

# 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)	$\frac{a}{2}$	$\frac{\sqrt{3}}{4}a$	$\frac{a}{2\sqrt{2}}$
	a = 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) <sup>1</sup>	$a\sqrt{2}$	12 (shared by 2 cubes)
(next) <sup>2</sup>	$a\sqrt{3}$	8 (unshared)



(II) **Body Centered Cubic (BCC) Structure :**

Type of neighbour	Distance	no. of neighbours
nearest	$2r = a \frac{\sqrt{3}}{2}$	8
(next) <sup>1</sup>	= a	6
(next) <sup>2</sup>	= $a\sqrt{2}$	12

(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) <sup>1</sup>	a	$6 = \left(\frac{3 \times 8}{4}\right)$
(next) <sup>2</sup>	$a\sqrt{\frac{3}{2}}$	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)

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

(d) Fluorite structure (CaF<sub>2</sub>) C.No. (8 : 4)

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

# Crystal Defects (Imperfections)

