Handwritten Notes
On
Magnetic Property and Method

MAGNETIC PROPERTY AND METHOD

 # Magnetic Field (H) → It is applied magnetic field for magnetising of ordanary Material Rod.

* Vector.
* Unit → Amp/M

 # Intensity of Magnetisation (I) →

* It is Induced Magnetic Moment per unit Volume of Rod.

or,

Induced pole Strength per unit cross-sectional Area.

$$I = \frac{M_{induced}}{Volume}$$

$$\boxed{I = \frac{M_{ind}}{vol} = \frac{M_{ind}}{A}}$$

* Vector
* unit → Amp/Meter

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 # Magnetic Susceptibility (χ) →

Tendency.

* It Represcent how easily a material can be magnetised.

$$\boxed{\chi = \frac{I}{H}}$$

* unit & dimension less.

$$\boxed{I = \chi H}$$

H → ext. mag. field.

 # Magnetic Permeablity (μ)

* It Represcent how many line of force are allowed to pass through a material.

$$\mu_0 = 4\pi \times 10^{-7} \frac{Henery}{M} \quad (MKS)$$

$$\mu = \mu_0 \mu_r$$

* Best ($\mu_r = 2000$) of soft Iron.
* Due to high permeablity external magnetic field can't enter in cavity of soft Iron box so soft Iron box are used for Magnetic shielding.

NOTE → * Electric & Magnetic shielding are possible but Gravitational Shielding is never possible.

*

$$\boxed{\begin{aligned} I &= \frac{M_{induced}}{vol.} \\ I &= \chi H \\ \mu_r &= 1 + \chi \\ \mu &= \mu_0 \mu_r \end{aligned}}$$

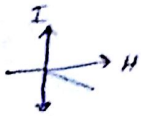
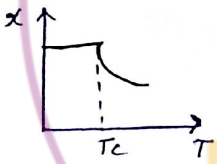
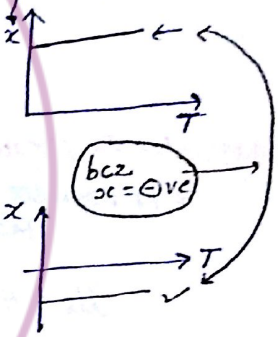
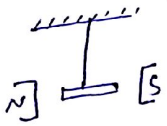
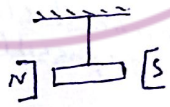
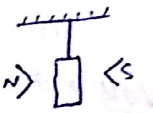
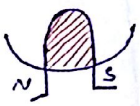
$$\boxed{1 \text{ oersted} = 80 \text{ A/m}}$$

* Relative permeablity of air → 1.04

A → Soft Iron is used as transformer core.
R → Soft Iron has narrow Hysteresis loop.

Ans → (A)

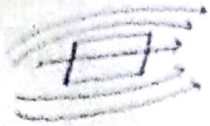
Types of Magnetic Material

Property	Ferromagnetic	paramagnetic	Diamagnetic
① I ∥ H	I >>> H (Along 'H')	I < H (Along 'H')	I < H (Opposite to H')
② B ∥ B_0	B >>> B_0	B > B	B < B_0
③ $\chi = I/H$	$\chi >>> I$ (+ve) b/c I ∥ H same dir^n $\boxed{\chi >> 1}$	$\chi < 1$ (+ve) bcz I ∥ H same dir^n $\boxed{0 < \chi < 1}$	$\chi < I$ (-ve) b/c I ∦ H opposite dir^n $\boxed{-1 < \chi < 0}$
④ $\mu_r = 1+\chi$	$\mu_r >> 2$	$1 < \mu_r < 2$	$0 < \mu_r < 1$
⑤ I v/s H			
⑥ χ v/s Temp(K)	Curie Wiss law $\boxed{\chi = \frac{C}{T-T_c}}$ T_c = curie Temp' ↓ Above which Ferro become Para 	Curie law $\boxed{\chi \propto \frac{1}{T}}$ 	$\boxed{\chi \propto T^0}$ If there be ppt(y) 
⑦ Behavior in non-uniform Mag. Field.	Moves from Weak to Strong field (Rapidly) 	Move From Weak to Strong Field (slowely-2) 	Move from Strong to Weak field. 
	 *Fe, Co, Ni Fe_3O_4, Gd	 Na, K Mg, Pt O_2, Sn, Mn	 Bi, Cu, Ag, H_2O, Au Sb, NaCl
⑧ Stak	 only solid	 Solid, Liq, Gas	 Solid liquid gas.
⑨ When material is filled in U-tube & mines cous is kept b/w mag field.	Level Rise	Level Rise	Level Fall

In atom magnetism is produced due to motion of electron.

$\vec{M_l}$ → due to orbital motion (negligible M)
$\vec{M_s}$ → Due to spin motion (effective M)

1. Diamagnetism (AIIMS 2018)



* All paired e⁻.
* Atomic dipole moment zero.
* It is inherient or, basic property of each material.
* Explain by orbital motion of e⁻.
* Acc. to Lenz law induced produced opposite to B.

$\chi = -1$

2. Paramagnetism

* Material having some unpaired e⁻
* Atomic dipole moment non-zero
* Explain by spin motion of e⁻.


Mnet = 0 Before


Mnet ≠ 0 After

$\chi = C\frac{H_0}{T}$

AIIMS * Liquid oxygen is suspended b/w the two pole faces of Magnet becz liq is paramagnetic.

3. Ferromagnetism (AIIMS 2016)

* Material having unpaired e⁻.
* Atomic dipole moment is non-zero.
* Interaction b/w atom of ferro material is very strong. So dipole in same direction make group or, Domain.
* So, It is explained by formation of domain & this phenomenon is called Bark hausen effect.

$\chi = \frac{C}{T - T_C}$


Mdipole ≠ 0
Mdomain ≠ 0
Mnet = 0
Before.


Mnet ≠ 0
After

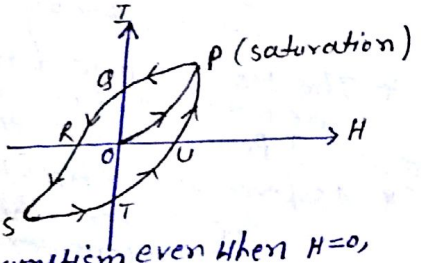
** Above curie temp. Ferromagnetic behaviour like paramagnetic due to breaking of domain.

* For Iron curie temp. 1043 K (770°C)
* curie law

$M = C(B/T)$

Hysteresis loop (B-H curve) (2016 AIEEE)

* only for Ferro Magnetic Material.
* It is I vs H graph (I - development. or, B - H graph (B → net)



Non-Linear curve
* During the magnetisation I or B lags behind H. So It is called Hysteris curve (Lake coming)
* Residual Magnetism / Retentivity → Remain magnetism even when H=0, Forward Retentivity (OQ) = Reversed Retentivity (OT)
* Coercivity → Applied opposite H for complete diamagnetism. Forward coercivity (RO) = Reversed coercivity (OU).

Hysteris loss → It is the energy loss during magnetisation & demagnetisation & represented by Area of BH curve.

* At saturation loop I-H curve = zero.

Slope of BH curve = μ_0

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

$$\boxed{\frac{dB}{dH} = \mu_0} \qquad I = \text{const.} \quad \boxed{\frac{dI}{dt} = 0}$$

* Area of BH curve = μ_0 [Area of I-H]
* Heat produced in time 't'

* $\boxed{\text{Heat} = VAnd}$

V → volume of Rod
A → Area of B-H curve
t → time in sec.

2016 3e

A/c to coercivity Feromagnetic material are two type

Soft	Hard
* Low coercivity, low Retentivity.	* High coercivity, high Retentivity.
* Low B-H curve.	* High B-H curve.
* Used for making temporary Magnet/Electromagnet & Transformer core. Ex → Soft Iron, permalloy.	* For making permanent magnet. * Ex → cobalt, steel, Al, Ni, Co.
* Magnetisation & Demagnetisation easy.	* Magnetisation & Demagnetisation diffult.

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Superconductor

* Perfect dielectric material.

$$\boxed{I = -H}$$

$$\chi = \frac{I}{H} = -1$$

$$\boxed{\mu_r = 1 + \chi = 0}$$

When a ferromaterial is magnetic its length (↑) slightly. This is called magnetostriction effect.

* The most exotic diamagnetic material are superconductor. These are metal cooled to very low temp. Which exibit both perfect conductivity & Perfect diamagnetism. Here field lines completely expelled.

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* A superconductor Repel a Magnet & (by Newton 3rd law) Repelled by the Magnet. The phenomenon of perfect diamagnetism in superconductor is called the Meissner Effect.

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* Superconductor Magnet can be gainfully exploited in variety of situation. For ex → For Running Magnetically levitated superfast trains.

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* A Frog can be leviated in a magnetic field produced by a current in a vertical solenoid placed below a frog. This is possible beoz the body of frog behave as → Diamagnetic.

But in Frog Iron (In blood) ← Ferro

But in Any living system 90% H_2O of its weight. ← Dia

!! But Magnetism of Iron one particle is More than Magnetism of many particle of H_2O. ?

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Demagnetising a Magnet

* Heating
* Hammering (Hitting)
* By put it inside the coil & AC is passed through the coil.