SOLID STATE

❍ Classification of Crystal into Seven System

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

❍ ANALYSIS OF CUBICAL SYSTEM

	Property	SC	BCC	FCC
(i)	atomic radius (r) a = edge length	$\frac{a}{2}$	$\frac{\sqrt{3}}{4}a$	$\frac{a}{2\sqrt{2}}$
(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) Tetrahderal (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

(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

- **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_2) C.No. (8 : 4) $a_{fcc} = \frac{4}{\sqrt{3}}(r_{Ca^{2+}} + r_{F^-})$

Crystal Defects (Imperfections)