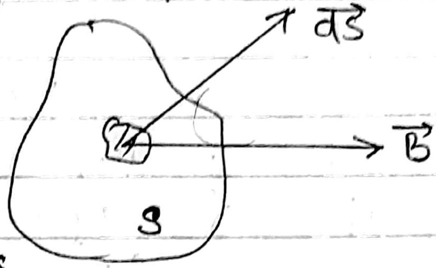
MAGNETISM& MATTER LECTURE-25

MAGNETISM AND GAUSS's LAW

MAGNETIC FLUX: Magnetic flux associated with any surface may be defined as the total number of Magnetic field lines crossing a given surface perpendicularly.

$$\phi_B = \int \vec{B} \cdot \vec{ds} \text{ Weber or Tesla-m}^2$$



GAUSS's LAW IN MAGNETICS

- It states that the Net flux associated with a closed surface (Body) is always zero.

$$\phi_B = \oint \vec{B} \cdot \vec{ds} = 0$$

- The difference in Gauss's law in electrostatics and in Magnetics is that single charge can exist but mono poles do not exist. Hence right hand side of equation in case of Magnetics has zero as due to existance of dipole, net pole strength will always be zero.

THE EARTH MAGNETISM

The magnetic field of earth at any point may be completely discribed by 3 parameters, These 3 parameters are known as Elements of earth's Magnetism -

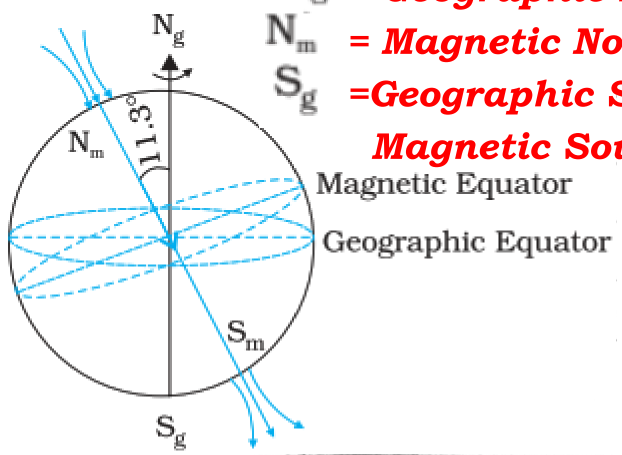
(i) Angle of Declination (ii) Angle of Dip (iii) Horizontal component of Earth Magnetic field.

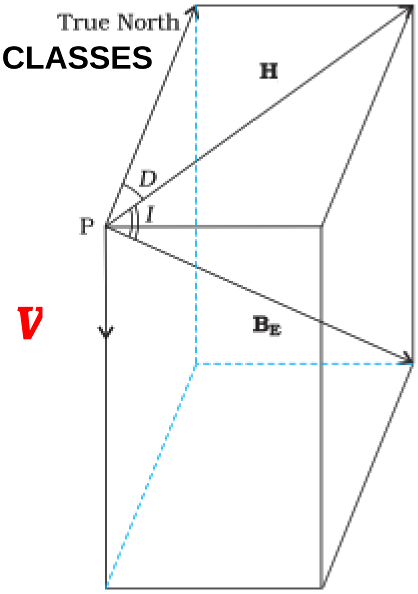
N_g = ***Geographic North***

N_m = ***Magnetic North***

S_g = ***Geographic South***

Magnetic South = S_m



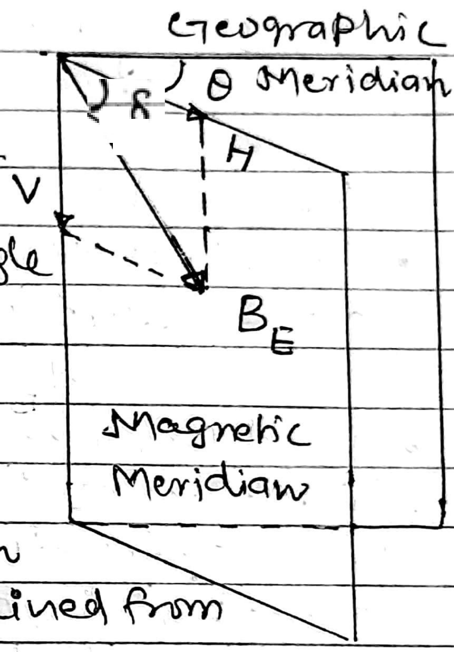


1. ANGLE OF DECLINATION (θ)

It is the smaller angle between Geographic & Magnetic Meridians.

or

It is also defined as the smaller angle between Geographic and Magnetic axes of earth.



2. ANGLE OF DIP (δ)

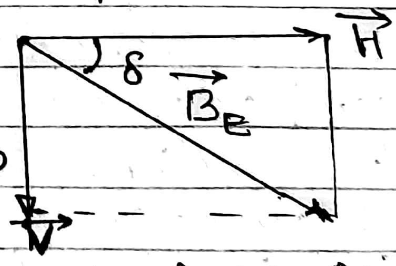
It is defined as the angle at which net magnetic field of earth is inclined from horizontal in Magnetic Meridian.

3. HORIZONTAL COMPONENT OF EARTH'S MAGNETISM ($\vec{H}$)

It is equal to $B_E \cos\delta$. It is different at different places on the earth. But vertical component remains same.

$H = B_E \cos\delta \quad V = B_E \sin\delta$

$B_E = \sqrt{H^2 + V^2}$ & $\tan\delta = \frac{V}{H}$



IMPORTANT POINT ON ANGLE OF DIP

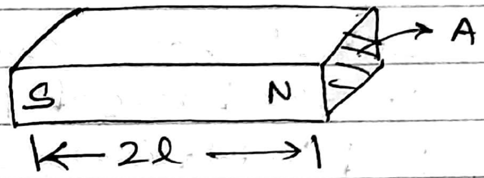
1. Angle of dip is 90° at poles. Therefore $H = 0$ & $V = B_E$.
2. Angle of dip is 0° at equator. ($\therefore H = B_e$ & $V = 0$)

Properties of Magnetic Substances

1. **Magnetic Intensity ($\vec{H}$):** It is defined as the degree to which a Magnetising field can magnetise the given Magnetic material.

$$\vec{H} = \frac{B_o}{\mu_o}$$ where B_o = Magnetic field in Vacuum, μ_o = permeability in Vacuum

2. **MAGNETISATION (Intensity of Magnetisation ($\vec{I}$))**
It is defined as the magnetic Moment developed per unit volume of a Material.



$$\vec{I} = \frac{\vec{M}}{V}$$
or
$$I = \frac{m \times \cancel{2l}}{A \times \cancel{2l}} = \frac{m}{A}$$

$\therefore$ It can also be defined as pole strength per unit cross sectional area of a bar magnet.

3. **Relation between $\vec{B}$, $\vec{H}$ & $\vec{I}$:** Let us consider a long solenoid of n turns per unit length and carrying current I. Hence Magnetic field in the interior of solenoid. $\vec{B_o} = \mu_o n I$ --- (I) (I = Current)
If solenoid is now filled with Non-zero magnetisation, the field inside the solenoid will be more than B_o.

$\vec{B} = \vec{B_o} + \vec{B_m}$, | $\vec{B_m}$ = Field contributed by Material core.

& $\vec{B_m} = \mu_o \vec{I}$

$\therefore \vec{B} = \mu_o \vec{H} + \mu_o \vec{I} = \mu_o(\vec{H} + \vec{I})$

But $\vec{I} = \chi_m \vec{H}$ where χ_m = Magnetic Susceptibility

$\therefore \vec{B} = \mu_o \vec{H}(1+\chi_m)$ $[\because 1+\chi_m = \mu_r]$

$\therefore \vec{B} = \mu_o \mu_r \vec{H} = \mu \vec{H}$.