#1

4.- Solid State

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** Crystalline Solid (characteristics) :-

→ i) There is a regularity & ~~constituent~~ periodicity in the arrangement of constituent particles.

ii) Crystalline solid have sharp melting point that is they melt at a definite temperature.

iii) All crystalline substance except those having cubic structure are anisotropic.

iv) Ex :→ ice, sodium chloride, metals such as gold, copper, material such as diamond, graphite, etc.

** Amorphous solid (characteristics) :-

→ i) The constituent particle in amorphous solid are randomly arranged.

ii) Amorphous solid do not have sharp melting point. They melt gradually over a temperature interval.

iii) These solids are isotropic.

iv) Ex :→ plastic, rubber, glass etc.

* Solid :-

→ • Strong molecular force bet particles.
• particle are closely packed.
• rigid & incompressible.
• sharp melting point.

* Anisotropic :-

→ different properties in different directions.

* Isotropic :-

→ Same properties in different direction

* Types of Crystalline Solid [based on similarity or dissimilarity in crystal structure] :-

1- Isomorphism :-

→ Two or more substance having the same crystal structure are said to be "Isomorphism". In these structure, the chemical composition has the same atomic ratio.

ex :→

NaF (1:1) & MgO (1:1)

$CaCO_3$ (1:1:3) & $NaNO_3$ (1:1:3)

2. polymorphism :-

→ A single substance that exists in two or more forms or crystalline structure is said to be "polymorphism". polymorphs of a substance are formed under different condition.

ex :→

① calcite & aragonite are two form of calcium carbonate

② α-Quartz, β Quartz & cristobalite are tree forms of silica

SiO_2 → α-Quartz
→ β-Quartz.

* Polymorphism occuring in element is called "allotropy".

ex :→ Three polymorphic fam of carbon i.e

Carbon → Diamond
→ Graphite
→ fullerene (C_{60})

* Classification of crystalline solide [Base on forces] :-

1- Ionic solid :-

→ i) The constituent particle in ionic crystal are charged ions, They are cation & anion.

ii) The particle of ionic crystal are held by "electrostatic force of attraction" between opp. charged ions.

iii) Ionic crystals are hard and brittle.

iv) Ionic crystals have high melting point.

v) Ionic ~~solid~~ crystals are non-conductor of electricity in solid state. However in aqueous sol or molten form they are good conductor of electricity.

vi) ex:→ NaCl

2- Covalent network crystal :-

→ i) The constituent particle in ~~of~~ covalent network ~~solid~~ crystal are atoms.

ii) The atoms of covalent network crystal are linked by a covalent bond.

iii) The covalent network crystal is a three dimensional rigid solid. which forms a giant molecule.

iv) C.N.C are very hard because atom are linked by covalent bond.

v) Due to absence of free electrons, the C.N.C is a poor conductor of electricity.

vi) The have high melting & boiling point.

3- Molecular crystal :-

Substance such as CH_4, O_2, H_2, Cl_2, CO_2 etc on solidification give molecular crystal.

i) The constituent particles in molecular solids are molecules. (unbonded single atom) of the same substance.

ii) The bond within the molecules are covalent. The molecules are held together by various intermolecular forces.

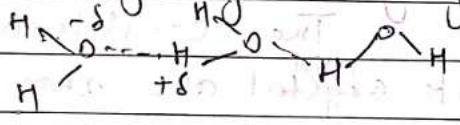
(a) Dipole-dipole interaction : The polar substance like H_2O, HCl have dipole-dipole interaction.

ex :→ $H^{+\delta}—Cl^{-\delta} \cdots H^{+\delta}—Cl^{-\delta}$

(b) London force / Dispersion force : The non-polar solid substances like CH_4, H_2, O_2 have weak london forces.

(c) Hydrogen bond : The solid substances like H_2O, HF & NH_3 have hydrogen bonding

ex :→



iii) They have low melting point.

iv) They are poor conductor of electricity.

4- Metallic crystals :-

These are the crystalline solid formed by the atoms of same metallic elements, held together by a metallic bond.

i) Metallic crystal are malleable

ii) They are ~~duetly~~ ductile

iii) They are good conductor of electricity.

iv) Some metals have high melting point.

#3

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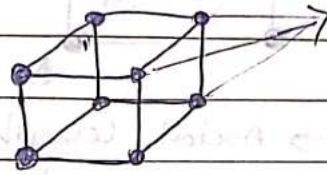
is the geometrical arrangement of points in a 3-D periodic array?

* **Lattice point :-**

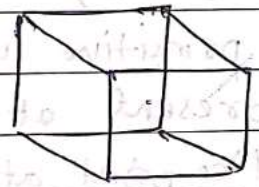
Lattice point are the atom, ion, molecules which are arranged in regular three dimensional to form a crystal



→ Lattice point.

* **Unit cell :-**

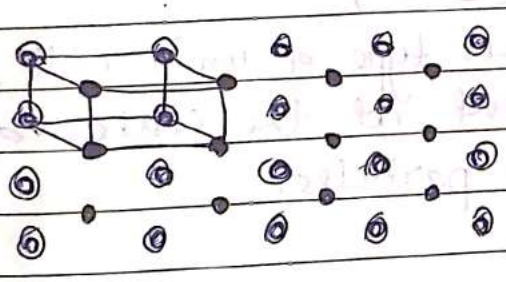
The smallest repeating structure unit of a crystalline solid is called unit cell.



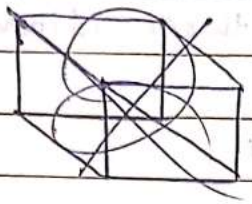
→ unit cell.

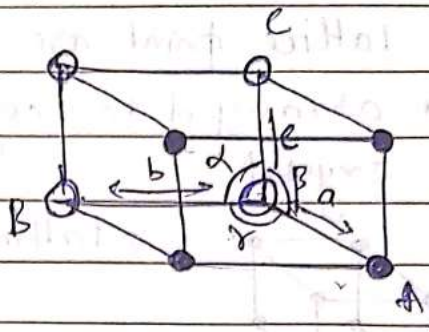
* **Crystal lattice :-**

When the lattice point are arranged in in a regular 3-D form, Then the structure called crystal lattice.



* Parameters of unit cell :





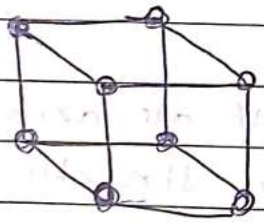
Bond Length → a, b, c → Axial length (Axes)
Bond angle → α, β, γ

* Types of unit cell :-

1- Primitive or simple unit cell :- (SCC)

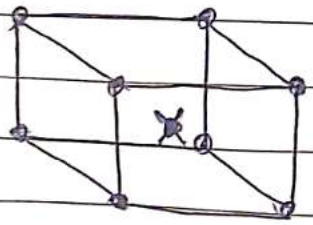
In primitive unit cell, the constituent particles are present at its corners only.

- They contain only eight (8) lattice point at the corners



2- Body-centered unit cell :- (BCC) non primitive

In this type of unit cell, one constituent particle is present at the centres of its Body. in add to the corners particles.



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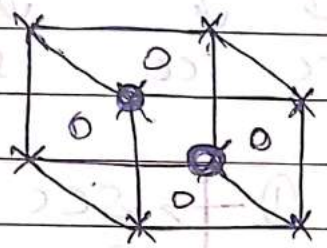
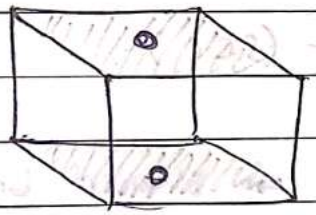
3- Face-centered unit cell :- (fcc) non-prim
This unit cell consist of particles at the center of each of the faces in addition to the corner particle.



4- Base-centered unit cell :- (End centered cell)
This unit cell consist of particle at the center of any two of its opposite in add to the corner particles.



* ~~Bravais~~ Crystal System :-
There are only 14 ways in which similar point ~~in which~~ can be arranged in a 3D order. These 14 lattices, which describe the crystal structure, are called "Bravais lattices".

The seven crystal system are named as cubic, tetragonal orthorhombic, rhombohedral, monoclinic, tri triclinic & hexagonal system.

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#4

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O	C	T	M	R	T	H
↓	↓	↓	↓	↓	↓	↓
Alko	Cubic	Retra	Mon	Rhom	Pricl	Hexa
(4)	(3)	(2)	(2)	(1)	(1)	(1)
↓	↓	↓	↓	↓	↓	↓
SCC	SCC	SCC	SCC	SCC	SCC	SCC
BCC	BCC	BCC	Base			
FCC	FCC					
Base						

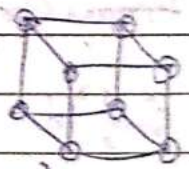
① → SCC
② → BCC
③ → FCC
④ → Base

** No. of particles in cubic unit cells:-

1] Primitive or simple cubic unit cell :- (SCC)

(particle)
8 no lattice point present at corner is shared by 8 unit cell.

No. of particles is present in SCC unit cell. $= \frac{1}{8} \times 8 = 1$ (atom / particles)

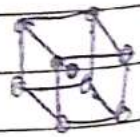


There are total 1 particle present in simple unit cell.

2] Body centred cubic unit cell :- (BCC)

8 lattice point present at corner are shared by 8 unit cell & one lattice is present at the centred of the body.

No. of P.P.I BCC $= \frac{1}{8} \times 8 + 1 = 1 + 1 =$ **2**



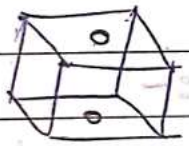
3. face centered unit cell :- (FCC) (march 2024)

8 lattice point present at corner are shared by 8 unit cell. & each face contain one lattice point.

No. of pp. FCC = $\frac{1}{8} \times 8 + \frac{3}{2} \times 1 = 1 + 3 = 4$

* In Base centered unit cell :-

No. of particle → $\frac{1}{8} \times 8 + \frac{2}{2} \times 1 = 1 + 1 = 2$.



#5

** Relation bet molar mass, density of the substance, & unit cell edge length. (march 2024)

⇒

i) If the edge length of the unit cell is "a" and volume of unit cell is "a^3"

ii) If the no. of particles present in unit cell is "n" & mass of each particle is "m"

$$\text{mass of unit cell} = n \times m \quad \rightarrow (1)$$

iii) The molar mass (M) is given by,

M = no. of particles * mass of one particle.

$M = N_A \times m$

$$m = \frac{M}{N_A} \quad \rightarrow (2)$$

($N_A = 6.022 \times 10^{23}$)

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iv) Since, we know that,

$$\text{Density} = \frac{\text{Mass of unit cell}}{\text{vol of unit cell}}$$

$$\rho = \frac{n \times m}{a^3} \longrightarrow (3)$$

$$\Rightarrow \frac{M}{N_A} \times \frac{n}{a^3}$$

v) Substitutes eq (2) in eq (3)

$$\therefore \rho = \frac{n \times M}{a^3 \times N_A}$$

* Packing of particles in crystal lattice :-

The no. of neighbouring spheres that touch any given sphere its co-ordination no.

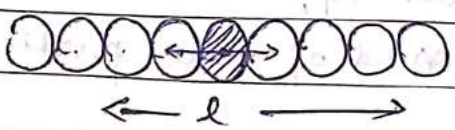
(for board exam learn from textbook)

↓ (CET)

- Closed Packing structures:

1] Closed Packing in 1-D :-

- When particle are placed near to each other in a straight line than the packing is called C.P in 1-D
- There is only one way to arrange the particles that is in straight line.



Co-ordination no. = 2

- The co-ordination no. of central atom in C.P in 1-D is 2 becz it touches two other atom when they are arranged in a straight line.

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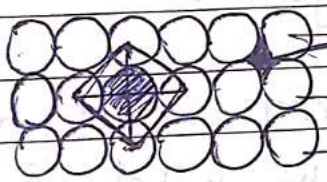
2) Closed Packing in 2-D :—

when 1-D layer is repeat itself again & again then the layer formed in 2-D There are two way's :

(i) Square closed packing :—

Square closed packing is also known as AAA type closed packing.

- When the particle of next layer is placed exactly in front of first layer. all the particles are surrounding by 4 particle forming a square and Hence called as S.C.P
- The co-ordination no. of in S.C.P is 4.
- S.C.P is not strongly or effectively packed bcz of large size of void.

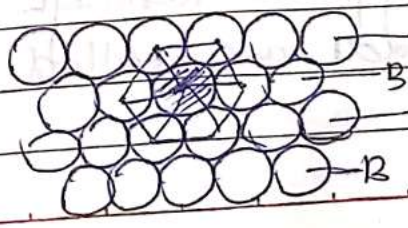


Square closed P.
AAA-type
Co-ord → 4

(ii) Hexagonal closed packing :—

H.C.P is also known as ABAB type packing.

- The particle of 2nd layer is placed bet the depression of two particle in 1st layer.
- the centeral particle are attached to six (6) other particle forming a hexagonal & hence called as H.C.P.
- The co-ordination no. of H.C.P is 6
- These are strongly or more effectively packed bcz void contain Least Space.
- It forms 0 as void



Hexagonal closed P
ABAB-type
Co-ord → 6

3] Closed Packing in 3-D :—

C.P. in 3-D are of two types:

(1) ~~3-D packing~~

(1) Stacking of Square closed packed layer:—

(3-D packing by 2-D square (CP)) → It is called as AAA type. becz each layer is same.

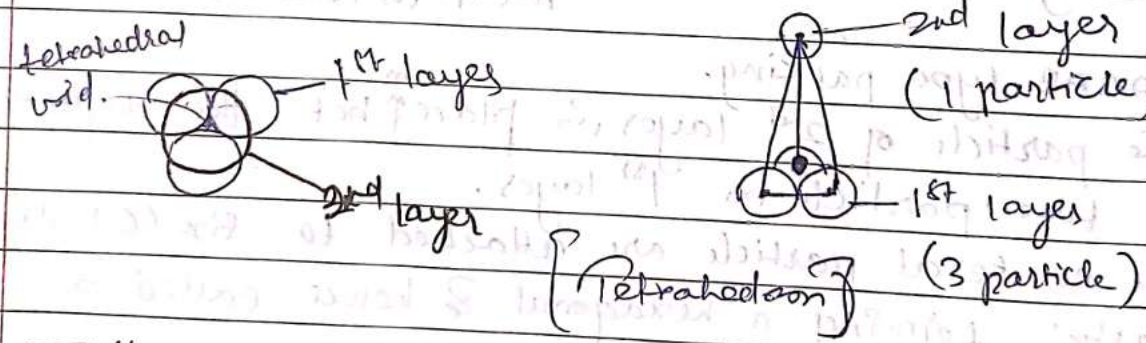
- when 2-D square closed packed layer is placed one over another so that particle of each layere are palced one over another.
- This arrangement of particle are not effective beck of large void.
- Fig. 1.4 → (Pg → 10)

(3-D packing from 2-D hexagonal CP) →

(2) Stacking of two hexagonal closed packed layers :—

(i) Placing 2nd layer over 1st layer :→

- The particle of 2nd layer is placed exactly above triangular void of 1st layer The void is ~~call~~. form & called tetrahedral void.



(ii) — " —

- when 2nd layer is placed over 1st layer still the void appears through both 1st & 2nd layer Such voids are called as octahedral voids.

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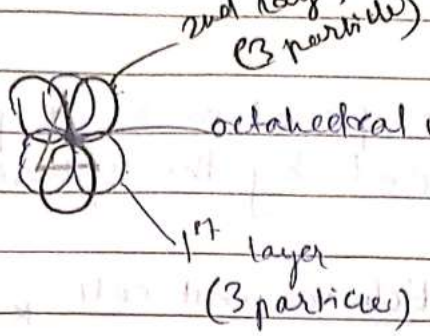
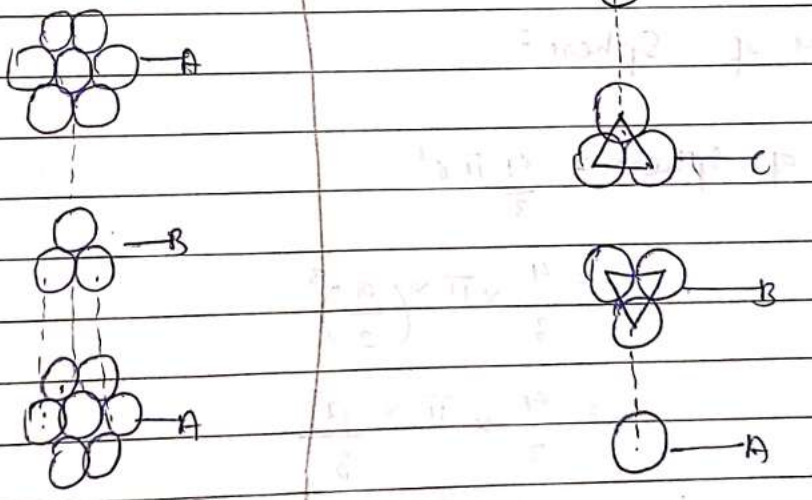


(iii) Placing 3rd layer over 2nd layer. ?→

(a)→ 3rd layer particle covering tetrahedral void of 2nd layer.

In this arrangement the 1st layer & 3rd layer are similar Therefore, it is also called as hexagonal closed packing.

The coordination no. of hcp is (12).



(b)→ 3rd layer particle covering octahedral void of 2nd layer.

This type of arrangement is called as ABC ABC - arrangements. This is also known as close cube packing (CCP) Generally CCP is also refered as FCC type of unit cell.

* Packing efficiency :-
— " — is the fraction or a percentage of the total space occupied by the spheres (particles).

P.E = $\frac{\text{vol}^m \text{ occupied by particle in unit cell}}{\text{total vol}^m \text{ of unit cell}} \times 100$

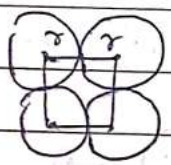
1- Packing efficiency in simple cubic lattice :-

[Q] calculate the percentage ~~of~~ efficiency of packing in case of SCC (march 2017)

{ rel bet edge lenght and radius of an atom in SCC (July 2022) }

⇒

i] Radius of Sphere:



From fig; $a = 2r$ — (July 2022)

$\therefore r = \frac{a}{2}$ — (1) (July 2014)

ii] volume of 1 Sphere :

vol^m of sphere = $\frac{4\pi r^3}{3}$

$= \frac{4}{3} \times \pi \times \left(\frac{a}{2}\right)^3$

$= \frac{4}{3} \times \pi \times \frac{a^3}{8_2}$

$= \frac{\pi a^3}{3 \times 2}$

$\text{vol}^m = \frac{\pi a^3}{6}$ — (2)

Coordination no:
scc → 6
bcc → 8
fcc → 12

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iii] Total vol^m of particles :

Since simple cubic unit cell contain only one particle

$\therefore$ Total vol^m of particle $= 1 \times \frac{\pi a^3}{6}$

$= \frac{\pi a^3}{6}$

iv] Packing efficiency :

Packing efficiency $= \frac{\text{Total vol}^m \text{ of particle in unit cell}}{\text{Total vol}^m \text{ of unit cell}} \times 100$

$= \frac{\pi a^3}{6 \times a^3} \times 100$

$= \frac{\pi}{6} \times 100$

$\therefore 52.36\ \%$

The free space or empty space (void) in unit cell is $100 - 52.36 = 47.64\ \%$

Empty space $= 100 - 52.36$

$= 47.64\ \%$

100.00
52.36
47.64

2. Packing efficiency in Body-centered cubic lattice :-

[A] The relation bet^n radius of sphere & edge lenght in body-centered cubic lattice is given by formula :

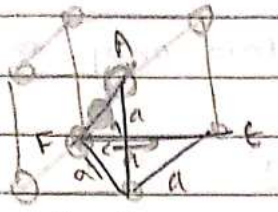
(a) $\sqrt{3}x = 4a$

(b) $r = \frac{\sqrt{3}}{a} \times 4$

(c) $r = \frac{\sqrt{3}}{4} a$

(d) $r = \frac{\sqrt{2}}{4} \times a$ (March 2023)

⇒ Radius of sphere:



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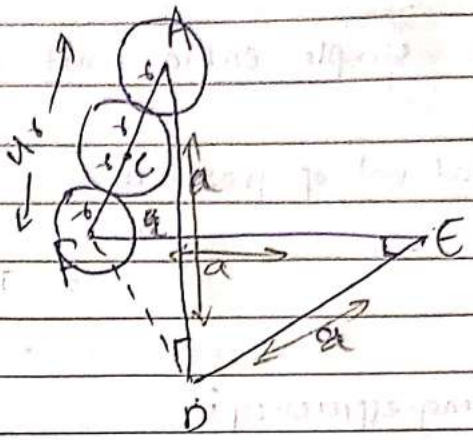

In ΔFED, $\angle FED = 90°$,
Acc. to pythagoroous theroom.

$$FD^2 = DE^2 + EF^2$$
$$FD^2 = a^2 + a^2$$
$$FD^2 = 2a^2$$

In ΔAFD, $\angle ADF = 90°$
Acc. to pythagoroous thm.

$$AF^2 = FD^2 + AD^2$$
$$(4r^2) = 2a^2 + a^2 \quad \ldots (AF = 4r)$$
$$(4r)^2 = 3a^2$$

Taking square root on both side.

~~$4r = \sqrt{}$~~

~~$[(4r)^2]^{\frac{1}{2}} = (3a^2)^{\frac{1}{2}} = 3^{\frac{1}{2}}$~~

$$4r = \sqrt{3}\, a$$

$$\therefore r = \frac{\sqrt{3}}{4} a \quad \text{---(1)}$$

{rel bet radius & edge length}

↓

(march 2023)

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iii] volume of sphere:

vol^{m} of Sphere $= \frac{4}{3}\pi r^3$

$= \frac{4}{3} \times \pi \times \left(\frac{\sqrt{3}}{4} a\right)^3$

$= \frac{4}{3} \times \pi \times \frac{\sqrt{3} \times \sqrt{3} \times \sqrt{3}}{4 \times 4 \times 4} \times a^3$

$= \frac{1}{3} \times \pi \times \frac{3\sqrt{3}}{4 \times 4} a^3$

$= \frac{\pi \sqrt{3} a^3}{16}$

iii] Total vol^{m} of particles:

Since body-centered unit cell contain 2 particles,

$\therefore$ Total vol^{m} of particles $= 2 \times \frac{\pi \sqrt{3} a^3}{16}$

$$= \frac{\pi \sqrt{3} a^3}{8} \quad \text{---} (2)$$

iv] Packing efficiency:

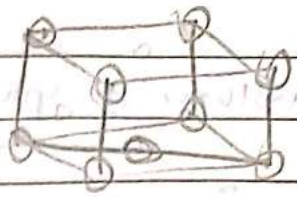
$$P.E = \frac{\text{Total vol}^{m} \text{ of particles in unit cell}}{\text{Total vol}^{m} \text{ of unit cell}} \times 100$$

$$= \frac{\pi \sqrt{3} a^3}{8 \times a^3} \times 100$$

$$= \frac{\pi \sqrt{3}}{8} \times 100$$

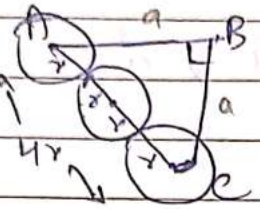
Packing efficiency = 68%

empty space = 100 − 68
= 32 %



3- Packing efficiency in face-centered cubic lattice :-

i) Radius of sphere :-



In Δ ABC, ∠ABC = 90°
Acc. to pyth. thm.

$AC^2 = AB^2 + BC^2$

$(4r)^2 = a^2 + a^2$

$(4r)^2 = 2a^2$

Taking Sq. root on both side.

$4r = \sqrt{2}\,a$

$r = \frac{\sqrt{2}\,a}{4}$

$r = \frac{\sqrt{2}\,a}{2\times 2} \times \frac{\sqrt{2}}{\sqrt{2}}$

$r = \frac{2a}{2\times 2\times\sqrt{2}}$

$\therefore r = \frac{a}{2\sqrt{2}}$ — ①

ii) vol^m of sphere :

vol^m of sphere $= \frac{4}{3}\pi r^3$

$= \frac{4}{3}\times\pi\times\left(\frac{a}{2\sqrt{2}}\right)^3$

$= \frac{4}{3}\times\pi\times\frac{a^3}{2\sqrt{2}\times 2\sqrt{2}\times 2\sqrt{2}}$

$= \frac{4}{3}\times\pi\times\frac{a^3}{2\times 2\times 2\times 2\sqrt{2}}$

$= \frac{4}{3}\times\pi\times\frac{a^3}{4\times 2\times 2\sqrt{2}}$

$= \frac{\pi a^3}{3\times 2\times 2\sqrt{2}}$

$= \frac{\pi a^3}{12\sqrt{2}}$ — ②

$2\sqrt{2}\times 2\sqrt{2}\times 2\sqrt{2}$

$2\times 2\times 2\times 2\sqrt{2}$

#7

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iii] Total vol of particles

Since face centered unit cell contain 4 particles

∴ Total vol of particle = $4 \times \frac{\frac{4}{3}\pi a^3}{16\sqrt{2}}$

$$= \frac{\pi a^3}{3\sqrt{2}} \quad \text{---(2)}$$

iv] Packing efficiency:

$$P.E = \frac{\text{Total - - -}}{\text{Total - - -}} \times 100$$

$$= \frac{\pi a^3}{3\sqrt{2} \times a^3} \times 100$$

$$= \frac{\pi}{3\sqrt{2}} \times 100 = 0.74 \times 100$$

$$= 74\%$$

empty space = 100 - 74

$$= 26\%$$

* No of particles & unit cell in 'x' g of metallic crystal :-

→ Let 'm' is the mass of one particle & 'n' is the no. of particles then,

mass of unit cell = n × m

If vol of unit cell is 'a³' then,

(ρ) density = $\frac{\text{mass of unit cell}}{\text{vol of unit cell}}$ $\boxed{= \frac{m \times n}{a^3}}$ ——— (1)

Molar mass (M) = m × N_A

$\therefore m = \frac{M}{N_A}$

put $m = \frac{M}{N_A}$ in eq (1).

$\therefore \rho = \frac{\frac{M}{N_A} \times n}{a^3}$ $\rho = \frac{m \times n}{a^3}$

$\therefore \rho = \frac{\frac{M}{Na} \times n}{a^3}$

$\therefore \rho = \frac{M \times n}{Na \times a^3}$

$\therefore \boxed{M = \frac{\rho N_A \times a^3}{n}}$ ——— (2)

No. of particles in 'x' g of metallic crystal.

molar mass contain N_A particles

'x' g of metal contains ——— particles = $\frac{N_A \times x}{M}$

from eq ②

'x' g of metal contains = $\frac{N_A \times x}{m}$

$\therefore = \frac{N_A \times x}{f \times a^3}$

$\boxed{= \frac{x \times n}{f a^3}}$

'x' g of metal contains $\frac{xn}{fa^3}$ particles.

a.

1 unit cell ⟶ 'n' particles

'p' unit cell ⟶ $\frac{xn}{fa^3}$ particles

$p \times n = 1 \times \frac{xn}{fa^3}$ ((p ⟶ is the no. of unit cell))

$p \times n = \frac{xn}{fa^3}$

$p = \frac{x n}{f a^3} \times \frac{1}{n}$

$\boxed{p = \frac{x}{f a^3}}$

no. of ~~particle~~ in unit cell in $\frac{xn}{fa^3}$ particles

is $\frac{x}{fa^3}$

$\therefore$ 'x' g. of metal = $\frac{x}{fa^3}$ unit cell.

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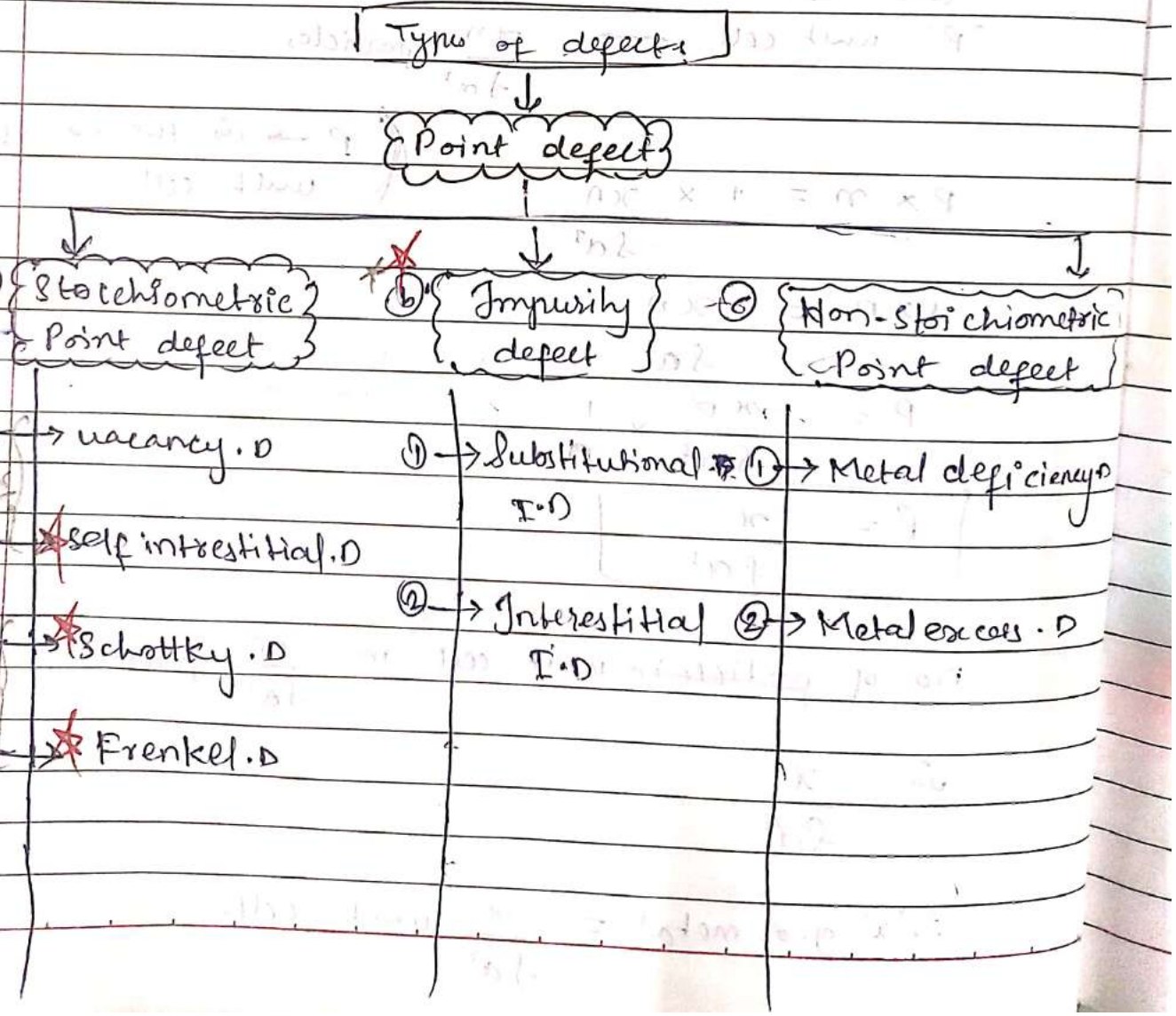
* Crystal defect or imperfection:-

(The real naturally occuring crystalline substance do not have perfect crystal structure. They have some disorders or irregularities in the (stacking of atom)) such arrangement of constituent particles of a solid crystal are called defect or imperfection.

- Defect are created during the process of crystallization
- The imperfection are more if the crystallization occures at faster rate.

Note:- Imperfection are possible only at absolute zero of temperature. Above this temp, no crystalline materials are 100% pure.

*



#9

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* Point defect :-

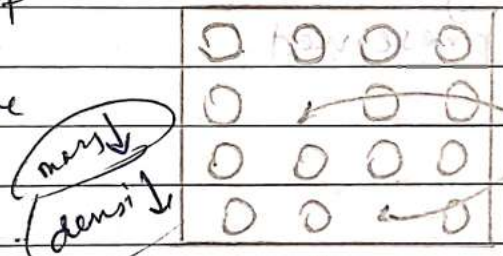
These defect are irregularities produced in the arrangement of basis at lattice point in crystalline solid.

a * Stoichiometric Point defect :-

In this defect the ratio of no. of atom or no. of cation & anion of the compound remains the same as represented by its chemical formula.

(i) Vacancy defect :-

During crystallization of solid, a particle is missing from its regular site in the crystal lattice. Durind the absence of particle the mass of substance decr but the wt remains unchanged As a result, the density of a substance decr.



vacancy defect.

mass & density ↓
wt → unchanged

(ii) Self-interstitial defect :-

When some particle of the crystalline elemental solid occupied interstitial site in the crystal structure, it is called self-interstitial defect.

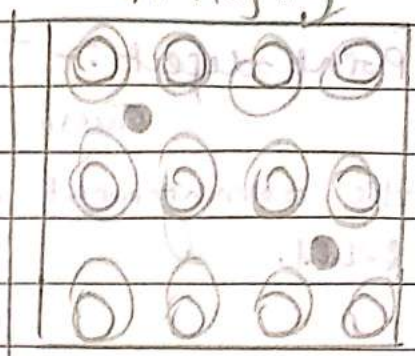
This defect occurs in two ways,
Firstly, an extra particle occupies an empty interstitial space in the crystal structure. The extra particle inc↑ the total mass without inc↑ing

mass ↓ density ↓ vol → same

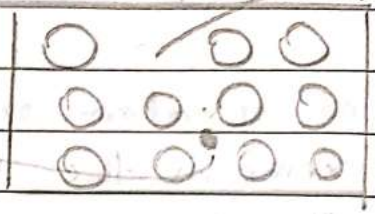
vol. Hence density incr.

- Secondly, a particle get shifted from its ~~pre-existing~~ (original) lattice point & occupies on intrestitial space in the crystal. Hence the density remains same beez theri is neither loss nor gain in mass of a substance.

firstly →



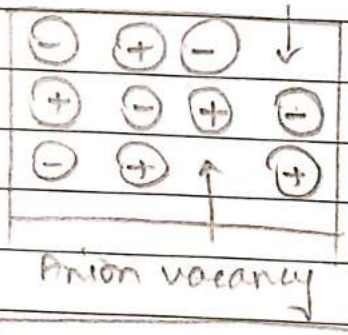
secondly →

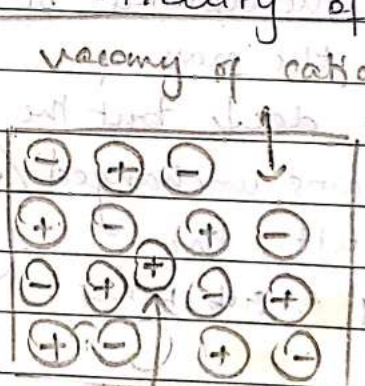


mass ↓ density ↓ vol → same

(iii) Schotty defect :- (march 2022)

In an ionic solid equal no. of cations or anions are missing from their regular position in the crystal lattice, As mass decr, hence density also decr. The neutrality of the compound is preserved.





Frenkel defect

(iv) Frenkel defect :-

This defect arises when an ion (cation) of an ionic compound is missing from its regular lattice site and occupies intrestitial position bet lattice points.

- The density & neutrality remains the same.

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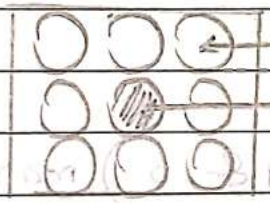
5* Impurity defect:

Impurity defect arises when foreign atoms, i.e, atom different from the host atom, are present in the crystal lattice

(i) Substitutional impurity defect:-

In this defect, the foreign atoms are found at the lattice sites in the place of host atoms. The regular atoms are displaced from their lattice sites by impurity atoms.



(Brass)

ex:- Brass

(ii) Interstitial impurity defect:-

In this defect, the impurity atom occupies a interstitial space of lattice structure.

(Stainless steel)

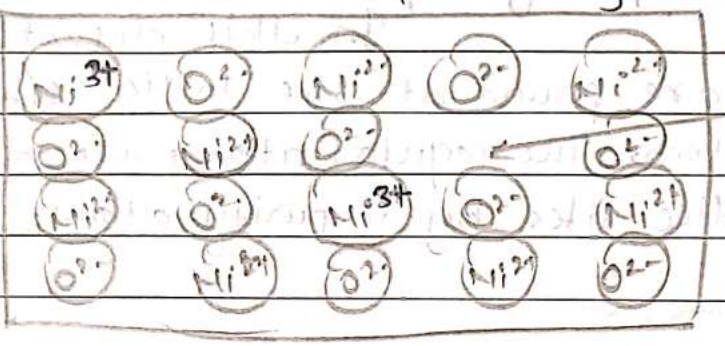
ex - steel

6] Nonstoichiometric defect:

This defect arises when ratio of no. of atom of one kind to that of other kind or that ratio of no. of cation to anion becom different.

#09

<i> Metal deficiency defect :-
In some crystals, the metal ions are missing from their original lattice sites. The extra -ve charge is balanced by the presence of cation of the same metal with higher oxidation state than that of missing cation.



<ii> Metal excess defect :-
(page no → 19 & 20) marked in textbook

#10

* Electrical properties of solid :-

1- Conductors :- ex → metal & electrolytes
range → $10^4 - 10^7$ $ohm^{-1} m^{-1}$

2- Insulators :- ex → non-metal, molecular solids
→ 10^{-20} to 10^{-10} $ohm^{-1}m^{-1}$

3- Semiconductors :- ex → metalloids like silicon, germanium etc.
→ 10^{-6} to 10^4 $\Omega^{-1}m^{-1}$

(pag → 20 & 21) marked in textbook.

* Band theory :

<i> Conduction band :-
<ii> valance band :-
<iii> Band gap :-

(Page no → 21) masked in textbook.

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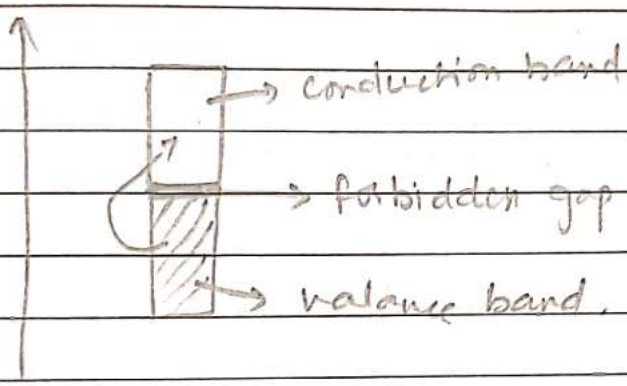
* Forbidden zone :-

(page → 21) marked within textbook.

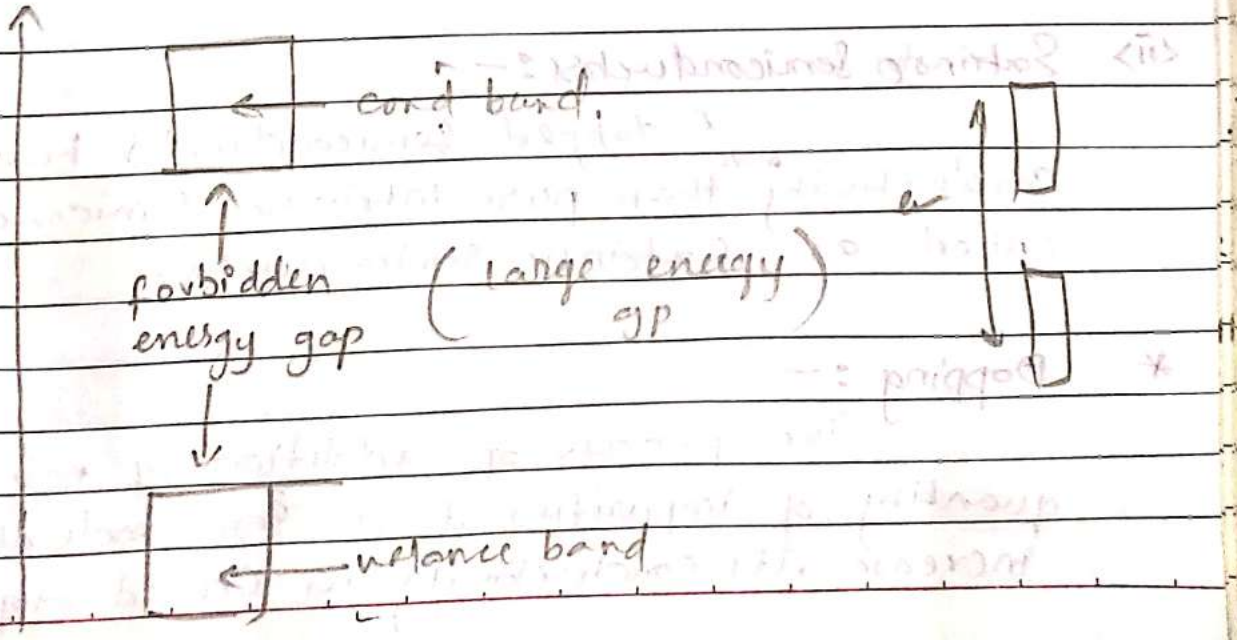
* Metals [conductors] :- (based on B.T)

There is almost negligible forbidden energy gap. Electron can easily jump from valence band to conduction band.



* Insulators :- (b. on B.T)

There is a large gap bet valence band & conduction band. Due to large forbidden gap, no electron jum from valance band to cond band



#10

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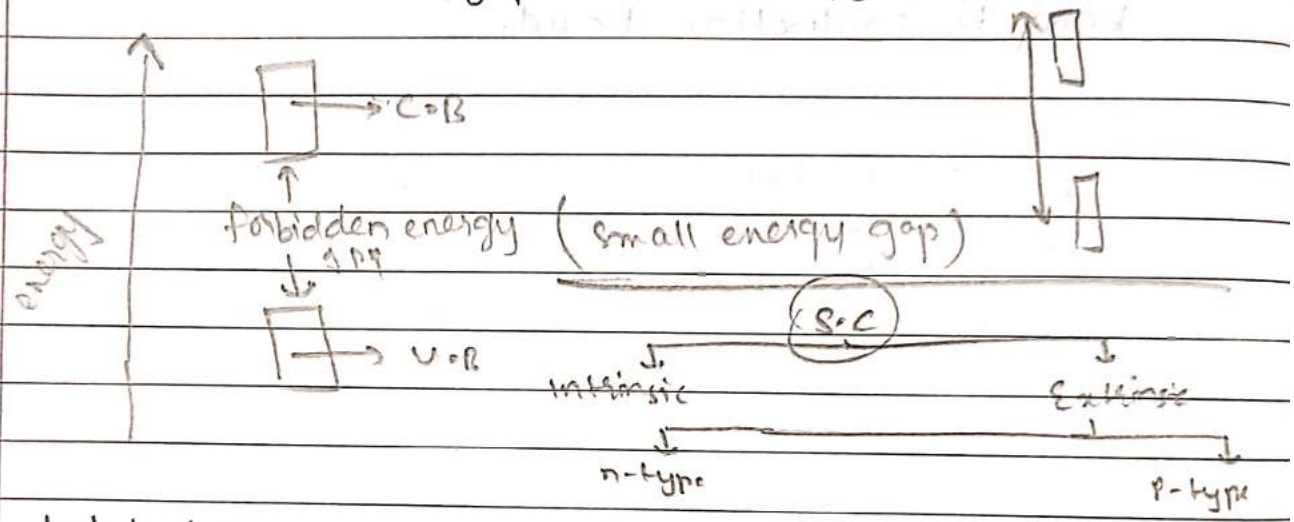
* Semiconductors :- (b. on : B.T)

The forbidden energy gap bet valance band and conduction band is smaller than insulators. At a temperature above absolute zero a few electrons in the valence band have enough thermal energy to jump through the small band gap and occupy cond band.



<i> Intrinsic Semiconductors :-

The pure semiconductor material which have very low but finite electrical conductivity is called intrinsic semiconductors. The conductivity of this semiconductors increases with increasing temp.

<ii> Extrinsic Semiconductors :-

A dopped semiconductors having conductivity more than pure intrinsic semiconductors is called as extrinsic semiconductors.

* Dopping :-

The process of addition of minute quantity of impurities to a semiconductors to increase its conductivity is called dopping.

* Dopant :-

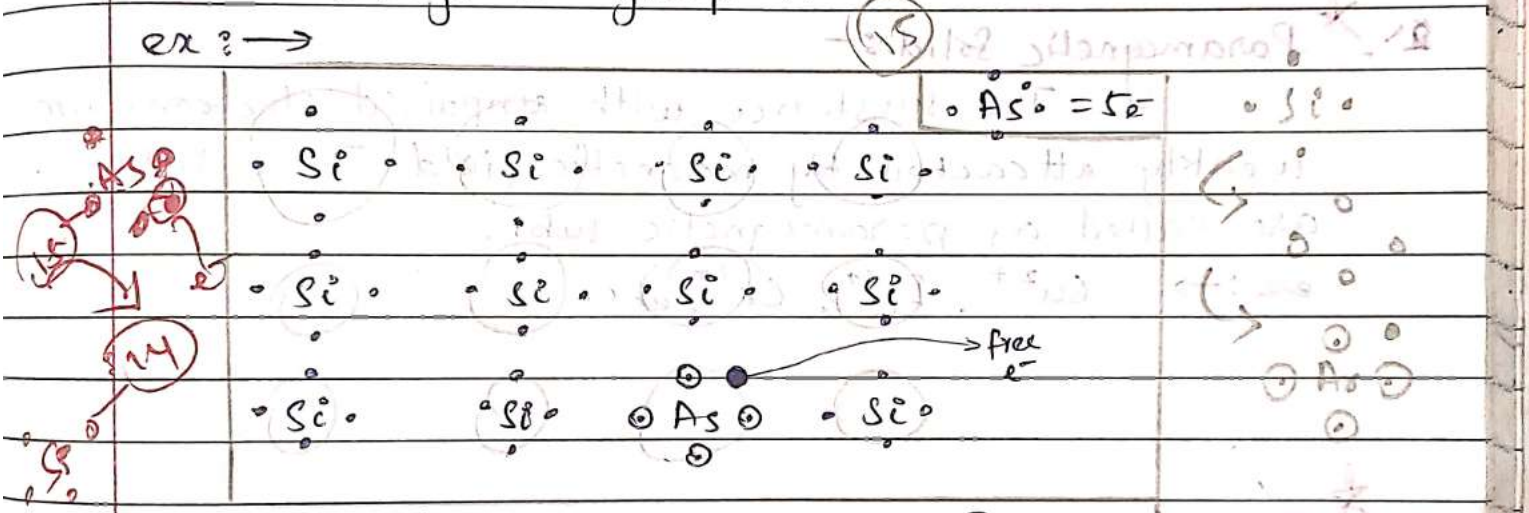
The added impurity is called as dopant.

* Types of extrinsic semiconductors :-

(i) n-type semiconductors :-

An n-type semiconductor is obtained by adding group 15 element to intrinsic semiconductors which belongs to group 14.

ex :→

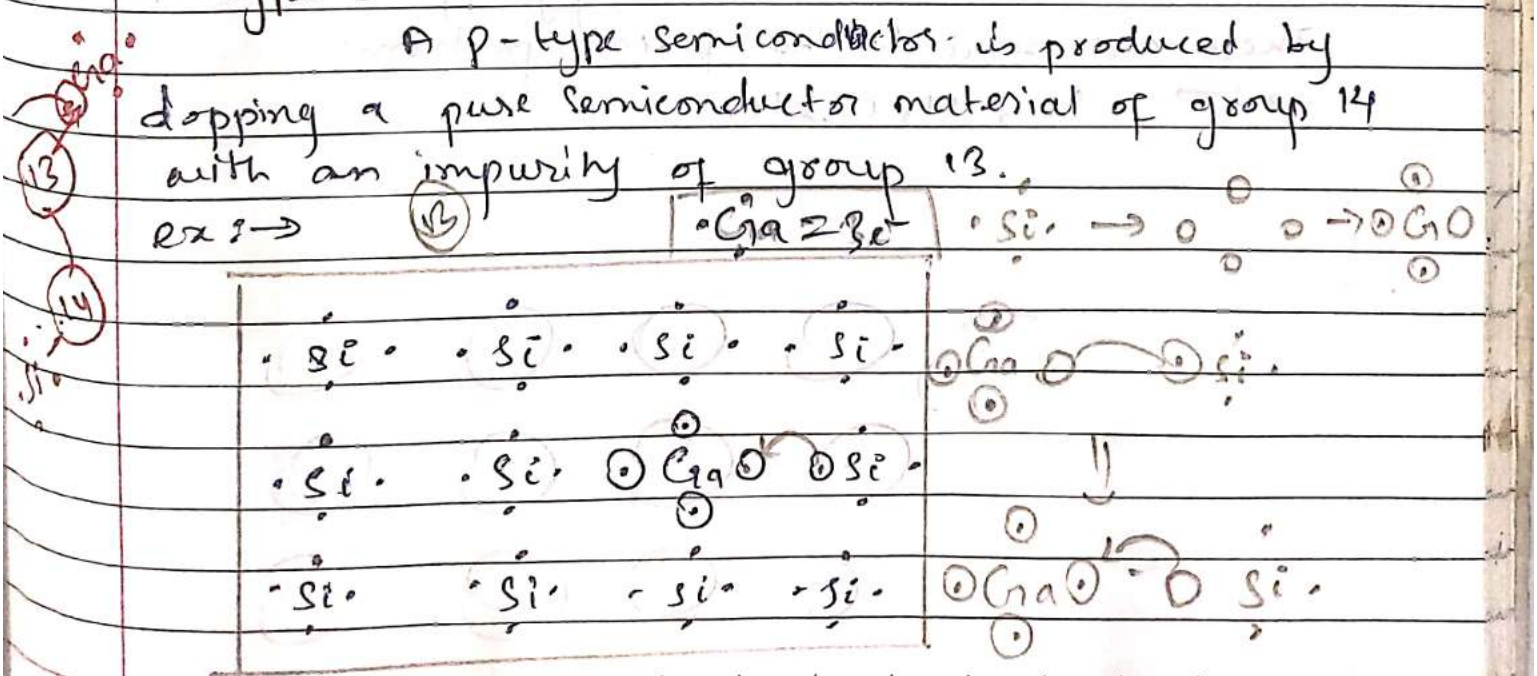


(e⁻ rich semiconductors)

(ii) P-type semiconductors :-

A P-type semiconductor is produced by dopping a pure semiconductor material of group 14 with an impurity of group 13.

ex :→



* Magnetic properties of solid :-

1- Diamagnetic solid :-

The substance with all electrons paired, are weakly repelled by magnetic fields. These substance are said to be diamagnetic. subs.

ex :→ N_2, F_2, NaCl etc.

even → Dia [loz & ice → Para]

odd → Para

2- Paramagnetic solid :-

The substance with unpaired electrons are weakly attracted by magnetic field. These substance are called as paramagnetic subs.

ex :→ Cu^{2+}, Fe^{2+}, Cr^{2+}, etc.

① + ② = 3

$Fe[26] = [Ar]\ 3d^6 4s^2$ ⊙ $3d^5$ [↑↓ | ↑ | ↑ | ↑ | ↑]

3- Ferromagnetism :-

The substance contain large no. of unpaired electrons are attracted strongly by magnetic field. These are said to be ferromagnetism.

ex :→ Fe, Ni, Co, etc.

$Fe[26] = [Ar]\ 3d^6 4s^2$

[↑↓ | ↑ | ↑ | ↑ | ↑] [4s]

* Coordination numbers :-

trick: A B C D E F
1 2 3 4 5 6

SCC	BCC	fcc
= ↓ Six = 6	2+3+1 = 8	6+3+1 = 12

CRISTALLINE SOLID	AMORPHOUS SOLID
(i) Regular arrangement of particle	Irregular arrangement of particle.
(ii) Long order in arrangement of par.	Short order in arrangement of particle
(iii) They are called True solid.	Pseudo solid / super cooled liquid.
(iv) Sharp melting point	Ranged melting point
(v) Anisotropic in nature (dependent of direction)	Isotropic in nature. (independent of direction)

Ionic Solid	metallic Solid
The constituent particle are cation & anion.	The cons. par are metallic ion in sea of electrons
(2) It has electrostatic bond	It has metallic bond.
(3) It is hard & brittle.	It shows range from soft to hard.
(4) Ionic Solid are non-conductor of electricity when it is in solid state	metallic solid are good conductor of electricity.

Covalent crystal.

(1) The constituent particle are atoms
(2) It has covalent bond.
(3) It is very hard.
(4) It is non-conductor of electricity