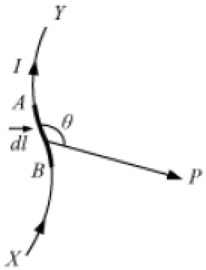
4. Moving Charges and Magnetism

- **Biot-Savart's law:**

  $$dB = \frac{Idl\sin\theta}{r^2}$$

- The magnetic field at the centre of a circular coil-carrying current is given by

  $$B = \frac{\mu_0 nI}{2r}$$

  Where,

  $n \rightarrow$ No. of turns in the coil

  $I \rightarrow$ Current flowing through the circular coil

  $r \rightarrow$ Radius of the coil

- The magnetic field at a point on the axis of a circular coil-carrying current is given by

  $$B = \frac{\mu_0 nIr^2}{2(r^2+x^2)^{\frac{3}{2}}}$$

  Where,

  $n \rightarrow$ No. of turns in the coil

  $I \rightarrow$ Current flowing through the circular coil

  $r \rightarrow$ Radius of the coil

  $x \rightarrow$ Distance of the point from the centre of the coil

- **Ampere's circuital law:**

  The line integral of magnetic field induction $\vec{B}$ around a closed path in vacuum is equal to μ_0 times the total current I threading it.

  $$\oint \vec{B}.\vec{dl} = \mu_0 I$$

- The magnetic field induction at a point well inside a solenoid is given by

  $B = \mu_0 nI$

  Where, n is the number of turns of the solenoid

- The magnetic field induction due to current in an ideal toroid is given by

  $B = \mu_0 nI$

- **Lorentz Force:** It is the force experienced by a charged particle moving in a space where both electric and magnetic fields exist.

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

Where,

$q\vec{E} \rightarrow$ Force due to electric field

$q(v \times \vec{B}) \rightarrow$ Force due to magnetic field

- **Cyclotron** $\rightarrow$ Device to accelerate positively charged particles
  - **Cyclotron frequency:**

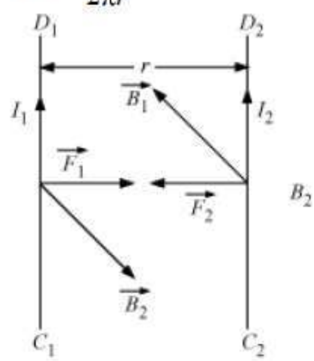
    $$\upsilon = \frac{Bq}{2\pi m}$$

    Where m is the mass of the ion
  - **Maximum energy of positive ion:**

    Max. K.E = $\dfrac{B^2 q^2 R^2}{2m}$

    Where, R is the radius of the deez
- The force on a current-carrying conductor placed in a magnetic field is given by $F = IlB \sin\theta$
- The force between two parallel conductors carrying current is given by

$$F_2 = \frac{\mu_0 I_1 I_2}{2\pi r}$$



Note

- Two linear parallel conductors carrying currents in the same direction attract each other.
- Two linear parallel conductors carrying currents in opposite directions repel each other.

- In a moving coil galvanometer, the coil is wound over the metallic frame in order to make the galvanometer dead beat, i.e., on passing current, the galvanometer shows a steady deflection without any oscillation.
- A moving coil galvanometer can be converted into an ammeter by introducing a shunt resistance r_s of a small value, in parallel. It can be converted into a voltmeter by introducing a resistance of a large value, in series.