- **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,
  $$\vec{F} = I\vec{l}x\vec{B}$$
- **Lorentz Force:**
  Force on a charge q moving with velocity v in the presence of magnetic and electric fields B and E.
  $$\vec{F} = q(\vec{v}x\vec{B} + \vec{E})$$
- **Magnetic Force:**
  The magnetic force $\vec{F_B} = q(\vec{v}x\vec{B})$ 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,
  $$d\vec{B} = \frac{\mu_0}{4\Pi} I \frac{d\vec{l}x\vec{r}}{r^3}$$
- **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
  $$B = \frac{\mu_0 I R^2}{2(X^2 + R^2)^{3/2}}$$
  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
  $$\oint_C \vec{B}.d\vec{l} = \mu_0 I$$
  where I refers to the current passing through S.
- If B is directed along the tangent to every point on the perimeter them

$$BL = \mu_0 I_e$$

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:**

  $$B = \mu_0 n I$$

  Where n is the number of turns per unit length.

- For a toriod,

  $$B = \frac{\mu_0 N I}{2\Pi r}$$

  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

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

- **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, $\vec{\tau} = \vec{m} x \vec{B}$

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

  $$k\phi = NI \text{ AB}$$

  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 Magneton:**

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

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