**ST. LAWRENCE HIGH SCHOOL**

**A JESUIT CHRISTIAN MINORITY INSTITUTION**

**STUDY MATERIAL : 6 (PART - 1)**

**Subject : PHYSICS**

**Topic :** Magnetic properties of materials.

CLASS : XII

Date : 03. 07.2020

## MAGNETIC FIELD AND STRENGTH OF MAGNETIC FIELD

A-1. Definition of $\vec{B}$ : The magnetic force experienced by a north pole of unit pole strength at a point due to some other poles (called source) is called the strength of magnetic field at that point due to the source.

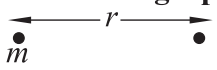
Mathematically, $\vec{B} = \frac{\vec{F}}{m}$

Here $\vec{F}$ = magnetic force on pole of pole strength $m$. $m$ may be +ve or -ve and any value.

*SI* unit of $\vec{B}$ is Tesla or $Wb/m^2$.

A-2 $\vec{B}$ due to various sources

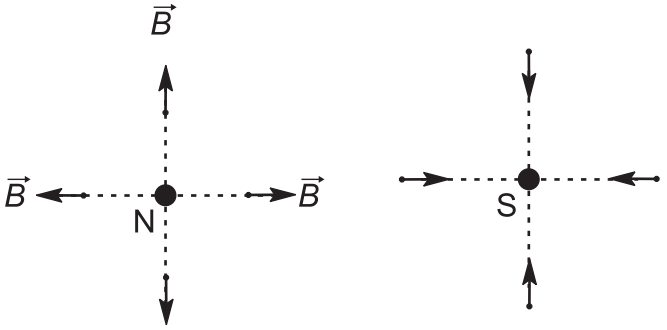
**Due to a single pole**




$$B = \left[\frac{\mu_0}{4\pi}\right]\frac{m}{r^2}.$$

This is magnitude

Direction of B due to north pole and due to south poles are as dhown

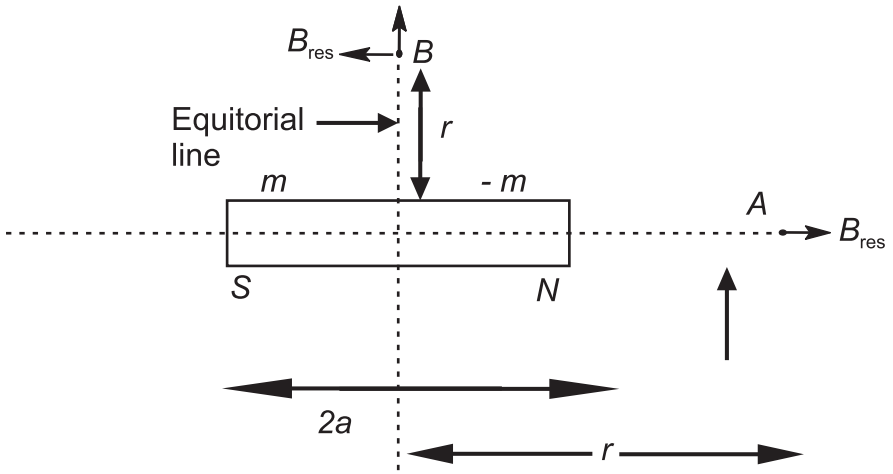



in vector form $\vec{B} = \left[\frac{\mu_0}{4\pi}\right]\frac{m}{r^3}\vec{r}$

Here $m$ is with sign and $\vec{r}$ = position vector of the test point with respect to the pole.

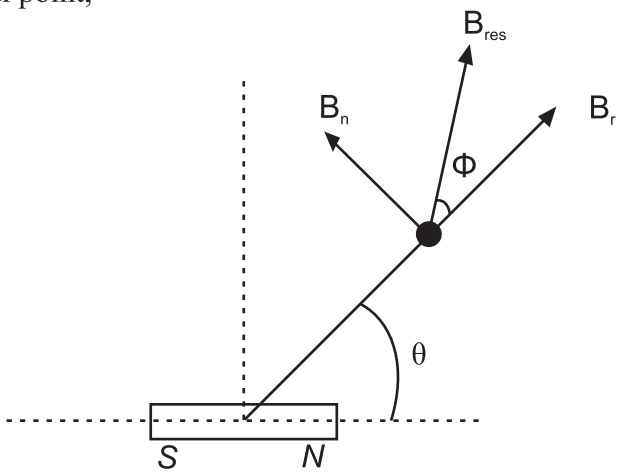
A-3. **Due to a bar magnet**

Independent case never found. Always 'N' and 'S' exist together as magnet.



at $A$ (on the axis) = $\left[\frac{\mu_0}{4\pi}\right]\frac{2M}{r^3}$ for a <<$r$ at $B$ (on the equatorial) = $-\left[\frac{\mu_0}{4\pi}\right]\frac{\vec{M}}{r^3}$ for a <<$r$

A-4. At general point,




$B_r = 2\left[\frac{\mu_0}{4\pi}\right]\frac{M\cos\theta}{r^3}$, $B_n = 2\left[\frac{\mu_0}{4\pi}\right]\frac{M\sin\theta}{r^3}$, $B_{res} = \frac{\mu_0 M}{4\pi r^3}\sqrt{1+3\cos^2\theta}$, $\tan\Phi = \frac{B_n}{B_r} = \frac{\tan\theta}{2}$

B. MAGNETIC FIELD OF EARTH

- The source of earth's magnetic field is due to some kind of circulating electric currents inside the earth.
- **Magnetic axis** is the line joining the magnetic north and south poles of earth. A vertical plane which passes through magnetic axis is called **magnetic meridian**
- The axis of rotation of earth is called **geographic axis.** A vertical plane which passes through geographic axis is called **geographic meridian.**
- **Magnetic declination** ($\theta$) at a place is the angle between geographic meridian and magnetic meridian at that place.
- **Magnetic dip** ($\delta$) is the angle between direction of total intensity of magnetic field of earth and a horizontal line in the magnetic meridian .

$$\tan\delta = \frac{B_V}{B_H}$$

- **Horizontal component of magnetic field of Earth.** $B_H = B_V/\tan\delta$ and $B = \sqrt{B_H^2 + B_V^2}$ where B, $B_H$ and $B_V$ are total magnetic field of earth, horizontal component of earth's magnetic field and vertical component of earth's field respectively.
- **Magnetic flux :** The number of magnetic field lines passing normally through a surface is defined as magnetic flux. It is denote by $\Phi$.
- **Magnetisation :** The degree or extent to which a substance is magnetised when placed in the m*agnetising* field is called intensity of magnetisation. It is denoted by M or I.
- **Magnetic Permeability** : The extent to which magnetic field lines can enter a substance is known as magnetic permeability. It is denote by $\mu$.
- **Magnetic Susceptibility** : It is the property of a substance which shows how easily the substance can be magnetised when placed in the magnetising field. It is denoted by $\chi_m$.
- **Magnetic Intensity :** The extent to which the magnetising field can magnetise a substanc is known as the intensity of magnetising field. It is denoted by H.
- **MAGNETIC MATERIALS**

Magnetic materials are classified as under :

*(I)* **Ferromagnetic materials** are strongly attracted by a magnet, their permeability is much more than unity and susceptibility has a large positive value. (to be continued .....)