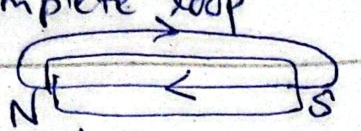
Chapter # 28

Magnetic Fields

electric charge → moving → then ~~ele~~ magnetic field

moving charge → current → magnetic field.

- arrow head → North (N)
- complete loop



→ outside loop → N→S
→ inside loop → S→N

Magnetic field:

$F \propto q$

$F \propto \sin\theta$

$F \propto V$

$F \propto B$

so

~~$F = q V B$~~

$F = |q| V B \sin\theta$ ← angle b/w V & B

$F = |q| (\vec{V} \times \vec{B})$

↳ Force always ⊥ to $\vec{V}$ & $\vec{B}$

In electric force (coulomb) and magnetic force use only magnitude of charges bc sign is used only for direction and find direction in magnetic field by fingers (~~RGH~~) method.

So now B: $B = \dfrac{F}{|q| V \sin\theta}$

if motion is perpendicular $B = \dfrac{F}{|q| V}$ $(\because \theta = 90^\circ)$

$1T = \dfrac{1\,\text{newton}}{1\,\text{coulomb} \times \text{meter/second}}$

$1T = \dfrac{1\,\text{newton}}{1\,\text{Ampere} \times \text{meter}} = \dfrac{N}{As}$

$1T = 10^4$ gauss

like charges repel each other
unlike (opposite) charges attract each other

like magnetic pole repel each other
unlike (opposite) magnetic pole attract each other.

- Dimagnetic → weak repulsion
- Paramagnetic → weak attraction
- ferromagnetic → strong attraction.

⊙ out of paper
⊗ into paper

Lorentz Force:

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

$$\boxed{F = qvB + qE}$$

if $F = 0$ crossed fields:

$$qE = qvB$$

$$\boxed{v = \frac{E}{B}}$$

Hall Effect: $V = Ed$

$$eE = eV_dB$$

$$\boxed{V_d = \frac{E}{B}}$$

$$eE = evB$$

$$V = vBd$$

$$\boxed{V = vBd}$$

$$V_d = \frac{J}{ne} = \frac{i}{neA} \quad \text{so}$$

$$\frac{i}{neA} = \frac{E}{B}$$

$$n = \frac{iB}{eA\cancel{V}/d} \quad (\because V = Ed)$$

$$\boxed{n = \frac{iB}{Vle}} \quad (\because l = A/d$$

Ampere's Law

$$\boxed{\oint \vec{B}\cdot d\vec{s} = \mu_0 i_{enclosed}}$$

Magnetic Fields ~~across~~ due to Long straight current carrying wire:

i) Outside of straight wire:

$$\boxed{B = \frac{\mu_0 i}{2\pi r}}$$

$$\oint \vec{B}\cdot ds = \mu_0 i$$

$$\oint B\,ds\cos\theta = \mu_0 i$$

$$\oint B\,ds = \mu_0 i$$

$$B\oint 2\pi r = \mu_0 i$$

$$B\,2\pi r = \mu_0 i$$

$$\boxed{B = \frac{\mu_0 i}{2\pi r}}$$

(ii) Inside Straight Wire:

$$B = \left(\frac{\mu_0 i}{2\pi R^2}\right)\cdot r$$

$$\oint B\cdot ds = \mu_0 i_{enclosed}$$

$$B(2\pi r) = \mu_0 i_{enclosed}$$

we know that:

$$i_{enclose} = JA \qquad \left(\because J = \frac{i}{A}\right)$$

$$i_{enclosed} = \frac{i}{\pi R^2}\cdot \pi r^2$$

$$B(2\pi r) = \mu_0 \frac{i r^2}{R^2}$$

~~Solenoid~~:

$$\boxed{B = \left(\frac{\mu_0 i}{2\pi R^2}\right)\cdot r}$$

Magnetic Field of a Solenoid:

for this

$$i_{enclosed} = i(nh)$$

Ampere's Law:

$$Bh = \mu_0 i n h$$

$$n = \frac{N}{L}$$

$$\boxed{B = \mu_0 i n} \text{ (ideal Solenoid)}$$

$$\boxed{B = \mu_0 n i} ✓$$

Magnetic Field of a toroid:

$$\boxed{B = \frac{\mu_0 N i}{2\pi r}}$$

N = no. of loops of toroid.

diagonal length = $\boxed{\sqrt{2}\,a}$