

9.SOLID STATE

○ Classification of Crystal into Seven System

Crystal System	Unit Cell Dimensions and Angles	Bravais Lattices	Example
Cubic	$a = b = c ; \alpha = \beta = \gamma = 90^\circ$	SC, BCC, FCC	NaCl
Orthorhombic	$a \neq b \neq c ; \alpha = \beta = \gamma = 90^\circ$	SC, BCC, end centred & FCC	S_R
Tetragonal	$a = b \neq c ; \alpha = \beta = \gamma = 90^\circ$	SC, BCC	Sn, ZnO_2
Monoclinic	$a \neq b \neq c ; \alpha = \gamma = 90^\circ \neq \beta$	SC, end centred	S_M
Rhombohedral	$a = b = c ; \alpha = \beta = \gamma \neq 90^\circ$	SC	Quartz
Triclinic	$a \neq b \neq c ; \alpha \neq \beta \neq \gamma \neq 90^\circ$	SC	H_3BO_3
Hexagonal	$a = b \neq c ; \alpha = \beta = 90^\circ ; \gamma = 120^\circ$	SC	Graphite

○ ANALYSIS OF CUBICAL SYSTEM

	Property	SC	BCC	FCC	
(i)	atomic radius (r)	$\frac{a}{2}$	$\frac{\sqrt{3}a}{4}$	$\frac{a}{2\sqrt{2}}$	$a = \text{edge length}$
(ii)	No. of atoms per unit cell (Z)	1	2	4	
(iii)	C.No.	6	8	12	
(iv)	Packing efficiency	52%	68%	74%	
(v)	No. voids				
	(a) octahedral (Z)	—	—	4	
	(b) Tetrahedral (2Z)	—	—	8	

○ NEIGHBOUR HOOD OF A PARTICLE :

(I) Simple Cubic (SC) Structure :

Type of neighbour	Distance	no.of neighbours
nearest	a	6 (shared by 4 cubes)
(next) ¹	$a\sqrt{2}$	12 (shared by 2 cubes)
(next) ²	$a\sqrt{3}$	8 (unshared)

(II) Body Centered Cubic (BCC) Structure :

Type of neighbour	Distance	no.of neighbours
nearest	$2r = a \frac{\sqrt{3}}{2}$	8
(next) ¹	$= a$	6
(next) ²	$= a\sqrt{2}$	12
(next) ³	$= a \frac{\sqrt{11}}{2}$	24
(next) ⁴	$= a\sqrt{3}$	8

(III) Face Centered Cubic (FCC) Structure :

Type of neighbour	Distance	no. of neighbours
nearest	$\frac{a}{\sqrt{2}}$	$12 = \left(\frac{3 \times 8}{2} \right)$
(next) ¹	a	$6 = \left(\frac{3 \times 8}{4} \right)$
(next) ²	$a\sqrt{\frac{3}{2}}$	24
(next) ³	$a\sqrt{2}$	12
(next) ⁴	$a\sqrt{\frac{5}{2}}$	24

○ **DENSITY OF LATTICE MATTER (d) = $\frac{Z}{N_A} \left(\frac{M}{a^3} \right)$**

where N_A = Avogadro's No. M = atomic mass or molecular mass.

○ **IONIC CRYSTALS**

C.No.	Limiting radius ratio $\left(\frac{r_+}{r_-} \right)$
3	0.155 – 0.225 (Triangular)
4	0.225 – 0.414 (Tetrahedral)
6	0.414 – 0.732 (Octahedral)
8	0.732 – 0.999 (Cubic).

○ **EXAMPLES OF A IONIC CRYSTAL**

(a) Rock Salt (NaCl) Coordination number (6 : 6)

(b) CsCl C.No. (8 : 8)

Edge length of unit cell :-

$$a_{sc} = \frac{2}{\sqrt{3}}(r_+ + r_-)$$

(c) Zinc Blende (ZnS) C.No. (4 : 4)

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

(d) Fluorite structure (CaF_2) C.No. (8 : 4)

$$a_{\text{fcc}} = \frac{4}{\sqrt{3}} (r_{\text{Ca}^{2+}} + r_{\text{F}^{--}})$$

○ Crystal Defects (Imperfections)

