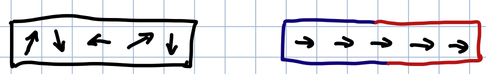
An electric field exists as a result of the charge that particles get. They exist as a monopole (either positive or negative)

A magnetic field exists when electrons start to move (such as in wires). The exists as a dipole (They will possess a North and south end)

A magnet gains strength when the electrons align their spin (Domain theory of magnets).

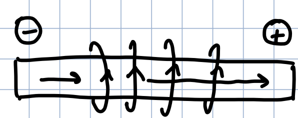


Left Hand rule vs Right hand rule (LHR vs RHR)

- LHR = electron flow
- RHR = conventional flow (direction of positive flow)

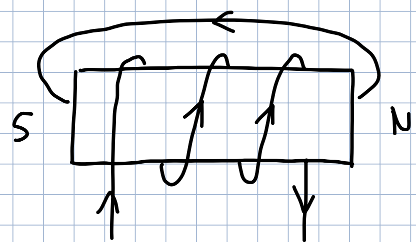
LHR for straight conductors

- Thumb points towards EF
- Fingers curl in magnetic field direction



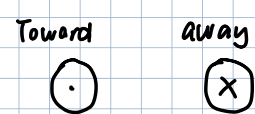
LHR for coiled conductors

- Fingers curl in direction of EF
- Thumb points towards North

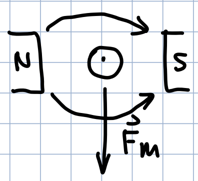


In a magnetic field, there are three factors that need to be considered to determine its strength (Force)

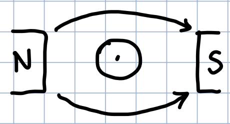
1) Charge (q): Positive = Right, Negative = Left
2) Speed of charge: Point thumb in direction of movement of charge
3) Direction of Magnetic Field. Use straight fingers $N \rightarrow S$



The direction of the magnetic force is your palm ex 1: Electron flow



ex 2 Proton movement



$$\vec{F}_M = qvB\sin\theta$$

Magnetic Field Strength (T)

Ex1 - An electron accelerates from rest in a horizontally [R] directed electric field through a potential difference of 46V. The electron leaves the electric field and enters a magnetic field with a magnitude of 0.20T, directed into the page.

1) Calculate the initial speed of the electron entering the magnetic field.

2) Calculate the magnitude and direction of the magnetic force on the electron

3) Calculate the radius of the electron's circular path

$$E_E = E_K$$

$$q\Delta V = \frac{1}{2}mv^2$$

$$\sqrt{\frac{2q\Delta V}{m}} = v$$

$$v = 4\times10^6 \text{ m/s}$$

$\Delta V = 46V$

$q_E = 1.6\times10^{-19}C$

$m_E = 9.1\times10^{-31}kg$

$B = 0.2T$

$$\vec{F}_M = qvB\sin\theta \quad \leftarrow \theta = 90$$

$$\vec{F}_M = 1.6\times10^{-19}(4\times10^6)0.2\sin 90$$

$$\vec{F}_M = 1.3\cdot10^{-13}N\,[D]$$

$$\vec{F}_M = \vec{F}_C$$

$$= m\vec{a}_c$$

$$= m\frac{v^2}{R}$$

$$r = \frac{(4.1\times10^{-31})(4\times10^6)^2}{1.3\times10^{-13}}$$

$$r = 1.12\times10^{-4}m$$

Ex2 - Calculate the mass of 35-Cl ions, of charge 1.6x10^-19C, accelerated into a mass spectrometer through a potential difference of 250V into a uniform 1.00T magnetic field. The radius of the curved path is 1.35cm

$q = 1.6\times10^{-19}C$

$\Delta V = 250V$

$B = 1.00T$

$r = 0.0135\,m$

$m = ?$

$E_E = E_K$

$q\Delta V = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2q\Delta V}{m}}$

$F_M = F_C$

$q\cancel{v}B\cancel{\sin\theta} = m\frac{v^{\cancel{2}}}{R}$

$\frac{qBr}{m} = v$

$\left(\sqrt{\frac{2q\Delta V}{m}}\right)^2 = \left(\frac{qBr}{m}\right)^2$

$\frac{2\cancel{q}\Delta V}{\cancel{m}} = \frac{q^{\cancel{2}}B^2r^2}{m^{\cancel{2}}}$

$m = \frac{qB^2r^2}{2\Delta V}$

$m = 5.8\times10^{-26}\,kg$

Ex3 - A straight conductor 10.0cm long with a current 15A moves through a 0.60T magnetic field. Calculate the magnitude of the force on the conductor when the angle between the current and the magnetic field is:

A) 90

B) 45

C) 0

$\vec{F}_M = ILB\sin\theta$

$= (15)(0.1)(0.6)\sin\theta$

$= 0.9\sin\theta$

$0.9\sin 90 = 0.9N$

$0.9\sin 45 = 0.64N$

$0.9\sin 0 = 0N$

length (m)

$\vec{F}_M = I\,L\,B\sin\theta$

Current (Amps)

Magnetic Field Strength (T)

Ex4 - What is the magnitude of the magnetic field 2.0cm from a long, straight conductor with a current of 2.5A?

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

permeability of free space

$4\pi\times10^{-7}\,\frac{T\cdot m}{A}$

$B = \frac{(4\pi\times10^{-7})(2.5)}{(0.02)(2)(\pi)}$

$= 2.5\times10^{-5}\,T$