CH # 16 27 NOV 2017

Physics of Solids

Study of solids and its properties and Structure

Solids:- properties of Solids:-

(i) Mechanical properties (stiffness, ductility etc)

(ii) Magnetic properties (ferromagnetic etc)

(iii) Electric properties (conductor, etc)

1. Crystaline Solids:- solids in which atoms, molecules or ion are arranged in a particular periodic and geometric maner is called Crystals.

* Repetation of unit cell after equall Interval of time

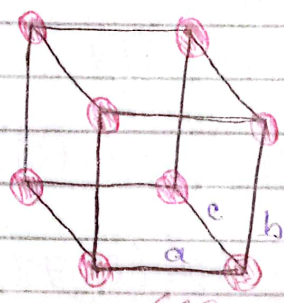
2. Amorphous Solids

3. polymeric Solids:

(*) "properties of Solids depends upon the arrangment of particles [atoms] in Solids"

Unit Cell:-

The Smallest repetitive volume that comprises the whole Symmetry of a Crystal is Called Unit Cell.



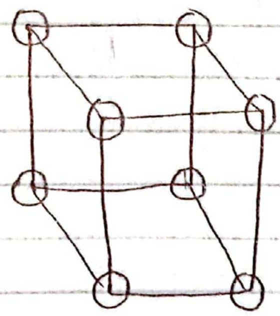
$a = b = c$

$\alpha = \beta = \gamma = 90^\circ$

SCC

Lattice :-

A regular periodically reapeted three dimenssional array of points which specify the position of atoms, molecules or Ions in a Crystal is Called lattice.



(O) may be
i) atoms
ii) Molecules
iii) Ions

* The dead Skeleton of a Crystal is Called Lattice.

* The Study of lattice is easy, because we don't Study atoms, molecules or Ions etc, we consider only points.

28 Nov 2017.

Crystal = Lattice + Basses

Lattice ↓ Skeleton

Basses ↓ Atoms, molecules or Ions.

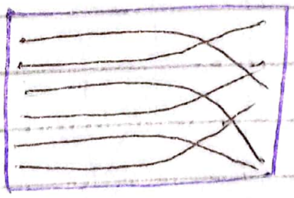
(ii) Amorphous Solids:- Solids which don't have particular arrangement.
oR, The solids in which particles are arranged randomly are called amorphous solids.

(iii) polymeric Solids:- Solids in which small molecules combine and form large molecules.

Example:- C=C + C=C + ... → C–C–C–C

Ethene → Polyethene

* In polymeric Solids, polymers shows Crystalinity in some reigon i.e no long range order.



Elasticity:- The ability of a body to regain its orignal position is called elasticity.

$$E = \frac{Stress}{Strain}$$

$$E = \frac{Stress}{Strain}$$ * More Stress, * Less Strain = More elastic

$$E = \frac{Stress}{Strain}$$

E = Elastic Modolus → (Ratios or Magnitude)

* The above equation is called Hook's Law.

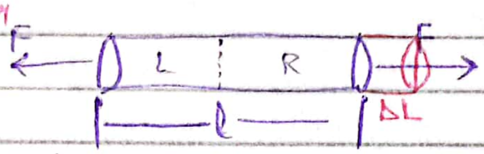
There are three types of Elastic Moduli:

① Young Modulus :-

(I) Tensile Stress :-

produce Tensile strain in a body

The force exerted on the Rod etc. All Particles become under tension.



* Normal force per Unit area is called Tensile Stress

$$T.stress = F/A \quad \text{— (i)}$$

(II) Tensile Strain:

Change in length per unit orignal length.

$$T.Strain = \frac{\Delta L}{L}$$

$$\text{Young Modolus} = \frac{\text{Tensile Stress}}{\text{Tensile Strain}}$$

$$Y = \frac{F}{A} \div \frac{\Delta L}{L}$$

$$Y = \frac{F}{A} \times \frac{L}{\Delta L}$$ — P.T.O *

$$Y = \frac{FL}{A\Delta L}$$

Young Modolus is related to change in length.

Unit:- $N\,m^{-2}$

Stress	Pressure
* Normal force per unit area	* Always Normal force per unit area
* Tangential force per unit area	

* Dimensionaly Both are Same.

(II) Bulk Modulus:-

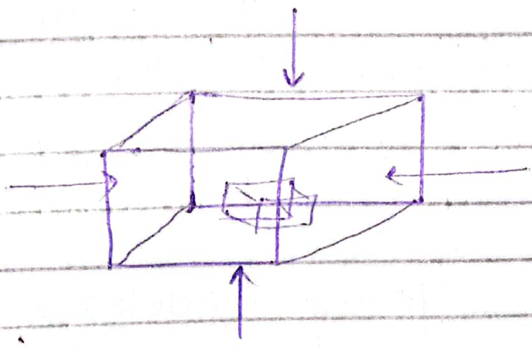
[Volume]

(I) Bulk Stress:

The change in pressure on a body is Called Bulk Stress.

$$B.\ Stress = \Delta P \quad \text{— (I)}$$

* Bulk Stress is related to volume



(II) Bulk Strain:-

change in volume per unit original volume is Called Bulk Strain.

$$B.\ Strain = \frac{\Delta V}{V} \quad \text{— (II)}$$

Bulk Modulus = $\frac{\text{Bulk Stress}}{\text{Bulk Strain}}$

$$B = -\frac{\Delta P}{\left(\frac{\Delta V}{V}\right)} \quad \text{--- (4)}$$

$\rightarrow B = -V\left(\frac{\Delta P}{\Delta V}\right)$

The negative sign shows that Bulk Modolus is always positive.

i.e Initial pressure $P_1 = 10\,atm$

$V_1 = 40m^3$ $P_2 = 30\,atm$

$V_2 = 30m^2$ $\Delta P = 20\,atm$

$\Delta V = V_2 - V_1 = 30 - 40$

$\Delta V = -10m^2$

Then ΔV will become negative So, to make it positive, we put a negative sign in the equation.

Compressibility:- The Resiprocal of bulk Modolus is called compressibility

$$\text{Compressibility} = \frac{1}{B} \quad \text{--- (5)}$$

(cappa) $\leftarrow K = \frac{1}{B}$

put (4) in (5)

$$K = \frac{1}{\frac{\Delta P}{\left(\frac{\Delta V}{V}\right)}}$$

$$K = \frac{1}{V\left(\frac{\Delta P}{\Delta V}\right)}$$

$$K = \frac{1}{V}\left(\frac{\Delta V}{\Delta P}\right)$$

$\frac{1}{V}\left(\frac{\Delta V}{\Delta P}\right)$ Reseprocal of Bulk Modolus.

* ~~If~~ ; $B = V\left(\frac{\Delta P}{\Delta V}\right)$

Unit:- $K = \frac{m^2}{N}$

* If Bulk Modouls is large
* compressibility will be low.

(III) Shear Modoulous:-

(I) Shear Stress:

Tangential force per unit area.

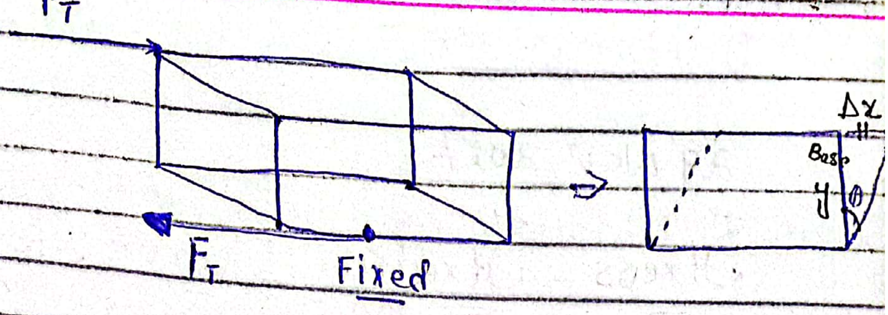
$$S.Stress = \frac{F_T}{A} \quad \text{---}(1)$$

(II) Shear Strain:-

Displacement of the Sheared Side divide by fixed Side.

F_T = Parallel

e.g:-



A Stress which changes the shape of a body without the net change in volume is called shear stress.

$$S.Strain = \frac{\Delta x}{y} \quad —② $$

$$\tan\theta = \frac{\Delta x}{y}$$

When $\theta <<$

$$\tan\theta \approx \theta$$

$$\theta = \frac{\Delta x}{y} \quad —③$$

put eq ③ in eq ②

$$S.Strain = \theta \quad —④$$

$$G = \frac{S.Stress}{S.Strain} \quad —⑤$$

put eq ① and ④ in eq ⑤.

$$S.G = \frac{F_T}{A} \div \theta$$

Shear Modolus

$$S.G = \frac{F_T}{A} \times \frac{1}{\theta}$$

$$S = \frac{F}{A\theta}$$

Unit:- Nm^{-2}

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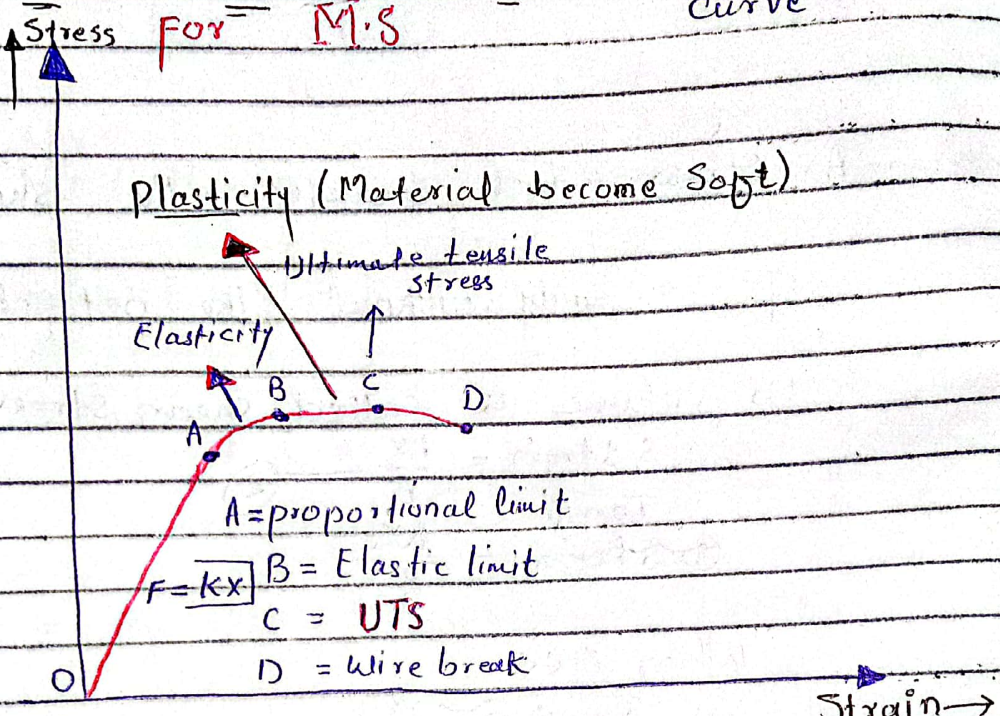
Stress - Strain Curve :- "Force extension curve"



A

Ductile:- property of a material to be hamered, streched, Sqize, twist is called ductily.

proportional limit:- The greatest stress a material can endure after before lossing the proportionality relationship is called proportional limit.

Elastic limit :- The greatest Stress a material Can endure before undergoing any permenent change is Called elastic limit.

UTS (Ultimate Tensile Strength (stress)) :-
The greatest Stress a material Can endure before breaking is Called UTS (Ultimate tensile strength).

Brittle Material :-
① if a material breaks before B, before B then it is Called Brittle or tough material.
e.g : Glass

Ductile Materials :-
Those Materials which break after B, is Called Ductile Materials.

Strain Energy in Deformed Bodies :-
The potential energy Stored in a body during its deformation is Called Strain energy.

OR

Energy Stored in a body when work is done on it.

* Sometime ~~Stress~~ Strain energy is regainable and sometime ~~it is~~ not.

Method # 1:

$$\text{Strain Energy} = \text{Work done}$$

$$U = (\text{Force})(\text{Extension})$$

$$U = \langle F \rangle e \quad \text{—— (I)}$$

We Can't apply constant force

e = +ive → Relaxation / Extension

e = −ive → Compression

$$\langle F \rangle = \frac{0 + F}{2}$$

$$\langle F \rangle = F/2 \quad \text{—— (II)}$$

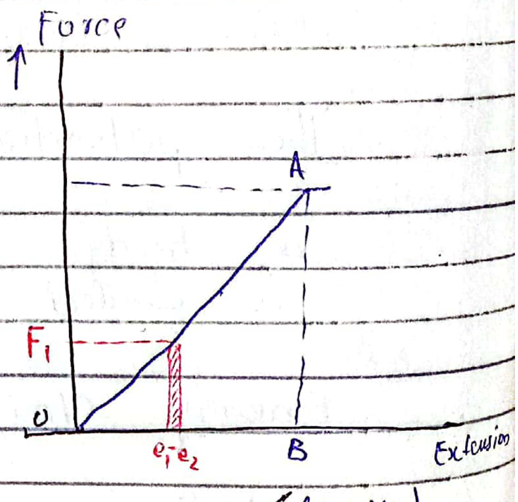
$$\boxed{U = \frac{1}{2} Fe}$$

Method # 2:

Area of the Shaded strip $= F_1(e_2 - e_1)$ —— (III)

$= F_1 \delta_e$ ($\because F = N$

$= \Delta W_1$ $\delta e = m$



$e_2 - e_1 = \delta$ (Delta) (Small)

Δ = capital

Area of $\Delta OAB = \frac{1}{2}(AB)(OB)$

$$U = \frac{1}{2} Fe \quad \text{——— (3)}$$

F = Force

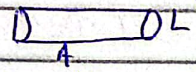
e = Extension / Relexation

Strain Energy Density:-

$$S.E.D = \frac{S.E}{\text{volume}}$$

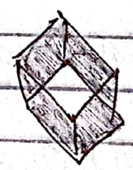
$$u = \frac{U}{V} \quad \text{——— (4)}$$

$$u = \frac{1}{2} Fe \div AL$$

(∵ 
$V = AL$)

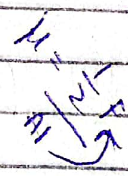
$$u = \frac{1}{2} Fe \times \frac{1}{AL}$$

$$u = \frac{1}{2}\left(\frac{Fe}{AL}\right)$$



$$u = \frac{1}{2}\left(\frac{F}{A} \times \frac{e}{L}\right)$$

$$\boxed{u = \frac{1}{2}(\text{Stress} \times \text{Strain})}$$



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Mechanical properties of Solids:-

Behaviour of Solids when Subjected to external M forces

1. **Strength:-** The ability of a Solid to withstand an external mechanical force is Called Strength of that Solid.
2. **Stiffness:-** The ability of a Solid to resist any change in its shape or Volume is Called Stiffness.

3. Toughness :- Materials which ~~have~~ are brittle are Called Tough materials and This property is Called Toughness.

4. Ductility :- (Can be hamered, Squize or twist) are Called Ductile materials

* Ductile materials shows plasticity.

Electrical properties of Solids:-

(I) Free Electrons Theory :-

(II) Energy Band Theory

(I) Energy Band :- Collection of Subenergy band

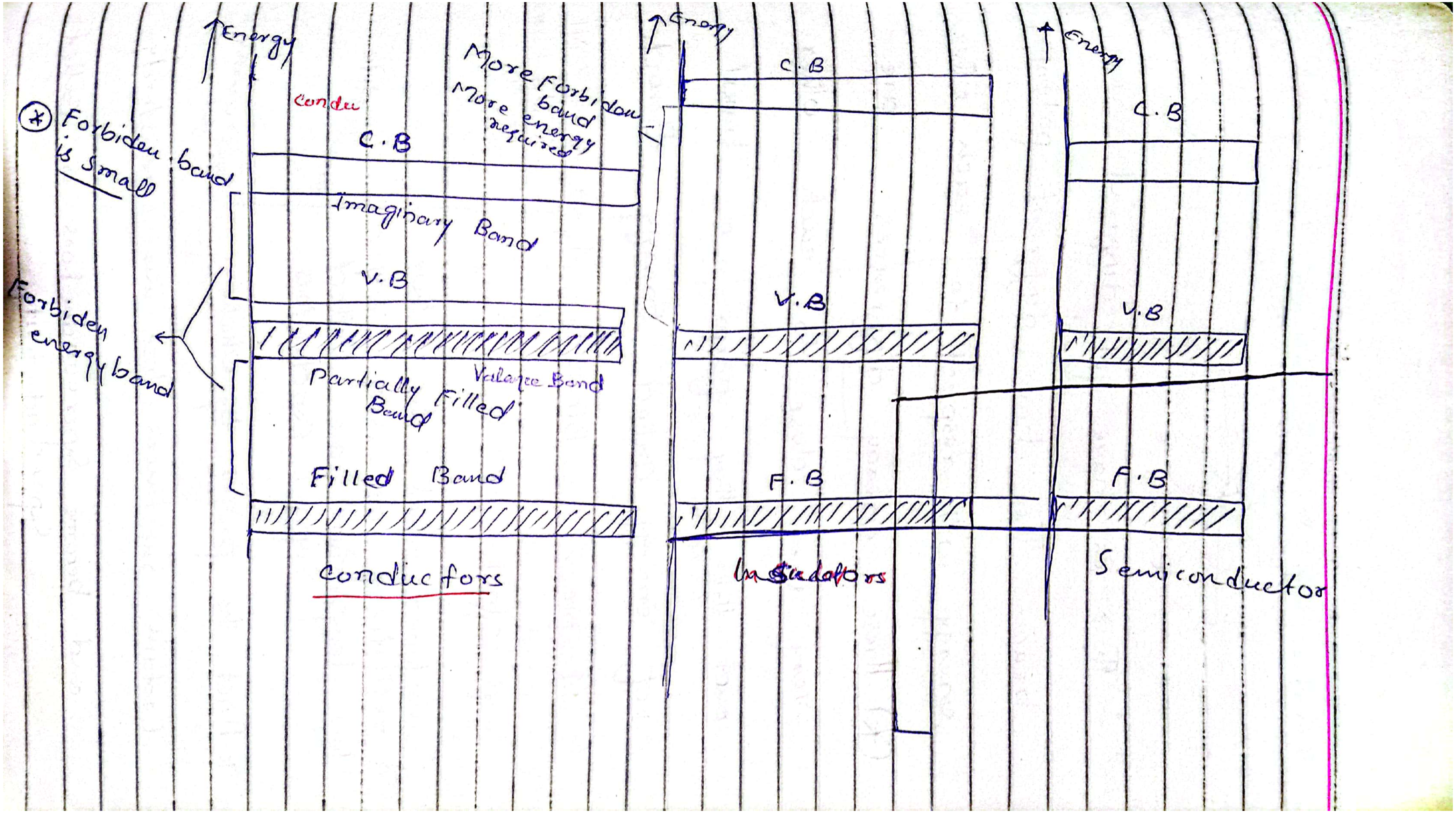
(I) Valance Band

(II) Conduction Band

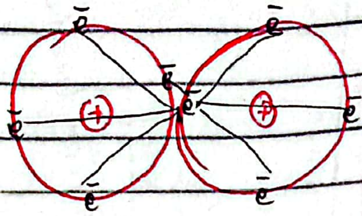
(IV) Filled energy Band

(V) Forbidden energy Band

Energy band :- Collection of Sub energy states obtained ~~band~~ due to spliting of a Singel energy State is Called energy band.



Energy
Condu
C.B
Imaginary Band
V.B
Partially Filled Band
Valance Band
Filled Band
Conductors
(*) Forbiden band is Small
Forbiden energy band
More Forbiden band
More energy required
Energy
C.B
V.B
F.B
Insulators
Energy
C.B
V.B
F.B
Semiconductor



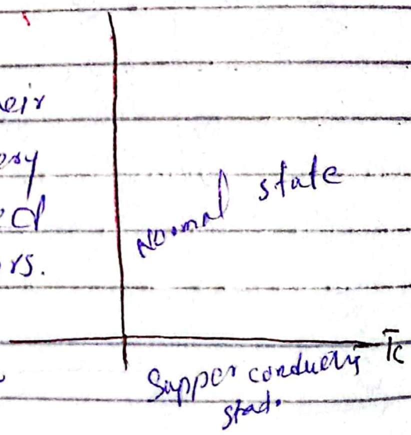
These ēs have got different energy beacuse They have different potential energy with respect to each other.

(*) These energy differences are very very close to each other and thus they form a band of energy Called Energy Band.

01 Dec 2017: Black day "Agriculture UNI Dirrectorate Attack", by terrorists.

Superconductors:-

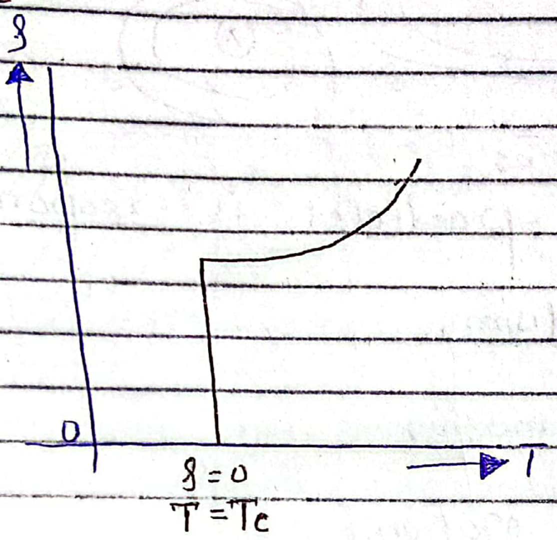
Substances which loose their resisitivity at very very low temprature are Called Supper Conductors.



* And the proces by which Certain Substances lose their resistivity and become Super conductors is called Super conductivity.

* The temprature at which the material lose their resistivity is called Critical temprature.

1. High T_c → It will be more benificial than low T_c superconductor...
2. Low T_c →



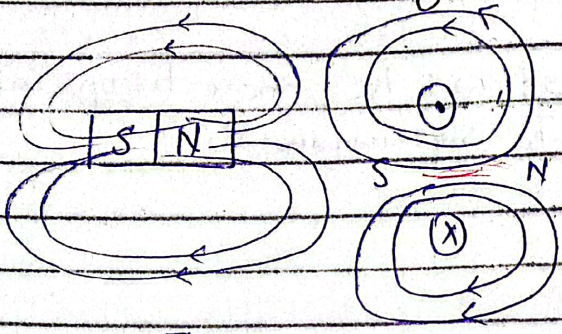
Magnetic properties of Solids:-

Solids State physics

* Origon of Magnetism

1. parramagnetisim
2. Ferromagnetisim
3. Diamagnetisim

* Behaviours of Solids when they are Subjected to external magnetic field.



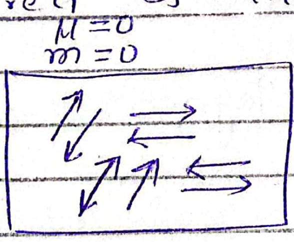
$\bar{e}s$ Charge particles is responsible for magnetisim.

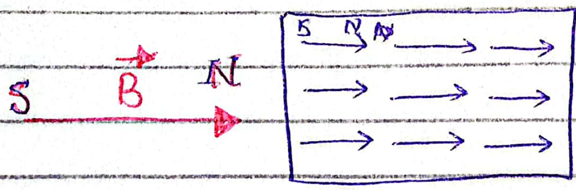
* Spin motion :

* orbital Motion :

paramagnetic Materials

unpaired $\bar{e}s$ in atoms.





Paramagnetism.

paramagnetic Materials

* All the atoms aligned along the direction of magnetic field.

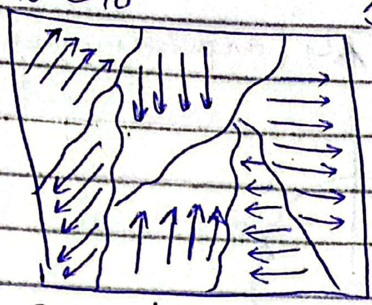
* paramagnetic materials are weakly attracted by magnetic field (External). ~~materials~~

* paramagnetic materials have unpaired $\bar{e}$s.

[ferrum] Ferromagnetisim:

In Iron, Nickel, Cobalt Domains grouping takes place.

$10^{12} \sim 10^{16}$

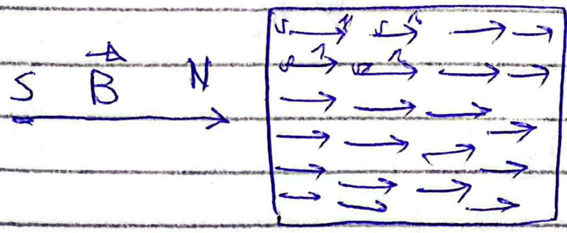


Domain → gp of atoms having same magnetic and spin motion etc.

Grouping take place Due to their nature

* Due to grouping they show strong effect than paramagnetic. When such materials are subjected to external magnetic field, the Domains are very easily aligned along the external magnetic field.

* In these substance the Domains are aligned very easily



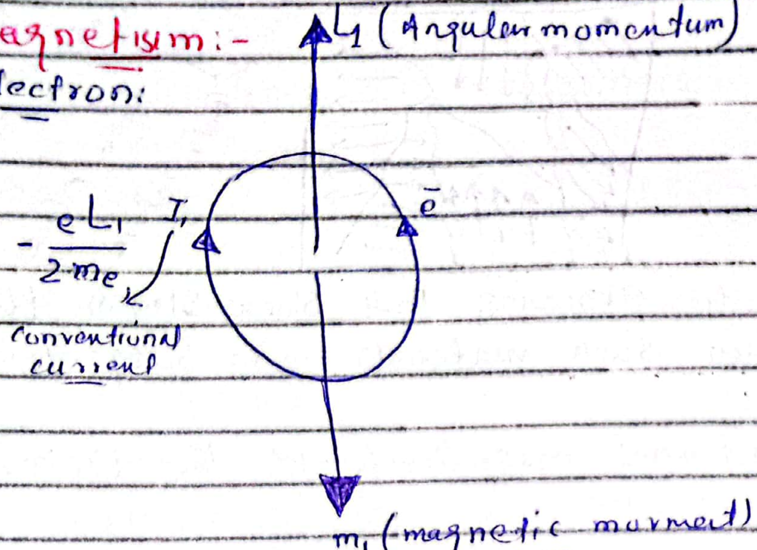
∴ Due to high paramagnetism.

Ferromagnetic materials are strongly attracted by the magnetic field.

* Due to formation of Domains, they are ~~most~~ strongly attracted by external magnetic field.

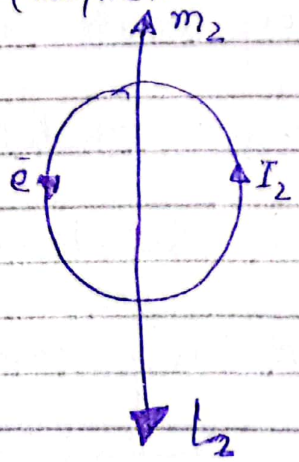
Diamagnetism:-

1st electron:



$$m_1 = -\frac{eL_1}{2m_e}$$

2nd electron:

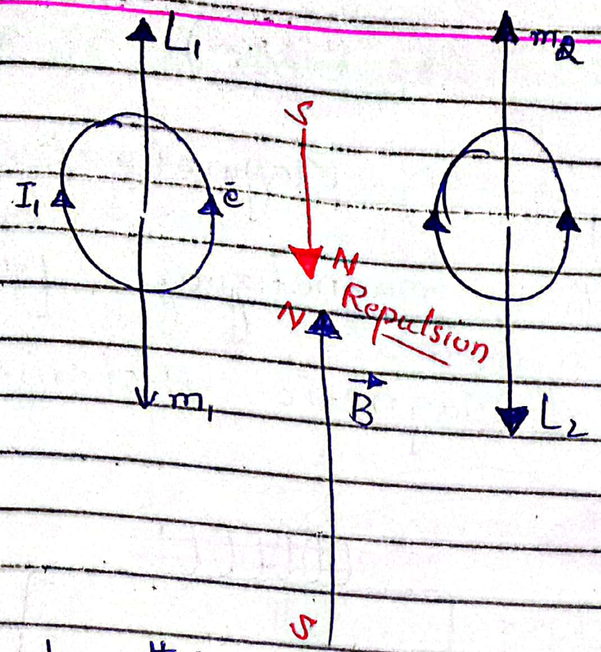


$$m_2 = \frac{-eL_2}{2m_e}$$

$$m_1 = -m_2$$

i.e $m_1 + m_2 = 0$ (Net magnetic moment is Zero).

*



In this Case m_1 will Increases So that to opose ~~m~~ external magnetic field and Similarly m_2 will decreases.

i.e

$m_1 > m_2$, ~~$m_1 \neq m$~~ $m_1 \neq -m_2$

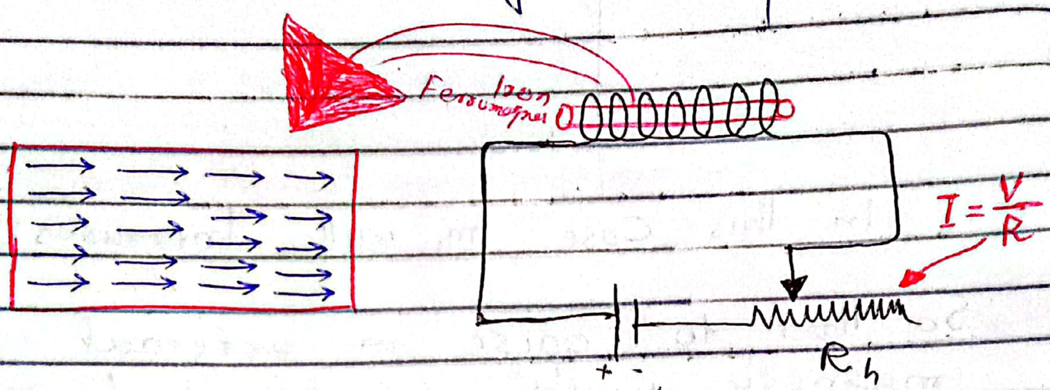
So the net magnetic field will be opposite to external magnetic field.

* Such materials will move from Stronger end to weaker end.

04 Dec 2017

Magnetic Hysterises:- (1.60)

The laging of Magnetization (B) behind the magnetizing field (H) is Called Magnetic Hysterises.



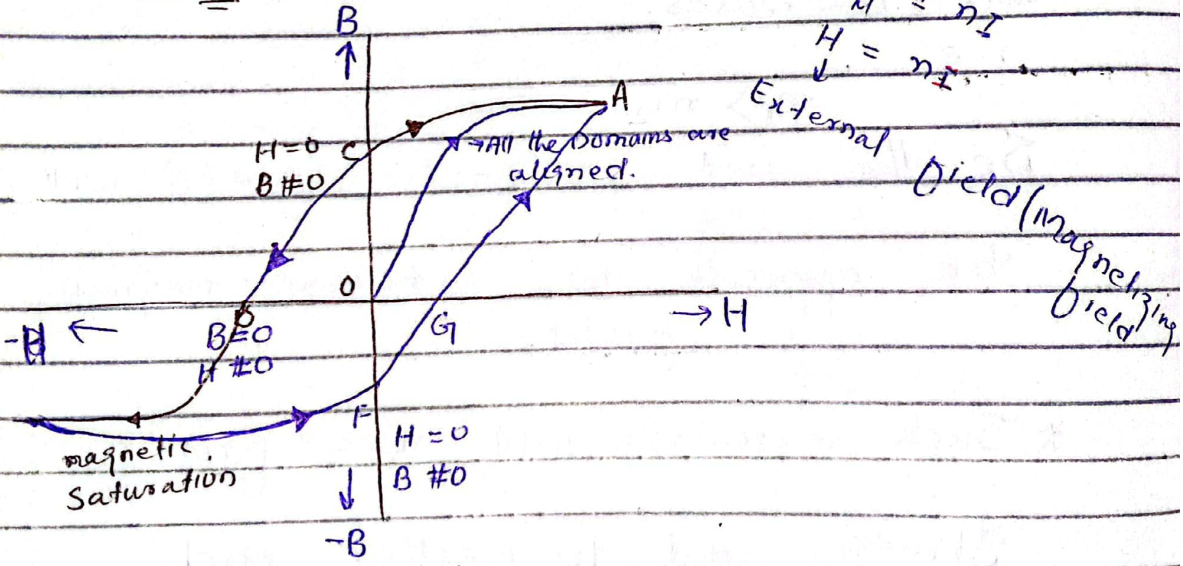
Internal or Magnetization ← $B = \mu n I$

$\frac{B}{\mu} = nI$

$H = nI$

↓ External field (Magnetizing field)

GRAPHICALY:-



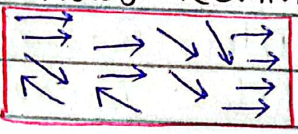
1. Magnetic Saturation:- The points at which all the Domains are aligned.

* There is no possibility of further magnetization.

2:- Residual Magnetisim / Retaintivity / Remanance

The ability of a material to retain some magnetism when external magnetic field or Magnetizing field (H) becomes Zero is Called Remanance or Retaintivity.

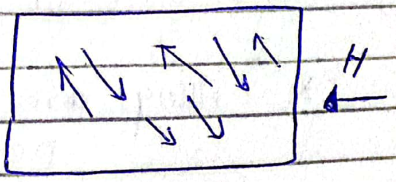
* OC in the graph shows Reminance.



* 3. Coercive field:-

The magnitude of the magnetizing field (H) aplied in oppossite dirrection to fully de-magnetize the material is Called coercive field.

* This property of the material is Called coercivity.

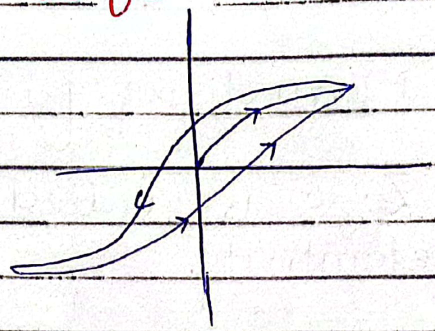


(i) Soft ~~Materials~~ Magnetic Materials

(ii) Hard Magnetic Materials.

-: Soft Materials :-

(i)



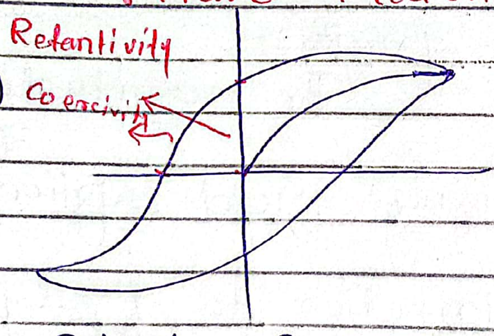
For soft materials,

(i) low Retaintivity

(ii) low Coercivity

-: Hard Materials :-

(2)



(i) High Retaintivity

(ii) High coercivity

(*) permenent magnets are made from those materials who have High Retaintivity and coercivity. i.e. Hard Materials.

* Alloy are ~~made~~ use ~~from~~ for making permenent magnets.

i.e (i) Al ni co

(ii) Cunife

Reluctance:-

The oppossision offered by a material to the establishment of magnetic field (B) is called Reluctance.

The End

اک فکر میں بیٹھے زرد ہوئے اس سوچ میں کلیاں سوکھ گئیں
اب کے گلستاں کیا ہوگا دستورِ بہاراں کیا ہوگا

اے موج حوادث ان کو بھی دو چار تھپیڑے ہلکے سے
کچھ لوگ ابھی تک ساحل پر طوفاں کا نظارہ کرتے ہیں

By:- SAJJAD-SANAN
55

My Next Destination → KMC Inshallah

ارادے جن کے پختہ ہوں نظر جن کی خدا پر ہو
تلاطم خیز موجوں سے وہ گھبرایا نہیں کرتے

اس قوم کو شمشیر کی حاجت نہیں رہتی
ہو جس کے جوانوں کی خودی صورتِ فولاد
(ڈاکٹر علامہ محمد اقبال رحمۃ اللہ)