Diamagnetic (li)

Individual atoms don't possess any net magnetic moment on its own.

They feebly get in direction opposite to magnetic feild

Tendency to move from stronger part to weaker part ($\mu_r < 1$, $\chi_m < 0$)

phenomenum of perfect diamagnetism in superconductors is called Meisner effect

(Cu, silver, Gold) Paramagnetic

Individual atoms has a net non-zero magnetic moment on its own.

feebly get magnetise in the direc^n to magnetic feild

Tendency to move from weaker to stronger part

($\chi_m > 0$,)

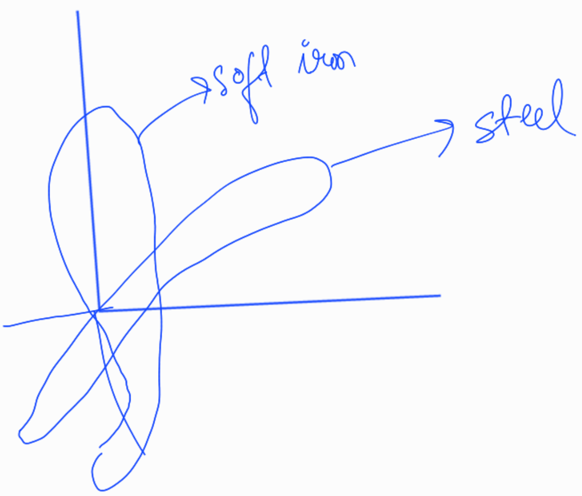
(Fe, Ni) Ferromagnetic

Individual atom/ion/molecule have non-zero magnetic moment on its own

Same as paramagnetic just it will have to a greater extent

$$\boxed{\chi_m \propto \frac{1}{T}} \longrightarrow \chi_m = \frac{C}{T} \longrightarrow \text{curie's Temperature}$$

Hysteresis Curve



Magnetism and Matter

(1) $L_{mag} = \frac{5L}{6}$.

(2) $T = 2\pi\sqrt{\frac{I}{MB}}$ — $I \rightarrow$ moment of Inertia, $M \rightarrow$ magnetic moment.

(3) $I = \frac{mL^2}{12}$

(4) Note :→ Magnetic Moment's direction → $\boxed{S : N}$.

(5) M.F due to bar magnet at for a point →

$$B = \frac{\mu_0 M}{4\pi r^3}\sqrt{1+3\cos^2\theta}, \quad \tan\alpha = \frac{B_\theta}{B_r}$$

$$\tan\alpha = \frac{\tan\theta}{2}.$$

along axis, $\vec{B}_{axis}$ is $\parallel$ to $\vec{M}$.

along equator, $\vec{B}_{equ}$ is opposite to $\vec{M}$.

$$B_{axis} = \frac{2\mu_0}{4\pi}\frac{M}{r^3}, \quad B_{equ} = \frac{\mu_0}{4\pi}\frac{M}{r^3}.$$

(6) Potential due to bar magnet -

$$V = \frac{\mu_0}{4\pi}\frac{M\cos\theta}{r^2}$$

$$\Rightarrow V = \frac{\mu_0}{4\pi}\frac{\vec{M}\cdot\vec{r}}{r^3} \text{ (in vector form)}$$

In bar magnet,

$$\tau = \vec{M}\times\vec{B}, \quad U = -\vec{M}\cdot\vec{B}$$

$$W = U_f - U_i.$$

$\theta = 0$, $U_i = -MB\cos 0° = -MB$

$\theta = 180°$ (final), $U_f = -MB\cos 180° = MB$.

∴ Net work done $= MB - (-MB) = \boxed{2MB}$

NOTE

Earth M.F → $\boxed{S \rightarrow N}$

At equator, M.F.L are horizontal.

7 M.F due to point charge

$$B = \frac{\mu_0}{4\pi}\frac{q}{r^2}$$

(8) Magnetism and Gauss law :→

According to the Gauss law for magnetism, the net magnetic flux through any closed surface is always zero.

(9) Earth is also a magnet. How??

Bcz, E. Currents circulating from earth's core give rise to earth's M.F.

Imp. Points :→ (10) Geo. Meridian (plane passing from geo $N \rightarrow S$)

Mag. Meridian (plane passing from magnet $N \rightarrow S$)

Magnetic Declination :→ angle b/w Geo and Mag. Meridian.

Diff or diff or point earths

* Magnetic Inclination / Angle of dip → $\tan\delta = \frac{B_V \rightarrow B\sin\delta}{B_H \rightarrow B\cos\delta}$, $B = \sqrt{B_H^2 + B_V^2}$

Note :→ (1) Earth E.F.L Geo of magnetic Meridian.

(11) For measuring dip angle :→

$$\tan\delta' = \frac{\tan\delta}{\cos\theta}, \quad \theta = \text{angle b/w M.M and dip circle}$$

$$= \frac{B_V}{B_H\cos\theta} \quad \delta = \text{angle b/w M.M and G.M}$$

Note :→

(1) When the N-pole of a bar magnet point towards the south pole and S-pole towards N, then the null points are at magnetic axis.

(2) Angle of dip (δ) is the angle → b/w Earth's M.F (vertical) and horizontal direction.

Formula bound to remember

(1) $U = \mu_0\mu_r$, $\mu_r = \frac{B}{B_0}$

(2) (Magnetization), $I = \frac{M \rightarrow \text{Magnetic Moment}}{V \rightarrow \text{Vol. of material}}$

(3) Magn. Susceptibility, $\chi_M = \frac{I}{H}$

(4) Relation b/w Mag. permeability and χ_M.

$$B = B_0 + B_m$$

$$B = \mu_0 H + \mu_0 I.$$

$$\boxed{\begin{aligned} B_0 &= \mu_0 H \\ B &= \mu_0 I \end{aligned}}$$

$\Rightarrow \boxed{B = \mu_0(H+I)}$

$\Rightarrow B = \mu_0(H + H\chi_M)$

$\Rightarrow \cancel{\mu_0 H} = \mu_0 H(1+\chi_M)$

$\Rightarrow \mu = \mu_0(1+\chi_M)$

$\Rightarrow \boxed{\mu_r = 1+\chi_M}$ → Relation b/w magnetic permeablity and magn. suceptibility.

$\boxed{\chi_M = \frac{I}{H} \Rightarrow I = H\chi_M}$

$B = \mu_0 H.$

Key Points

$\boxed{B_0 = \mu_0 H, \quad B = \mu_0 I, \quad B = \mu H}$

~~Derivation~~

* Angle of dip at poles = 90°, * Angle of dip in equator = 0°.
* B_H points in N-S direction.
* 0.6 G at poles and 0.3 G at equator.

1 Gauss = 10^{-4} T