

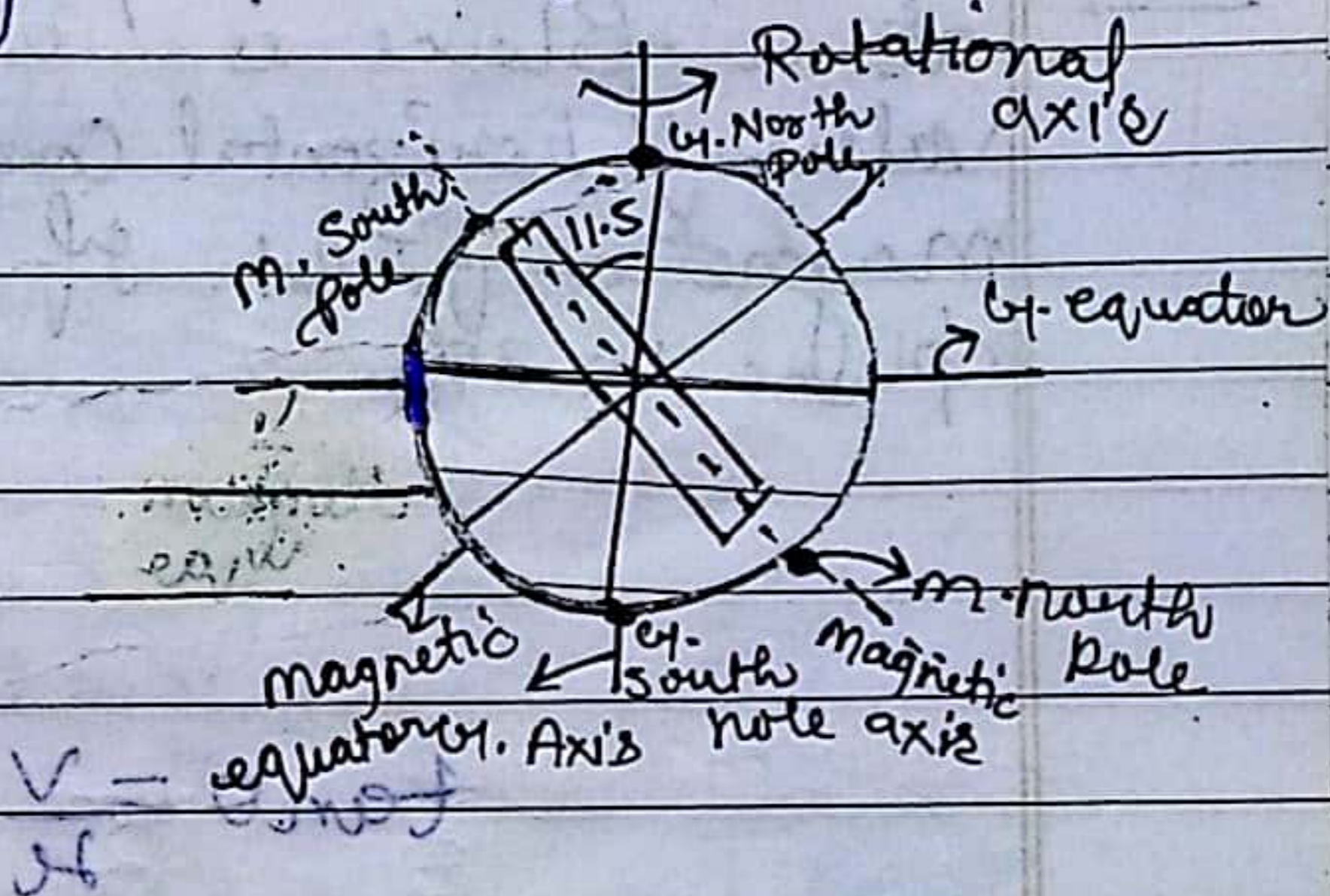
Chapter-5

Magnetism and Matter

Earth Magnetism

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

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



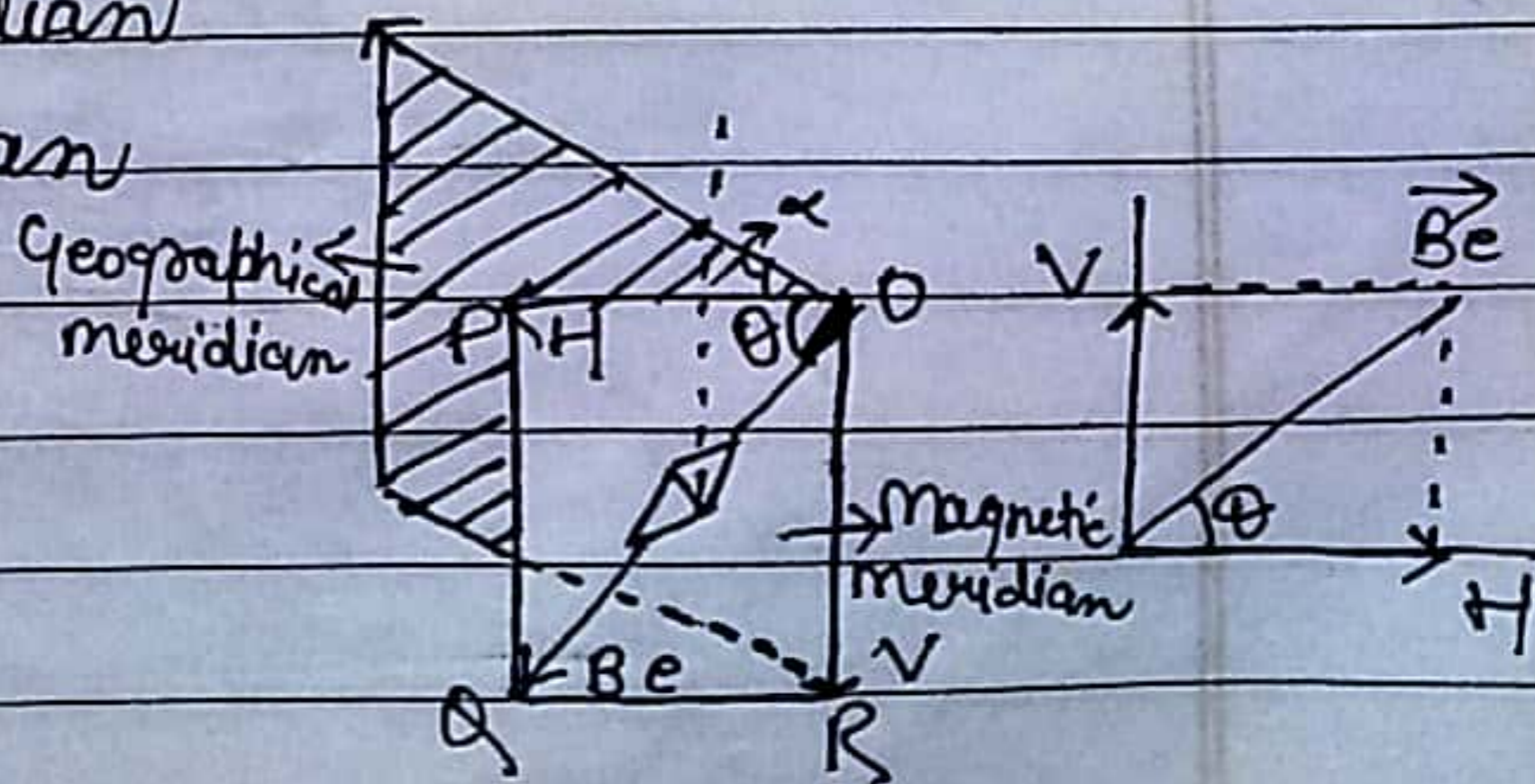
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The Component of Earth Magnetism

- i) Angle of declination (α) = $\angle N$
- ii) Angle of Dip (θ)
- iii) Horizontal component of Earth magnetic field.

i) Geographical Meridian

ii) Magnetic Meridian



$$H = B_e \cos \theta \quad \text{--- (i)}$$

$$V = B_e \sin \theta \quad \text{--- (ii)}$$

$$(i)^2 + (ii)^2$$

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

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

②

÷

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.

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

B_0 = magnetic field inside vacuum
 μ_0 = Permeability of space.

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

Its 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.

$$[I = \frac{\vec{m}}{V}] \quad \vec{m} = iA$$

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 \underline{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 magnetic 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.

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

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

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

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

$$\therefore B = \mu H$$

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

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

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

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.

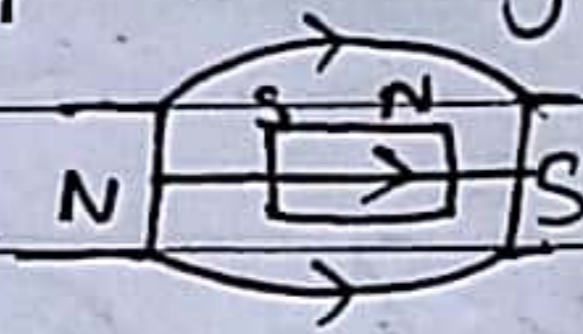
* No of e^- paired

and its property is called Diamagnetism

→ It has 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, Bismuth, etc.
Copper, Pb, Nitrogen (STP).

② Para magnetic



No of e^- odd

These 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 Ferreo magnetic



Domain

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 .

The susceptibility of a ferromagnetic substance —

$$\chi_m = \frac{C}{T - T_c} \rightarrow \text{Curie's Law}$$

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

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Hysteresis Curve

to which...



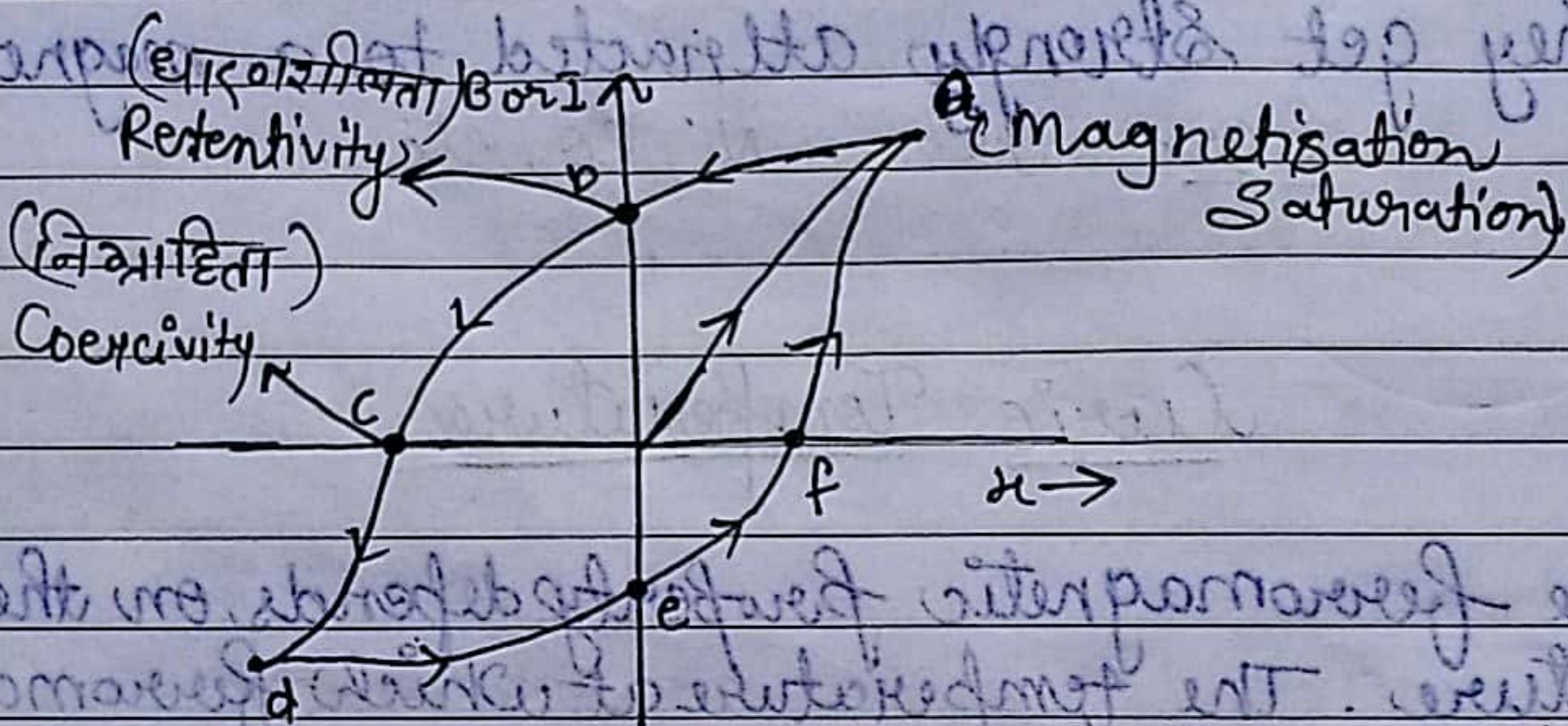
Solenoid

Ammeter

manometer



ferromagnetic material



The hysteresis curve represent the relation b/w the magnetic induction of a ferromagnetic 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) (curve ab)

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 so cycle repeat
itself this phenomenon is called Hysteresis
and this curve is called Hysteresis Curve