Circular path of radius 2 cm, If the speed of electron is double then the radius of circular path will be

(1) 2.0 cm

(2) 0.5 cm

(3) 4.0 cm

(4) 1.0 cm

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

Qu A charge having e/m equal to 10^8 c/kg and with velocity 3×10^5 m/s enters into a uniform magnetic field $B = 0.3$ tesla at an angle $30°$ with direction of field. The radius of curvature will be.

(1) 0.01 cm

(2) 0.5 cm

(3) 1 cm

(4) 2cm

$\frac{e}{m} = 10^8$ c/kg

$v = 3 \times 10^5$ m/s

$B = 0.3T$

$\theta = 30°$

Nature of charge particle ??

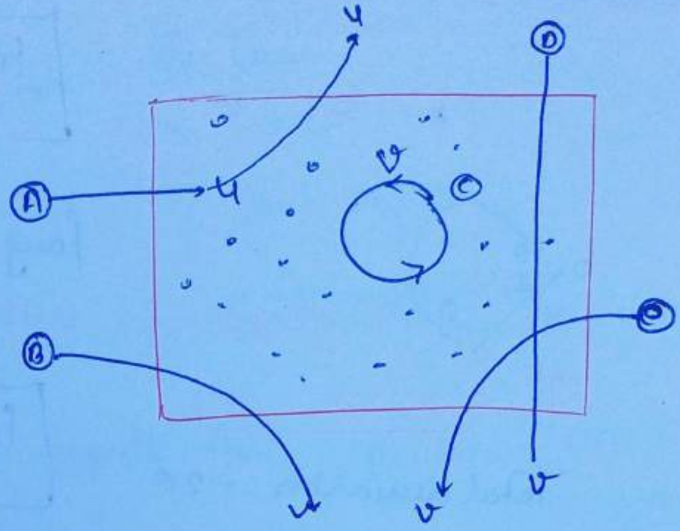
A — -ve

B → +ve

C → -ve

D → neutral

e → -ve



Now charge particle ⊥r to magnetic field but beam outside of region of magnetic field.

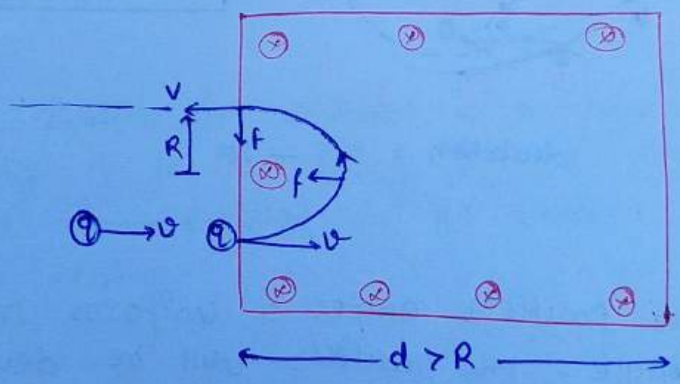
$$\frac{mv^{\cancel{2}}}{R} = q\cancel{v}B$$

$$\boxed{R = \frac{mv}{qB}}$$

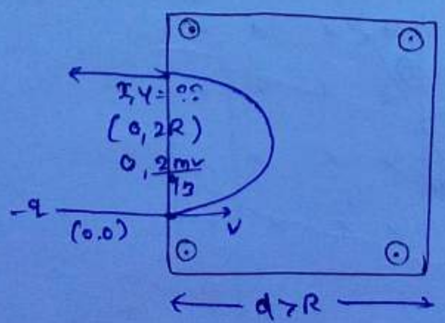
$$T = \frac{m\pi}{qB}$$

deviation = π rad

= 180°



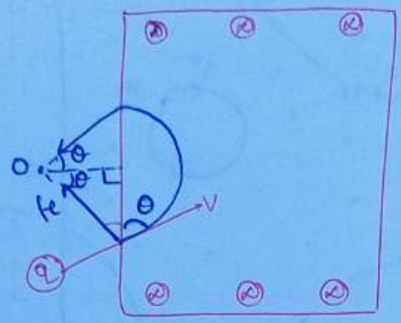
Qu



Angle b/w $\vec{B}$ & $\vec{V}$ is $90°$

Angle b/w boundary and velocity

M.f. ke bahar



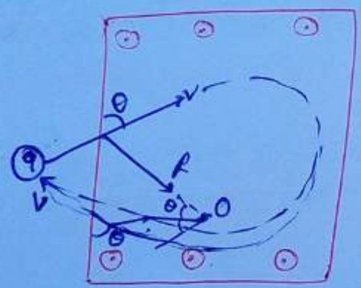
Total deviation $= 2\theta$

$$\boxed{\text{time} = \frac{m\,2\theta}{qB}}$$

$$F_{avg} = \frac{qvB\sin\left(\frac{2\theta}{2}\right)}{\frac{2\theta}{2}}$$

$$\boxed{F_{avg} = qvB\,\frac{\sin\theta}{\theta}}$$

m. field ke andar

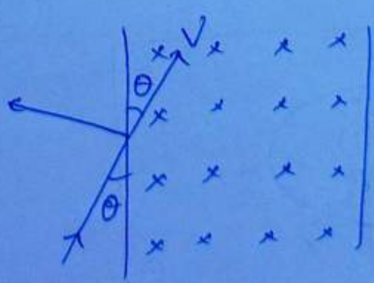


deviation $= 2\pi - 2\theta$

$$\boxed{\text{time} = \frac{m}{qB}(2\pi - 2\theta)}$$

Que A charged particle entree a uniform magnetic field at some angle. the particle will be deviated from its path by angle $180°$ Value of θ will be

(1) $90°$ ✓
(2) $60°$
(3) $120°$
(4) $180°$



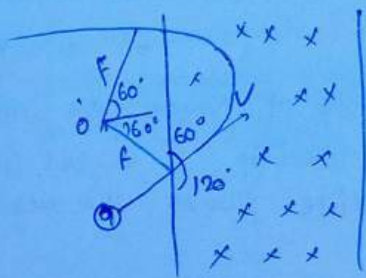
Q. Charge particle can't accelerate in the magnetic field ?
or magnetic field can't accelerate the charge particle.

accln → speed change, dirn change

(a) True
(b) false
(c) can't say

Magnetic field can velocity — True

Que. find time spend in magnetic field, deviation ??

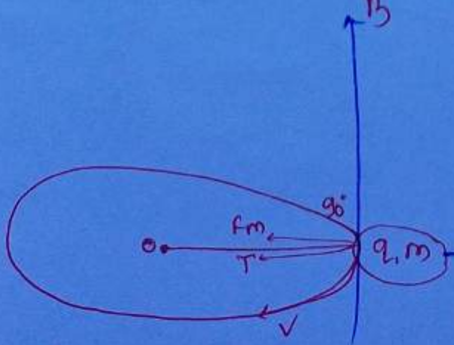


① 120°
② 60°
③ 240°
④ None

Que. A charged particle is whirled in a horizontal circle by attaching it to a string fixed at one point If a magnetic field is switched on the vertical direction the tension in the string.

① will increase
② will decrease
③ will remain the same
④ May Inc. or dec.

motion in a Horizontal circle is clockwise or anti clock is not given.



→ Fm (m) ⇒ Charge B +ve or -ve is not given

Que A particle having a charge of 10 μc and mass 1 μg moves in a horizontal circle of radius 10 cm. Under the Influence of a magnetic field of 0.1 T when the particle is at a point P a uniform electric field is switched on so that the particle start moving along the tangent with uniform velocity the electric field is.

① 0.1 V/m
② 1.0 V/m
③ 10.0 V/m ✓
④ 100 V/m

$$V = \frac{RqB}{m}$$

$$E = V \times B = \frac{RqB^2}{m}$$

$$\frac{10^{-5} \times 10^{-4}}{10 \times 100 \times 10^{-9}}$$

$$= 10 \, V/m$$

$$F_c = qvB = qE$$

$$E = V \times B$$

$$\frac{RqB(B)}{m} = \frac{1}{10} \times \frac{10^{-8}}{10^{-6} \times 10^{3}} \times \frac{1}{100}$$

$$= 10^4,$$

Qu A particle of charge per unit mass α is released from origin with a velocity $\vec{v} = v_0 \hat{i}$ in a uniform magnetic field $\vec{B} = -B_0 \hat{k}$ if the particle passes through (0, y, 0) then y is equal to.

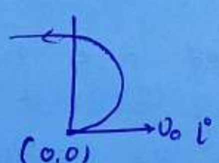
(a) $-\frac{2v_0}{B_0 a}$

(b) $\frac{v_0}{B_0 a}$

(c) $\frac{2v_0}{B_0 a}$ ✓

(d) $-\frac{v_0}{B_0 a}$

$$\frac{q}{m} = \alpha$$



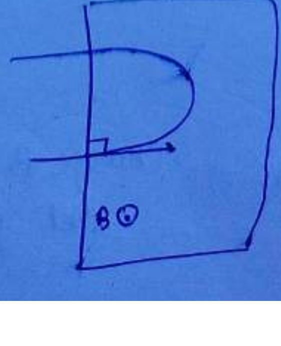
$B(x) = -B_0 \hat{k}$

$$y = 2R = \frac{2mv}{qB}$$

$$\boxed{= \frac{2V}{\alpha B}}$$

Qu A charged particle enter a magnetic field at right angle to the magnetic field. The field exist for a length equal to 1.5 times the radius of circular path of the particle, the particle will be deviated from its path by

① 90°
② $\sin^{-1}\left(\frac{2}{3}\right)$
③ 30°
④ 180° ✓



Qu A proton and an α-particle entre a uniform magnetic field perpendicular with the same speed. If proton take 20 μs to make 5 revolution then the periodic time for the α particle would be

(1) 5 μs
(2) 8 μs ✓
(3) 10 μs
(4) 16 μs

Proton $(m, e) \longleftrightarrow \alpha$ - Par $(4m, 2e)$

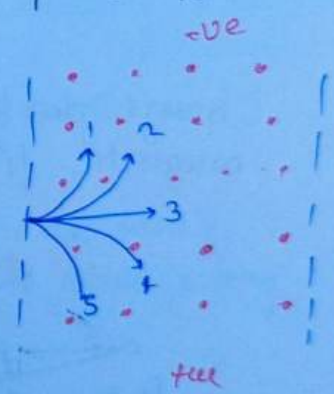
$T = 20\,\mu s$ in 5 rev

time $= 4\,\mu s$

$$T = \frac{2\pi m}{qB} \propto \frac{m}{q} = \frac{\cancel{4}^{2} m}{\cancel{2} e}$$

$2(T)$

Qu A proton an elec, a neutron an α-particle and an unknown particle entre in a region of uniform magnetic field with equal momenta. figure shows path (marked 1 to 5) followed by these particle. Identify which path correspond to which particle.



Proton → ~~54~~

electron → 2

neutron → 3

α- particle → ~~5~~

Unknown particle - -ve (1)

Q A particle with a specific charge (s) is fired with a speed v towards a wall at a distance d. perpendicular to the wall what minimum magnetic field must exist in this region for the particle doesn't hit the wall

(1) $\frac{v}{sd}$ ✓
(2) $\frac{2v}{sd}$
(3) $\frac{v}{2sd}$
(4) $\frac{v}{4sd}$

$R = d$

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

$$B = \frac{mv}{qd} = \frac{v}{sd}$$

Que A particle of mass m carrying charge q is accelerated by a potential difference v. It enters perpendicularly in a region of uniform magnetic field B and executes arc of radius R. then $\frac{q}{m}$ equals

(1) $\frac{2V}{B^2R^2}$ ✓

(2) $\frac{V}{2BR}$

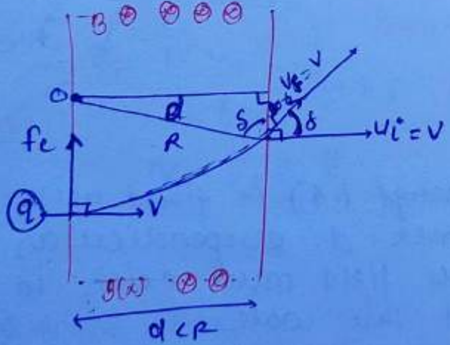
(3) $\frac{VB}{2R}$

(4) $\frac{mV}{BR}$

$$R = \frac{\sqrt{2mK.E}}{qB} = \frac{\sqrt{2mqv}}{qB}$$

$$R^2 = \frac{2mqv}{q^2B^2} \qquad \frac{q}{m} = \frac{2V}{B^2R^2}$$

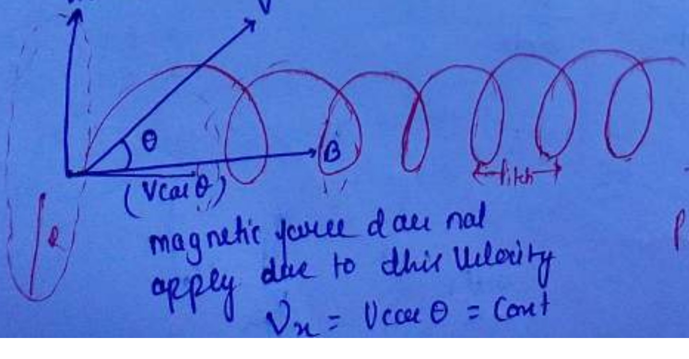
Charge particle projected outside from a region of magnetic field but (d < R) then find deviation.



$$\sin\delta = \frac{d}{R}$$

$$\boxed{\delta = \sin^{-1}\left(\frac{d}{R}\right)}$$

Particle is projected at an angle ($\theta < 90°$) from mag-field



magnetic force does not apply due to this velocity

$V_x = V\cos\theta = \text{Const}$

$$\frac{m(v\sin\theta)^2}{R} = q\,v\sin\theta\, B$$

$$\boxed{R = \frac{mv\sin\theta}{qB}}$$

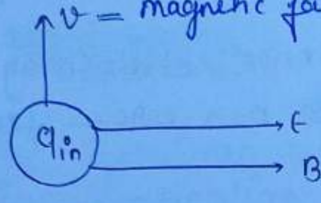
Time Period $= \frac{2\pi R}{V} = \frac{2\pi}{V\sin\theta}\left(\frac{mv\sin\theta}{qB}\right)$

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

Pitch = dist moved by charge particle along mag. field. when it Complete on revolution

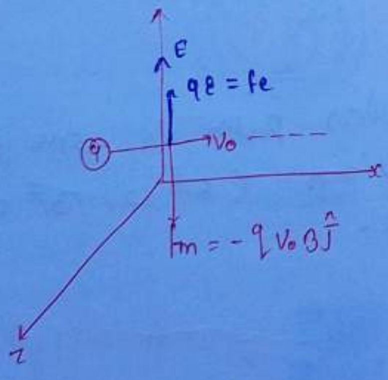
$$\boxed{\text{Pitch} = v_x \,\text{time per} = v\cos\theta\left(\frac{2\pi m}{q\theta}\right)}$$

Q



① Circular
② Uniform helix
③ non uniform helix

moving of charge particle in Combined electric and magnetic field.



now I apply electric field along Y-axis such that force along Y-axis

$F_e = qE$

So that

$F_{net} = 0$

electric force will balance mag. force

1 Ramlaal ka Sar phod diya.

$F_E = F_m$ ($F_{net} = 0$)

$\cancel{q}E = \cancel{q}V_0B$

$\boxed{V_0 = \left(\frac{E}{B}\right)}$ Velocity Selector

Velocity of porpagation of charge

Now charge will passed without deviation

S-1 charge particle is at rest experience zero electromagnetic force then electric field may be zero - false

S-2 charge particle is at rest experience zero electro magnetic force then magnetic field may be zero True.

S-3 charge particle is at rest experience electromagnetic force then electric field must be non zero. - True

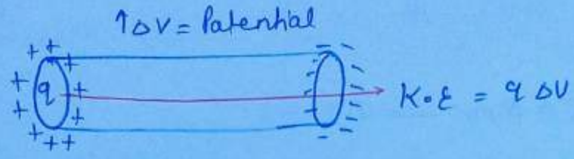
S-4 charge particle is at rest experience electromagnetic force then magnetic field must be non zero. - false

S-5 charge is moving in E-M field without deviation then electric field & magnetic field both may be non zero or both may be zero. - True

S-6 Charge particle passes EM field without accleration then ~~three~~ position $(E=0, B=0)$ $(E=0, B\neq 0)$ $(E\neq 0, B\neq 0)$ - True

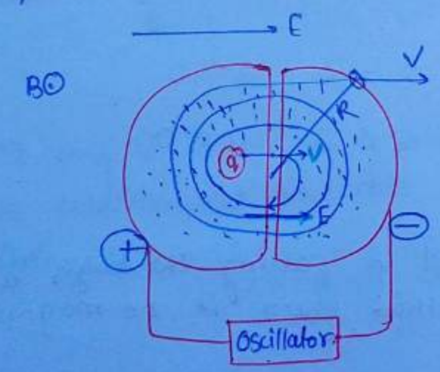
S-7 charge is moving on circular path in EM field then any possible condition $(E=0, B\neq 0)$ True -

Charge particle are bombarded on their target



Cyclotron → The Cyclotron is a machine to accelerate charged particles or ions to high energies. The cyclotron uses both electric and magnetic field in combination to increase the energy of charged particle. Magnetic field use to keep the charge particle inside electric field, and electric field will increase the K.E of charge particle.

not for e^-



ΔV = Potential diff^n

$K.E = 2(q\Delta V)$ in one rot^n

$K.E_{n\ rot^n} = 2n(q\Delta V)$

$$\boxed{f_{\text{frequency of oscillation}} = f_{\text{charge}} = \left(\frac{qB}{2\pi m}\right)}$$

Working Principle – Time / frequency does not depends on speed and radius

Qu If frequency of cyclotron is n then find B (magnetic field use in cyclotron)

$$f_{\text{charge}} = \frac{qB}{2\pi m} = n$$

$$\boxed{B = \frac{2\pi m n}{q}}$$

Potential difference of oscillator is 100 KV. Find total no. of oscillation for 20 MeV kinetic energy of Proton

$$K.E_{Total} = 20\ MeV \quad \text{—— (1)}$$

$$K.E \text{ gain in } n\text{-rot}^n = 2nq\Delta V$$

$$20 \times \cancel{10^6} eV = 2ne\ \cancel{100} \times \cancel{10^3}$$

$$200 = 2n$$

$$\boxed{n = 100}$$

~~[illegible]~~

Qu. A charged particle moves in a gravity free space without change in velocity which of the following is not possible in the space?

(a) $E = 0,\ B = 0$

(b) $E \neq 0,\ B = 0$ ✓

(3) $E = 0,\ B \neq 0$

(4) $E \neq 0,\ B \neq 0$

Qu. If an electron is not deflected in passing through a certain region of space can be sure that there is no magnetic field in that region

(a) Yes

(b) No ✓

Q. A beam of proton is deflected sideway could this deflection be caused

(1) By an electric field — Yes

(2) By a magnetic field — Yes

(3) If either could be responsible how would you be able to tell which was present

If charge particle at rest experience no electromagnetic force. then the electric field must be zero.

OR

The magnetic field may or may not be zero

If charge particle projected in a gravity free room reflects then both fields cannot be zero

OR

Both field can be (non zero)

$\mathcal{E}=0,\ B=0$ ✗

$\mathcal{E}=0,\ B\neq 0$ ✓

$\mathcal{E}\neq 0,\ B=0$ ✓

$\mathcal{E}\neq 0,\ B\neq 0$ ✓

Can Reflect

A charged particle moves in a gravity free space without change in velocity possible cases are

$\mathcal{E}=0,\ B=0$ or $\mathcal{E}=0,\ B\neq 0$, or $\mathcal{E}\neq 0,\ B\neq 0$

a charged particle move along a circle under the under action of possible constant electric and mag. field possible case is $\boxed{\mathcal{E}=0,\ B\neq 0.}$ – only one condiⁿ for circular

A charge particle goes undeflected in a region containing electric field and mag. field it is possible that

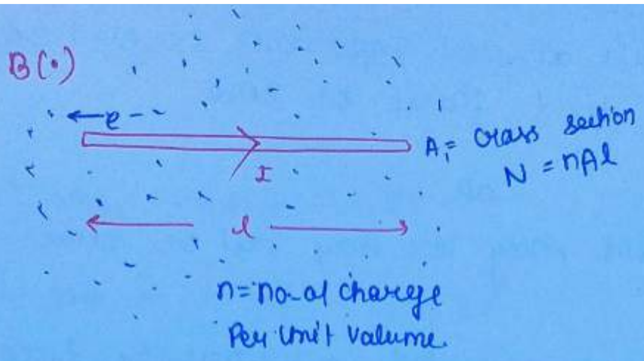
$\mathcal{E}=0,\ B=0$, $\mathcal{E}\neq 0,\ B=0$, $\mathcal{E}=0,\ B\neq 0$

Velo. ||r B.

dirⁿ is not change

If charged particle goes accelerated in a region containing electric and magnetic field then.

$\vec{\mathcal{E}}$ must be perpendicular to $\vec{B}$ and $\vec{v}$ must be perpend to $\vec{\mathcal{E}}$

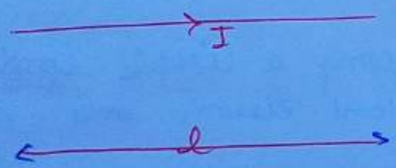


force on 1 e^- = qvB = eV_dB $\because I = neAV_d$

force on N-electron = NeV_dB = $nAl\,eV_dB$ = $\underline{IlB}$

Magnetic force on a Current Carrying conductor

As we know that magnetic field applies force on a moving charge particle hence it should apply force on a current carrying wire as well



$F = I\vec{L} \times \vec{B}$

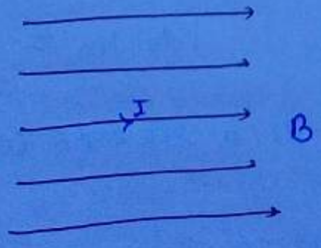
force must be ⊥r to $\vec{B}$ & $I\vec{L}$

$F = I\vec{l} \times \vec{B}$

$IlB\sin\theta$

$F = IlB$

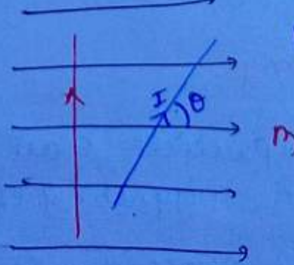
Ex



$F = BIl\sin 0$

$= 0$

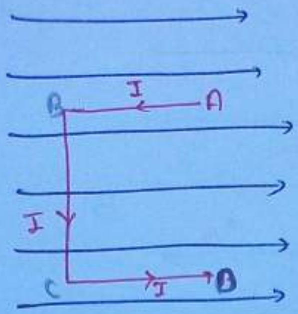
Ex.



$F = BIL\sin\theta$

$F = BIL(x)$

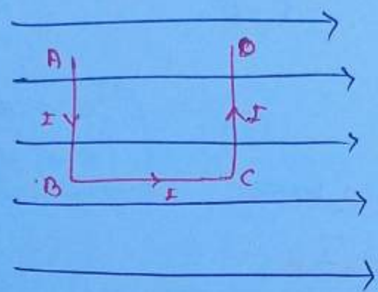
Ex.



$F_{AB} = 0 = F_{CD}$

$F_{BC} = IBL\ (\cdot)$

Ex



B

$F_{AB} = BIL\ (\cdot)$

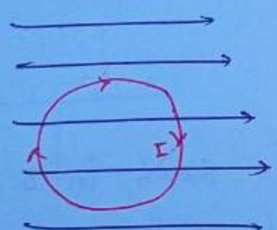
$F_{BC} = 0$

$F_{CD} = BIL\ (x)$

$F_{net\ on\ wire} = 0$

$F = BIL = 0$

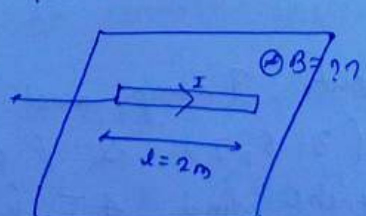
Ex!



B

$\boxed{F = 0}$

Qu A straight wire of mass 400 gm and length 2 m carries a current of 2A. If it suspended in mid air by a uniform horizontal field B. What is the magnitude of the magnetic field.?



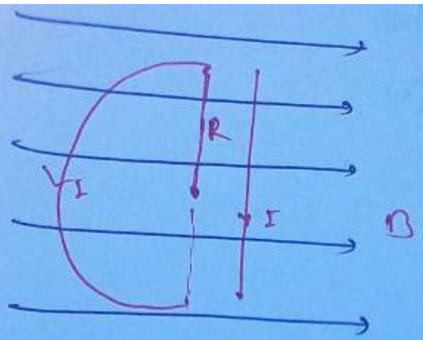
rest

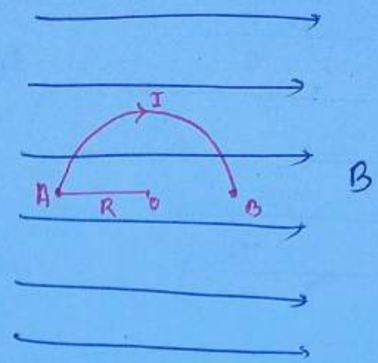
$BIL = mg$

$B = \frac{mg}{IL}$

$B = \frac{4\cancel{00} \times 1\cancel{0}}{1\cancel{000} \times 2 \times 2}$

$\boxed{B = 1\ Tesla}$



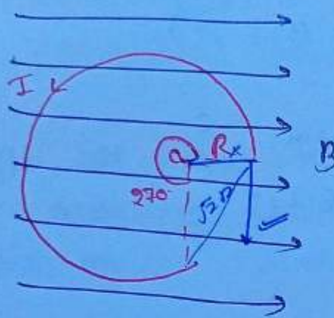


$f = BI(\text{leaf})(\text{Lr to } B)$

$$\boxed{F = B2RI}$$

$F = 0$

Qu



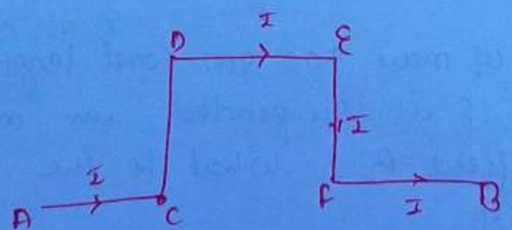
(a) $F = BIR$

(b) $F = BI\sqrt{2}R$

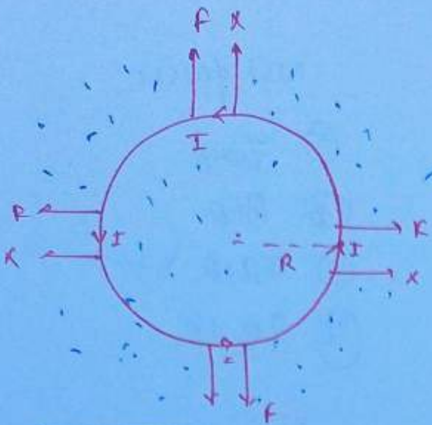
(c) $f = 3\sqrt{2}\,BIR$

Qu A uniform magnetic field $\overline{B} = B_0\hat{k}$ exist in a region A current carrying wire is placed in x-y plane as shown find the force acting on the axis wire AB if each section of the wire is of length

$F = (B\hat{I}\,3a)/2$

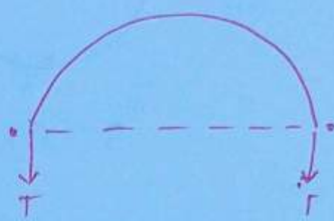


Qu A wire having current 3 Amp and coordinate of its two end is $(3, 6, 7)$ & $(6, 10, 12)$. Then find force if magnetic find $4T\,\hat{k}$.



$\boxed{\begin{matrix}\tau_{net} = 0 \\ F_{net} = 0\end{matrix}}$ BO

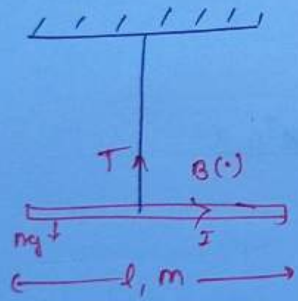
FBD of half loop



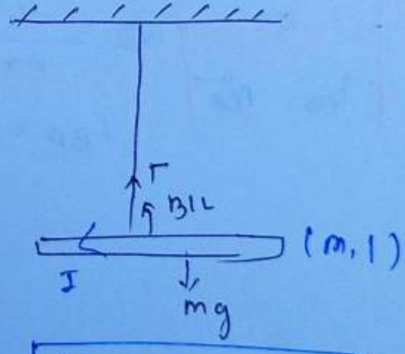
$\cancel{2}T = \cancel{2}BIR$

$\boxed{T = BIR}$

Q. Find Tension in string.

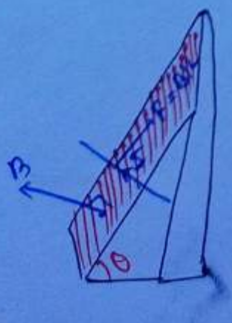


$\boxed{T = mg + BIL}$



$\boxed{T = mg - BIL}$

Q. Find value B so that wire can be at rest on smooth inclined plane.



$BIL = mg\sin\theta$

$B = \left(\dfrac{mg\sin\theta}{IL}\right)$ Q