Distinction between Crystalline and Amorphous Solids				
Property	Crystalline solids	Amorphous solids		
Shape	Definite characteristic geometrical shape	Irregular shape		
Melting point	Melt at a sharp and characteristic	Gradually soften over a range of temperature		
Cleavage property	on cutting with a knife, split into two pieces	cut into two pieces with irregular surfaces		
Heat of fusion	definite and characteristic heat of fusion	They do not have definite heat of fusion		
Anisotropy	Anisotropic in nature	Isotropic in nature		
Nature	True solids	Pseudo solids or super cooled liquids		
Order in arrangement of	Long range order	Only short range order.		
constituent particles				

Like liquids, amorphous solids have a tendency to flow, though very slowly. Therefore, amorphous solids are sometimes called **super-cooled liquids** or **pseudo-solids**. *e.g.* Rubber and Glass.

- Q. Why are solids rigid?
- A. The intermolecular forces of attraction that are present in solids are very strong. The constituent particles of solids cannot move from their positions i.e., they have fixed positions.
- Q. Why do solids have a definite volume?
- A. The intermolecular forces of attraction that are present in solids are very strong. The constituent particles of solids have fixed positions i.e., they are rigid. Hence, solids have a definite volume
- Q. Classify the following as amorphous or crystalline solids: Polyurethane, naphthalene, benzoic acid, teflon, potassium nitrate, cellophane, polyvinyl chloride, fibre glass, copper.
- A. **Amorphous solids -** Polyurethane,teflon, cellophane, polyvinyl chloride, fibre glass **Crystalline solids-**Naphthalene, benzoic acid, potassium nitrate, copper
- Q. Why is glass considered a super cooled liquid?
- A. Similar to liquids, glass has a tendency to flow, though very slowly. Therefore, glass is considered as a super cooled liquid. This is the reason that glass windows and doors are slightly thicker at the bottom than at the top.
- Q. Refractive index of a solid is observed to have the same value along all directions. Comment on the nature of this solid. Would it show cleavage property?
- A. the given solid, having the same value of refractive index along all directions, is isotropic in nature. Hence, the solid is an amorphous solid. When an amorphous solid is cut with a sharp edged tool, it cuts into two pieces with irregular surfaces.

Space lattice -A crystal is a repetition of basic units of constituent particles. This results in a three-dimensional orderly arrangement of points (constituent particles) called **space lattice** or **crystal lattice**. Thus, a space lattice may be defined as a regular three-dimensional arrangement of identical points in space.

Unit cell is the smallest but complete unit in the space lattice, which when repeated over in the three dimensions generates the crystal of the given substance.

Parameters which characterize a unit cell:

- a. Dimensions of the unit cell along the three edges, a, b and c: These edges may or may not be mutually perpendicular.
- b. Inclination of the edges to each other: This is denoted by the angle between the edges alpha, Bita, and gamma respectively.

Types of Unit Cells -Unit cells are basically of two types, primitive and non-primitive.

- 1. **Primitive Unit Cell**: A unit cell is called a primitive unit cell if it has particles (or points) only at the corners. It is also called simple unit cell.
- 2. Centred unit cells: In this type of unit cells, particles (or points) are present not only at the corners but also at some other positions. Centred unit cells are of three types:
 - (*i*) **Face-centred:** Particles (or points) are located at the corners and also at the centre of each face.

(ii) Body-centred: Particles (or points) are located at the corners and also at the centre within the body.

(*iii*) **End-centred:** Particles (or points) are located at the corners and also at the centres of any two opposite faces.

Seven Primitive Unit Cells-Bravais has established 14 types of lattices called Bravais lattices according to the arrangement of the points in the different unit cells involved.

Crystal system	Possible variations	edge lengths	Axial angles	Examples
Cubic	Primitive,Body-centred, Face-centred	a = b = c	$\alpha = \beta = \gamma = 90^{\circ}$	NaCl, Zinc blende
Tetragonal	Primitive,Body-centred	a = b ≠ c	$\alpha = \beta = \gamma = 90^{\circ}$	White tin, SnO2,
Orthorhombic	Primitive,Body-centred, Face-centred & End Centre	a≠b≠c	$\alpha = \beta = \gamma = 90^{\circ}$	Rhombic sulphur,
Hexagonal	Primitive	a = b ≠ c	α = β = 90°, γ = 120°	Graphite, ZnO,CdS
Rhombohedral or Trigonal	Primitive	a = b = c	$\alpha = \beta = \gamma \neq 90^{\circ}$	Calcite (CaCO3), HgS

<u>Contributaion of atom</u> - At corner = 1/8 to the unit cell; At Face = 1/2 to the unit cell , on the edge of the unit cell = 1/4 to the unit cell and

A point present within the body of the unit cell = 1

(a) Simple Cubic Unit Cell:
$$Z = \frac{n_{Comer}}{8} + \frac{n_{FaceCentre}}{2} + \frac{n_{BodyCentre}}{1} = 8 \times \frac{1}{8} = 1$$
 Also, Radius (R) : length: $r = \frac{a}{2}$

- (b) Body Centered Cubic Unit Cell : Effective number of atoms in a unit cell = $\left[8 \times \frac{1}{8}\right] + 1 = 2$. Radius : $r = \frac{\sqrt{3a}}{4}$
- (c) Face Centered Cubic Unit Cell (FCC) : Effective number of atoms in a unit cell = $\left(8 \times \frac{1}{8}\right) + \left(6 \times \frac{1}{2}\right) = 4$; R: $r = \frac{a}{2\sqrt{2}}$
- Q. Give the significance of a 'lattice point'
- A. The significance of a lattice point is that each lattice point represents one constituent particle of a solid which may be an atom, a molecule (group of atom), or an ion.
- Q. Distinguish between Face-centred and end-centred unit cells.
- A. Face-centred unit cell -I, the constituent particles are present at corners and one at the centre of each face. End-centred unit cell -An end-centred unit cell contains particles at the corners and one at the centre of any two opposite faces.
- Q. A compound is formed by two elements X and Y. Atoms of the element Y (as anions) make *ccp* and those of the element X (as cations) occupy all the octahedral voids. What is the formula of the compound?
- A. No of Atoms of Y as ccp structure = 4, No. Of atoms of X at Octahedral Void = 4 (equal to no. of atoms at ccp) Formule = XY.
- Q. Atoms of element B form *hcp* lattice and those of the element A occupy 2/3rd of tetrahedral voids. What is the formula of the compound formed by the elements A and B?
- A. The number of tetrahedral voids formed is equal to twice the number of atoms of element B and only 2/3rd of these are occupied by the atoms of element A. Hence the ratio of the umber of atoms of A and B is $2 \times (2/3)$:1 or 4:3 and the formula of the compound is $A_{A}B_{2}$.

Packing Fraction (P.F.): In whatever way the constituent particles (atoms, molecules or ions) are packed, there is always some free space left in the form of voids. Packing efficiency is percentage of total space occupied by particles.

P.F. = $\frac{\text{Volume ocupied by atoms in a unit cell}}{\text{Volume of unit cell}} \times 100 = \frac{\text{Effective number of atoms}(Z) \times \text{Volume of an atom}}{\text{Volume of unit cell}} \times 100$

(*i*) For Simple Cubic Unit Cell: P.F. = $\frac{1 \times 4/3 \times \pi r^3}{a^3} \times 100$ Also, $r = \frac{a}{2}$; P.F. = $\frac{\pi}{6} = \frac{11}{21} = 0.5238$; P.E.= 52.38% (*ii*) For Body Centered Cubic Unit Cell: P.F. = $\frac{2 \times 4/3 \times \pi r^3}{a^3}$ Also, $r = \frac{\sqrt{3}a}{4}$; P. F. = $\frac{2 \times \frac{4}{3} \times \left(\frac{\sqrt{3}a}{4}\right)^3}{a^3}$.= 0.6802; P.E = 68.02%

(*iii*) FCC Unit Cell: P. F. =
$$\frac{4 \times \frac{4}{3} \times \pi r^3}{a^3} = \frac{\frac{16}{3} \times \pi \times \left(\frac{a}{2}\sqrt{2}\right)^3}{a^3}$$
; P. F. = 0.7406; % Packing efficiency = 74.06%

C. Density of Crystal : Density of Unit Cell (d or d) =

$$\frac{\text{Mass of atom present in unit cell}}{\text{Volume of unt cell}} = \frac{(\text{Effective number of atoms}) \times (\text{Mass of an atom})}{\text{Volume of unit cell}}; d = \frac{Z. M.}{a^3 \times N_A}$$

Hand-Out (CBSE Section) Chemistry: Ch:1_Solid State



- Q. An element has a body-centred cubic *(bcc)* structure with a cell edge of 288 pm. The density of the element is 7.2 g/cm³. How many atoms are present in 208 g of the element?
- A. No of atoms = $Z \times M$ /density x (a)³ = $4 \times 208/7.2 \times (288 \times 10^{-8})^3$ = 24.16×10^{23} atoms
- **D. Co-ordination Number :** The number of spheres that are touching a given sphere is called the coordination number.

(*i*) In S.C. C. Unit cell – 6 ; (*ii*) In B.C.C. unit cell – 8; (*iii*) In F. C. C. unit cell – 12; In HCP & CCP : C. No. of each atom is 12.

CLASSIFICATION OF CRYSTALLINE SOLIDS

- 1. **Molecular solids:** Molecules are the constituent particles of molecular solids. These are further sub-divided into the following categories:
 - (i) Non-polar molecular solids; (ii) Polar-molecules solids; (iii) Hydrogen bonded molecular solids
- 2. Ionic Solids: lons are the constituent particles of ionic solids.
- **3. Metallic Solids:** Metals are orderly collections of positive ions surrounded by and held together by a sea of free electrons.
- 4. Covalent or Network Solids: Non metals form this kind of solids.
- 5 **Ionic Solids :** Ionic solids contain ions in lattice points as well as in voids. To better understand ionic solids the radius ratio should be understood.
- Q. Classify the following solids in different categories based on the nature of intermolecular forces operating in them: Potassium sulphate, tin, benzene, urea, ammonia, water, zinc sulphide, graphite, rubidium, argon, silicon carbide.
- A. Potassium sulphate -lonic solid;Tin'-Metallic solid;Benzene-Molecular (non-polar) solid;Urea'-Polar molecular solid;Ammonia-Polar molecular solid,Water-Hydrogen bonded molecular solid,Zinc sulphide-lonic solid,Graphite-Covalent or network solid Rubidium-Metallic solid,Argon-Non-polar molecular solid,Silicon carbide -Covalent or network solid
- Q. Solid A is a very hard electrical insulator in solid as well as in molten state and melts at extremely high temperature. What type of solid is it?
- A. The given properties are the properties of a covalent or network solid. Therefore, the given solid is a covalent or network solid.
- Q. Ionic solids conduct electricity in molten state but not in solid state. Explain.
- A. In solid state, ions are held together by strong electrostatic forces and are not free to move about within the solid. Hence, ionic solids do not conduct electricity in solid state. However, in molten state or in solution form, the ions are free to move and can conduct electricity.
- Q. What type of solids are electrical conductors, malleable and ductile?
- A. Metallic solids

IMPERFECTIONS IN SOLIDS: Broadly speaking, the defects are two types, namely point defects and line defects. Points defects can be classified into three types:

Stoichiometric or intrinsic or thermodynamic defects: These are the point defects that do not disturb the stoichiometry of the solid. They are two type

Vacancy defect	Interstitial defect
A crystal is said to have vacancy defect when some of the lattice sites are vacant.	A crystal is said to have interstitial defect when some constituent particles (atoms or molecules) occupy an interstitial site.
This results in decrease in density of the substance.	This results in increase in density of the substance.

Stoichiometric defects for ionic solids are of two types: b. Non – stoichiometric defects: These are the point defects that disturb the stoichiometry of the solid.

Schottky defect	Frenkel or dislocation defect		
In this defect equal number of cations and anions are	In this defect, the smaller ion (usually cation) is		
missing.	dislocated from its normal site to an interstitial site.		
It is basically a vacancy defect in ionic solids.	It creates a vacancy defect at its original site and an interstitial defect at its new location.		
It decreases the density of a solid	It does not change the density of the solid		
Schottky defect is shown by ionic substances in which the cation and anion are of almost similar sizes.	shown by ionic substance in which there is a large difference in the size of ions.		
For example: NaCl, KCl, CsCl and AgBr	For example: ZnS, AgCl, AgBr and AgI		

c. Impurity defects: These are the defects in ionic solids due to the presence of impurities present in them. This defect arises where foreign atoms or ions are presents in the lattice (Fig.). If molten NaCl containing a little amount of SrCl₂ is crystallised, some of the sites of Na⁺ ions are occupied by Sr²⁺. Each Sr²⁺ replaces two Na⁺ ions. The cationic vacancies thus produced are equal in number to that of Sr²⁺ ions. Another similar example is the solid solution of CdCl₂ and AgCl.

Non-stoichiometric defects are of two types:

- a. Metal excess This type of defect is due to excess of metal cations. These may be due to:
- i. Anionic vacancies: A compound may have an extra metal ion if the negative ion is absent from its lattice site. This empty lattice site is called a hole. To maintain electrical neutrality this site is occupied by an electron. The hole occupied by an electron is called f-centre or Farbenzenter centre . F- centre is responsible for the colour of the compound.
- ii. Presence of extra cations: A compound is said to have extra cations if a cation is present in the interstitial site. An electron is present in the interstitial site to maintain the electrical neutrality.
- b. Metal deficiency: This defect arises because of absence of metal ions from its lattice sites. The electrical neutrality is maintained by an adjacent ion having a higher positive charge.
- Solids can be classified into the following three types on the basis of their conductivities:
- (*i*) **Conductors :** Solids with conductivities ranging between 10⁴ and 10⁷ ohm⁻¹ m⁻¹ are called conductors.
- (*ii*) **Insulators**: These are the solids with low conductivities ranging between 10^{-20} and 10^{-10} ohm⁻¹m⁻¹.
- (*iii*) Semiconductors : These are the solids with conductivities in the intermediate range from 10⁻⁶ to 10⁴ ohm-Conduction of Electricity in semiconductors: In case of semiconductors, the gap between the valence band and conduction band is small. Therefore, some electrons may jump to conduction band and show some conductivity. Electrical conductivity of semiconductors increases with the rise in temperature. Because more electrons can jump to the conduction band, substances like silicon and germanium show this type of behaviour and are called intrinsic semiconductors.

The conductivity of intrinsic semi-conductors is too low to be of practical use. So they are doped by introducing impurities.

- (*i*) **Electron-rich impurities:** When silicon and germanium (group 14 elements) having four valence electrons are doped with a group 15 element such as P that contains five valence electrons, their conductivity increases due to negatively charged electron. Therefore, silicon doped with electron-rich impurity is called n-type semiconductor.
- (*ii*) **Electron-deficit impurities:** Silicon or germanium can also be doped with a group 13 element like B, Al or Ga that contains only three valence electrons resulting into creation of holes. These are called *p*-type semiconductors.

Applications of *n*-type and *p*-type semiconductors :

A large variety of semiconductors have been prepared by the following types of combinations:

- (i) Elements of group 13 (B, Ga) and group 15 (P, AS, Sb). Example: InSb, AIP, GaAs.
- (ii) Elements of group 12 and group 16, e.g., ZnS Cds, CdSe, Hg Te

MAGNETIC PROPERTIES OF SOLIDS

On the basis of their magnetic properties, substances can be classified into five categories:

- a. Paramagnetic: These are those substances which are weakly attracted by the magnetic field. It is due to presence of one or more unpaired electrons.
- b. Diamagnetic: Diamagnetic substances are weakly repelled by a magnetic field. Diamagnetism is shown by those substances in which all the electrons are paired and there are no unpaired electrons.
- c. Ferromagnetic: These are those substances which are attracted very strongly by a magnetic field.
- d. Antiferromagnetic: They have equal number of parallel and anti parallel magnetic dipoles resulting in a zero net dipole moment.
- e. Ferrimagnetic: They have unequal number of parallel and anti parallel magnetic dipoles resulting in a net dipole moment.
- Q. X-ray diffraction studies show that copper crystallises in an *fcc* unit cell with cell edge of 3.608×10⁻⁸ cm. In a separate experiment, copper is determined to have a density of 8.92 g/cm³, calculate atomic mass of copper.
- A. In case of *fcc* lattice, number of atoms per unit cell, z = 4 atoms Therefore, $M = d Na a^{3}/Z = 8.92 \times 6.022 \times 10^{23} \times (3.608 \times 10^{-8})^{3}/4 = 63.1 \text{ u}$
- Q. Silver forms *ccp* lattice and X-ray studies of its crystals show that the edge length of its unit cell is 408.6 pm.
 Calculate the density of silver (Atomic mass = 107.9 u).
- A. do it your self, 10.5 g cm⁻³
- Q. What is the two dimensional coordination number of a molecule in square close-packed layer?
- A. In square close-packed layer, a molecule is in contact with four of its neighbours. Therefore, the two-dimensional coordination number of a molecule in square close-packed layer is 4.



- Q. A compound forms *hexagonal close-packed* structure. What is the total number of voids in 0.5 mol of it? How many of these are tetrahedral voids?Number of close-packed particles = $0.5 \times 6.022 \times 10^{23} = 3.011 \times 10^{23}$ Therefore, number of octahedral voids = 3.011×10^{23} And, number of tetrahedral voids = $2 \times 3.011 \times 10^{23} = 6.022 \times 10^{23}$ Therefore, total number of voids = $3.011 \times 10^{23} + 6.022 \times 10^{23} = 9.033 \times 10^{23}$
- Q. A compound is formed by two elements M and N. The element N forms *ccp* and atoms of M occupy 1/3rd of tetrahedral voids. What is the formula of the compound?
- A. No of atoms of N =4, no of atoms at tetrahedral void = 2x4 =8 (double of atoms), so no of atoms of M = 2/3 x 8 = 16/3, Ratio of M and N = 8:16/3 = 3:4
- Q. An element with molar mass 2.7×10^{-2} kg mol⁻¹ forms a cubic unit cell with edge length 405 pm. If its density is 2.7×10^3 kg⁻³, what is the nature of the cubic unit cell?
- A. $Z = d. a^3$. Na/ M = $2.7 \times 10^3 x (405 \times 10^{-8})^3 x 6.022 \times 10^{23} / 2.7 \times 10 = 4$
- Q. What type of defect can arise when a solid is heated? Which physical property is affected by it and in what way?
- A. A solid crystal is said to have vacancy defect when some of the lattice sites are vacant. Vacancy defect leads to a decrease in the density of the solid.
- Q. What type of stoichiometric defect is shown by: (i) ZnS (ii) AgBr
 - (i) ZnS shows Frenkel defect.(ii) AgBr shows Frenkel defect
 - AgBr shows Frenkel defect as well as Schottky defect.
- Q. Explain how vacancies are introduced in an ionic solid when a cation of higher valence is added as an impurity in it.
- A. When a cation of higher valence is added to an ionic solid as an impurity to it, the cation of higher valence replaces more than one cation of lower valence so as to keep the crystal electrically neutral. As a result, some sites become vacant. For example, when Sr²⁺ is added to NaCl, each Sr²⁺ ion replaces two Na⁺ ions. However, one Sr²⁺ ion occupies the site of one Na⁺ion and the other site remains vacant. Hence, vacancies are introduced.
- Q. Ionic solids, which have anionic vacancies due to metal excess defect, develop colour. Explain with the help of a suitable example.
- A. The colour develops because of the presence of electrons in the anionic sites. These electrons absorb energy from the visible part of radiation and get excited.
- Q. A group 14 element is to be converted into n-type semiconductor by doping it with a suitable impurity. To which group should this impurity belong?
- A. *n*-type semiconductor conducts because of the presence of extra electrons. Therefore, a group 14 element can be converted to *n*-type semiconductor by doping it with a group 15 element.
- Q. What type of substances would make better permanent magnets, ferromagnetic or ferrimagnetic. Justify your answer.
- A. Ferromagnetic substances would make better permanent magnets.
- Q. What makes a glass different from a solid such as quartz? Under what conditions could quartz be converted into glass?
- A. The arrangement of the constituent particles makes glass different from quartz. In glass, the constituent particles have short range order, but in quartz, the constituent particles have both long range and short range orders. Quartz can be converted into glass by heating and then cooling it rapidly.
- Q. Classify each of the following solids as ionic, metallic, molecular, network (covalent) or amorphous.
 (i) Tetra phosphorus decoxide (P₄O₁₀), (ii) Ammonium phosphate (NH₄)₃PO₄(iii) SiC(iv) I₂v) P₄(vii) Graphite, (viii) Brass(ix) Rb (x) LiBr((xi) Si
- A. Ionic -(ii)Ammonium phosphate (NH₄)₃PO₄, (**x**) LiBr; Metallic-(**viii**)Brass, (**ix**)Rb; Molecular-(**i**) Tetra phosphorus decoxide (P₄O₁₀), (**iv**) I₂, (v) P₄.;Covalent (network) (**iii**) SiC,(**vii**)Graphite, (**xi**) Si Amorphous-(**vi**) Plastic
- Q. Silver crystallises in fcc lattice. If edge length of the cell is 4.07 × 10⁻⁸cm and density is 10.5 g cm⁻³, calculate the atomic mass of silver. (Ans- 107.13 u)
- Q. A cubic solid is made of two elements P and Q. Atoms of Q are at the corners of the cube and P at the bodycentre. What is the formula of the compound? What are the coordination numbers of P and Q? (Ans-8)
- Q. Niobium crystallises in body-centred cubic structure. If density is 8.55 g cm⁻³, calculate atomic radius of niobium using its atomic mass 93 u. (Ans- 14.32 nm)
- Q. Copper crystallises into a fcc lattice with edge length 3.61 × 10⁻⁸cm. Show that the calculated density is in agreement with its measured value of 8.92 g cm⁻³.
- Q. Analysis shows that nickel oxide has the formula $Ni_{0.98}O_{1.00}$. What fractions of nickel exist as Ni^{2+} and Ni^{3+} ions? A. Let the number of Ni^{2+} ions be *x*.So, the number of Ni^{3+} ions is 98 -*x*., Now, total charge on Ni^{2+} ions = x(+2) = +2x
- A. Let the number of Ni²⁺ions be x.So, the number of Ni³⁺ions is 98 -x.,Now, total charge on Ni²⁺ions = x(+2) = +2xAnd, total charge on Ni³⁺ions = (98 - x)(+3) = 294-3x,Since, the compound is neutral, we can write: 2x+(294-3x) = 100x 2, x = 94, Therefore, number of Ni²⁺ions = 94 And, number of Ni³⁺ions = 98 - 94 = 4

- Q. Non-stoichiometric cuprous oxide, Cu₂O can be prepared in laboratory. In this oxide, copper to oxygen ratio is slightly less than 2:1. Can you account for the fact that this substance is a *p*-type semiconductor?
- A. the number of Cu⁺ions is slightly less than twice the number of O²⁻ions. This is because some Cu⁺ions have been replaced by Cu²⁺ions. Every Cu²⁺ion replaces two Cu⁺ions, thereby creating holes. As a result, the substance conducts electricity with the help of these positive holes. Hence, the substance is a *p*-type semiconductor.
- Q. Ferric oxide crystallises in a hexagonal close-packed array of oxide ions with two out of every three octahedral holes occupied by ferric ions. Derive the formula of the ferric oxide.
- A. Let the number of oxide (O⁻²)ions be x.So, number of octahedral voids = x, It is given that two out of every three octahedral holes are occupied by ferric ions.So, number of ferric (Fe³⁺) ions = $2/3 \times \text{Fe}^{3+}$: O^{-2 =} 2 : 3, Hence, the formula of the ferric oxide is Fe₂O₃. Classify each of the following as being either a *p*-type or an *n*-type semiconductor:

(i) Ge doped with In (ii) B doped with Si.

- A. *p*-type semiconductor (ii)*n*-type semiconductor
- Q. If the radius of the octachedral void is r and radius of the atoms in close packing is R, derive relation between r and R.



A sphere with centre O, is fitted into the octahedral void as shown in the above figure. It can be observed from the figure that ΔPOQ is right-angled ? $POQ = 90^{\circ}$

Now, applying Pythagoras theorem, we can write:

 $PQ^{2} = PO^{2} + OQ^{2}$ $\Rightarrow (2R)^{2} = (R + r)^{2} + (R + r)^{2}$ $\Rightarrow (2R)^{2} = 2(R + r)^{2}$ $\Rightarrow 2R^{2} = (R + r)^{2}$ $\Rightarrow \sqrt{2}R = R + r$ $\Rightarrow r = \sqrt{2}R - R$ $\Rightarrow r = (\sqrt{2} - 1)R$ $\Rightarrow r = 0.414 R$

Vidyamandir Classes

- Q. In terms of band theory, what is difference between (i) a conductor and an insulator and a semiconductor?
 Q. Aluminium crystallises in a cubic close-packed structure. Its metallic radius is 125 pm.
- (i) What is the length of the side of the unit cell?(ii) How many unit cells are there in 1.00 cm³ of aluminium?
 Q. If NaCl is doped with 10⁻³ mol % of SrCl₂, what is the concentration of cation vacancies?
- A. It is given that NaCl is doped with 10^{-3} mol% of SrCl₂. This means that 100 mol of NaCl is doped with 10^{-3} mol of

SrCl₂. Therefore, 1 mol of NaCl is doped with $\frac{10^{-3}}{100}$ mol of SrCl₂ = 10⁻⁵ mol of SrCl₂. Cation vacancies produced

by one Sr^{2+} ion = 1

 $\therefore \quad \text{Concentration of the cation vacancies} \\ \text{produced by } 10^{-5} \text{ mol of } \text{Sr}^{2+} \text{ ions} = 10^{-5} \times 6.022 \times 10^{23} = 6.022 \times 10^{18} \text{ mol}^{-1}$