Class XII: Physics
Ch 4: Moving Charges and Magnetism
Chapter Notes

Top Formulae

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

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

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

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

   $\vec{F} = I\vec{\ell}x\vec{B}$

3. A charge q executes a circular orbit in a plane normal with frequency called the cyclotron frequency given by:

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

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

4. Biot – Savart law asserts that the magnetic field $d\vec{B}$ due to an element $d\vec{\ell}$ carrying a steady current I at a point P at a distance r from the current element is:

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

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

   $$B = \frac{\mu_0 I R^2}{2\left(x^2 + R^2\right)^{3/2}}$$

   At the centre of the coil,

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

6. Ampere's Circuital Law: For an open surface S bounded by a loop C, then the Ampere's law states that $\oint_C \vec{B}.d\vec{\ell} = \mu_0 I$ where I refers o the current passing through S.

   If B is directed along the tangent to every point on the perimeter them

   $$BL = \mu_0 I_e$$

   where I_e is the net current enclosed by the closed circuit.

7. 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.

8. Magnetic field B inside a long Solenoid carrying a current I is

   $B = \mu_0$ nI

   where n is the number of turns per unit length.

   For a toriod,

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

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

9. 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 $\vec{m}$ (and $\vec{A}$).

   When this loop is placed in a uniform magnetic field B, the force F on it is: F = 0

   And the torque on it is,

   $$\vec{\tau} = \vec{m} x \vec{B}$$

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

$k\Phi = NI\,AB$

where Φ is the equilibrium deflection and k the torsion constant of the spring.

10. An electron moving around the central nucleus has a magnetic moment μ_ℓ, given by

$$\mu_\ell = \frac{e}{2m}\ell$$

where ℓ is the magnitude of the angular momentum of the circulating electron about the central nucleus. The smallest value of μ_ℓ is called the Bohr magneton μ_B and it is $\mu_B = 9.27 \times 10^{-24}$ J/T