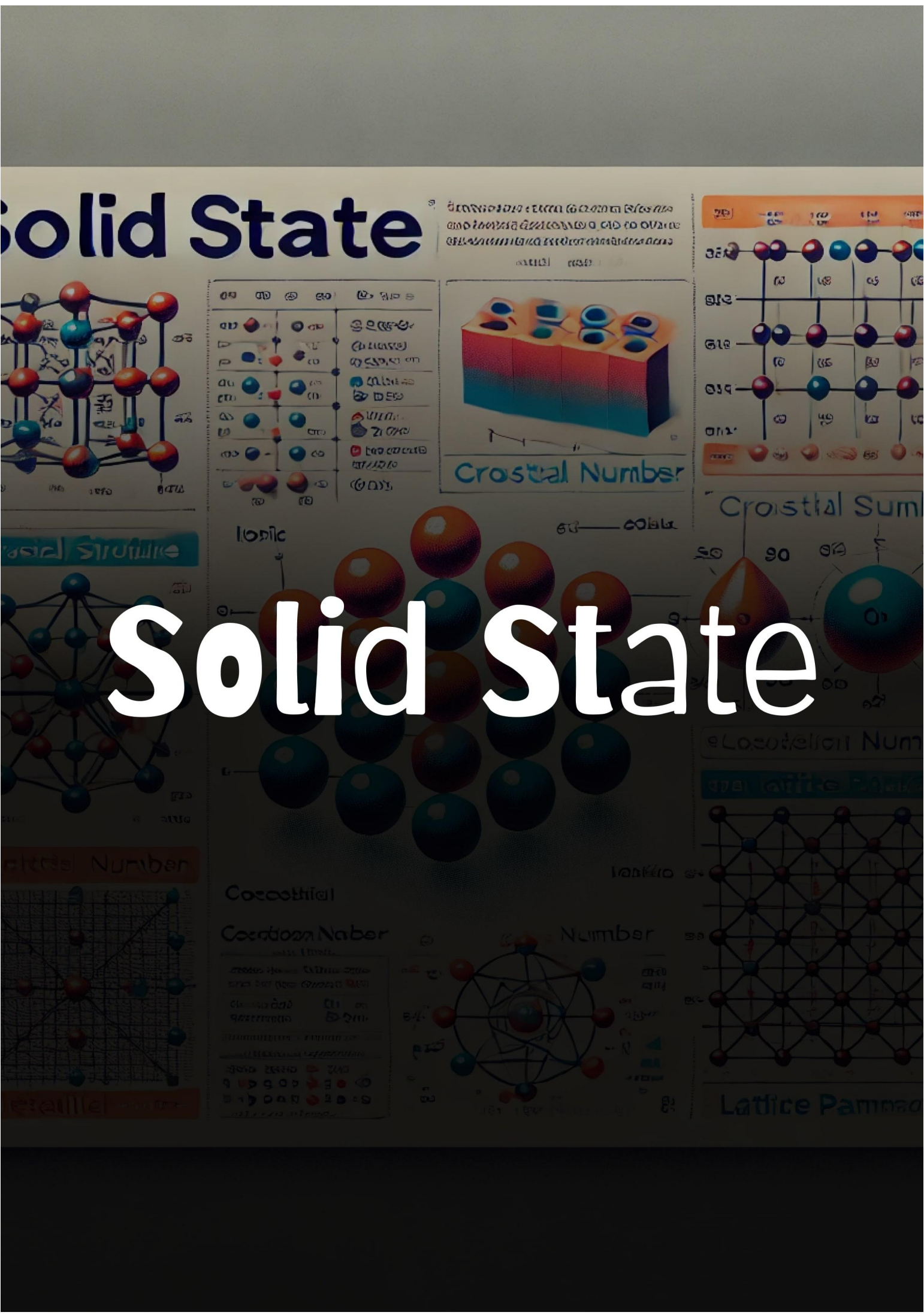


Solid State

SOLID STATE

CLASSIFICATION OF SOLIDS

Solids are divided into two classes –

Crystalline

CRYSTALLINE

1. They have definite and regular geometry due to definite and orderly arrangement of atoms, ions or molecules in 3D space.
2. They have sharp melting points & change abruptly into liquid.

Amorphous

AMORPHOUS

1. They do not have any pattern of arrangement of atoms, ion or molecules and thus do not have any definite geometrical shape.
2. Amorphous solids do not have sharp melting points & do not change abruptly into liquids.

3. Crystalline solids are aniso-tropic. some of their properties are different in different directions.	3. They are isotropic. their physical properties are same in all directions. e.g light refractive index of glass is same
4. They are considered as true solids.	4. They are considered as pseudo solids or super cooled liquid (e.g - glass).
5. They are rigid and their shape is not distorted by mild distorting forces.	5. They are not very rigid. These can be distorted by bending or compressing forces. e.g - rubber
6. Crystals are bound by plane forces. The angle between any two forces is called interfacial angle. For a given crystalline solid, it is a definite angle & remains always constant no matter how the faces develop - when a crystalline solids is ham-mered, it breaks up into sma-ller crystals of same geometrical shape.	6. Amorphous solids do not have well defined planes. When an amorphous solid is broken, the surfaces of the broken pieces are generally not flat & intersect at random angles - amorphous solids do not have any symmetry.
7. e.g:- Nacl, KCl, Sugar, Quartz etc.	7. e.g:- Plastic, glass, rubber etc.

TYPES OF CRYSTALLINE SOLIDS

	IONIC	METALLIC	COVALENT	MOLECULAR
Particles occupying lattice points	Anions Cations	Metal ions in electron cloud	Atoms	Molecules (or atoms)
Binding force	Electrostatic attraction	Metallic bonds	Covalent Bonds	Vander Waal's dipole dipole
Properties	Hard, Brittle poor, thermal & electric conductors	Soft to very hard, good thermal electric conductors.	very hard, poor thermal & electrical conductors	soft, poor thermal & electrical conductors
Examples	NaCl, $CaBr_2$ KNO_2 etc.	Li, K, Ca, Cu, Na etc.	C (diamond) SiO_2 (Quartz) etc.	H_2O, H_2, CO_2, Ar etc.

CUBE

There are 6 faces, 8 corners, 12 edges, 12 face diagonals, 4 body diagonals, 6 face centres, 1 body centre $(a/2, a/2, a/2)$.

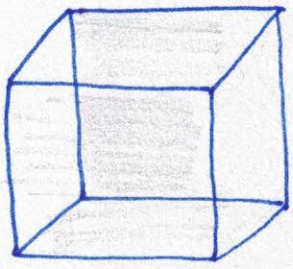
Body centre will be at a distance of $\frac{a\sqrt{3}}{2}$ from every corner.

Every corner will be attached to 6 edges.

Every corner will be touched / attached to 12 faces

Cube touching a corner is 8.

No. of body diagonals per corner is 8.



No. of face diagonals per corner is 12.

Distance of a corner to face centre $= \frac{a\sqrt{2}}{2} = \frac{a}{\sqrt{2}}$

If atom, molecule or ion present in →

(i) **At Corner** ⇒ It's contribution will be $1/8^{th}$ for one unit cell.

(ii) **Edge centre** ⇒ It's contribution will be $1/4^{th}$ for one unit cell.

(iii) **Face Centre** ⇒ It's contribution will be $1/2^{th}$ for one unit cell.

(iv) **Body Centre** ⇒ It's contribution be 100%. The unit cell will entirely cover the body centre.

E.g:- How many atoms present in a cube from infinite cube system if atoms are present at corners and face centre?

From corner, $= 1/8 \times 8 = 1$

From face centres, $= 1/2 \times 6 = 3$

Total in 1 unit cell $= 4$ Ans.

Que... How many atoms present in a cube from infinite cube systems if atoms are present at edge centre & body centre?

Body centre $= 1 \times 1 = 1$

Edge centre $= 1/4 \times 12 = 3$

Total $= 4$ Ans.

Que... If 'A' atom present at corner, 'B' atom present at edge centre and 'C' atom present at alternate centre of mini cube. How many atoms of A, B, C present in a cube?

Cube corner = $\frac{1}{8}$ × No. of corners = $\frac{1}{8} \times 8 = 1$

edge centre = $\frac{1}{4}$ × No. of edges = $\frac{1}{4} \times 12 = 3$

Centre of mini cube = $4 \times 1 = 4C$

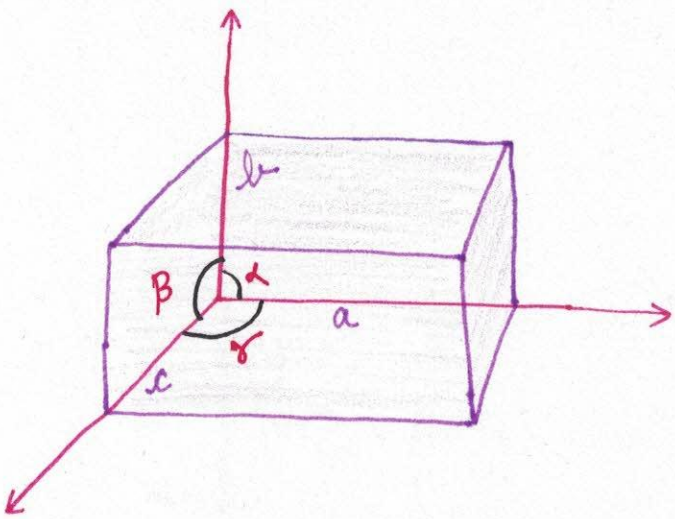
FORMULA: AB_3C_4

SPACE LATTICE OR CRYSTAL LATTICE

It is defined as regular 3D arrangement of identical points in space. These points contains atoms, molecules or ions, & called Lattice points.

UNIT CELL

- A space lattice can be divided into small units. The smallest unit is called unit cells.



a, b, c, α, β, γ are called parameters of unit cell.

Body centred → B.C

Face centered → F.C

End centered → E.C

Simple cubic cube → S.C.C

Crystal System	Bravais Lattices	Parameters: Intercepts	Parameters: Interfacial angle	Example
Cubic	Primitive, F.C, B.C	$a=b=c$	$\alpha=\beta=\gamma=90^\circ$	Pb, Hg, Ag, Ar, Diamond.
Tetragonal	Primitive, B.C	$a=b\neq c$	$\alpha=\beta=\gamma=90^\circ$	TiO_2, SnO_2
Orthorhombic	Primitive, F.C, B.C, E.C	$a\neq b\neq c$	$\alpha=\beta=\gamma=90^\circ$	KNO_2, K_2SO_4
Hexagonal	Primitive	$a=b\neq c$	$\alpha=\beta=90^\circ$, $\gamma=120^\circ$	Mg, SiO_2, Zn, Cd
Rhombohedral (Trigonal)	Primitive	$a=b=c$	$\alpha=\gamma\neq90^\circ$, $\beta\neq90$	As, Sb, Bi, $CaCO_3$
Monoclinic	Primitive, E.C	$a\neq b\neq c$	$\alpha=\gamma=90^\circ$, $\beta\neq90^\circ$	$CaSO_4\cdot2H_2O$
Triclinic	Primitive	$a\neq b\neq c$	$\alpha\neq\beta\neq\gamma\neq90^\circ$	$K_2Cr_2O_7$, $CaSO_4\cdot5H_2O$

TYPES OF CRYSTALS (Lattice)

1. Primitive or Simple unit cell

All atoms, ion or molecules are present at corners.

2. Body centered unit cell

All atoms, molecules, ions are present at corners as well as at body centre.

3. Face centered unit cell

All atoms, molecules, ions will be present at corners as well as at face centre.

4. End centered unit cell

All atoms, molecules, ions are present at corners and at on alternate face centres.

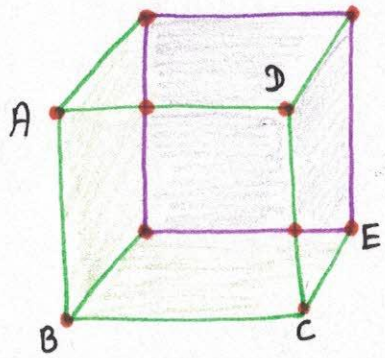
CUBICAL CRYSTAL SYSTEM

1. Simpal Unit or Primitive

In Simple unit cell, All atoms, molecules, ions will be present at corners.

COORDINATION NUMBER

It is number of atoms nearest to any atom.



AD = edge length
AC = diagonal length
AE = body diagonal length

Co-ordination no. of a simple unit cell is six (at edge length).
Next co-ordination no. will be twelve (at diagonal length).
Next co-ordination no. will be eight (at body diagonal length).

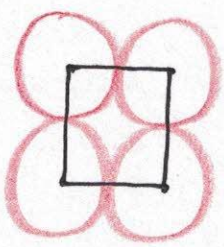
No. of atoms per unit cell

One atom present per unit cell.

Radius of atom

$$\text{Radius} = \frac{a}{2}$$

where a is edge length of unit cell.



Packing Fraction

It is volume occupied by atoms per unit cell.

Volume of atom = $4/3 \pi r^3 \times$ ① → no. of atom per unit cell

Volume of cubic at unit cell = a^3

DENSITY

No. of atoms per unit cell = 1

Moles = $1/N_a$

Mass = $\frac{M}{N_a}$

Vol × density = $\frac{M}{N_a}$

$$\text{density} = \frac{M}{a^3 N_a}$$

RATIO

$$\frac{4\pi r^3}{3 \times 8 r^3} \Rightarrow \frac{4\pi}{24} \Rightarrow \frac{\pi}{6}$$

$$\simeq \frac{3.14}{6}$$

Ratio = 0.5236

2. Body centered unit Cell

All atoms present at corners and at body centre. smallest distance will be from body centre to corner.

i.e = $\frac{\sqrt{3}a}{2} = 0.866a$

Co-ordination number will be thus

Next nearest distance will be

Nest nearest distance will be

Next nearest distance will be

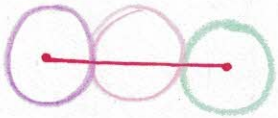
8 $(CN_1) \rightarrow \frac{a\sqrt{3}}{2}$

6 $(CN_2) \rightarrow a$

12 $(CN_3) \rightarrow a\sqrt{2}$

8 $(CN_4) \rightarrow a\sqrt{3}$

No. of atoms per unit cell :- $\frac{1}{8} \times 8 + 1 \times 1 \Rightarrow 2$



$4r = \sqrt{3}a \Rightarrow r = \frac{\sqrt{3}a}{4}$

Packing Fraction

Vol. of atom $\Rightarrow \frac{4}{3}\pi r^3 \times 2$

Vol. of unit cell $\Rightarrow a^3$

Fraction – $\frac{\frac{4}{3}\pi \frac{3a^3 \times \sqrt{3} \times 2}{16 \times 4}}{a^3} = \frac{\sqrt{3}\pi}{16} \times 2 = \frac{\sqrt{3}\pi}{8}$

Fraction = 68%.

DENSITY

Density $\times$ Vol $\Rightarrow \frac{2}{Na} \times M$

$$\text{Density} = \frac{2M}{a^3 Na}$$

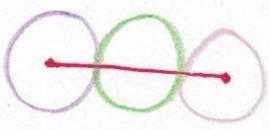
3. Face Centered unit cell

Atoms are present at corners & face centres.

$4r = a\sqrt{2}$

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

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



No. of atom per unit cell

$= \frac{1}{8} \times 8 + \frac{1}{2} \times 6 = 4$

Nearest distance $= \frac{a}{\sqrt{2}}$

Co-ordination number ⇒ 12 $\left(\frac{a}{\sqrt{2}}\right)$

Next co-ordination number ⇒ 6

Next co-ordination number ⇒ 12

Next co-ordination number ⇒ 8

Packing Function

$$\frac{\frac{4}{3}\pi \times r^3 \times 4}{a^3} \Rightarrow \frac{\frac{16\pi}{3} \times \frac{a^3}{8} \times \frac{1}{2\sqrt{2}} \times 100}{a^3}$$

$\frac{\pi}{3\sqrt{2}}$

$\Rightarrow 74\%$

Density...

Density $\times$ Vol $\Rightarrow \frac{4}{N_a} \times M$

$$\text{Density} = \frac{4M}{a^3 N_a}$$

SCC BCC FCC

PIN : 526874

(i) "A" atom is present at the corner of FCC packing and "B" is present at face centres. What will be formula for compound?

→ Formula : AB_3 $\quad \frac{1}{8} \times 8 = 1 \longrightarrow A$

$\frac{1}{2} \times 6 = 3 \longrightarrow B$

(ii) If atoms along one body diagonal are removed what will be formula?

→ $A_{3/4}B_3 \longrightarrow A_3B_{12} \longrightarrow AB_4$

$8 - 2 = 6 \Rightarrow \frac{1}{8} \times 6 \Rightarrow 3/4 \qquad \frac{1}{2} \times 6 = 3$

(iii) If one face is removed in every cube, what will be formula ?

$B = \frac{1}{2} \times 4 \Rightarrow 2$

Formula : AB_2

Q. (i) "A" atom is FCC packed, "B" atom is at body center and at edge center and "C" atom is at center of mini cubes, what will be formula ?

$A \longrightarrow \frac{1}{8} \times 8 + \frac{1}{2} \times 6 \longrightarrow 4$

$B \longrightarrow 1 + \frac{1}{4} \times 12 \longrightarrow 4$

$C \longrightarrow 1 \times 8 \longrightarrow 8$

$A_4 B_4 C_8 \Longrightarrow \boxed{ABC_2}$ Ans.

(ii) If atoms along one body diagonal are removed what will be formula ?

$A \longrightarrow \frac{3}{4} + 3 \Rightarrow \frac{15}{4} \longrightarrow \frac{1}{4} \times 12 \longrightarrow 3 \qquad C \longrightarrow 6$

$A_{15/4} B_3 C_6 \longrightarrow A_{5/4} B_1 C_2 \longrightarrow \boxed{A_5 B_4 C_8}$ Ans.

(iii) What will be formula if atoms along one face are removed ?

$A \longrightarrow \frac{1}{8} \times 4 + 5 \times \frac{1}{2} \Rightarrow \frac{1}{2} + \frac{5}{2} = 3$

$B \longrightarrow 1 + \frac{1}{4} \times 8 \longrightarrow 3$

$C \longrightarrow 8$

$\boxed{A_3 B_3 C_8}$ Ans.

(iv) What will be formula if alternate corners are missing ?

$A \longrightarrow \frac{1}{8} \times 4 + \frac{1}{2} \times 6 \longrightarrow \frac{1}{2} + \frac{6}{2} = \frac{7}{2}$

$B \longrightarrow 4$

$C \longrightarrow 8$

$A_{7/2} B_4 C_8 \longrightarrow \boxed{A_7 B_8 C_{16}}$

(v) What will be formula if atoms from centre of mini cubes are removed in alternate order?

A → 4 B → 4 C → 4

Formula : ABC

(vi) What will be formula if atoms are removed from centre of alternate edges?

A → 4

B → $1+6 \times \frac{1}{4} \longrightarrow 1+\frac{3}{2} \longrightarrow \frac{5}{2}$

C → 8

$A_4 B_{5/2} C_8 \longrightarrow A_8 C_5 C_{16}$

(vii) If atoms are removed from alternate edges, what will be formula?

A → 0

B → 5/2

C → 8

$B_{5/2} C_8 \longrightarrow B_5 C_{16}$

(viii) If body centre is origin and atom along one axis removed, find formula.

A → $\frac{1}{2} \times 4 + 8 \times \frac{1}{8} \longrightarrow 3$

B → $0 + \frac{1}{4} \times 12 \longrightarrow 3$

C → 8

$A_3 B_3 C_8$

If origin is at face centre, what will be formula (s) if atoms along one axis are removed?

I

A → $\frac{1}{2} \times 4 + \frac{1}{8} \times 8 \rightarrow 3$

B → 3

C → 8

$A_3B_3C_8$

II

A → $\frac{1}{2} \times 5 + 1 \rightarrow \frac{7}{2}$

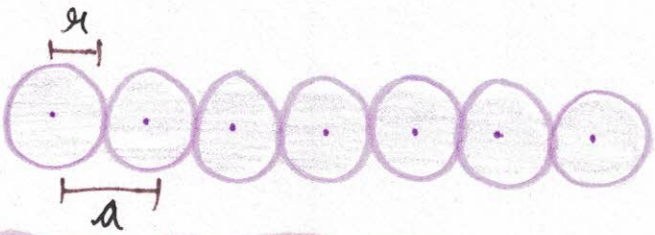
B → $1 + \frac{1}{4} \times 10 \rightarrow \frac{7}{2}$

C → 8

$A_7B_7C_{16}$

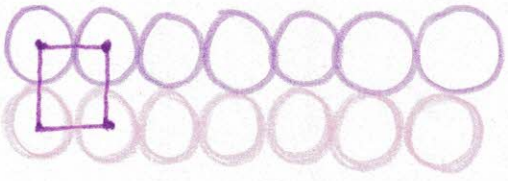
CLOSE PACKING IN CRYSTALS

I. In 1 Dimension



radius = $r = a/2$

II. In 2 Dimension

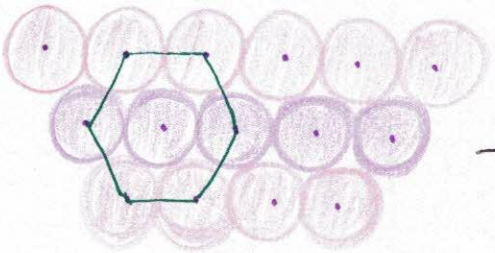


→ square packing...

Packing Function

$$PF = \frac{\text{area of atoms}}{\text{area of unit cell}}$$

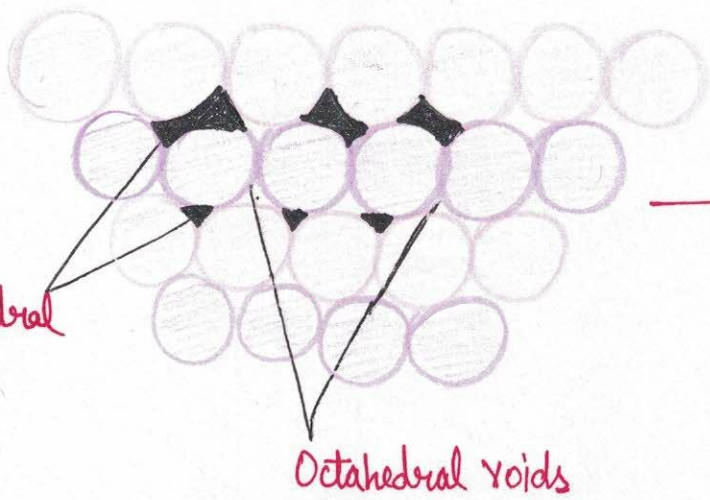
$$\frac{4 \times \frac{\pi r^2}{4}}{a^2} \Rightarrow \frac{\pi r^2}{(2r)^2} = \frac{\pi}{4} = 78.5\%$$



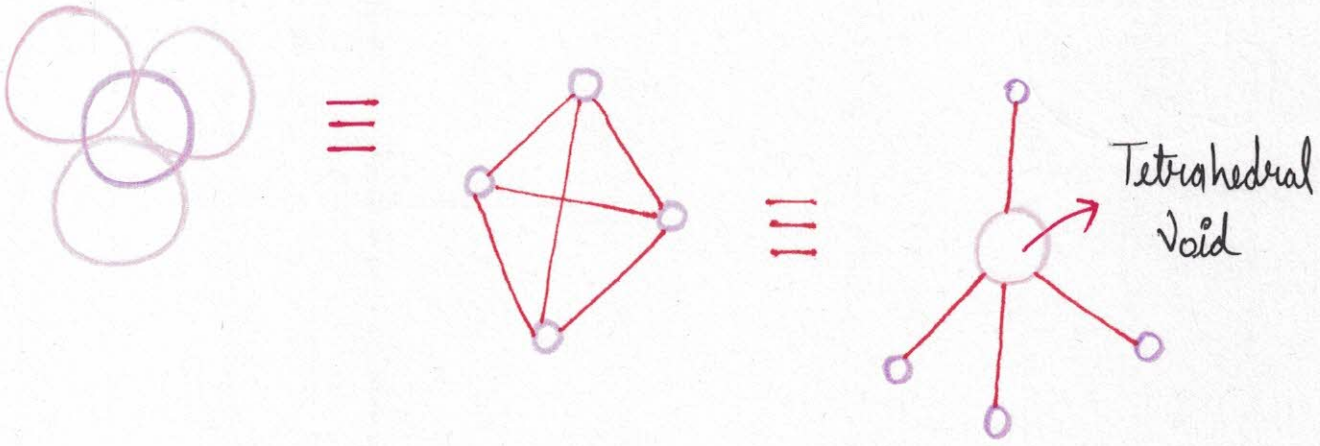
→ Hexagonal Packing...

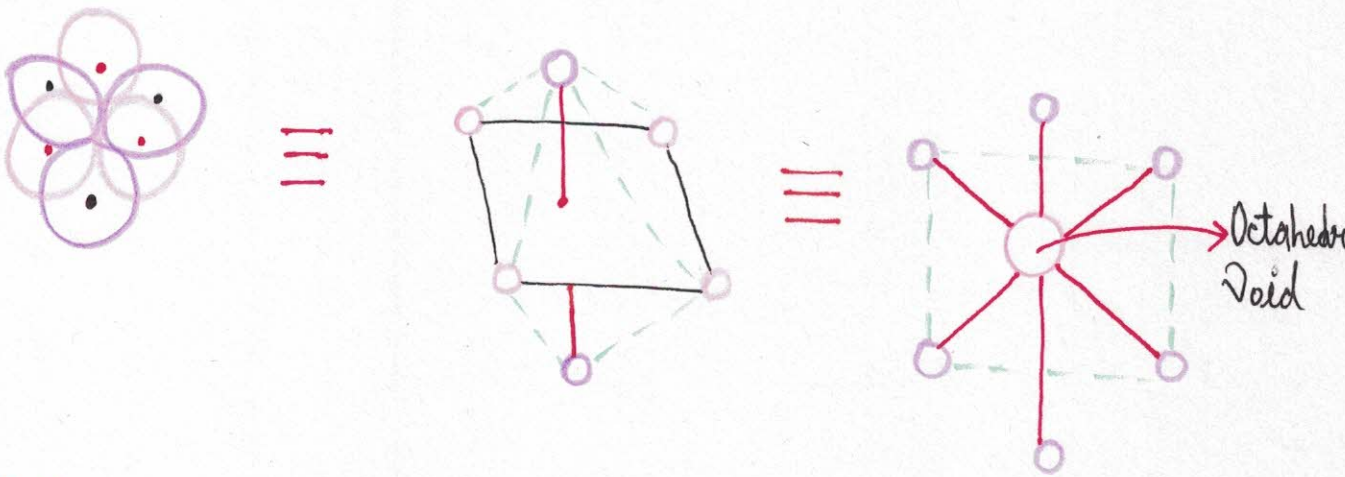
$$PF \Rightarrow \frac{\pi r^2 + 3 \times \frac{\pi r^2}{3} \times 2}{6 \times \frac{\sqrt{3}}{4} a^2} \Rightarrow \frac{\pi}{2\sqrt{3}} \Rightarrow \boxed{90.6\%}$$

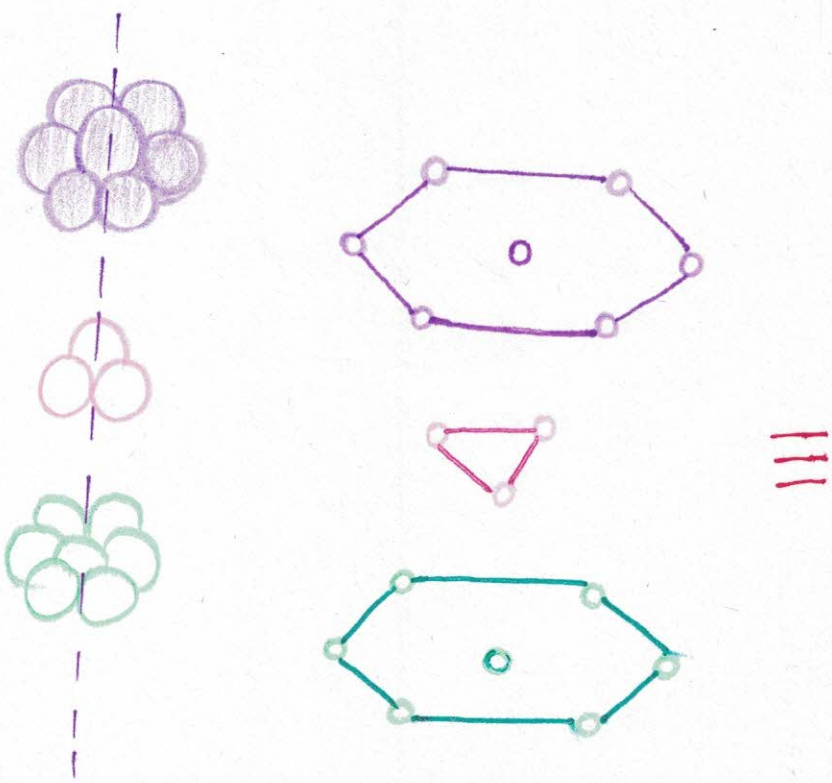
In 3 Dimension



→ Hexagonal Packing







Contribution of atom at face centre = ½

Contribution of atom at corner = ⅙

PARAMETERS

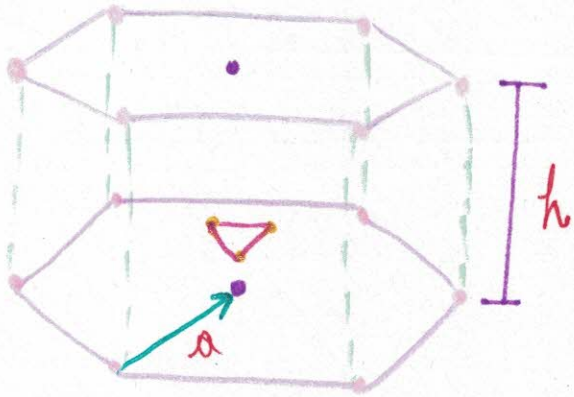
a. Atoms Per unit cell

Atoms = ⅙ × corners + ½ × face centre + 3

= ⅙ × 6 + ½ × 2 + 3 + ⅙ × 6

= 6

Co-ordination Number = 2



$a = 2r$

$h = 4r\sqrt{\frac{2}{3}}$

Vol. = base area × h

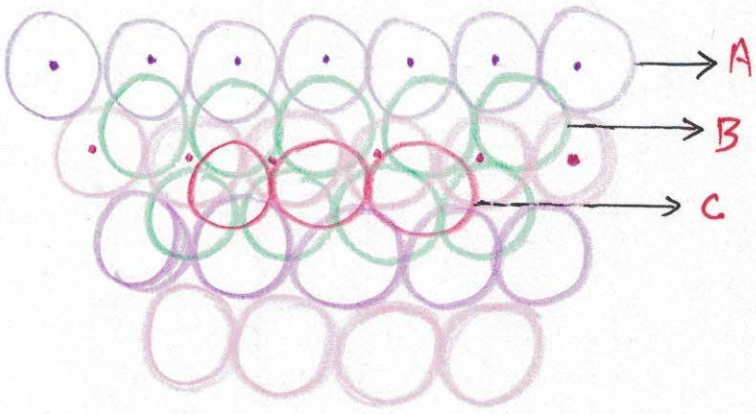
$= 6 \times \frac{\sqrt{3}}{4} \times a^2 \times h$

$\Rightarrow 6 \times \frac{\sqrt{3}}{4} \times (2r)^2 \times h \Rightarrow 24\sqrt{2}\, r^3$

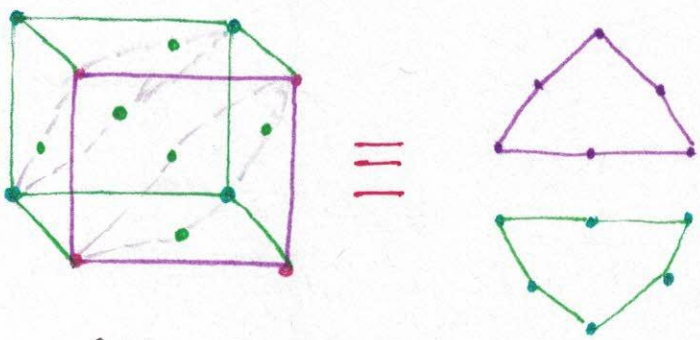
$P.F = \frac{6 \times \frac{4}{3}\pi r^3}{\text{Vol.}} \Rightarrow \frac{6 \times \frac{4}{3}\pi r^3}{24\sqrt{2}\, r^3} = 74\%$

CUBICAL CLOSE PACKING

It is FCC Packing.



{ABC ABC - - - - arrangement}



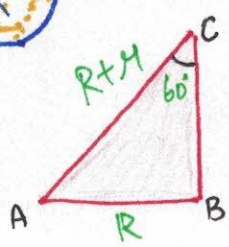
C.N = 12

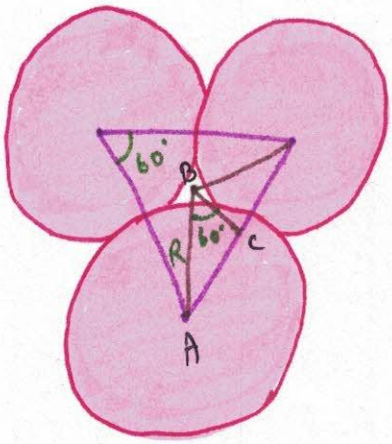
No. of atoms per unit cell = 4

Packing efficiency = 74%

VOIDS

TRIANGULAR

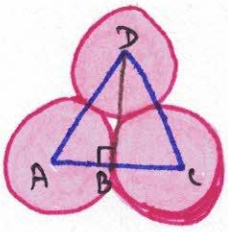


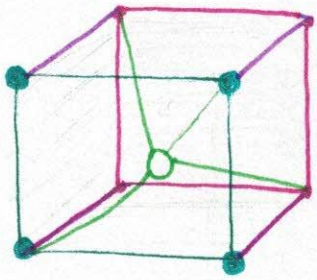


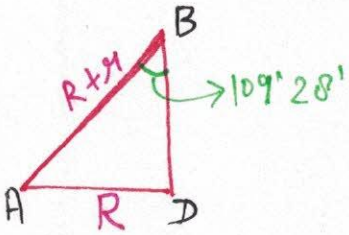
$$\sin 60^\circ = \frac{R}{R+r}$$

$$\frac{r}{R} + 1 = \frac{2}{\sqrt{3}} \Rightarrow \boxed{\frac{r}{R} = 0.155}$$

TETRAHEDRAL





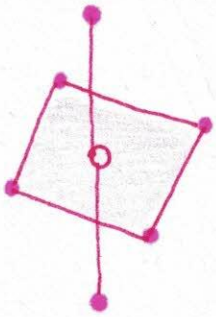


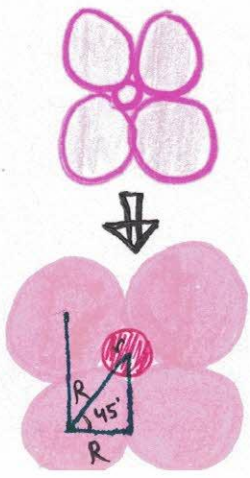
(Mini Cube)

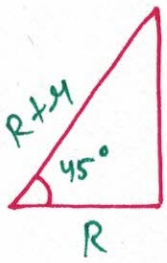
$$\sin\left(\frac{109°28'}{2}\right) = \frac{R}{r+R}$$

$$\frac{r}{R} = 0.225$$

OCTAHEDRAL





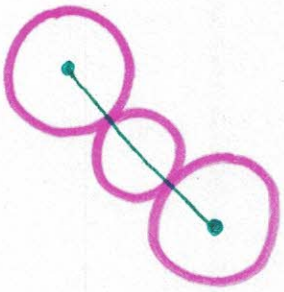


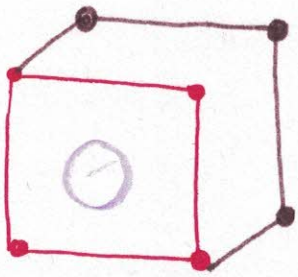
$$\cos 45° = \frac{R}{R+r}$$

$$\frac{r+R}{R} = \sqrt{2} = 1.414$$

$$\boxed{\frac{r}{R} = 0.414}$$

CUBICAL





$$2r + 2R = \sqrt{3}a$$

$$a = 2R$$

$$2r + 2R = \sqrt{3} \times 2R$$

$$r + R = \sqrt{3}R$$

$$\frac{r}{R} + 1 = 1.732$$

$$\boxed{\frac{r}{R} = 0.732}$$

IONIC CRYSTAL

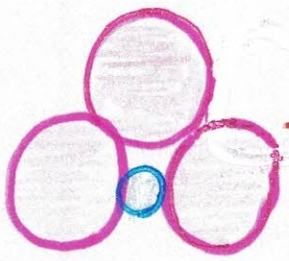
Radius Ratio Rule – Radius ratio $= \frac{r^+}{r^-}$, where $\{r^+ =$ radius of cation, $r^- =$ radius of anion$\}$

$\frac{r^+}{r^-}$ – CN	Shape	Eg.
$< 0.155 \rightarrow 2$	Linear	BeF_2

r^+/r^-	CN
< 0.155	2
0.155 - 0.225	3
0.225 - 0.414	4
0.414 - 0.732	4
0.414 - 0.732	6
0.732 - 1	8

Shape	Eg.
Linear	BeF_2
Triangular	B_2O_3
Tetrahedral	ZnS
Squar Planar	$PtCl_4$
Octahedral	NaCl
Cubical	CsCl

When $\frac{r^+}{r^-} < 0.155$

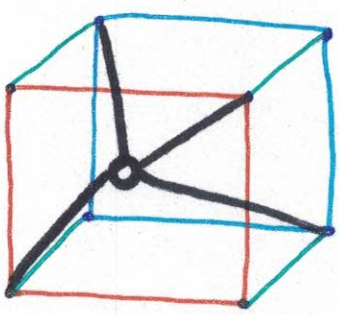


→ Cation gets attracted towards any of two balls. Hence C.N = 2.

LOCATION OF VOID IN FCC PACKING

We can two voids in it —

1. TETRAHEDRAL VOID - It is central of mini cube.



$8 \times \frac{1}{8} \Rightarrow$ 1 void per unit mini cube

∴ 8 tetrahedral voids per unit atom.

2. OCTAHEDRAL VOID - It is body centre as well as edge centre.

No. of octahedral voids - $T + \frac{1}{4} \times 12 = 4$ (cations)

No. of anions - $\frac{1}{2} \times 6 + \frac{1}{8} \times 8 = 4$

Ionic formula = $A_4B_4 = AB$ (eg NaCl)

If all octahedral voids filled, they

$\frac{1}{4} \times 12 + 1 = 4$ atoms per unit cell.

Therefore,

F.C.C → 4 atoms
Octahedral → 4
Tetrahedral → 8

E.g. If no. of atoms is 200 per unit cell in close packing, find no. of octahedral & tetrahedral voids.

No. of atoms = 200
Octahedral = 00
Tetrahedral = 400

1. ROCK SALT STRUCTURE — NaCl

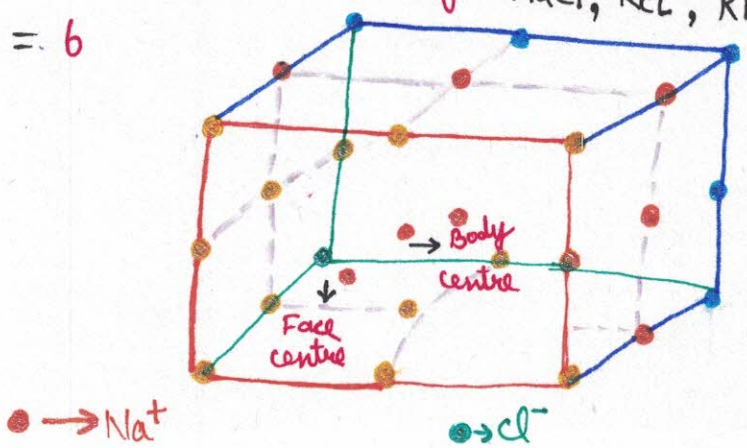
All anions are F.C.C packed, cations are at octahedral voids.

Experimentally, $\frac{r_{Na}^+}{r_{a}^-} = 0.52$

C.N of Na^+ & Na^+ = 12
C.N of Cl^- & Cl^- = 12

C.N of NaCl = 6

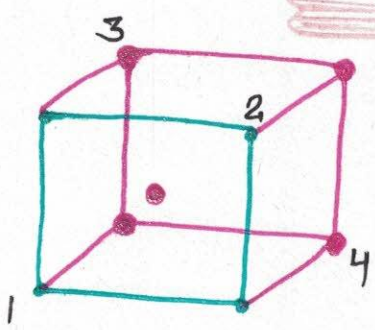
Eg:- Most of halids of alkali metals & oxides of alkaline earth metals.
Eg:- NaCl, KCl, RbI, RbF, FeO.



2. ZINC BLENDE — ZnC

Anions are F.C.C packed and cations present at alternate tetrahedral voids.

Experimentally, $\frac{r_{Zn^{2}}}{r_{S^{-2}}} = 0.40$



C.N of $Zn^{+2} = 4$

C.N of $S^{-2} = 4$

No. of ions per unit cell = 4 $(Zn_4 S_4) \longrightarrow ZnS$

$$\text{Density} = \frac{4 \times (M.M)_{ZnS} \times 1.66 \times 10^{-24}}{a^3}$$

E.g:- Ionic solids, CuBr, CuI, CuCl, AgI

3 CALSIUM CHLORIDE STRUCTURE — CsCl

Anions present at corners and cations present at body centre.

C.N of $Cs^{+} = 8$

C.N of $Cl^{-} = 8$

No. of Cs^{+} ions per unit cell = 1

No. of Cl^{-} ions per unit cell = 1

CsCl

$$\text{Density} = \frac{1 \times (M.M)_{CsCl} \times 1.66 \times 10^{-24}}{a^3}$$

$$\frac{r_{Cs^+}}{r_{Cl^-}} = 0.93$$

e.g:- CsBr, Cs^+, TlCl, TlBr

4. FLUORITE STRUCTURE

Cations are F.C.C packed and anions will occupy all tetrahedral voids.

C.N. of cation = 8

C.N of anion = 4

No. of cation per unit cell = 4

No. of anion per unit cell = 8

CaF_2

No. of CaF_2 units per unit cell = 4

$$\text{Density} = \frac{4 \times (M.M)_{CaF_2} \times 1.66 \times 10^{-24}}{}$$

5. ANTIFLUORITE STRUCTURE

Na_2O

Anions F.C.C packed & cations are at tetrahedral voids (Na_2O).

C.N. of O^{-2} = 8

C.N of Na^+ = 4

No. of O^{-2} per unit cell = 4

No. of Na^+ per unit cell = 8

$Na_8O_4 \longrightarrow Na_2O$

e.g:- Li_2O, K_2O, Rb_2O, Rb_2S.

$$\text{Density} = \frac{4 \times (M.M)_{Na_2O} \times 1.66 \times 10^{-24}}{a^3}$$

Special Structure

1. WURZITE STRUCTURE

Sulphide ion have HCP and Zn^{+2} occupy alternate tetrahedral voids.

No. of S^{-2} ion = 6

No. of Zn^{+2} ion = $\frac{1}{2} \times 12 = 6$

$Zn_6S_6 = ZnS$ C.N. = 4.4

2. SPINAL STRUCTURE

GENERAL FORMULA = AB_2O_4

2 metal ions with oxide in CCP (FCC) layer.

In normal spinal, 1/8 of tetrahedral holes occupied by one type of metal and half of octahedral voids are occupied by another metal.

E.g:- In $ZnAl_2O_4$, O^{-2} is FCC packed, Zn^{+2} is at $\frac{1}{8}^{th}$ of tetrahedral voids & Al^{+3} is at half of octahedral voids.

No. of Zn^{+2} ions = $\frac{1}{8} \times 8 = 1$

No. of Al^{+3} ions = $\frac{1}{2} \times 4 = 2$

No. of O^{-2} ions = 4

3. PEROVSKITE

Ba^{+2} ion at corner, O^{-2} ion occupy FCC, Ti ion at centre of unit cell.

∴ FORMULA = $BaTiO_3$

No. of Ba^{+2} = 1

No. of O^{-2} = 3

No. of Ti = 1

Eg:- $BaTiO_3$, $MgTiO_3$

4. LATTICE OF DIAMOND

It is having structure similar to Zinc Blende (ZnS).

It is containing only carbon atom.

Effect of Pressure & Temperature on C-N

On increasing pressure, C.N. will increase.

On increasing temperature, C.N. will decrease.

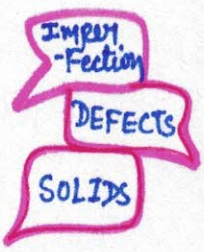
$4:4 \xrightarrow{P\uparrow} 6:6$

$8:8 \xrightarrow{T\downarrow} 6:6$

on ↑P, atoms come close, C.N. ↑

on ↓T, atoms expand hence move away, C.N. ↓

IMPERFECTION OR DEFECTS IN SOLIDS



During formation of ionic solid, there may be imperfection or defect because of thermodynamic conditions or some external forces.

We can observe defects -

1. Line defect
2. Plane defect
3. Point defect

This is of two kinds :-

STOICHIOMETRIC POINT DEFECT

Compounds in which the no. of positive & negative ions are exactly in ratios indicated by their chemical formula are called **stoichiometric compounds.**

The defects that do not disturb the stoichiometric are called **stoichiometric defects.**

a. Schottky defect

This type of defect is created when one (+)ve ion and one (-)ve ion are

missing from their positions leaving behind a pair of holes.

E.g:- NaCl, CsCl, KCl, KBr

Due to this defect, density of solid will decrease as no. of atoms also decrease.

b. Frenkel Defect

This type of defect is created when an ion leaves its correct lattice side and occupies an interstitical site.

e.g:- ZnS, AgCl, AgBr, AgI

Due to this defect, density of solid will remain same as no. of atoms will remain some per unit cell.

c. Interstitial defect

This type of defect is caused due to presence of ions in normally vacant interstitialsites in the crystals. The ions occupying the interstitial sites are called *interstitials*.

NON STOICHIOMETRIC DEFECT

It's types are -

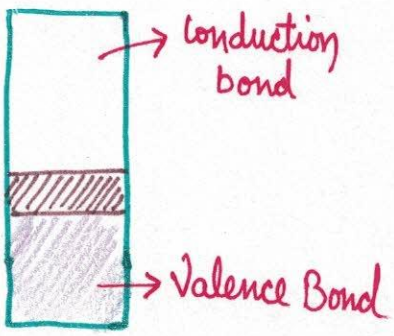
1. Metal excess defect

Due to schottky defects or other defects which create holes in lattice sites, anion vacancies in alkali halides are

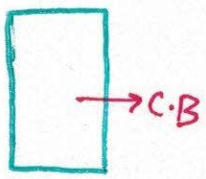
ELECTRICAL PROPERTIES

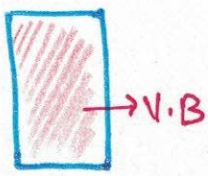
1. Metals 2. Insulators 3. Semi conductor

This property can be explained by electrical conductivity ranging from 10^{-70} to 10^{-7} Ω^{-1} cm^{-1}

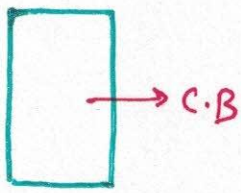


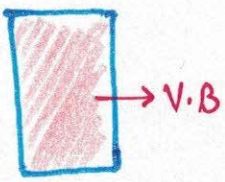
(Metals)





(Insulators)





(Semi conductor)

(Read from Booklet)

Megnetic Properties

PARAMAGNETIC SOLIDS

are those which when we apply external field and materials get defected then paramagnetism is observed.

When a charge moves it creates magnetic field.

DIMAGNETIC SOLIDS

Those solids which are weakly repelled by magnetic field are called dimagnetic materials. They don't have unpaired e⁻.

TERROMAGNETIC SOLIDS

Those materials which will show magnetic field without applying external magnetic field.

E.g:- Fe, Co, Ni

e⁻ in same spin Hence, high magnetic field Ferromagnetism arises due to spontaneous alignment of magnetic moments of ions or atoms in same directions.

ANTI FERRO MAGNETIC

Alignment of magnetic moments in opposite directions in a compen-
-ensatory manner and resulting in zero magnetic moments gives rise to anti ferromagnetism.

spin is opposite