

$$\vec{F} = q\vec{v} \times \vec{B}$$

$$= qvB \sin\theta$$

- For $\theta = 0$, $\vec{F} = 0$ along the magnetic field
- For $\theta = 90^\circ$, i.e. if charge's velocity is perpendicular to field direction, Force is perpendicular to both field & velocity

$$F = qvB = \frac{mv^2}{r}$$

$$r = \frac{mv}{qB} = \text{radius of the circle in which charge rotates}$$

$$\text{Time period (T)} = \frac{2\pi m}{qB}$$

$$v(\text{frequency}) = \frac{1}{T} = \frac{qB}{2\pi m}$$

If $\theta \neq 0, 180^\circ, 90^\circ$

Then, $F = qvB \sin\theta$

And the charge particle will follow helix path whose

$$r = \frac{m v_{\perp}}{qB} \text{ and pitch} = v_{\parallel} \times T = v_{\parallel} \times \frac{2\pi m}{qB}$$

$$B = \frac{\mu_0 i}{2a}$$

$$B = \frac{\mu_0 i a^2}{2d^3}$$

$$B = \frac{\mu_0 i a^2}{2(a^2 + d^2)^{3/2}}$$

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

$\theta = \text{angle between } d\vec{l} \text{ and } \vec{r}$

Direction of field will be perpendicular to plane containing current element and the point of observation.

$$dB = \frac{\mu_0}{4\pi} \frac{idl \sin\theta}{r^2}$$

where $\mu_0 = \frac{1}{\epsilon_0 c^2} = 4\pi \times 10^{-7} \text{ TmA}^{-1}$

Field at the centre

Field at a point far away from the centre

Field at an axial point

Biot-Savart Law



- It is a region around a magnet or current carrying conductor or a moving charge in which its magnetic effect can be felt
- SI unit is Tesla(T) = weber/m²
- 1 Gauss = 10⁻⁴ Tesla

Magnetic Field (\vec{B})

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

where θ_1 and θ_2 are the angle corresponding to the lower and upper ends respectively



Magnetic Force on moving charge

Moving Charges and Magnetism

Magnetic field due to straight wire current

Field due to a long straight wire current

i.e $\theta_1 = 0$
 $\theta_2 = \pi$
 $B = \frac{\mu_0 i}{2\pi d}$

Ampere's Law

Magnetic field due to Toroid

Force between parallel currents

Definition of Ampere

Gal. to ammeter

Gal. to voltmeter

Solenoid

Force on a current carrying conductor

Torque experienced by a loop in uniform magnetic field

Sensitivity of moving coil galvanometer is nBA/k

Oersted Law

$$S = \frac{I_g}{I_c} G$$

$$R = \frac{V}{I_g} - G$$

$$B = \frac{\mu_0 Ni}{2\pi r}, \quad N = \text{total no. of turns}$$

$i = \text{current in toroid}$

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

If two parallel wire kept 1 m apart, if $F = 2 \times 10^{-7}$, then current = 1A in each.

- Magnetic field at a point inside due to a long solenoid $B = \mu_0 ni$
- And at point on one end $B = \frac{\mu_0 ni}{2}$
- where $n = \text{no. of turns per unit length along the length of solenoid.}$

$$\tau = MB \sin\theta = M \times B$$

In April, 1820, Hans Christian Oersted discovered that flow of current in a wire could deflect a nearby magnetic compass needle

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

where $i = \text{total current crossing the area bounded by closed curve.}$