

## CBSE Class-12 Physics Quick Revision Notes

### Chapter-04: Moving Charges and Magnetism

- **Force on a Straight Conductor:**

Force  $F$  on a straight conductor of length  $l$  and carrying a steady current  $I$  placed in a uniform external magnetic field  $B$ ,

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

- **Lorentz Force:**

Force on a charge  $q$  moving with velocity  $v$  in the presence of magnetic and electric fields  $B$  and  $E$ .

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

- **Magnetic Force:**

The magnetic force  $\vec{F}_B = q(\vec{v} \times \vec{B})$  is normal to  $\vec{V}$  and work done by it is zero.

- **Cyclotron:**

A charge  $q$  executes a circular orbit in a plane normal with frequency called the cyclotron frequency given by,

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

This cyclotron frequency is independent of the particle's speed and radius.

- **Biot – Savart Law:**

It asserts that the magnetic field  $d\vec{B}$  due to an element  $d\vec{l}$  carrying a steady current  $I$  at a point  $P$  at a distance  $r$  from the current element is,

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

- **Magnetic Field due to Circular Coil:**

Magnetic field due to circular coil of radius  $R$  carrying a current  $I$  at an axial distance  $X$  from the centre is

$$B = \frac{\mu_0 IR^2}{2(X^2 + R^2)^{3/2}}$$

At the centre of the coil,

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

- **Ampere's Circuital Law:**

For an open surface  $S$  bounded by a loop  $C$ , then the Ampere's law states that

$$\oint_C \vec{B} \cdot d\vec{l} = \mu_0 I$$

where  $I$  refers to the current passing through  $S$ .

- If  $B$  is directed along the tangent to every point on the perimeter then

$$BL = \mu_0 I_e$$

Where  $I_e$  is the net current enclosed by the closed circuit.

- **Magnetic Field:**

Magnetic field at a distance  $R$  from a long, straight wire carrying a current  $I$  is given by,

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

The field lines are circles concentric with the wire.

- **Magnetic field  $B$  inside a long Solenoid carrying a current  $I$ :**

$$B = \mu_0 nI$$

Where  $n$  is the number of turns per unit length.

- For a toroid,

$$B = \frac{\mu_0 NI}{2\pi r}$$

Where  $N$  is the total numbers of turns and  $r$  is the average radius.

- **Magnetic Moment of a Planar Loop:**

Magnetic moment  $m$  of a planar loop carrying a current  $I$ , having  $N$  closely wound turns, and an area  $A$ , is

$$\vec{m} = NI \vec{A}$$

- **Direction of  $\vec{m}$  is given by the Right – Hand Thumb Rule:**

Curl and palm of your right hand along the loop with the fingers pointing in the direction of the current, the thumb sticking out gives the direction of

$$\vec{m}(\text{and } \vec{A})$$

- **Loop placed in a Uniform Magnetic Field:**

a) When this loop is placed in a uniform magnetic field  $B$ ,

Then, the force  $F$  on it is,  $F = 0$

And the torque on it is,  $\vec{\tau} = \vec{m} \times \vec{B}$

In a moving coil galvanometer, this torque is balanced by a counter torque due to a spring, yielding.

$$k\phi = NI AB$$

where  $\phi$  is the equilibrium deflection and  $k$  the torsion constant of the spring.

- **Magnetic Moment in an Electron:**

An electron moving around the central nucleus has a magnetic moment  $\mu_l$ , given by

$$\mu_l = \frac{e}{2m} l$$

where  $l$  is the magnitude of the angular momentum of the circulating electron about the central nucleus.

- **Bohr Magnetron:**

The smallest value of  $\mu_l$  is called the Bohr magneton  $\mu_B$

$$\mu_B = 9.27 \times 10^{-24} \text{ J/T}$$