MAGNETISM AND MATTER

BRAIN MAP

CLASS XII

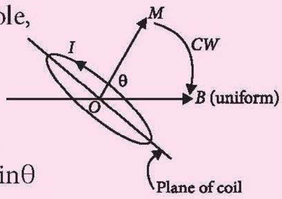
THE BAR MAGNET

Bar Magnet as an Equivalent Solenoid

For solenoid of length $2l$ and radius a consisting n turns per unit length, the magnetic field is given by

$B = \dfrac{\mu_0 2m}{4\pi r^3}$ (where m = magnetic moment of solenoid $= n\,(2l)\,I\,(\pi a^2)$)

Magnetic Dipole in Magnetic Field



Torque on magnetic dipole,

$\tau = MB\sin\theta$

Torque on coil or loop,

$\vec{\tau} = \vec{M}\times\vec{B}$, here $\vec{M} = NI\vec{A}$,

$\vec{\tau} = NI(\vec{A}\times\vec{B})$, $\tau = BINA\sin\theta$

$\theta = 90°$ $\Rightarrow \tau_{max} = BINA$

$\theta = 0°$ or $180°$ $\Rightarrow \tau_{min} = 0$

Potential energy of magnetic dipole,

$U = -MB\cos\theta = -\vec{M}\cdot\vec{B}$

Magnetisation and Magnetic Intensity

Relation between B, χ_m and H

$\vec{B} = \vec{B}_0 + \mu_0\vec{M}$

$\vec{B} = \mu_0(\vec{H}+\vec{M})$ $\quad (\because \vec{B}_0 = \mu_0\vec{H})$

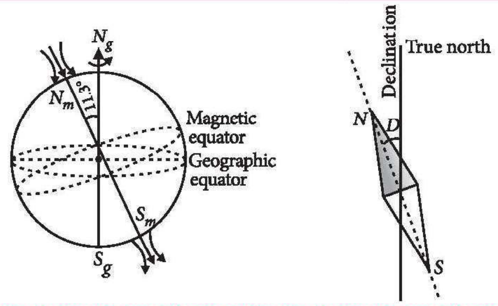
$\vec{B} = \mu_0(1+\chi_m)\vec{H} = \mu\vec{H}$ $\quad (\because \vec{M} = \chi_m\vec{H})$

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

THE EARTH'S MAGNETISM

Cause of Earth's Magnetism

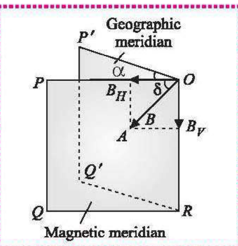
The magnetic field of earth arises due to electrical current produced by convective motion of metallic fluids in the outer core of the earth. This is known as the dynamo effect.



The Earth's Magnetism

Magnetic declination (α): The angle between the geographic meridian and magnetic meridian.

Magnetic dip (δ): The angle made by the earth's magnetic field with the horizontal in the magnetic meridian.



Relation between angle of dip(δ) and components of earth's magnetic field.

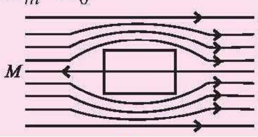
$\tan\delta = \dfrac{B_V}{B_H}$, $B = \sqrt{B_H^2 + B_V^2}$

CLASSIFICATION OF MAGNETIC MATERIALS

Diamagnetic

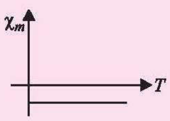
Poor magnetisation in opposite direction.

Here $B_m < B_0$



$\chi_m \rightarrow$ Small, negative and temperature independent

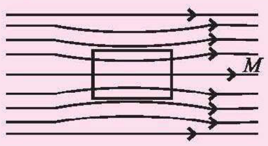
$\chi_m \propto T_0$



Paramagnetic

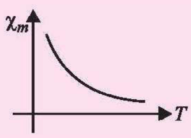
Poor magnetisation in same direction.

Here $B_m > B_0$



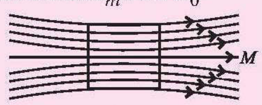
$\chi_m \rightarrow$ Small, positive and varies inversely with temperature

$\chi_m \propto \dfrac{1}{T}$ (Curie's law)



Ferromagnetic

Strong magnetisation in same direction. Here $B_m >>> B_0$



$\chi_m \rightarrow$ Very large, positive and temperature dependent

$\chi_m \propto \dfrac{1}{T - T_C}$ (Curie-Weiss law)

(for $T > T_C$)