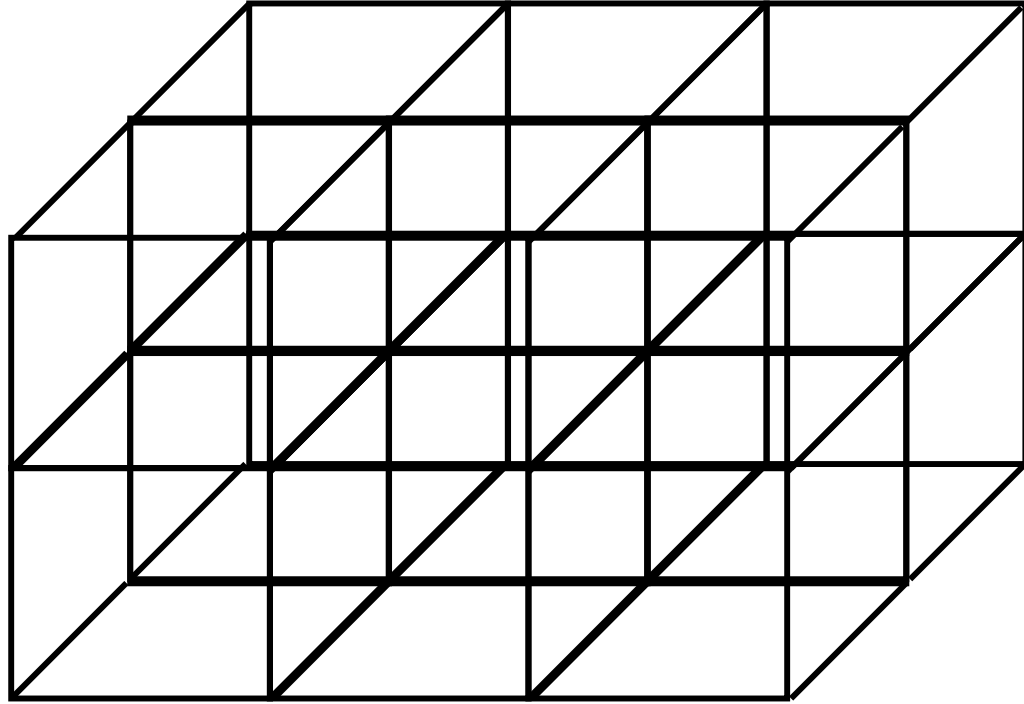
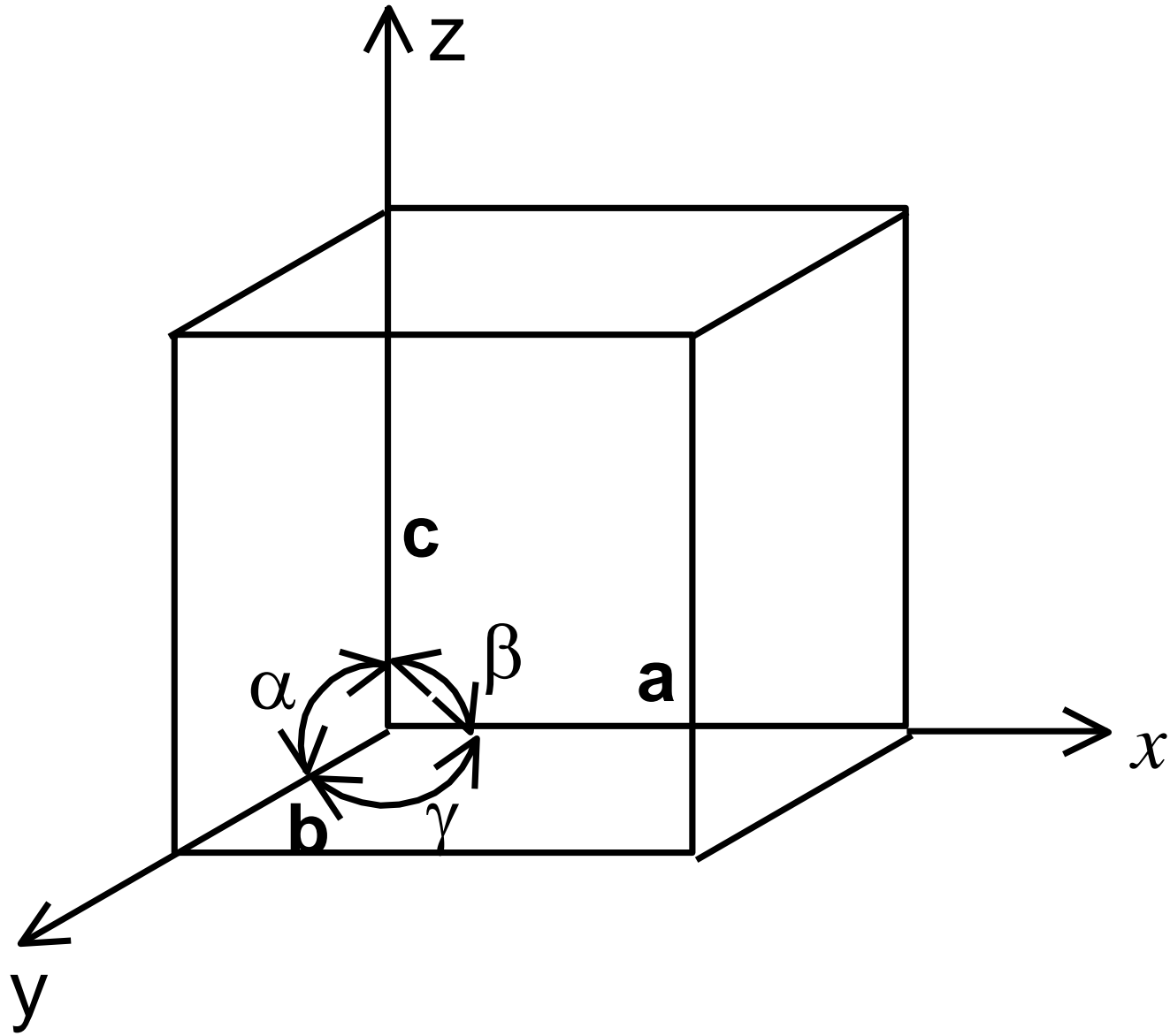


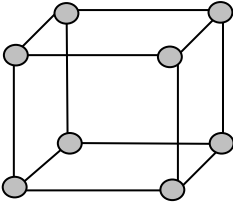
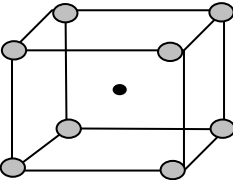
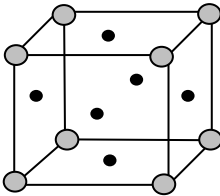
Crystalline solid	Amorphous solid
1. The constituent particles are arranged in a regular fashion containing short range as well as long range order.	1. The constituent particles are not arranged in any regular fashion. There may be at the most some short range order only.
2. They have sharp melting point	2. They melt over a range of temperature.
3. They are anisotropic i.e., properties like electrical conductivity, thermal expansion, etc have different values in different direction.	3. They are isotropic i.e., properties like electrical conductivity, thermal expansion, etc have same value in different directions
4. They undergo a cleavage.	4. They undergo an irregular cut

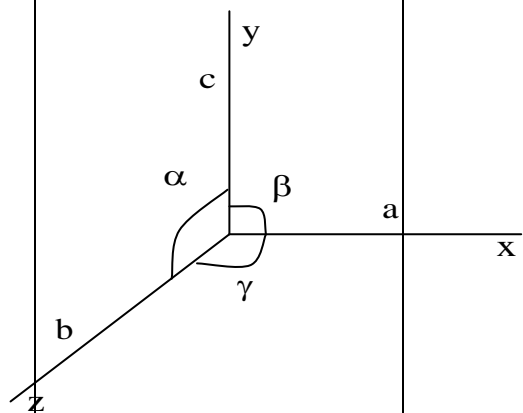


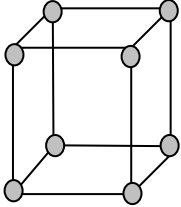
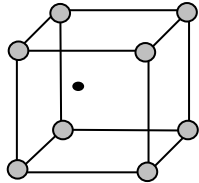
. Unit cells arranged together




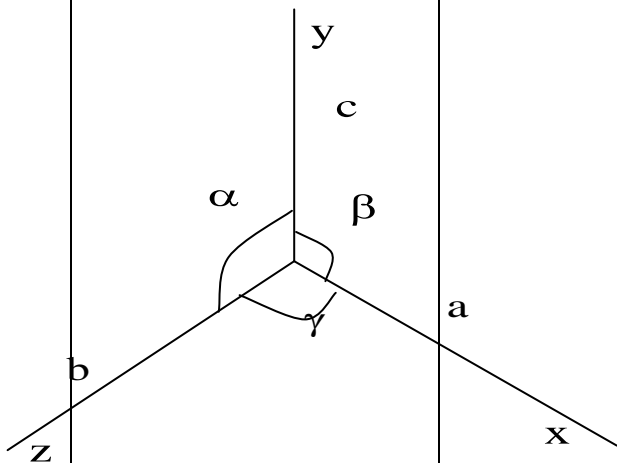
Sr. NO	Crystal system	Axial distance	Axial angles	Spaces lattice	Unit cell
-----------	----------------	-------------------	--------------	----------------	-----------

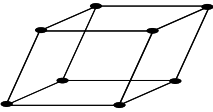
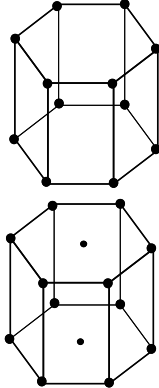
1	Cubic	$a = b = c$	$\alpha = \beta = \gamma = 90^\circ$	<p>(a) Simple – Lattice points at the Eight corners of the unit cells.</p> <p>(b) Body centered : – Lattice points at the eight corners and at the body centered.</p> <p>(c) Face centered : Lattice points at the eight corners and at the six face centres</p>	  
---	-------	-------------	--------------------------------------	---	--

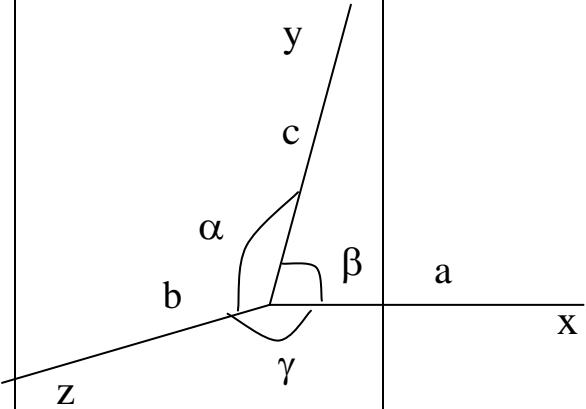
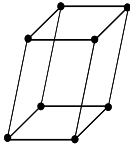
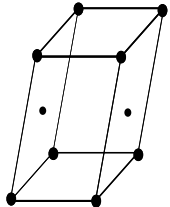


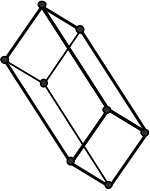
2.	Tetragonal	$a = b \neq c$	$\alpha = \beta = \gamma = 90^\circ$	<p>(d) Simple – Lattice points at the eight corners of the unit cell</p> <p>(e) Body centered : Lattice points at the eight corners and at the body centre.</p>	 
----	------------	----------------	--------------------------------------	---	--

3.	Orthorhombic (Rhombic)	$a \neq b \neq c$	$\alpha = \beta = \gamma = 90^\circ$	<p>(f) Simple : – Lattice points at the eight corners of the unit cell</p> <p>(g) End centered : Also called side centered or base centered. Lattice Points at the eight corners and at two face centre opposite to each other.</p> <p>(h) Body centered : Lattice points at the eight corners and at the body centre.</p> <p>(i) Face centered : – Lattice points at the eight corners and at the six face centres</p>	
----	-----------------------------	-------------------	--------------------------------------	---	--

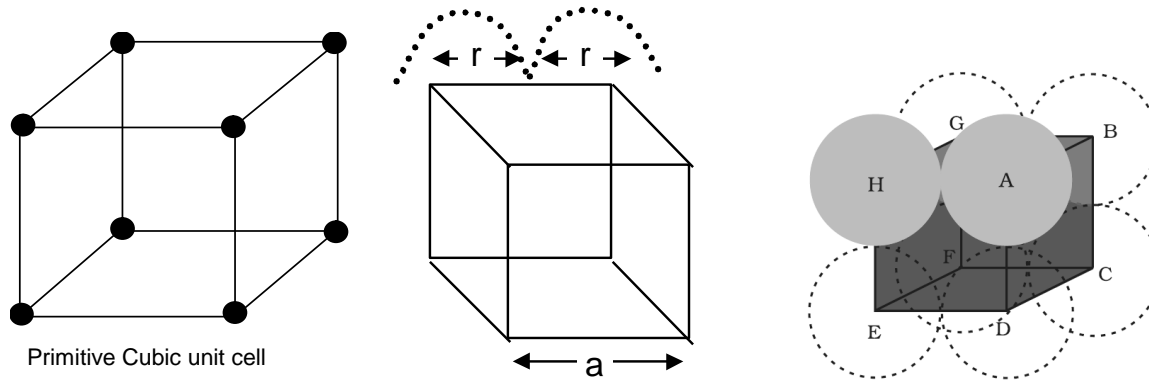


4.	Rhombohedral Or Trigonal	$a = b = c$	$\alpha = \beta = \gamma \neq 90^\circ$	(j) Simple : Lattice points at the eight corners of the unit cell.	
5	Hexagonal	$a = b \neq c$	$\alpha = \beta = 90^\circ$ $\gamma = 120^\circ$	(k) Simple : i. Lattice points at the twelve corners of the unit cell out lines by thick line ii. Lattice points at the twelve corners of the hexagonal prism and at the centres of the two hexagonal faces.	

6.	Monoclinic 	$a \neq b \neq c$	$\alpha = \beta = 90^\circ \neq \gamma$	<p>(I) Simple : Lattice points at the eight corners of the unit cell</p> <p>(m) End centered : Lattice point at the eight corners and at two face centers opposite to the each other.</p>	 

7.	Triclinic	$a \neq b \neq c$	$\alpha \neq \beta \neq \gamma \neq 90^\circ$	(n) Simple : Lattice points at the eight corners of the unit cell.	
----	-----------	-------------------	---	--	---

Simple Cubic Unit Cell

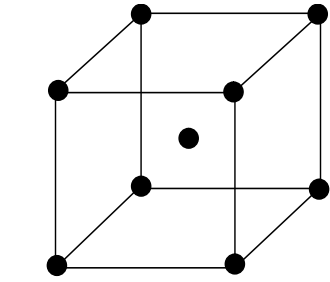


$$\text{Packing fraction (PF)} = \frac{4}{3} \frac{\pi r^3}{(2r)^3} \approx 0.52$$

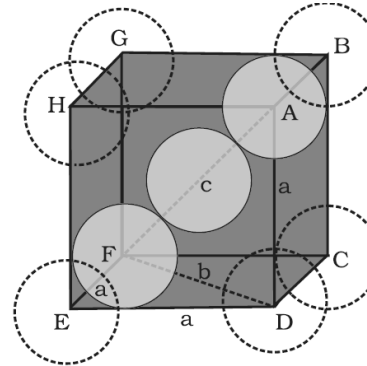
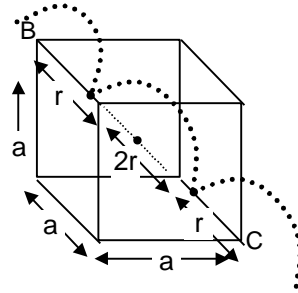
(This implies that 52 % of the volume of a unit cell is occupied by spheres).

$$\therefore \text{Void Fraction (VF)} \approx 0.48$$

Body Centered Cubic Unit Cell



Body Centered Cubic unit cell

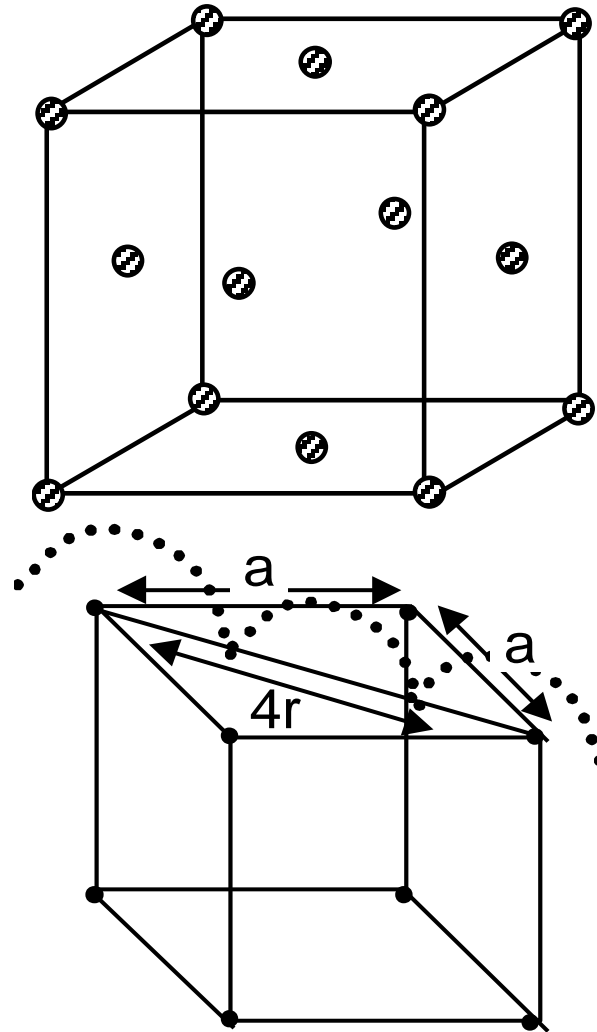


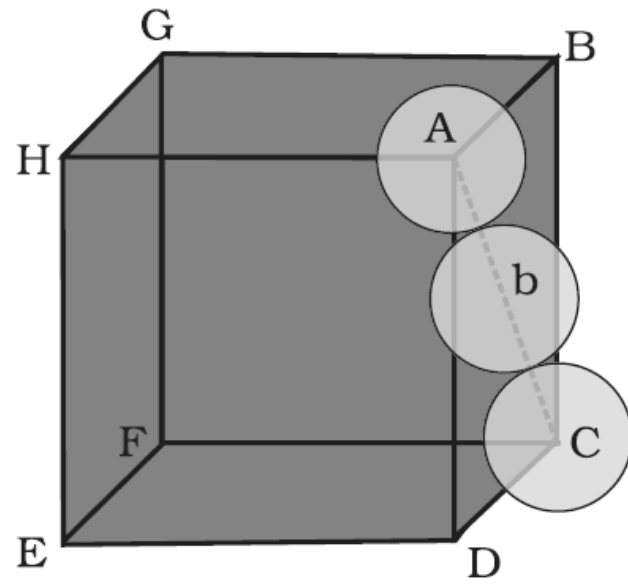
the length of the body diagonal ($\sqrt{3}a$) is equal to $4r$.

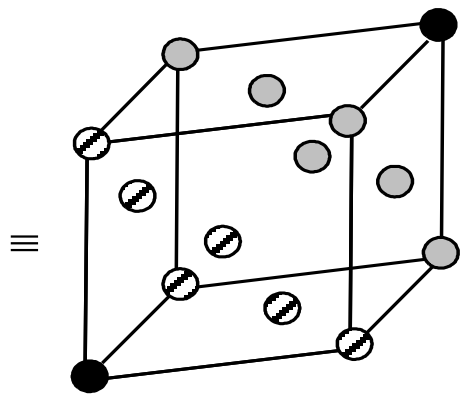
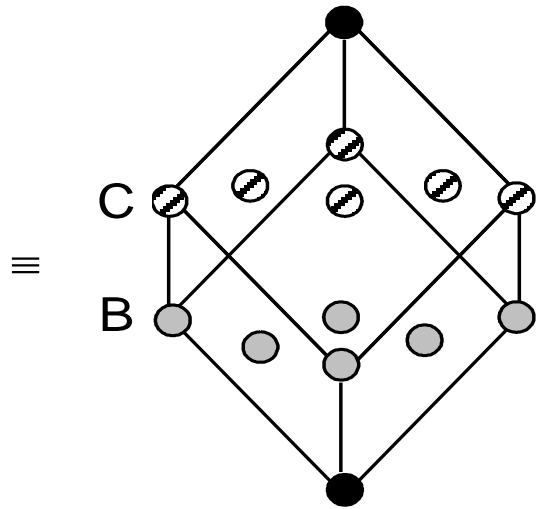
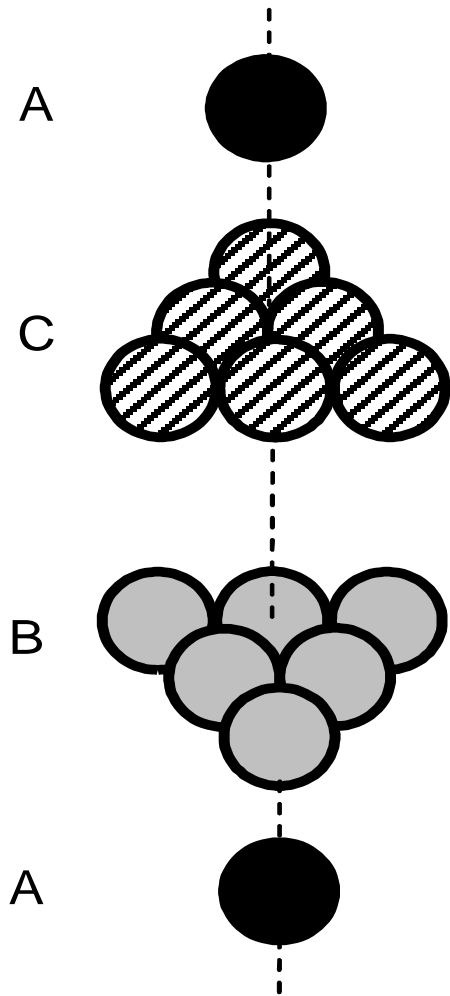
The packing fraction in this case is
$$= \frac{2 \times \frac{4}{3} \pi r^3}{\left(\frac{4r}{\sqrt{3}}\right)^3} \approx 0.68$$

\therefore Void fraction (VF) ≈ 0.32

4,3 Face Centered Cubic Unit Cell







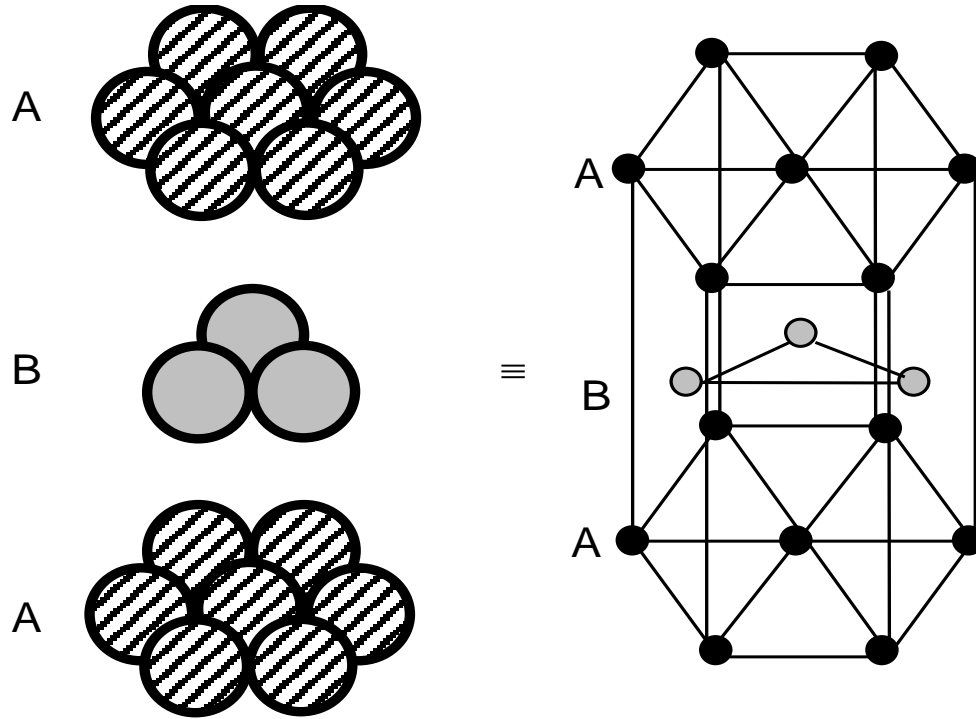
CUBIC CLOSE PACKING (CCP)
 \equiv FACE-CENTRED CUBIC (FCC)

each face centered atom touches the four corner atoms,
the face diagonal of the cube ($\sqrt{2} a$) is equal to $4r$.

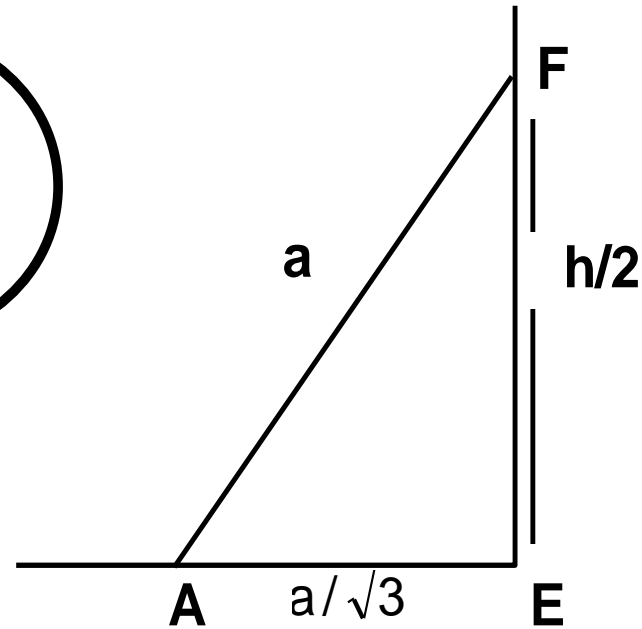
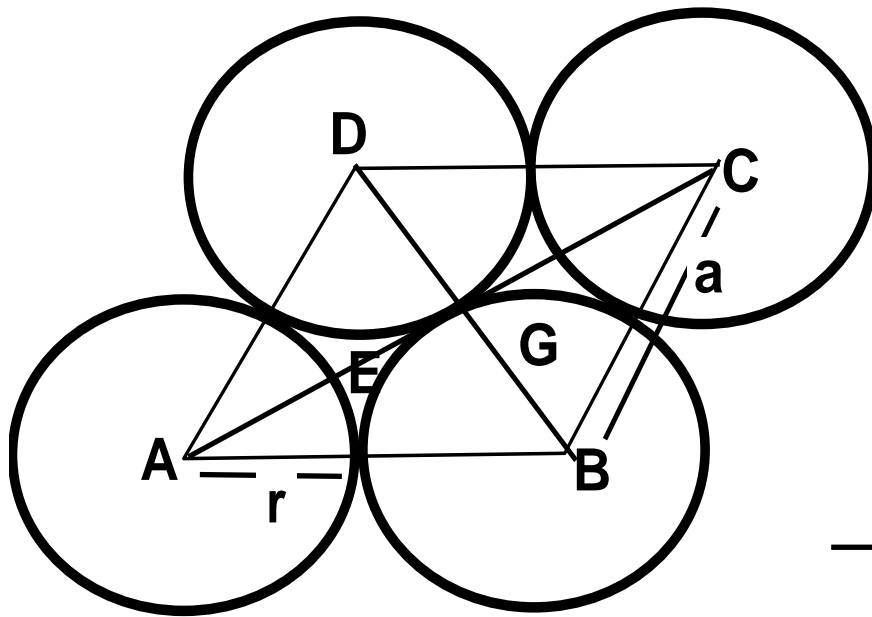
$$\therefore \text{Packing fraction(PF)} = \frac{4 \times \frac{4}{3} \pi r^3}{\left(\frac{4r}{\sqrt{2}}\right)^3} \approx 0.74$$

$$\therefore \text{Void fraction(VF)} \approx 0.26$$

4.4 Hexagonal Primitive Unit Cell



HEXAGONAL CLOSE PACKING (HCP)



the total number of effective atoms in Hexagonal Primitive

unit cell would be $\left(\frac{1}{6} \times 12\right) + \left(\frac{1}{2} \times 2\right) + 3 = 6$

$$\therefore \text{The height of unit cell (h)} = 4r\sqrt{\frac{2}{3}}$$

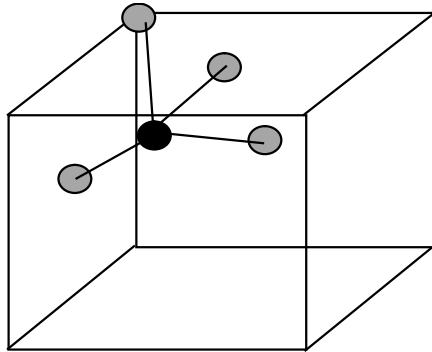
The area of the base is equal to the area of six equilateral triangles, = $6 \times \frac{\sqrt{3}}{4}(2r)^2$.

$$\text{The volume of the unit cell} = 6 \times \frac{\sqrt{3}}{4}(2r)^2 \times 4r\sqrt{\frac{2}{3}}$$

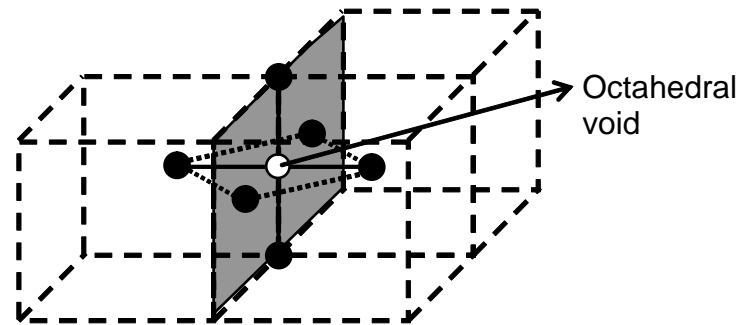
$$\therefore \text{Packing fraction (PF)} = \frac{6 \times \frac{4}{3}\pi r^3}{6 \times \frac{\sqrt{3}}{4}(2r)^2 \times 4r\sqrt{\frac{2}{3}}} \approx \mathbf{0.74} ;$$

$$\therefore \text{Void fraction (VF)} \approx 0.26$$

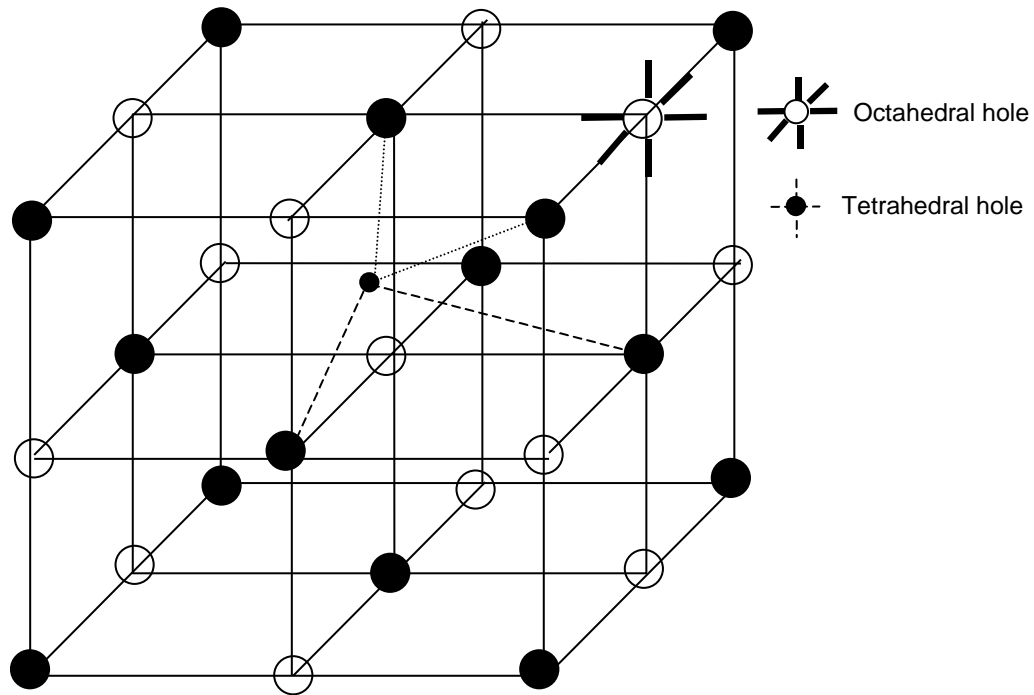
6. Octahedral and Tetrahedral Void



An atom occupying a tetrahedral void



An octahedral void at the centre of an edge in a FCC unit cell.



(Voids in FCC unit cell)

(Effective number of octahedral holes = 4, Effective number of tetrahedral holes = 8)

Density of crystal lattice

The density of crystal lattice is same as the density of the unit cell which is calculated as

$$\rho = \frac{\text{mass of unit cell}}{\text{volume of unit cell}} = \frac{\text{number of effective atoms} \times \text{mass number}}{\text{volume of unit cell} \times \text{Avogadro number}}$$

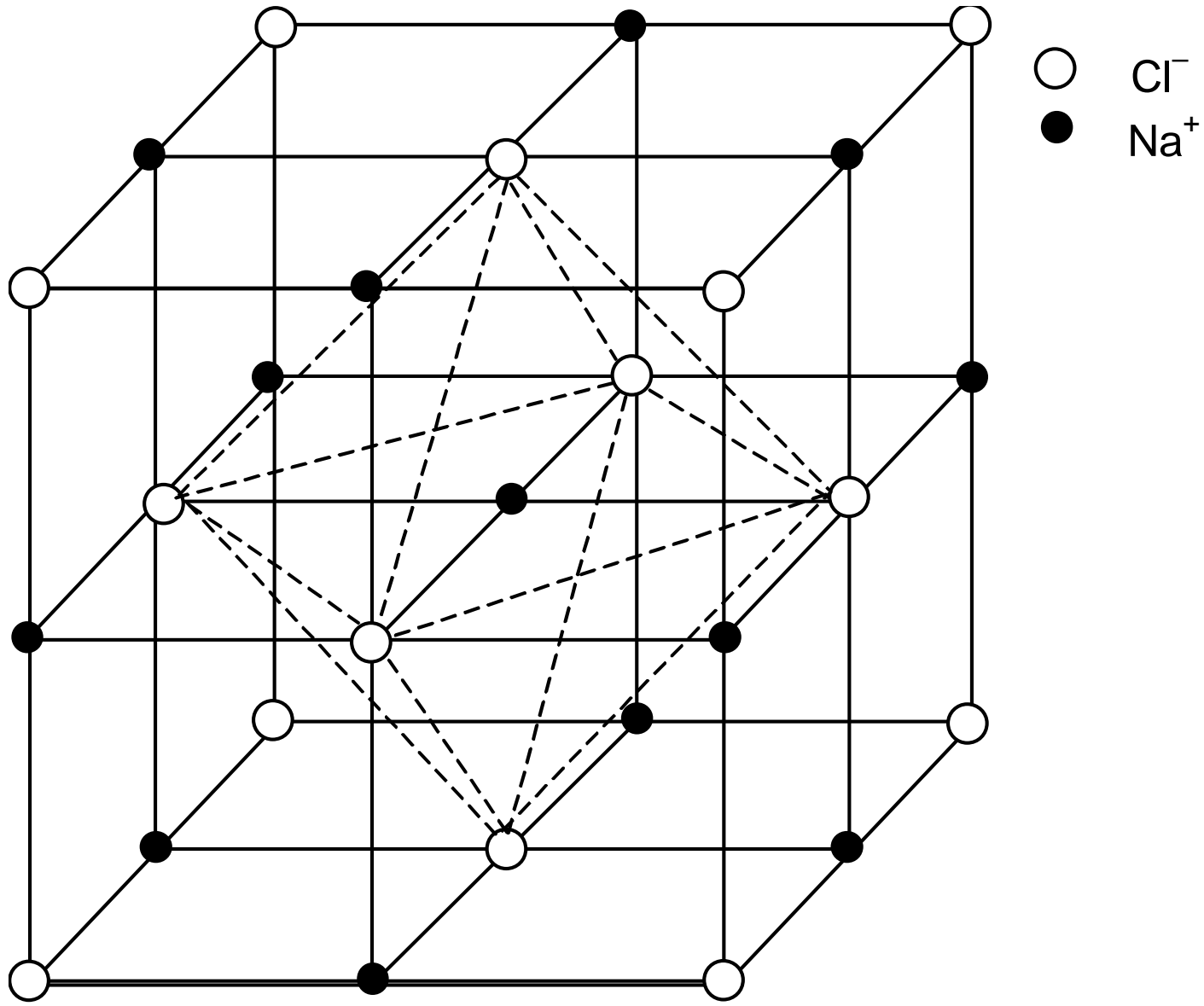
$$\rho = \frac{n \times M}{N_A \times V}$$

8. Classification of Ionic Structures

In any solid of the type A_xB_y , the ratio of the coordination number of A to that of B would be $y : x$.

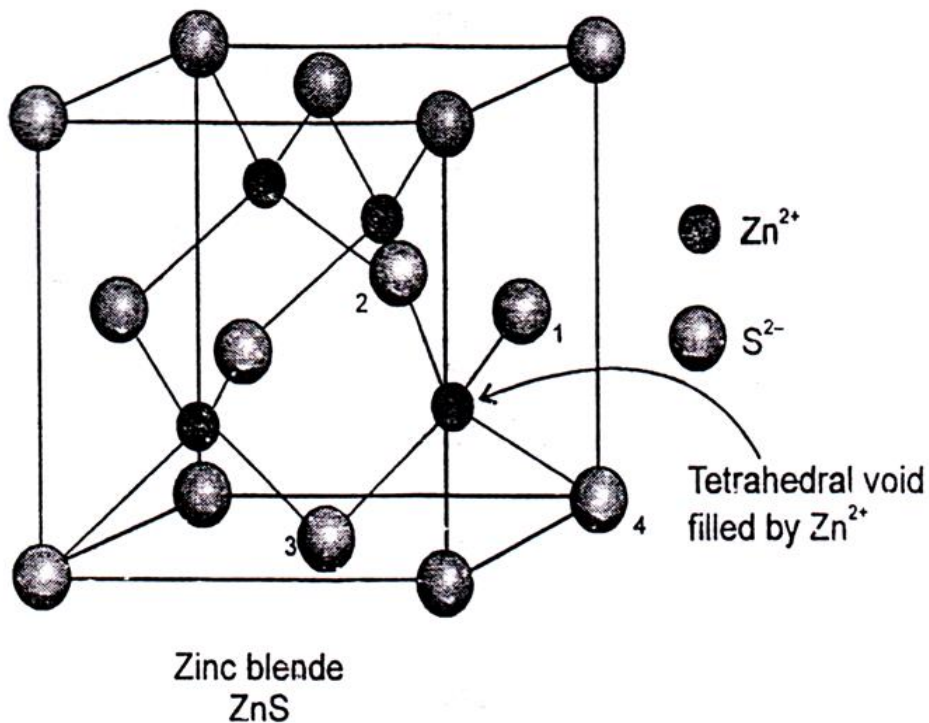
8.1 Rock Salt Structure

NaCl exhibits this type of structure. In the rock salt structure, Cl^- ions exist in FCC pattern and Na^+ ions occupy all octahedral voids. There are 4 effective Na^+ ions and 4 effective Cl^- ions in a unit cell of NaCl. So, the general formula is Na_4Cl_4 or NaCl as per the effective ions in a unit cell. The co-ordination number of Na^+ ion is 6 and co-ordination number of Cl^- ion is also 6. So, the general formula (using co-ordination number of ions) is Na_6Cl_6 or NaCl. The other substances having this kind of a structure are halides of all alkali metals except cesium halides and oxides of all alkaline earth metals except beryllium oxide.



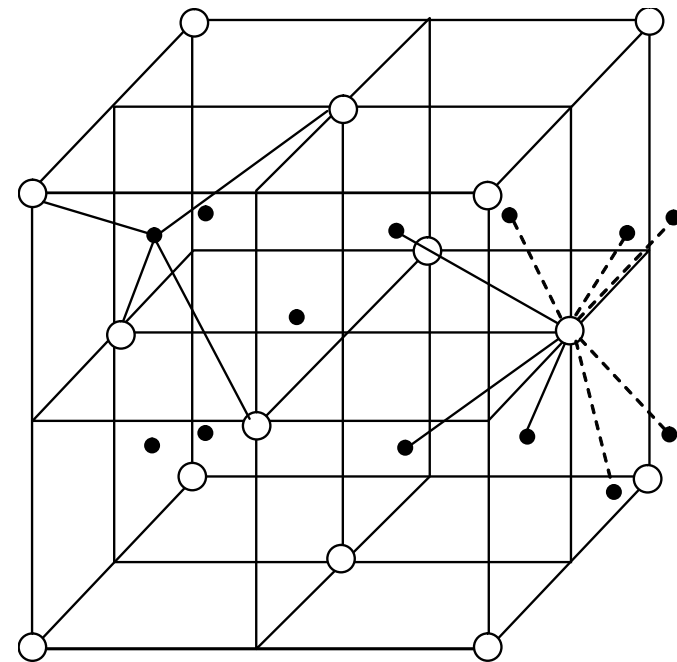
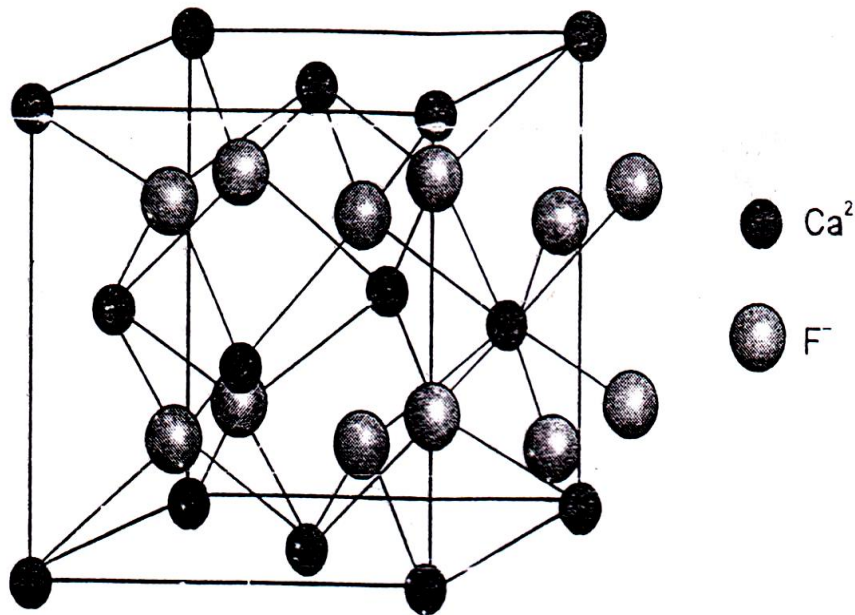
8.2 Zinc Blende Structure

This structure is shown by ZnS. Sulphide ions are face centered cubic position and Zinc is present in alternate tetrahedral voids. Formula is Zn_4S_4 , i.e, ZnS. Coordination number of Zn is 4 and that of sulphide is also 4. Other substance that exists in this kind of a structure is BeO.



8.3 Fluorite Structures

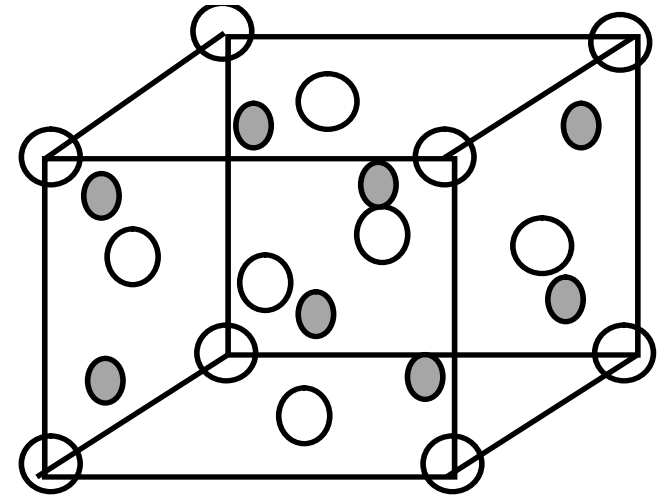
This structure is exhibited by CaF_2 . Calcium ions are face centered cubic position and fluoride ions are present in all the tetrahedral voids. There are four calcium ions and eight fluoride ions per unit cell. Therefore the formula is Ca_4F_8 , (i.e, CaF_2). The coordination number of fluoride ions is four (tetrahedral voids) and thus the coordination number of calcium ions is eight. Other substances which exist in this kind of structure are UO_2 , and ThO_2 .



Unit cell representation of CaF_2 structure

8.4 Anti-Fluorite Structure

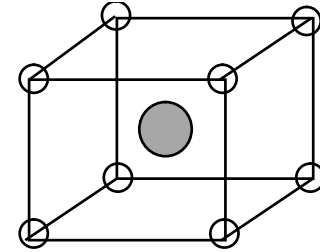
This structure is shown by Li_2O . Oxide ions are face centered cubic position and lithium ions are present in all the tetrahedral voids. There are four oxide ions and eight lithium ions per unit cell. As it can be seen, this unit cell is just the reverse of Fluorite structure, in the sense that, the positions of cations and anions is interchanged. Other substances which exist in this kind of a structure are Na_2O , K_2O and Rb_2O .



Anti-fluorite structure

8.5 Cesium Halide Structure

This structure is shown by CsCl. Chloride ions are primitive cubic while the Cesium ion occupies the center of the unit cell. There is one chloride ion and one cesium ion per unit cell. Therefore the formula is CsCl. The coordination number of cesium is eight and that of chloride ions is also eight. Other substances which exist in this kind of a structure are all halides of cesium.



Cesium halide structure

8.6 Spinel and Inverse Spinel Structure

Spinel is a mineral (MgAl_2O_4). Generally they can be represented as $\text{M}^{2+}\text{M}_2^{3+}\text{O}_4$,

where M^{2+} is present in one-eighth of tetrahedral voids in a FCC lattice of oxide ions

and M^{3+} ions are present in half of the octahedral voids.

M^{2+} is usually Mg, Fe, Co, Ni, Zn and Mn;

M^{3+} is generally Al, Fe, Mn, Cr and Rh.

Examples are ZnAl_2O_4 , Fe_3O_4 , FeCr_2O_4 etc.

Many substances of the type $\text{M}^{4+}\text{M}_2^{2+}\text{O}_4$ also have this structure.

In an inverse spinel the ccp is of oxide ions, M^{2+} is in one-eighth of the tetrahedral voids while M^{3+} would be in one-eighth of the tetrahedral voids and one-fourth of the octahedral voids.

9. Imperfections in a Crystal

Imperfection or **defect** is generally used to describe any deviation of the ideally perfect crystal from the periodic arrangement of its constituents.

9.1 Stoichiometric Defects

Stoichiometric compounds are those where the numbers of the different types of atoms or ions present are exactly in the ratios indicated by their chemical formulae.

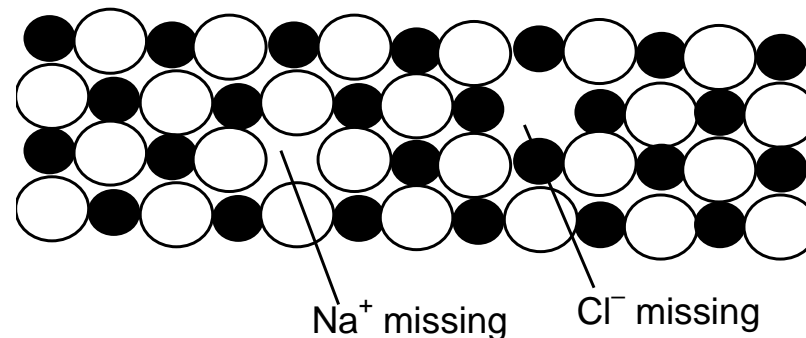
At absolute zero, crystals tend to have a perfectly ordered arrangement.

Schottky Defects:

A vacancy at a cation site is mostly accompanied by a vacancy at a nearby anion site. Such paired cation–anion vacancies are referred to as **Schottky defect**.

Such defect **preserves the electrical neutrality** of the crystal but the density of crystal decreases.

The points which are unoccupied are called *lattice vacancies*.



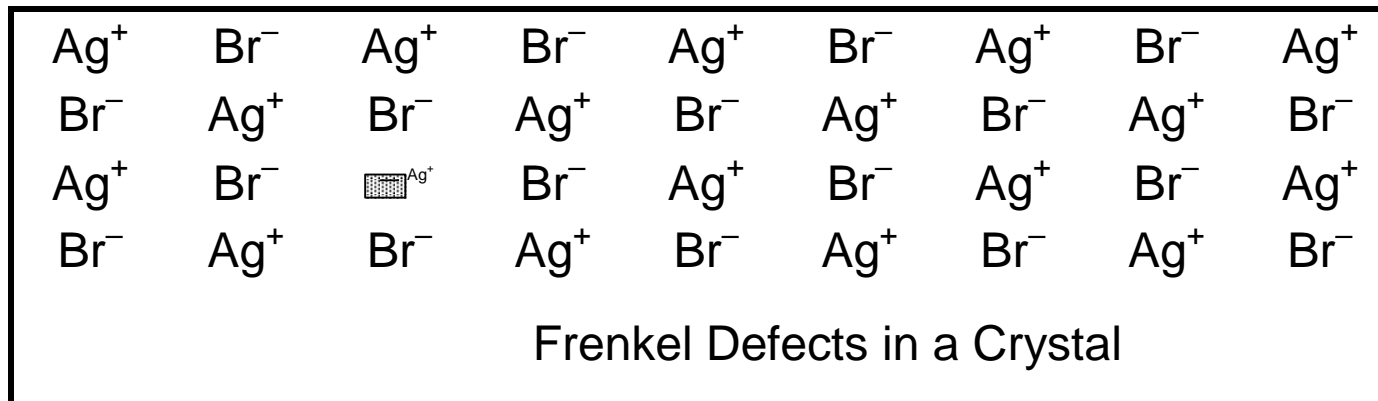
Schottky defects appear generally in highly ionic crystals in which the positive and the negative ions **do not differ much in size**.

Sodium chloride and cesium chloride furnish good examples of ionic crystals in which Schottky defects occur.

Frenkel Defects

When an ion (cation or anion) leaves its lattice point and occupies some interstitial space, the defect is called **Frenkel defect**.

This defect also preserves the electrical neutrality of the crystal and the density of the crystal also remains unaltered .



The presence of Ag^+ ions in the interstitial space of AgBr crystal is responsible for the formation of a photographic image on exposure of AgBr crystals (i.e., photographic plate) to light. ZnS is another crystal in which Frenkel defects appear.

Frenkel defects appear in crystals in which the **negative ions are much larger than the positive ions**. Like Schottky defects, the Frenkel defects are also responsible for the conduction of electricity in crystals and also for the phenomenon of diffusion in solids.

9.2 Non-Stoichiometric Defects

The defects discussed so far do not disturb the stoichiometry of the crystalline substance. Such compounds do not obey the law of constant composition.

Electrical neutrality is maintained either by having extra electrons in the structure or changing the charge on some of the metal ions.

This makes the structure irregular in some way i.e., it contains defects. These defects are of two types:

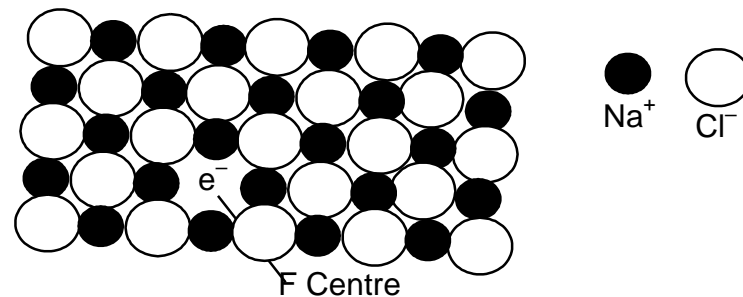
- (i) metal excess defect and (ii) metal deficiency defect.

(i) Metal Excess defect:

This may occur in two different ways

F-Centres: A negative ion may be absent from its lattice site leaving a hole which is occupied by an electron, thereby maintaining the electrical balance.

When compounds such as NaCl, KCl, are heated with excess of their constituent metal vapours, or treated with high energy radiation, they become deficient in the negative ions and their formulae may be represented by $AX_{1-\delta}$, where δ is a small fraction. The crystal lattice has vacant anion sites which are occupied by electrons. Anion sites occupied by electrons in this way are called F centres (F is an abbreviation Farbe, the German word for colour).

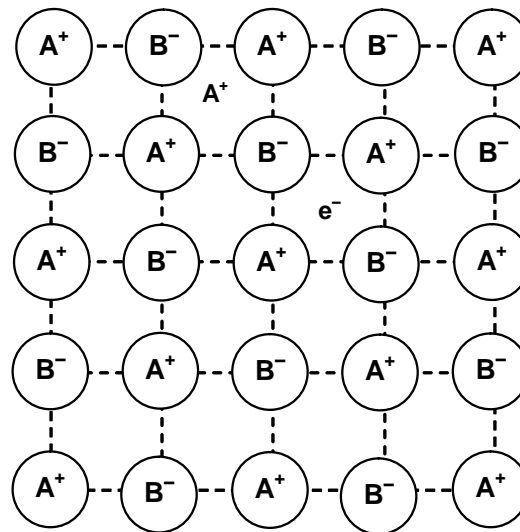


F-centre in a Sodium chloride crystal

Figure 18

Interstitial ions and electrons: Metal excess defects also occur when an extra positive ion occupies an interstitial position in the lattice and electrical neutrality is maintained by the inclusion of an interstitial electron.

Their composition may be represented by general formula $A_{1+\delta}X$. Examples include ZnO, CdO, Fe_2O_3 .




Metal excess defects caused by interstitial cations.

These free electrons may be excited to higher energy levels, giving absorption spectra and in consequence their compounds are often coloured e.g. non-stoichiometric NaCl is yellow, nonstoichiometric KCl is lilac.

(ii) Metal Deficiency Defects:

In certain cases, one of the positive ions is missing from its lattice site and the extra negative charge is balanced by some nearby metal ion acquiring two charges instead of one. There is evidently, a deficiency of the metal ions although the crystal as a whole is neutral. This type of defect is generally found amongst the compounds of transition metals which can exhibit variable valency. Crystals of FeO, FeS and NiO show this type of defects. The existence of metal deficiency defects in the crystal of FeO is illustrated.

Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}
O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}
Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}		O^{2-}	Fe^{2+}	O^{2-}
O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}	Fe^{3+}	O^{2-}	Fe^{3+}	O^{2-}	Fe^{2+}
Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}	Fe^{2+}	O^{2-}
Metal Deficiency Defects									

BOOST YOUR LEARNING

Example 1:

If the edge length of the unit cell of sodium chloride is 600 pm, and the ionic radius of Cl^- ion is 190 pm, then the ionic radius of Na^+ ion is

- (a) 310 pm (b) 110 pm
(c) 220 pm (d) none of these

Solution:

$$\text{As, } r_{\text{Na}^+} + r_{\text{Cl}^-} = \frac{a}{2}$$

$$\therefore r_{\text{Na}^+} + 190 = \frac{600}{2} = 300$$

$$r_{\text{Na}^+} = 300 - 190 = 110 \text{ pm}$$

∴ (b)

Example 2:

A compound XY crystallizes in BCC lattice with unit cell edge length of 480 pm. If the radius of Y^- is 225 pm, then the radius of X^+ is

- (a) 190.68 pm (b) 225 pm
(c) 127.5 pm (d) None of these

Solution:

For bcc structure,

$$2(r_c + r_a) = \sqrt{3} a$$

where r_c and r_a represents radius of cation and anion respectively.

$$\text{or, } 2(r_c + 225) = \sqrt{3} \times 480$$

$$\therefore r_c = 190.68 \text{ pm}$$

∴ (a)

Example 3:

An ionic compound AB has ZnS type structure. If the radius A^+ is 22.5 pm, then the ideal radius of B^- would be

- (a) 54.35 pm (b) 100 pm
(c) 145.16 pm (d) None of these

Solution:

Since ionic compound, AB has ZnS type structure, therefore it has tetrahedral voids, for which ideal radius ratio is 0.225.

$$\therefore \frac{r_{A^+}}{r_{B^-}} = 0.225$$

$$\therefore r_{B^-} = \frac{22.5}{0.225} = 100 \text{ pm}$$

\therefore (b)

Example 4:

Select the incorrect statement among the following.

(a) For CsCl unit cell (edge length = a), $r_c + r_a = \frac{\sqrt{3}a}{2}$

(b) For NaCl unit cell (edge length = a), $r_c + r_a = \frac{a}{2}$

(c) The void fraction in a BCC unit cell is 0.68.

(d) The percent void space in face-centered unit cell is 26%.

Solution:

In CsCl structure, $r_c + r_a = \frac{\sqrt{3}a}{2}$

In NaCl structure, $r_c + r_a = \frac{a}{2}$

Packing fraction of a BCC unit cell is 0.68, so the void fraction would be $1 - 0.68 = 0.32$
In FCC unit cell, packing percentage = 74%

\therefore Void percentage = $100 - 74 = 26\%$ \therefore (c)

Example 5:

In the diamond type cubic unit cell of silicon ($a = 5.43 \text{ \AA}$), the number of atoms per metre along the body diagonal are

(a) $8.5 \times 10^9 \text{ m}^{-1}$

(b) $2.1 \times 10^9 \text{ m}^{-1}$

(c) $2.6 \times 10^9 \text{ m}^{-1}$

(d) $1.84 \times 10^9 \text{ m}^{-1}$

Solution:

In diamond cubic unit cell, carbon atoms are present as FCC and in alternate tetrahedral voids.

On body diagonal ($\sqrt{3}a$), there will be 2 atoms.

$$\therefore \text{Number of atoms per meter along the body diagonal} = \frac{2}{\sqrt{3} \times 5.43 \times 10^{-10}} = 2.1 \times 10^9$$

\(\therefore\) (b)

Example 6:

In cubic ZnS lattice, if the radii of Zn^{2+} and S^{2-} ions are 0.83 \AA and 1.74 \AA , the lattice parameter (edge length, a) of cubic ZnS is

(a) 11.87 \AA

(b) 5.94 \AA

(c) 5.14 \AA

(d) 2.97 \AA

Solution:

In ZnS lattice, S^{2-} ions are present as FCC with Zn^{2+} ions occupying alternate tetrahedral voids.

$$\therefore \frac{\sqrt{3} a}{4} = (r_{\text{Zn}^{2+}} + r_{\text{S}^{2-}})$$

$$a = \frac{4}{\sqrt{3}} (0.83 + 1.74) = 5.94 \text{ \AA}$$

\therefore (b)

Example 7:

The packing efficiency of a simple cubic crystal with an interstitial atom exactly fitting at the body center is

(a) 0.48

(b) 0.52

(c) 0.73

(d) 0.91

Solution:

In a simple cubic crystal, $a = 2r$

Let the radius of the interstitial atom in simple cubic structure be $r\phi$, then

$$2(r + r\phi) = \sqrt{3}a = \sqrt{3} \times 2r$$

$$\therefore r\phi = \sqrt{3}r - r = 0.732r$$

$$\text{Packing fraction} = \frac{\frac{4}{3}\pi r^3 + \frac{4}{3}\pi (0.732r)^3}{(2r)^3} = \frac{\frac{4}{3}\pi r^3 [1 + (0.732)^3]}{8r^3} = \frac{\pi}{6} [1 + (0.732)^3] = 0.73$$

\therefore (c)

Example 8:

The diameter of the largest sphere that fits the void at the center of a cube edge of a BCC crystal of lattice parameter, a is

(a) $0.293 a$

(b) $0.414 a$

(c) $0.134 a$

(d) $0.336 a$

Solution:

Let the radius of sphere that fits the void at the center of edge of BCC lattice be $r\phi$, then

$$a = 2r + 2r\phi$$

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

$$a = \frac{\sqrt{3}a}{2} + 2r\phi$$

$$\therefore 2r\phi = a - \frac{\sqrt{3}a}{2} = a \left(1 - \frac{\sqrt{3}}{2}\right) = 0.134 a$$

\therefore (c)

Example 9:

The stacking, which has one stacking fault in the FCC lattice is

- (a) ... ABCABABCABABCAB ...
- (b) ... ABCABABCABCABC ...
- (c) ... ABABABCABABABCABABABC ...
- (d) ... ABCABCABABCABCABCABCABC...

Solution:

Stacking faults are planar surface imperfections created by a fault in the stacking sequence of atomic planes in crystals. Consider the stacking arrangement in an

FCC crystal....ABCABC_ABCABC.....

If an A plane indicated by an arrow above is missing, the stacking sequence becomesABCABCBCABC.....

The stacking in the missing region is ...BCBC... which is HCP stacking.

In (a), these are 2 stacking faults. In (b), there is only one, (c) has 6 and (d) has 2 faults. The stacking, which has only one stacking fault is ...ABCABABCABCABC... ∴ (b)

Example 10:

Which of the following statement for crystals having Frenkel defect is not correct?

- (a) Frenkel defects are observed where the difference in sizes of cations and anions is large.
- (b) The density of crystals having Frenkel defect is lesser than that of a pure perfect crystal.
- (c) An ionic crystal may have Frenkel defect along with the Schottky defect.
- (d) Pure alkali halides do not have Frenkel defect.

Solution:

The density of crystals having Frenkel defect is unaltered as the defect involves displacement of an atom or ion from its lattice position to an interstitial position, so the mass and volume remains unaffected.

∴ (b)

PAASAGE-1

Density of a unit cell is represented as

$$\rho = \frac{\text{Effective no. of atom(s)} \times \text{Mass of a unit cell}}{\text{Volume of unit cell}} = \frac{Z.M.}{N_A \cdot a^3}$$

Where, mass of unit cell = mass of effective no. of atom(s) or ion(s).

$M = \text{At. Wt./formula wt.}$, $N_A = \text{Avogadro's no.} \Rightarrow 6.023 \times 10^{23}$ $a = \text{edge length of unit cell}$

1. Silver crystallizes in a fcc lattice and has a density of 10.6 g/cm^3 . What is the length of an edge of the unit cell?
(A) 0.407 nm (B) 0.2035 nm (C) 0.101 nm (D) 4.07 nm

1. A

2. An element crystallizes in a structure having fcc unit cell of an edge 200 pm. Calculate the density, if 100 g of this element contains 12×10^{23} atoms:
(A) 41.66 g/cm^3 (B) 4.166 g/cm^3 (C) 10.25 g/cm^3 (D) 1.025 g/cm^3

2. A

3. The density of KBr is 2.75 g/cm^3 . The length of the edge of the unit cell is 654 pm. To which type of cubic crystal, KBr belongs?
(A) Simple cubic (B) bcc (C) fcc (D) none of these

3. C

PASSAGE-2

A spinel is an important class of oxides consisting of two types of metal ions with the oxide ions arranged in ccp layers. The normal spinel has one-eighth of the tetrahedral holes occupied by one type of metal ion and one-half of the octahedral holes occupied by another type of metal ion. Such a spinel is formed by Mg^{2+} , Al^{3+} and O^{2-} . The neutrality of the crystal is being maintained.

1. The formula of the spinel is:
(A) Mg_2AlO_4 (B) MgAl_2O_4 (C) $\text{Mg}_3\text{Al}_2\text{O}_6$ (D) none of these
2. Type of hole occupied by Al^{3+} ions is:
(A) Tetrahedral (B) octahedral (C) both (A) and (B) (D) none of these

2. **B**

3. Type of hole occupied by Mg^{2+} ions is:
(A) Tetrahedral (B) octahedral (C) both (A) and (B) (D) none of these

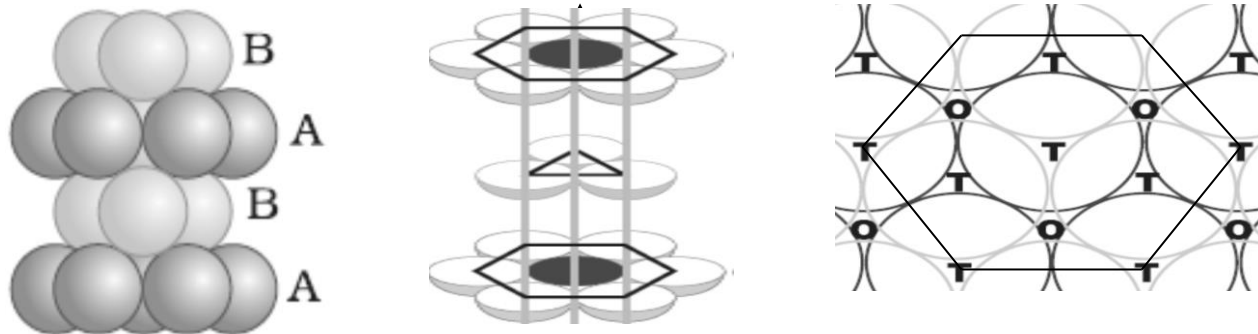
3. **A**

4. If oxide ion is replaced by $X^{-8/3}$, the number of anionic vacancy per unit cell is:
(A) 1 (B) 2 (C) 3 (D) 3/4

4. **A**

PASSAGE-3

In close packed structure, there is two possibility of arrangement in 3-D space: ABABA..... and ABCABC..... In which the detail view of ABAB..... is given below-



Number of tetrahedral voids = (2×Number of Particles) = (2×Number of octahedral voids)

1. The anions (A) form hexagonal closest packing and atoms (C) occupy 16.67% of octahedral voids and 25% of tetrahedral voids in it, then the general formula of the compound is

- (A) CA (B) C₂A₂ (C) C₂A₃ (D) C₃A₂

1. **C**

2. Coordination Number of Ag atom, if Silver is found to be packed in ABAB.....

- (A) 6 (B) 8 (C) 12 (D) 18

2. **C**

3. Approximate density of Silver metal, packed in hcp, if the density of Ag atom is given as 1.44×10^3 g/cc

- (A) 1.07×10^3 g/cc (B) 1.54×10^3 g/cc (C) 9.8×10^3 g/cc (D) 9.8×10^2 g/cc

3. **A**

4. A steel of carbon and Iron is found to have carbon constituting the ccp lattice. If Iron atoms occupy the edge centres, the alloy percentage carbon as
(A) 22% (B) 17.6% (C) 40.2% (D) 50%

4. **A**

5. In Cadmium iodide every alternate octahedral hole in an hcp arrays of iodide I^- ions is occupied by a cadmium ion. Molecular formula of Cadmium iodide is
(A) Cd_2I_3 (B) CdI_2 (C) CdI_3 (D) None of these
(B)

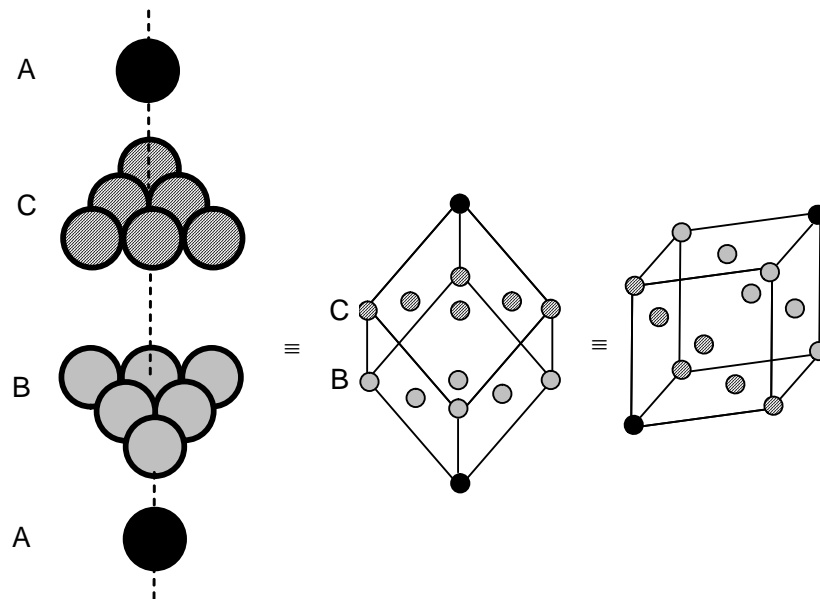
5. **B**

6. A solid is made up of elements X, Y and Z and has bcc arrangements of atoms with X occupying body center and Y and Z are at alternate corners. If atoms from two corners along a body diagonal are removed, the simplest formula of this solid
(A) $X_3Y_8Z_8$ (B) $X_2Y_3Z_3$ (C) $X_8Y_3Z_3$ (D) XY_3Z_3

6.C

PASSAGE-4

In close packed structure, there is two possibility of arrangement in 3-D space: ABABA..... and ABCABC.....In which the detail view of ABCABC..... is given below- In a fcc unit cell, the same atoms are present at all the corners of the cube and are also present at the centre of each square face and are not present anywhere else. The effective number of atoms in fcc is 4 (one from all the corners, 3 from all the face centers since each face centered atom is shared by two cubes). Since, each face centered atom touches the four corner atoms, the face diagonal of the cube ($\sqrt{2} a$) is equal to $4r$.



1. Total number of tetrahedral voids per unit cell of ccp
(A) 2 (B) 4 (C) 6 (D) 8

1. **D**

2. Total number of octahedral voids per unit cell of ccp
(A) 2 (B) 4 (C) 6 (D) 8

2. **B**

3. Coordination number of particle in ccp
(A) 4 (B) 6 (C) 8 (D) 12

3. **D**

4. The minimum distance between two tetrahedral voids in ccp
(A) $a/2$ (B) $\sqrt{3}a/2$ (C) $\sqrt{2}a/2$ (D) $\sqrt{3}a/4$

4. **A**

5. The minimum distance between two octahedral voids in ccp
(A) $a/2$ (B) $\sqrt{3}a/2$ (C) $\sqrt{2}a/2$ (D) $\sqrt{3}a/4$

5. **C**

6. The minimum distance between tetrahedral and octahedral voids in ccp
(A) $a/2$ (B) $\sqrt{3}a/2$ (C) $\sqrt{2}a/2$ (D) $\sqrt{3}a/4$

6. **D**

7. The distance between A and B-type layer in ccp

- (A) a (B) $2r\sqrt{\frac{2}{3}}$ (C) $4r\sqrt{\frac{2}{3}}$ (D) $\sqrt{2}a$

7. **B**

8. The distance between A and C-type layer in ccp

- (A) $2a$ (B) $2r\sqrt{\frac{2}{3}}$ (C) $4r\sqrt{\frac{2}{3}}$ (D) $2\sqrt{2}a$

8. **C**

11.3 MATRIX MATCH

1. Column - I

- (A) Nearest Neighbours of Na^+
- (B) Second
- (C) Third
- (D) fourth

Column – II (Rock salt Structure)

- (p) 4
- (q) 6
- (r) 8
- (s) 12

2. Column - I

- (A) Non-Stoichiometric FeO
- (B) Non-Stoichiometric NiO
- (C) Silicon doped with boron
- (D) KCl containing F-centres

Column – II (Imperfection of defects)

- (p) Anion deficiency crystal
- (q) p-type conductor
- (r) n-type conductor
- (s) cation deficiency crystal

3. Column - I

(A) $0.155 < \left(\frac{r^+}{r^-}\right) < 0.225$

(A) $0.225 < \left(\frac{r^+}{r^-}\right) < 0.414$

(C) $0.414 < \left(\frac{r^+}{r^-}\right) < 0.732$

(D) $0.732 < \left(\frac{r^+}{r^-}\right) < 0.999$

Column – II

(p) *bcc*

(q) Coordination No.- 4

(r) AlCl_3

(s) Octahedron

MATRIX MATCH

1. $A \rightarrow q;$ $B \rightarrow s;$ $C \rightarrow r;$ $D \rightarrow q$
2. $A \rightarrow q, s;$ $B \rightarrow q, s;$ $C \rightarrow q;$ $D \rightarrow p, r$
3. $A \rightarrow r;$ $B \rightarrow q;$ $C \rightarrow q, s;$ $D \rightarrow p$

