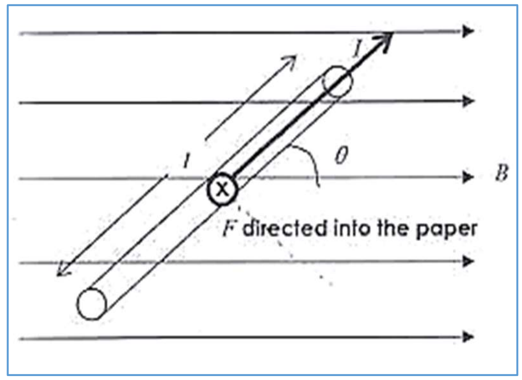
Magnetic Force on a Current Carrying Conductor:



Let us consider a conductor of length l, area of cross section 'A' and carrying current 'I' is placed in uniform magnetic field 'B' in such a way that the plane of conductor makes an angle θ with the direction of magnetic field. Since a conductor contains large number of free electrons even at normal temperature.
Let 'n' be the no. of electrons per unit volume and 'e' be the charge on each electron. The current is flowing in the conductor means the free electrons are moving in opposite direction with certain velocity known as drift velocity (v_d).
Let 'n' be the no. of electrons per unit volume and 'e' be the charge on each electron. The current is flowing in the conductor means the free electrons are moving in opposite direction with certain velocity known as drift velocity (v_d).
Let, total no. of electrons = N
Volume of conductor = Al
No. of electrons per unit volume, n = $\frac{N}{Al}$
Total no. of electrons N = n Al
We know that when electron moves in magnetic field, it experiences a force, which is known as Magnetic force. The Magnetic force experienced by each electron is,

$$F = Bev_d \sin\theta$$

Total magnetic force experience by all the charges in the Conductor is,

Or, $F = NBev_d \sin\theta$
Or, $F = \text{n } AlBev_d \sin\theta$
Or, $F = (v_d enA)lB \sin\theta$
Or, $F = IlB \sin\theta$ $[I = v_d enA]$
$\therefore \vec{F} = I(\vec{l}x\vec{B})$

Which is the required expression for the magnetic force on a current carrying Conductor.

Special Cases:

1. If θ = 0

   Or, $F = IlB \sin\theta$
   $\boldsymbol{F = 0}$

The above result shows that a current carrying conductor placed in magnetic field does not experience any force when its plane is in the direction or opposite direction of magnetic field.

2. If θ = 90°

   Or, $F = IlB \sin\theta$
   Or, $F = IlB \sin 90$
   Or, $\boldsymbol{F = IlB}$

The above result shows that a current carrying conductor placed in magnetic field experience maximum force when it is plane is perpendicular to the direction of magnetic field.