CHAPTER

1 The Solid State

Table: Classification of solid on the basis of nature of order of arrangement of constituent particles.

Crystalline	Amorphous
These solids have definite characteristic shape	These solids have irregular shape.
Definite melting point & heat of fusion	Indefinite melting point & heat of fusion.
Cleavage surfaces are smooth	Cleavage surface are irregular.
Anisotropic in nature.	Isotropic in nature.
Long range order.	Short range order.
Ex.: NaCl, Quartz, Metal, Diamond etc.	Ex. Glass, Quartz Glass, Rubber, Plastics etc.

Table: Seven Primitive Unit Cells and their Possible Variations as Centred Unit Cells

Name of system	Axis	Axial angles	Bravais Lattices
1. Cubic	$a = b = c$	$\alpha = \beta = \gamma = 90°$	SCC, BCC, FCC
2. Tetragonal	$a = b \neq c$	$\alpha = \beta = \gamma = 90°$	SCC, BCC
3. Orthorhombic or Rhombic	$a \neq b \neq c$	$\alpha = \beta = \gamma = 90°$	SCC, BCC, FCC, ECC
4. Monoclinic	$a \neq b \neq c$	$\alpha = \gamma = 90°, \beta \neq 90°$	SCC, ECC
5. Triclinic	$a \neq b \neq c$	$\alpha \neq \beta \neq \gamma \neq 90°$	SCC
6. Rhombohedral or Trigonal	$a = b = c$	$\alpha = \beta = \gamma \neq 90°$	SCC
7. Hexagonal	$a = b \neq c$	$\alpha = \beta = 90°, \gamma = 120°$	SCC

Density

$$d = \frac{Z \times M}{N_A \times a^3}$$

CONTRIBUTION			
AT CORNER	1/8	CORNERS	8
AT FACE	1/2	FACES	6
AT EDGE	1/4	EDGES	12
AT BODY CENTRE	1	BODY CENTRE	1
		BODY DIAGONAL	4
		FACE DIAGONAL	12
		FACE CENTRES	6
		EDGE CENTRES	12

Table: Properties of SCC, BCC, FCC and HCP

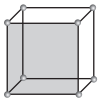
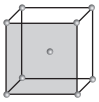
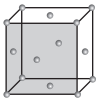
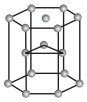
S. No.	Contents	SCC	BCC	FCC/CCP	HCP
1.	Geometry				
2.	Arrangement	AAAA.... Packing but not close packing	ABAB..... Packing but not close packing	ABCABC.... Close packing or CCP packing	ABAB.... Close packing
3.	No. of atoms/UC	1	2	4	6
4.	Coordination No.	6	8	12	12
5.	a & r relation	$r = a/2$	$r = \sqrt{3}a/4$	$r = \sqrt{2}a/4$	—
6.	Packing Efficiency	$\pi/6$ or 52.4%	$\sqrt{3}\pi/8$ or 68%	$\pi/3\sqrt{2}$ or 74%	$\pi/3\sqrt{2}$ or 74%
7.	Example	Mn	IA ; Group: V&Cr; Ba, Fe	Ca, Sr, Al, Group : Co, Ni, Cu All inert gases except He	Remaining d-block elements, Be & Mg

Table: Limiting radius ratio, coordination number of cation and type of void occupied

Limiting Radius Ratio	Coordination No. of Cation	Geometry of Void	Void found in	Location of void	No. of void per atom	Example
$0.155 < r/R \leq 0.225$	3	Plane Trigonal	—	—	—	Boron oxide (B_2O_3)
$0.225 < r/R \leq 0.414$	4	Tetrahedral	FCC,HCP	On body diagonal at $\sqrt{3}a/4$ distance from corner of the unit cell in FCC	2	ZnS, SiO_2, Na_2O, CaF_2
$0.414 < r/R \leq 0.732$	6	Octahedral	FCC, HCP	Body centre & edge centre	1	NaCl, MgO
$0.732 < r/R \leq 1.000$	8	Cubical	SCC	Body centre	1	CsCl

Table: Crystal Structure of Some Ionic Crystals

S. No.	Type of Ionic Crystal	Geometry	Coordination Number	No. of formula per U.C.	Examples
1.	NaCl (1:1) (Rock salt Type)	Cl^-: Every element of CCP CCP Na^+: At Every OHV	6 : 6	$4Na^+ + 4Cl^-$ 4NaCl (4)	❖ Halides of (Li, Na, K, Rb); Oxides & sulphides of alkaline earth metals; (some exception) ❖ AgF, AgCl, AgBr, NH_4X
2.	CsCl Type (1 : 1)	Cl^-: At Every Corner BCC Type Cs^+: At Body centre	8 : 8	$1Cs^+ + 1Cl^-$ 1CsCl (1)	❖ Halides of 'Cs' TlCl, TlBr, CaS
3.	ZnS Type (1 : 1) (Zinc Blende Type) (Sphalerite)	S^{-2}: Every element of CCP CCP Zn^{+2}: At 50% of THV or At Alternate THV	4 : 4	$4Zn^{+2} + 4S^{-2}$ 4ZnS (4)	❖ BeS, BeO, CaO, AgI, CuCl, CuBr, CuI

S. No.	Type of Ionic Crystal	Geometry	Coordination Number	No. of formula per U.C.	Examples
4.	CaF_2 Type (1:2) (Fluorite Type)	Ca^{+2}: Every element of CCP CCP F^-: At every THV	$4Ca^{+2}$ $8F^-$ 8 : 4	$4Ca^{+2} + 8F^{-1}$ $4CaF_2$ (4)	❖ $BaCl_2$, BaF_2, $SrCl_2$, SrF_2, $CaCl_2$, CaF_2
5.	Na_2O Type (2:1) (Antifluorite Type)	Na^+: At every THV CCP O^{-2}: Every element of CCP	$8Na^+$ $4O^{-2}$ 4 : 8	$8Na^+ + 4O^{-2}$ $4Na_2O$ (4)	❖ Li_2O, Li_2S, Na_2O, Na_2S, K_2O, K_2S
6.	ZnS type (1:1) (Wurtzite) another geometry of ZnS	S^{-2}: Every Element of HCP HCP Zn^{+2}: 50% of THV or at alternate THV	4 : 4	$6Zn^{+2} + 6S^{-2}$ 6ZnS (6)	❖ Same as Sphalerite