

MAGNETIC FIELD

Magnetic field is the region surrounding a moving charge in which its magnetic effects are perceptible on another moving charge (electric current).

BIOT-SAVART LAW

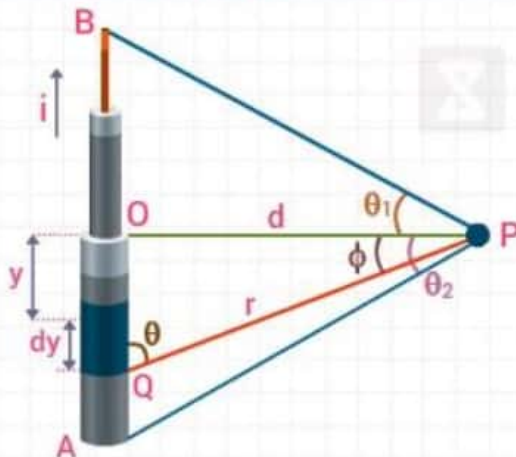
Biot-Savart law gives the magnetic induction due to an infinitesimal current element. According to 'Biot-Savart Law', the magnetic field induction $d\vec{B}$ at P due to the current element $d\vec{l}$ is given by,

$$d\vec{B} = k \frac{i(d\vec{l} \times \vec{r})}{r^3}$$

FIELD DUE TO A STRAIGHT CURRENT CARRYING WIRE

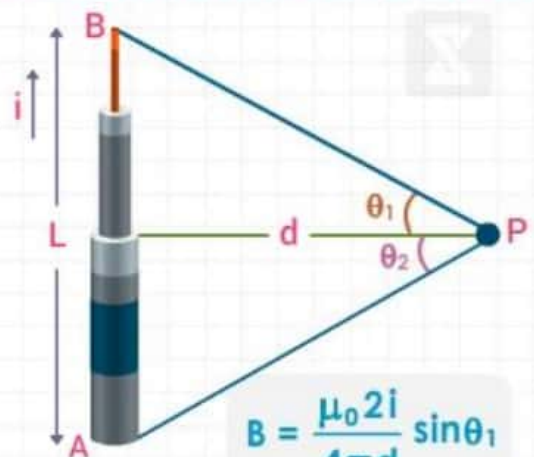
1 When the wire is of finite length

At any point P



$$B = \frac{\mu_0 i}{4\pi d} [\sin\theta_1 + \sin\theta_2]$$

P is on perpendicular Bi-sector

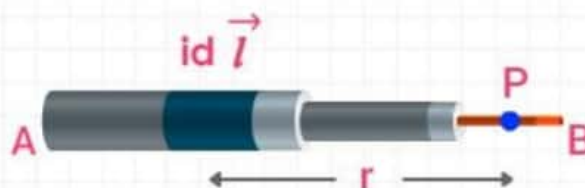


$$B = \frac{\mu_0 2i}{4\pi d} \sin\theta_1$$

$$\text{where } \sin\theta_1 = \frac{L}{L^2 + 4d^2}$$

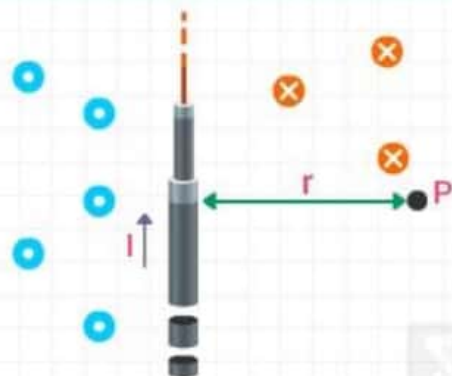
When the point lies along the length of wire (but not on it)

$$\vec{B} = \int_A^B d\vec{B} = 0$$



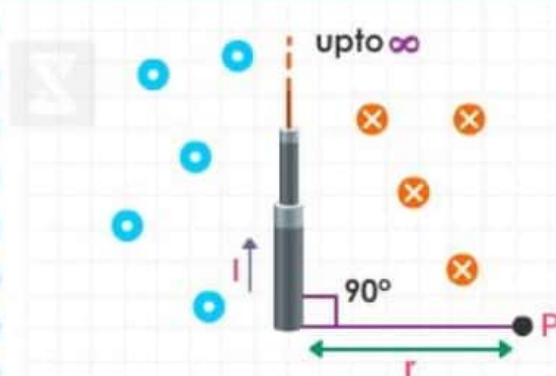
2 When the wire is of infinite length

Case-I



$$B = \frac{\mu_0 I}{2\pi r} \Rightarrow B \propto \frac{1}{r}$$

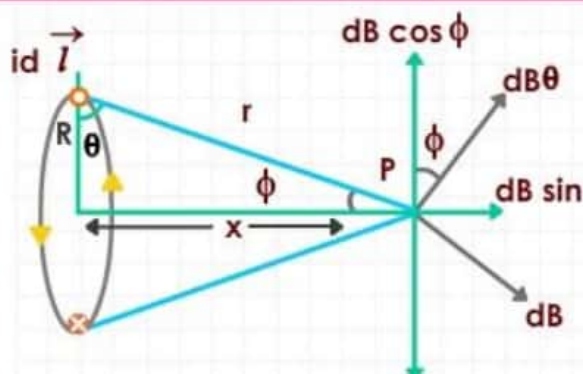
Case-II



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

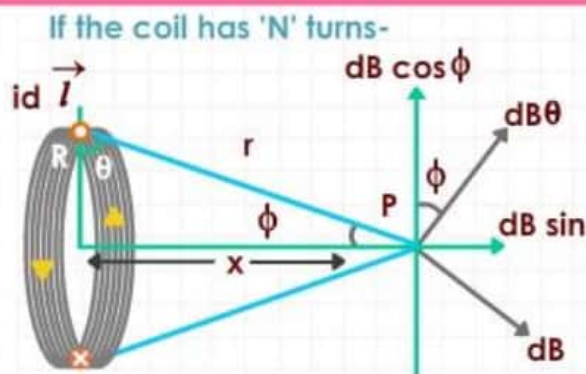
MAGNETIC FIELD AT AN AXIAL POINT OF A CIRCULAR COIL

Case - I



$$B = \frac{\mu_0}{4\pi} \frac{2\pi i R^2}{(R^2 + x^2)^{3/2}}$$

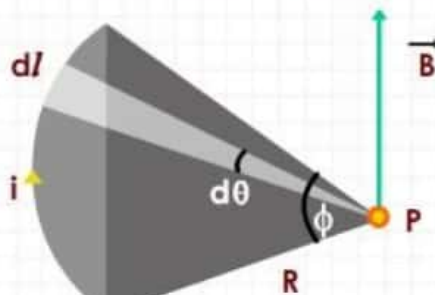
Case - II



$$B = \frac{\mu_0}{4\pi} \frac{2\pi N i R^2}{(R^2 + x^2)^{3/2}}$$

FIELD AT THE CENTRE OF A CURRENT ARC

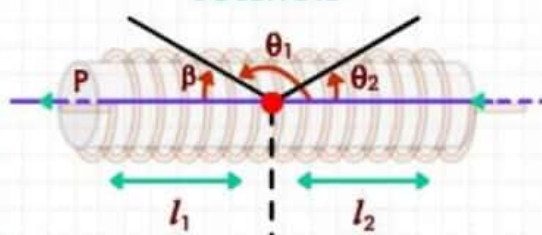
Case - I



$$B = \frac{\mu_0}{4\pi} \frac{i \phi}{R}$$

Case - II

SOLENOID



$$B = \frac{\mu_0 n i}{2} (\cos \theta_1 - \cos \theta_2)$$

MAGNETIC FORCE DUE TO CHARGE PARTICLES

Charge q moving with velocity \vec{v} , in a magnetic field has magnetic force $\vec{F} = q (\vec{v} \times \vec{B})$



MOTION OF A CHARGED PARTICLE IN A UNIFORM MAGNETIC FIELD



CHARGED PARTICLE GIVEN VELOCITY PERPENDICULAR TO THE FIELD

The particle will move on a circular path.



Time period

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

Frequency

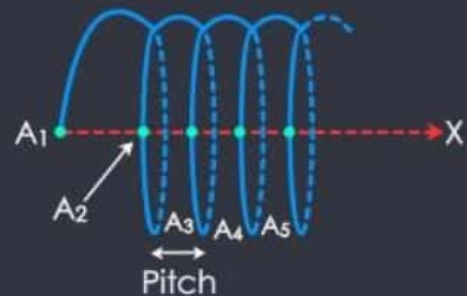
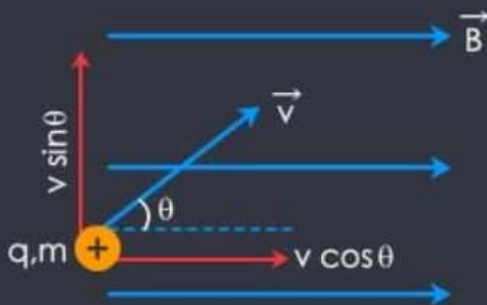
$$v = \frac{1}{T} = \frac{qB}{2\pi m}$$

$$\frac{mv^2}{r} = qvB \Rightarrow r = \frac{mv}{qB}$$



CHARGED PARTICLE IS MOVING AT AN ANGLE TO THE FIELD

$v_{||} = v \cos \theta$ and $v_{\perp} = v \sin \theta$



The radius of path is, $r = \frac{mv_{\perp}}{qB} = \frac{mv \sin \theta}{qB}$, Time period (T) = $\frac{2\pi r}{v_{\perp}} = \frac{2\pi m}{qB}$

$$\text{Frequency (f)} = \frac{qB}{2\pi m}$$



MOTION OF CHARGED PARTICLE IN COMBINED ELECTRIC & MAGNETIC FIELD

When the moving charged particle is subjected simultaneously to both electric field \vec{E} and magnetic field \vec{B} , the moving charged particle will experience electric force $\vec{F}_e = q\vec{E}$ and magnetic force $\vec{F}_m = q(\vec{v} \times \vec{B})$

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

which is 'Lorentz force equation'.

