Class : 12th Physics

Chapter- 5 : Magnetism and Matter

Magnetism and Matter

Dipole moment

Revolving Electron

$|\vec{\mu}| = iA = \frac{ev}{2\pi r} \times \pi r^2$

$= evr/2$

$\vec{\mu} = \frac{-e}{2m_e}\vec{L}$

$\mu = md$

m = magnetic charge or pole strength

d = separation between poles

r = radius of circular orbit

e = charge on electron

v = speed of electron;

L = angular momentum

m_e = mass of electron

Circular Loop

Current loop of area $A = \pi r^2$ carrying current i may be replaced by a magnetic dipole of dipole moment $\mu = md = iA$

Solenoid

$\mu = NIA$,

N = no. of turns

I = current

A = area

Earth's Magnetic field

Earth is a natural source of magnetic field having geometric north and geometric south pole

Declination — Angle b/w magnetic meridian and geographical meridian.

Inclination or dip (δ) — Angle made by earth's magnetic field with horizontal in the magnetic direction

$\delta_{equator} = 0, \delta_{pole} = 90°$

Horizontal component

$B_H = B\cos\theta$

B_H (at pole) = 0

B_H(at equator) is maximum

Magnetic Substance

Para-magnetism — Tendency to increase the magnetic field due to magnetization

e.g. Al, Mn I, X_m, $\mu_r > 1$

Diamagnetism — Tendency to magnetise in a direction opposite to direction of magnetic field

e.g. Bi, Cu, Hg, Ni.

μ_r, I, χ_m

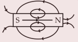
Ferromagnetism — Tendency of strongly magnetization in the direction of magnetic filed.

e.g. Fe, Co, Ni, μ_r, I, χ_m >>1

In 1833, Carl Friedrich Gauss and Wilhelm Weber Made the first Electromagnetic Telegraph

Magnetic field lines

Imaginary lines which continuously represent the direction of magnetic field.



Electromagnets

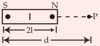
Magnet in which the magnetic field is produced by an electric current. Magnetic field disappears when current is turned off.

Bar Magnet

Magnetic field Intensity

- End–on–position

$= \frac{\mu_0}{4\pi}\frac{2M}{d^3}$

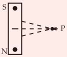


M = 2ml

d>>>l

- Broadside –on Position

$B = \frac{\mu_0}{4\pi}\frac{M}{(d^2+l^2)^{3/2}}$



For d>>>l

$B = \mu_0 M/4\pi d^3$

potential Energy of a Field-Magnet System

$U_\theta = U_\theta - U_{90°} = -MB\cos\theta = -\vec{M}.\vec{B}$

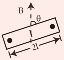
we take P.E. at θ = 90° to be zero

Torque

$\vec{\tau} = \vec{M}\times\vec{B} = MB\sin\theta$

M = 2ml

B = Magnetic field



Magnetic Terms

Magnetic Intensity

$H = \frac{B_0}{\mu}$

Magnetic permeability

$\mu = \mu_0(1+\chi_m)$

$\mu = \mu_0(1+\chi_m)$

Time period oscillating bar magnet

$(T) = 2\pi\sqrt{\frac{I}{MB}}$

Magnetic susceptibility

$\chi = \frac{I}{H}$

Intensity of magnetization

$I = \frac{M}{V}$