Quick Revision MAGNETISM AND MATTER

TERMINOLOGY

B : Magnetic field
q_m : Pole strength
μ_o : Permeability of vacuum
t : Time taken
τ : Torque
e : Charge on electron
h : Planck's constant
B_H : Horizontal component of magnetic field
B_v : Vertical component of magnetic field
δ : Angle of dip
V : Volume
m : Pole strength
I : Intensity of magnetisation
M : Magnetic dipole moment
χ_m : Susceptibility
H : Magnetising force
C : Curie's constant

DEFINITIONS

1) **Magnetic field:** The space around a magnet in which its influence can be felt.
2) **Uniform magnetic field:** A magnetic field is said to be uniform if it has same magnitude and direction at all points of that region.
3) **Magnetic poles (*m*):** The regions of apparently concentrated magnetic strength in a magnet where magnetic attraction is maximum.
4) **Magnetic axis :** The line passing the poles of magnet is called the magnetic axis of magnet.
5) **Magnetic length:** The distance between two poles of a magnet is called magnetic length.
6) **Coulomb's law of magnetic force:** The law states that the force of attraction or repulsion between two magnetic poles is directly proportional to their pole strength and inversely proportional to square of distance between them.

$$F = \frac{\mu_o}{4\pi}\frac{q_{m_1}q_{m_2}}{r^2}$$

7) **Unit pole strength:** Unit magnetic pole strength may be defined as that pole strength which when placed in vacuum at a distance of 1 meter apart from identical pole, repels it from a force of 10^{-7} newton.
8) **Magnetic dipole:** An arrangement of equal and opposite magnetic poles separated by a certain distance called a magnetic dipole.
9) **Magnetic dipole moment (*M*):** The magnetic dipole moment of a magnetic dipole is defined as the product of its pole strength and its magnetic length. S.I. unit of magnetic dipole moment is Am^2.
10) **Magnetic field lines:** Magnetic field lines may be defined as the curve, the tangent to which at any point gives the direction of magnetic field at that point. It may also be defined at the path along which a unit magnetic pole would tend to move if free to do so.
11) **Bohr Magneton:** It is defied as the magnetic moment associated with an electron due to its orbital motion in the first orbit of hydrogen atom.
12) **Magnetising field (*H*):** When a magnetic material is placed in magnetic field a magnetism induced in it. The magnetic field that in vacuum and induced magnetism is called magnetising field.
13) **Magnetic Induction (*B*):** The total magnetic field inside a magnetic material is the sum of equal magnetic field and additional magnetic field produced by magnetisetion of material , and is called magnetic induction *B*.
14) **Magnetising field intensity:** The ability of magnetising field to magnetise a material medium is called magnetising field intensity. Its magnitude may be defiled as number of ampere turns flowing round the unit length of solenoid required to produce given magnetic field.

15) **Intensity of magnetisation (I):** The magnetic moment developed per unit volume of material when placed in magnetising field is called intensity of magnetisation.

Intensity of magnetisation may also be defined as the pole strength developed per unit cross section of material.

16) **Magnetic permeability:** The magnetic permeability of a material is defied at the ratio of its magnetic induction B to magnetic intensity H.

17) **Relative permeability:** It is defined as the ratio of permeability of the medium to the permeability of free space.

18) **Magnetic Susceptibility:** It is defiled as the ratio of intensity of magntisation to the magnetic field intensity H.

19) **Diamagnetic materials:** These are those substances which develop feeble magnetisation in the opposite direction of magnetising field. Such substance are free to repelled by magnets and tend to move from stronger to weaker parts of field.

20) **Paramagnetic material:** These are those substances which develop feeble magnetisation in the direction of magnetising field. Such substances are freely attracted by magnets and tend to move from weaker to a strong magnetic field.

21) **Ferromagnetic substance:** There are those materials which develop strong magnetisation in the direction of magnetising field. They are attracted by magnets and tend to move from weaker to stronger part.

FORMULAE

Magnetic dipole moment : $M = q_m \times 2l$

$$F = \frac{\mu_0}{4\pi}\frac{q_{m_1}q_{m_2}}{r^2}$$

$$B_{\text{axis}} = \frac{\mu_0}{4\pi}\frac{2Mr}{(r^2 - l^2)^{3/2}}$$

$$B_{\text{eq.}} = \frac{\mu_0}{4\pi}\frac{M}{(r^2 + l^2)^{3/2}}$$

when $l << r$

$$B_{\text{axis}} = \frac{\mu_o}{4\pi}\frac{2M}{r^3}$$

$$B_{\text{eq.}} = \frac{\mu_o}{4\pi}\frac{M}{r^3}$$

Torque = $MB \sin \theta$

$W = \Delta U = -MB(\cos\theta_2 - \cos\theta_1)$

$M = NIA$

$$\mu_l = \frac{neh}{4\pi m_e} \qquad \therefore \phi_B = \oint \vec{B}.\vec{ds} = 0$$

$$\frac{B_v}{B_H} = \tan\delta \qquad \therefore B = \sqrt{B_H^2 + B_v^2}$$

$$B_H = \frac{\mu_0}{4\pi}\frac{2Mr}{(r^2 - l^2)} = \frac{\mu_0}{4\pi}\frac{2M}{r^3}$$

$$\mu = \frac{B}{H} = \mu_0(1 + \chi_m)$$

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

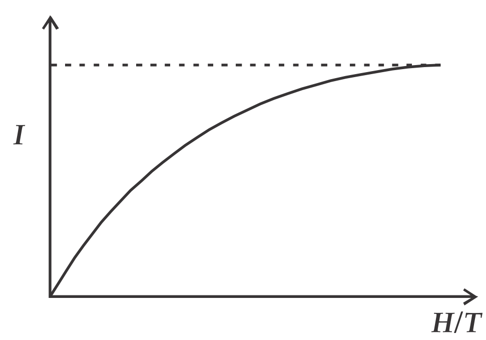
$$\chi_m = \frac{I}{H}$$

$$\therefore \chi_m = \frac{C}{T} \text{ (Curie's Law)}$$

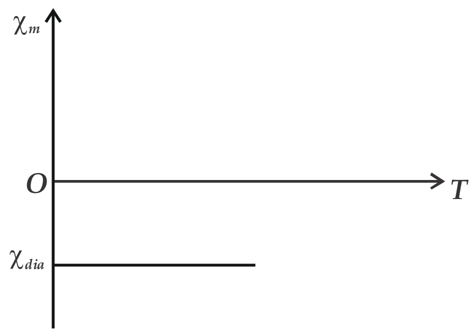
$$B = \mu_0(H + I)$$

GRAPHS

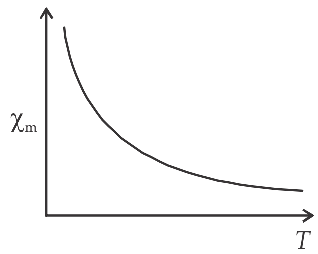
1) Intensity of magnetisation as a function of H/T



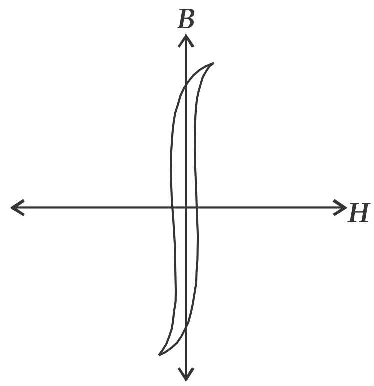
2) $\chi_m - T$ graph for diamagnetic material



3) $\chi_m - T$ graph for paramagnetic material



4) Hysteresis curve for soft iron core



5) Hysteresis curve for ferromagnetic material