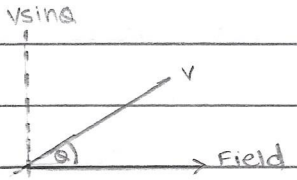
27- Charged Particles

Q-1) What is Lorentz Force?

> It's the force on a charged particle moving in a magnetic field.

$$F = BqV \sin\theta$$



Fleming's Left Hand Rule

Thumb : Motion / Force ; +ve charges.

First finger: Magnetic field

Second finger: direction of velocity.

Q-2) What are orbiting charges?

> The charges move in a circular path because the magnetic force is always perpendicular to its velocity ∴ it acts as a centripetal force.

$$F = BqV \quad \text{and} \quad F = \frac{mv^2}{r}$$

$$\therefore BqV = \frac{mv^2}{r}$$

$$\therefore Bqr = mv$$

$$\hookrightarrow r = \frac{mv}{Bq}$$

$$\therefore r \propto \frac{m}{q} \quad \text{and} \quad r \propto \frac{1}{B}$$

; stronger field makes the particles move in tighter circles.

Q-3) Determining the specific charge.

> $Bqv = \frac{mv^2}{r}$

$\therefore \frac{q}{m} = \frac{v}{Br}$

But if you dont know velocity v then...

$r = \frac{mv}{Bq} \quad \therefore v = \frac{Bqr}{m} \quad \therefore v^2 = \frac{B^2q^2r^2}{m^2}$

Electrical energy is converted to k.e.

$qV_{ol} = \frac{1}{2}mv^2 \quad \therefore v^2 = \frac{2qV_{ol}}{m}$ → V_{ol} = voltage / p.d.

Equate v^2

$\frac{B^2q^2r^2}{m^2} = \frac{2qV_{ol}}{m}$

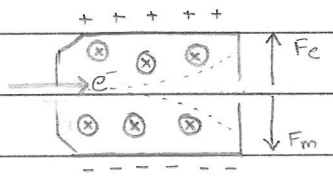
$\therefore \frac{q}{m} = \frac{2V_{ol}}{r^2B^2}$

Q-4) Velocity selection of charged particles.

> A velocity filter is a device to produce a beam of charged particles, all moving at the same velocity.

$F_e = Eq$

$F_m = Bqv$



$Eq = Bqv$

$v = \frac{E}{B} = \frac{V}{dB}$ → $E = \frac{V}{d}$

If V is high, Fm is greater ∴ e^- deflect downwards
If V is low, Fe is greater ∴ e^- deflect upwards.
If Fm = Fe; no deflection.

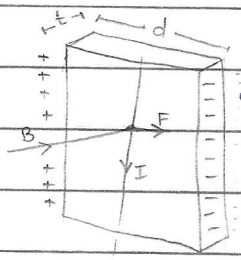
Q-5) What is the Hall effect?

> The Hall effect is production of a voltage accross a conductor when a current flows through the conductor at right angles to the magnetic field.

> $F_e = E q = \frac{q V_H}{d}$ —o $E = V/d$

$F_m = B q v$

$B q v = \frac{B q I}{n q A}$ —o $v = \frac{I}{n q A}$



e^- are pushed as their mass is low and can't move out of the semi-conductor.

> $\therefore \frac{B q I}{n q A} = \frac{q V_H}{d}$

$\therefore V_H = \frac{B I d}{n q A}$ —o $A = d \times t$

$\therefore V_H = \frac{B I}{n q t}$

n = no. of e^- unit volume
q = charge on e^-
A = area of cross-section
d = width
t = thickness
B = magnetic flux density.

Q-6) Uses of electron deflection beams.

> Computer monitors

> TV sets.

↳ e^- are moved using electric and magnetic fields. This results in an image on the screen.

Q-7) What is quantization of charge?

> It's the principle that charge on any object is an integer multiple of the elementary charge.

eg: 1e, 2e, 3e, 4e ... etc...