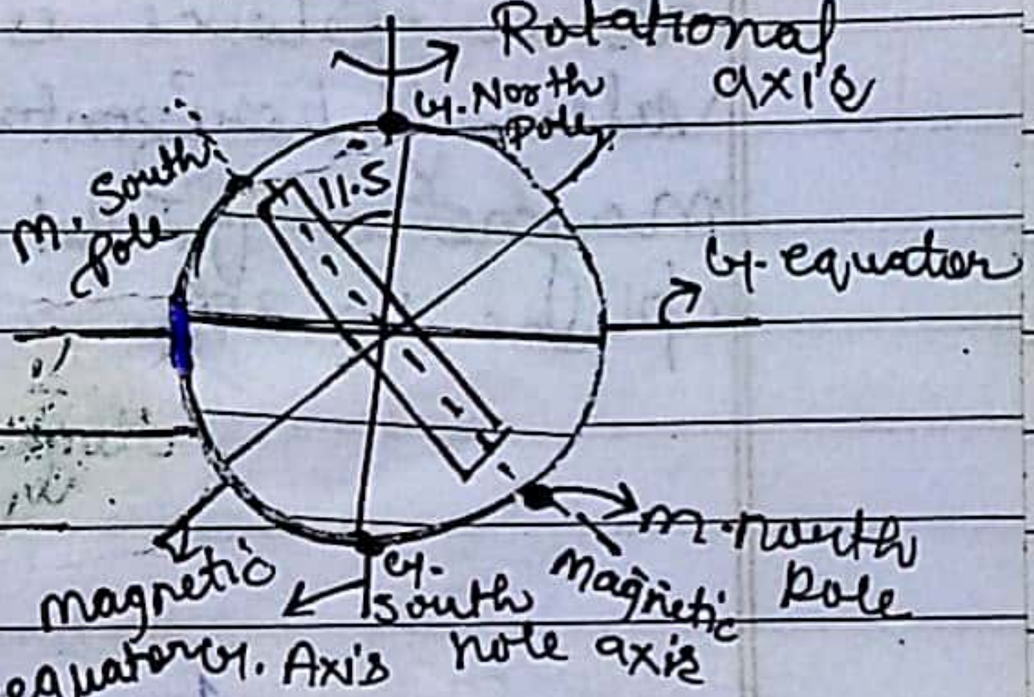
Chapter-5 Magnetism and Matter

Earth Magnetism

Earth is a magnet and it have a magnetic field. This magnetic field arise due to electrical current produced by motion of crust and ions inside the earth.

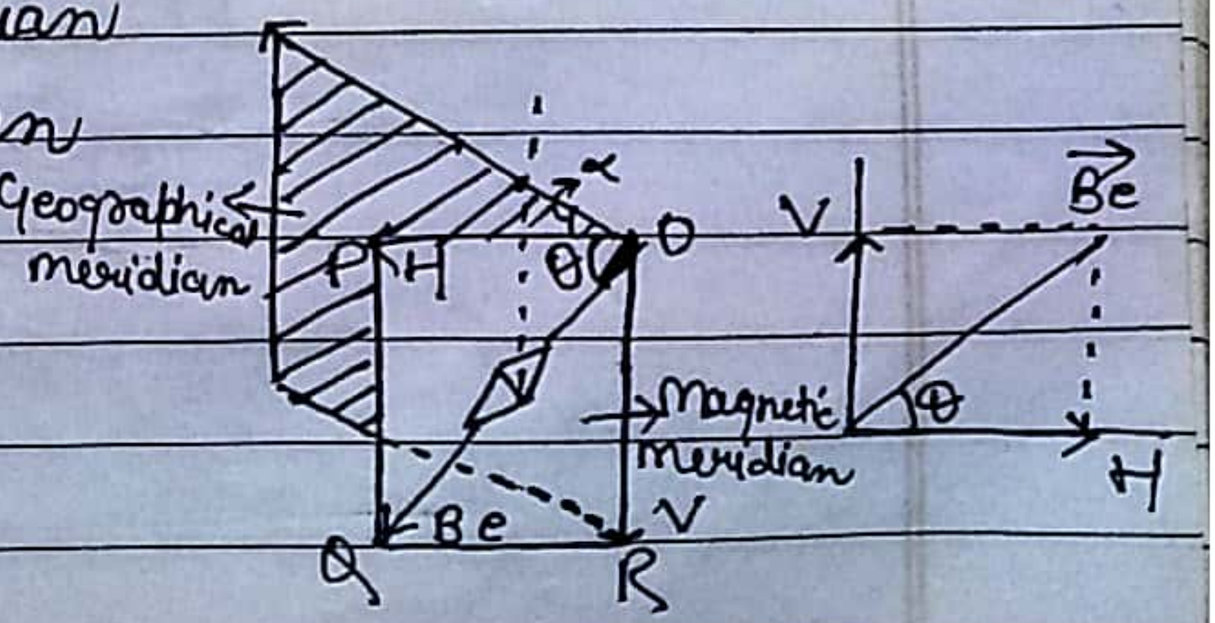


- Geographical axis
- Geographical equator
- Magnetic axis
- Magnetic equator

The Component of Earth Magnetism

i. Angle of Declination (α)
ii. Angle of Dip (θ)
iii. Horizontal component of earth magnetic field.

i. Geographical Meridian
ii. Magnetic Meridian



$H = B_e \cos\theta$ — (1)

$V = B_e \sin\theta$ — (2)

$(1)^2 + (2)^2$

$H^2 + V^2 = B_e^2$

$$B_e = \sqrt{H^2 + V^2}$$

(11) ÷ (1)

$$\tan\theta = \frac{V}{H}$$

$$\left[\theta = \tan^{-1}\left(\frac{V}{H}\right)\right]$$

Various terms related to magnetism

① Magnetic Intensity (H)

The capability of magnetic field to magnetise the substance is called its magnetic intensity it is denoted by H.

$$\left[H = \frac{B_0}{\mu_0}\right]$$

B_0 = Magnetic field inside vacuum

μ_0 = Permeability of space.

It is also known as magnetising force or magnetic field strength.

It's S.I unit is amp/m.

② Intensity of magnetisation (I)

The magnetic moment per unit volume is called intensity of magnetisation

It is denoted by (I)

It is a vector quantity.

Its S.I unit is amp/m.

$$\left[\vec{I} = \frac{\vec{m}}{V}\right] \qquad \vec{m} = iA$$

③ Magnetic Induction

It is the number of magnetic lines of induction crossing per unit area normally through the magnetic substance. It is denoted by B

$$B = B_0 + \mu_0 I$$

$$[B = \mu_0 H + \mu_0 I]$$

$$[B = \mu_0 (H + I)]$$

4 Magnetic Susceptibility

The intensity of magnetisation of a magnetise substance is directly proportion to the magnetic intensity of the field.

$$I \propto H$$

$$I = \chi_m H$$

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

where χ_m is constant it is called magnectic Susceptibility of magnetic Substance

" Magnetic Susceptibility is the ratio of intensity of magnetisation and magnetic

intensity".

Its unit is ~~amp/m~~, no unit.

⑤ Magnetic Permeability

Magnetic Permeability is a measure of conduction of magnetic field lines through a substance.

$$\left[\mu = \frac{B}{H}\right]$$

It is the ratio of magnetic induction to the magnetic intensity.

Its unit is TmA^{-1}

⑥ Relative magnetic Permeability

It is the ratio of magnetic Permeability of substance with respect to the permeability of space.

It is denoted by μ_r.

$$\left[\mu_r = \frac{\mu}{\mu_0}\right]$$

It has no unit.

Relation between Relative magnetic Permeability (μ_r) and magnetic Susceptibility (χ_m)

$$B = \mu_0 (H + I)$$

$$I = \chi_m H$$

$$B = \mu_0 (H + \chi_m H)$$

$$B = \mu_0 H (1 + \chi_m)$$

$$\therefore B = \mu H$$

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

$$\frac{\mu}{\mu_0} = 1 + \chi_m$$

$$\left[\mu_r = 1 + \chi_m\right]$$

Magnetic properties of materials

Materials can be classified in following forms.

① Diamagnetic

Those substances which are when placed in an external magnetic field it small magnetise in opposite direction of external magnetic field these substances are called diamagnetic

★ No of e⁻ paired

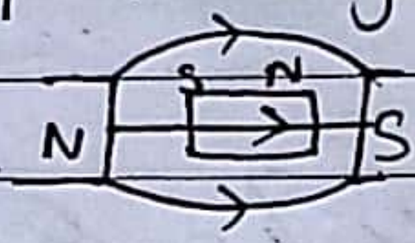
and it's property is called Diamagnetism

→ It have a tendency to move from stronger to the weaker part of the external magnetic field.

→ Its magnetic Susceptibility is Negative (small)

e.g → Gold, Silver, Bismith etc.
Copper, Pb, Nitrogen (STP).

② Para magnetic



No of e⁻ odd

Those substances which get weakly magnetise in the direction of external magnetic field when placed in an external magnetic field are called para magnetic substances.

→ These substances have the tendency to move from a region of weak magnetic field to strong magnetic field.

→ They Get weakly attracted to a magnet.

e.g → Al, Na, Ca, O at STP

③ Ferro magnetic

The substances which get strongly magnetise in the direction of external magnetic field when they are placed in an external magnetic field.

→ They have Strong tendency to move from a region of weak magnetic field to Strong magnetic field.

→ $\chi_m \gg 1$

→ They get Strongly attracted to a magnet.
E.g. Iron, Ni, Co, etc.

Curie Temperature

The ferromagnetic property depends on the temperature. The temperature at which ferromagnet becomes a paramagnet is called Curie temperature.

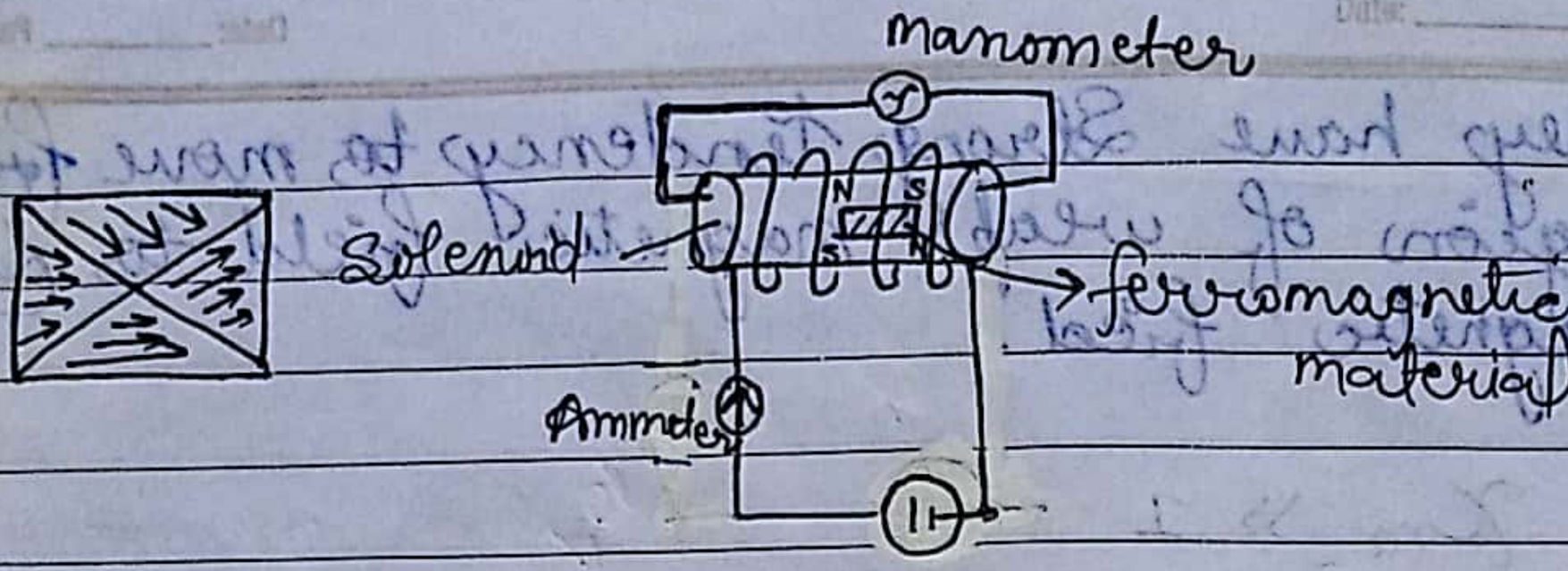
The transition of temperature from ferromagnetic to paramagnetic is called Curie temperature. It is denoted by T_c or θ

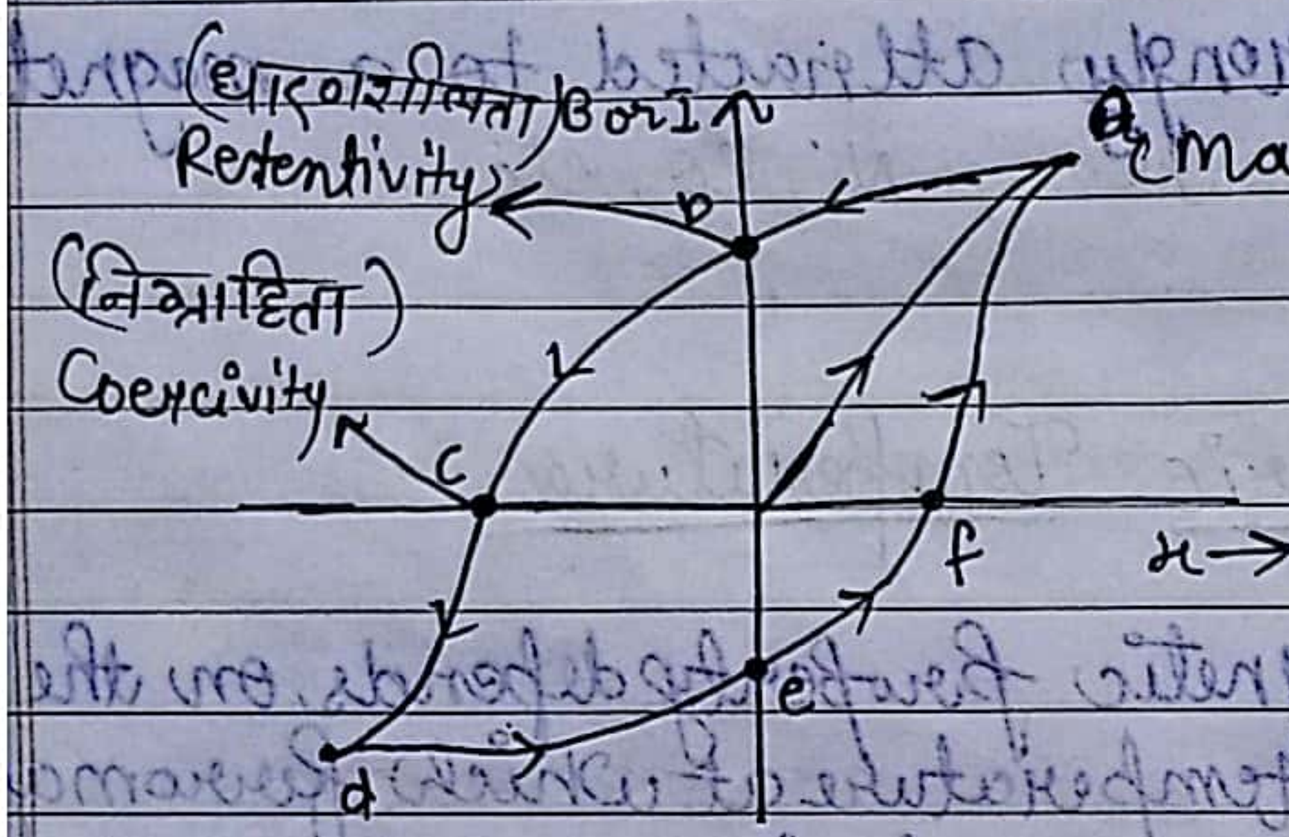
The Susceptibility of a ferromagnetic substances is

$$\chi_m = \frac{C}{T - T_c}$$ → Curie's law

where C is a Constant it is called Curie's Constant

☆ Hysterisis Curve





The Hysterisis Curve represent the relation b/w the magnetic induction of a ferro magnetic material with magnetic intensity (H). When a ferromagnetic substance placed in a Solenoid and the current through the Solenoid is increased the magnetic field B in the material rises and saturates at a point a. If H is decreases and it reduce to zero. The value of B at this point is called retentivity.

✓ When $H = 0$, $B \neq 0$ (Retentivity)

The Current in Solenoid is reverse and slowly increased we again obtain Saturation in the reverse direction at d.

But at point c the value of B become zero this is called Coercivity.

Now the current is reduced the B increased in reverse direction and this cycle repeat itself this phenomenon is called Hysterisis and this curve is called Hysterisis curve