CH-4 : MOVING CHARGES AND MAGNETISM

* Motion of charge particle :-

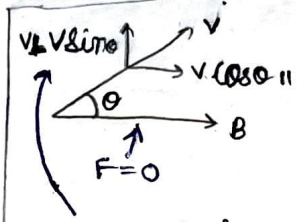
$F = q[V \times B]$

$F = qVB\sin\theta$

$\theta = 90°$

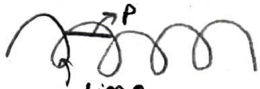
$F = IlB$

$F = qVB$



$F = qV_\perp B\sin 90$

$F = qVB$



Helical path

$r = \frac{mv}{qB}$

pitch $(p) = V\cos\theta T$

$p = \frac{V\cos\theta\, 2\pi m}{qB}$

Circular motion

$qVB = \frac{mv^2}{r}$ $\quad B = \frac{p}{qr}$

$r = \frac{mv}{qB}$ $\quad K = \frac{p^2}{2m}$

$v = r\omega$

$r = \frac{mr\omega}{qB}$ $\quad r = \frac{\sqrt{2mK}}{qB}$

$\omega = \frac{qB}{m}$

$\omega \rightarrow$ Angular velocity

$2\pi f = \frac{qB}{m}$

$f = \frac{qB}{2\pi m}$

$T = \frac{2\pi m}{qB}$

Work done $F \perp V$

$\therefore W = 0$

$\Delta K = 0$

$K_f - K_i = 0$

$K_f = K_i = \text{constant}$

If charge is not moving

$F = 0$

② $\rightarrow V$, $\rightarrow B$ $\quad \theta = 0$, $F = 0$

③ $\rightarrow B$, $\leftarrow V$ $\quad \theta = 180°$, $F = 0$

$m\alpha = 4m_p$

$q\alpha = 2q_p$

* Bio savart's law :-

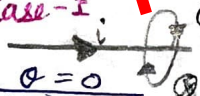
$d\vec{B} = \frac{\mu_0 i dl \times \hat{r}}{4\pi r^2}$

$dB = \frac{\mu_0 i dl \sin\theta}{4\pi r^2}$

$\mu_0 \rightarrow$ Permeability of free space $[M^1 L^1 T^{-2} A^{-2}]$

$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

Case - I



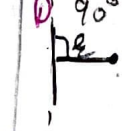
$\theta = 0$

$dB = 0$

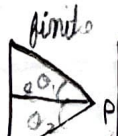
Case - II

Case - III

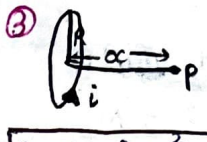
* Magnetic field due to ∞ length of I wire :-



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



$B = \frac{\mu_0 i}{4\pi r}[\sin\theta_1 + \sin\theta_2]$



$B = \frac{\mu_0 i R^2}{2(x^2+R^2)^{3/2}}$

$B_{Centre} = \frac{\mu_0 i R^2}{2R^3}$

$B_{Centre} = \frac{\mu_0 i}{2R}$

$B = \frac{\mu_0 i\theta}{4\pi r}$

* Ampere's circuital law :-

$\oint \vec{B}\cdot d\vec{l} = \mu_0 i$ (close loop)

⇒ Solenoid :-

$B = \mu_0 n i$

$B = \frac{\mu_0 N i}{l}$

⇒ Toroid :-

$B = \mu_0 n i$

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

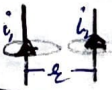
* Torque on Rectangular coil :-

$\tau = NiAB\sin\theta$

$\tau = mB\sin\theta$

$\vec{\tau} = \vec{m} \times \vec{B}$

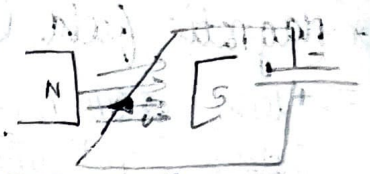
* Magnetic force due to ∥ wire :-



$F = \frac{\mu_0 i_1 i_2 l}{2\pi r}$

SAME = Attractive

OPP = Repulsive



$F = IlB\sin\theta$

$\theta = 90°$

$F = IlB$

* Moving coil galvanometer :-

$\tau = NiAB\sin 90°$

$\tau = NiAB = K\theta$

$F \propto x$

$\tau \propto \theta$

$\tau = K\theta$

$NiAB = K\theta$

$\frac{\theta}{i} = \frac{NAB}{K}$

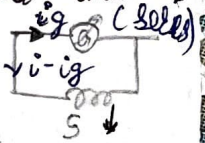
Current sensitivity

$\frac{\theta}{V} = \frac{NAB}{KR}$

Voltage sensitivity

* Galvanometer → ammeter

$i = \frac{V}{G+R}$



$i_g G = (i - i_g) S$

$S = \frac{i_g G}{i - i_g}$

* Galvanometer → voltmeter

$V = i_g[R + G]$

$R = \frac{V}{i_g} - G$

$I = q \times f$

frequency

$R \propto \frac{\sqrt{m}}{q}$

Mobility $\mu = \frac{m^2}{sV}$

$R = \frac{\sqrt{2mK}}{qB}$

$K \propto \frac{q^2}{m}$