7/8/23

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CHAPTER - 5
MAGNETISM AND MATTER

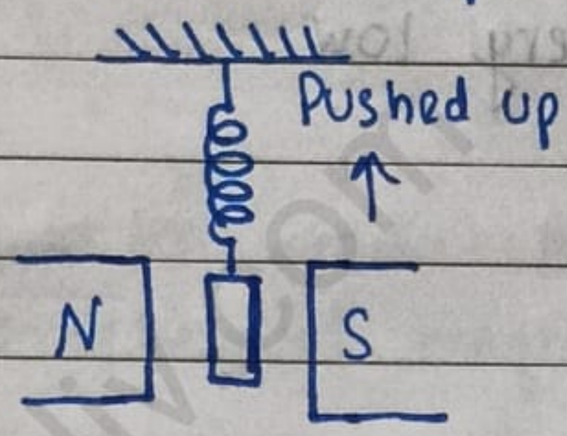
S.No.	ELECTROSTATICS	MAGNETISM
1.	Electric Charges (q) [+q, -q] Unit = Coulomb (C) Dimensional formula = [AT]	Pole Strength (m) [N, S] Unit = A-m (+m, -m) Dimensional formula = [AL]
2.	Electric Dipole Examples= NaCl, H_2O, HCl -q ⟵ 2l ⟶ +q	Magnetic Dipole Example = Bar Magnet 2l N S
3.	Electric Dipole Moment ($\vec{p}$) $\vec{p} = q \times 2\vec{l}$ Unit = C-m, Dim. = [LAT]	Magnetic Dipole Moment ($\vec{M}$) $\vec{M} = m \times 2\vec{l}$ Unit = A-m^2, Dim = $[AL^2]$
4.	Coulomb's Law of Electrostatics $F_e = \frac{1}{4\pi\varepsilon_0} \times \frac{q_1 q_2}{r^2}$	Coulomb's Law of Magnetism $F_B = \frac{\mu_0}{4\pi} \times \frac{m_1 m_2}{r_2}$
5.	Electric Field $E = \frac{F}{q_0} = \frac{1}{4\pi\varepsilon_0} \times \frac{q}{r^2}$	Magnetic Field Density $B = \frac{F}{m_0} = \frac{\mu_0}{4\pi} \times \frac{m}{r^2}$
6.	Electric Field on axial line of electric dipole $E = \frac{2Kp}{r^3}$ $\left[K = \frac{1}{4\pi\varepsilon_0}\right]$	Magnetic Field on axial line of magnetic dipole $B = \frac{2kM}{r3}$ $\left[K = \frac{\mu_0}{4\pi}\right]$
7.	Electric Field on ~~Equipotential~~ equitorial Line of electric dipole $E = \frac{Kp}{r^3}$ $\left[K = \frac{1}{4\pi\varepsilon_0}\right]$	Magnetic field on equitorial Line of magnetic dipole $B = \frac{KM}{r^3}$ $\left[K = \frac{\mu_0}{4\pi}\right]$
8.	Torque on electric dipole in uniform electric field $\tau = pE\sin\theta$ (OR) $\vec{\tau} = \vec{p} \times \vec{E}$	Torque on magnetic dipole in uniform magnetic field $\tau = MB\sin\theta$ (OR) $\vec{\tau} = \vec{M} \times \vec{B}$
9.	P.E of electric dipole in U.E field $U = -pE\cos\theta$ (OR) $U = -\vec{p} \cdot \vec{E}$	P.E of magnetic dipole in U.E field $U = -MB\cos\theta$ (OR) $U = -\vec{M} \cdot \vec{B}$

★ MAGNETIC MATERIALS

• DIAMAGNETIC SUBSTANCES

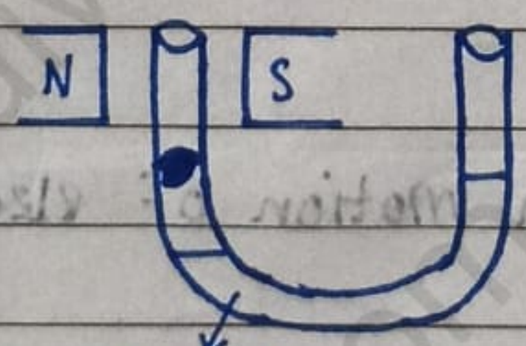
1. Cause of magnetism - Orbital motion of electrons

2. Behaviour in a non-uniform magnetic field
These are repelled in an external magnetic field i.e have a tendency to move from high to low field region



3. State of magnetisation
These are weekly magnetised in a direction opposite to that of applied magnetic field.

4. When the material in the form of liquid is filled in the U-tube and placed between pole pieces, liquid level in that limb gets depressed.

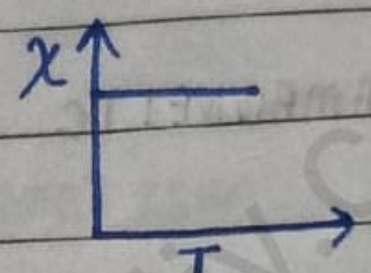


5. On placing the gaseous materials between pole pieces, the gas expands at right angles to the magnetic field.

6. $B < B_0$
B → magnetic induction
B_0 → magnetic induction in vacuum

7. Magnetic susceptibility (χ)
Low and negative, $|\chi| \simeq 1$

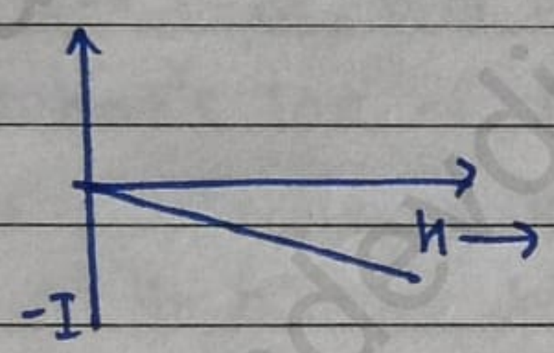
8. Dependence of χ on temperature
Does not depend on temperature (except Bi at low temperature)



9. Relative permeability (μ_r) < 1

10. Intensity of magnetisation (I) is in a direction opposite to that of H and its value is very low

11. I - H curves



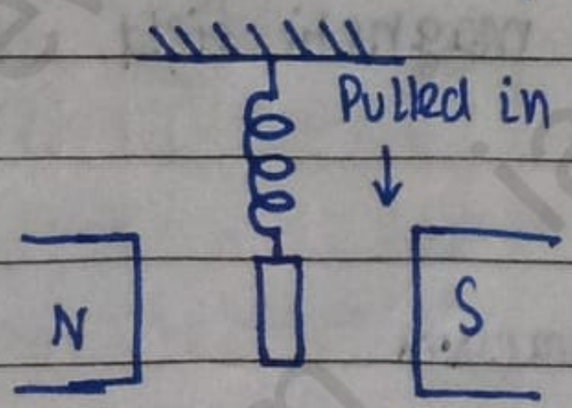
12. Magnetic moment (M) is very low ($\simeq 0$)

13. Examples: Cu, Ag, Au, Zn, H_2O, air and diamond, etc.

- PARAMAGNETIC SUBSTANCES

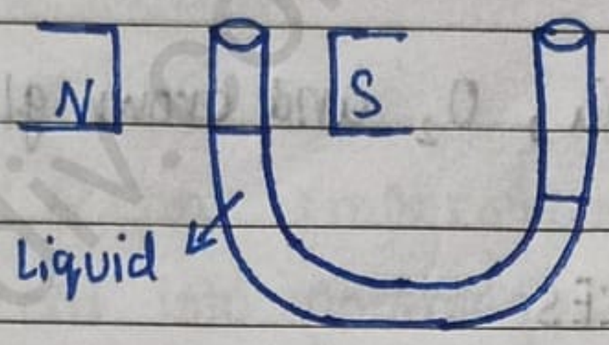
1. Cause of magnetism - Spin motion of electrons

2. Behaviour in a non-uniform magnetic field
These are feebly attracted in an external magnetic field i.e, have a tendency to move from low to high field region



3. State of magnetisation
These are weekly magnetised in a direction opposite to that of applied magnetic field

4. When the material in the form of liquid is filled in the U-tube and placed between pole pieces, liquid level in that limb rises up.

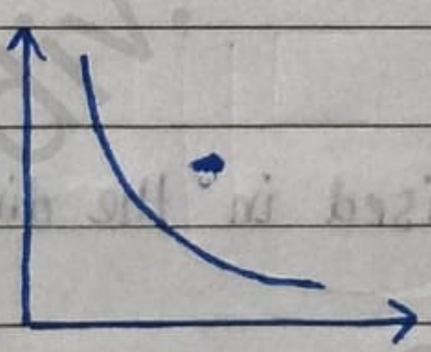


5. On placing the gaseous materials between pole pieces, the gas expands in the direction of magnetic field

6. $B > B_0$

7. Magnetic susceptibility (χ)
Low but positive $\chi \approx 1$

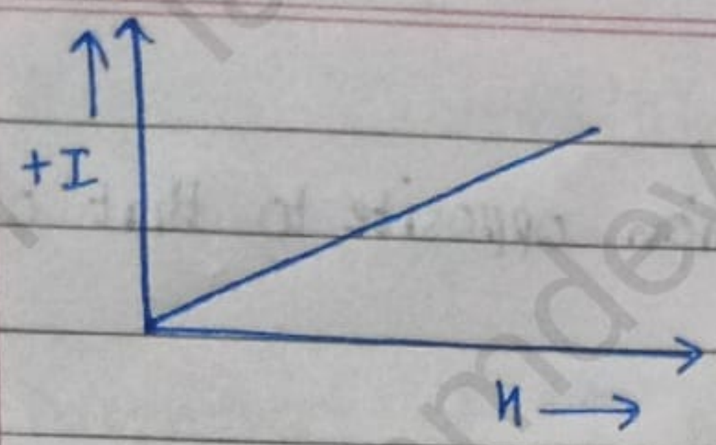
8. Dependence of χ on temperature
On cooling, these get converted to ferromagnetic materials at Curie temperature



9. Relative permeability (μ_r) >1

10. Intensity of magnetisation (I) is in the direction of H but value is low.

11. I-H curves



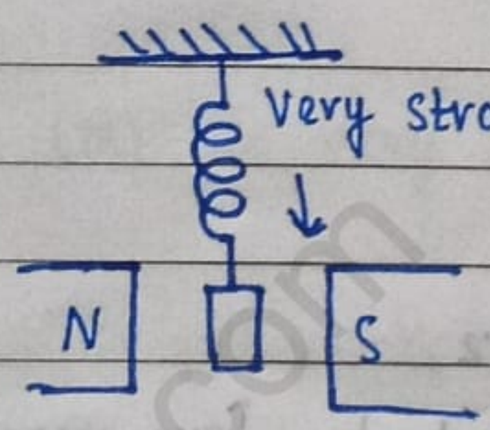
12. Magnetic moment (M) is very low

13. Examples: Al, Mn, Pt, Na, O_2 and crown glass.

- FERROMAGNETIC SUBSTANCES

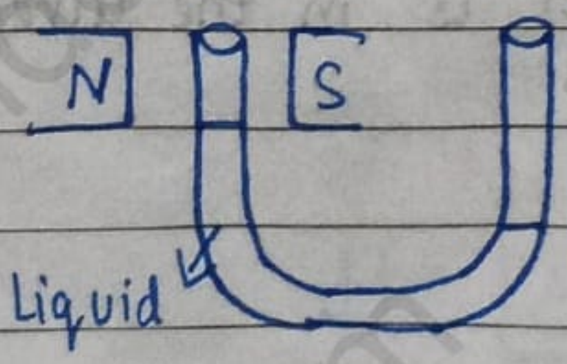
1. Cause of magnetism - Formation of domains

2. Behaviour in a non-uniform magnetic field
These are strongly attracted in an external magnetic field i.e. they easily move from low to high field region



3. State of magnetism
These ~~are~~ get strongly magnetised in the direction of applied magnetic field

4. When the material in the form of liquid is filled in the U-tube and placed between pole pieces, liquid level in that limb rises up very much

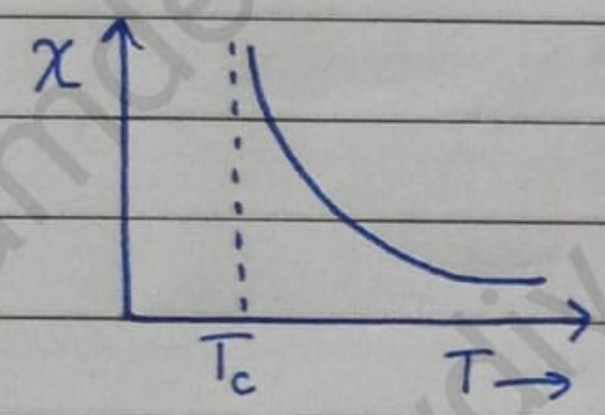


5. On placing the gaseous materials between pole pieces, the gas rapidly expands in the direction of magnetic field

6. $B >> B_0$

7. Magnetic susceptibility (χ)
Positive and high $\chi \simeq 10^2$

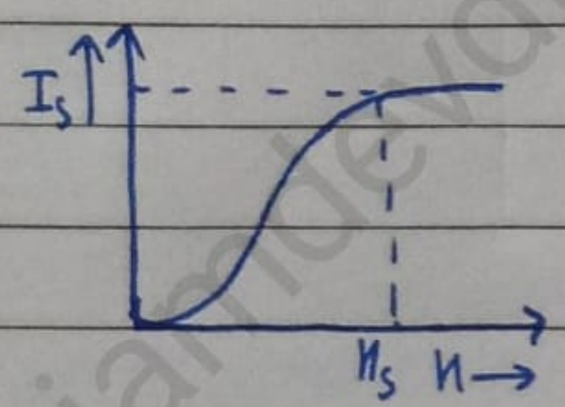
8. Dependence of χ on temperature
These get converted into paramagnetic materials at Curie temperature



9. Relative permeability (μ_r) >> 1 ($\mu_r = 10^2$)

10. Intensity of magnetisation (I)
I is in the direction of H and value is very high

11. I-H curves



12. Magnetic moment (M) is very high

13. Examples: Fe, Co, Ni, Cd, Fe_3O_4, etc.