Density of Crystals :-

M = Molar mass
= mass of 1 mole

$m = \left(\frac{M}{N_A}\right)$ = mass of 1 particle

① $$d = \frac{Z \times m}{V}$$

$$\boxed{d = \frac{Z \times \left(\frac{M}{N_A}\right)}{V}} \quad \frac{gm}{cm^3}$$

② $$d = \frac{Z_1 \times \left(\frac{M_1}{N_A}\right) + Z_2 \times \left(\frac{M_2}{N_A}\right)}{V}$$

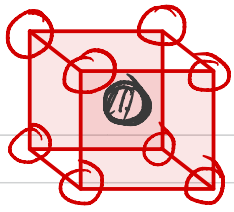
#

$\frac{4}{3}\pi r^3 \times$ $$d = \frac{Z \times \frac{M}{N_A}}{V} \times \frac{4}{3}\pi r^3$$

$$Pf = \frac{d \times \frac{4}{3}\pi r^3}{(M/N_A)}$$

$$\boxed{Pf \propto d}$$

4. If number of nearest neighbours, next nearest (2nd nearest) neighbour and next to next nearest (3rd nearest) neighbours are x, y and z respectively for body centered cubic unit cell, then calculate value of $\frac{xy}{z}$.



$x = 8$
$y = 6$
$z = 12$

$\frac{xy}{z} = \frac{8 \times 6}{12} = 4$

5. In a face centered lattice of X and Y, X atoms are present at the corners while Y atoms are at face centers. Then the formula of the compound is :
(a) XY_3 (b) X_2Y_3
(c) X_3Y (d) XY

$X = 8 \times \frac{1}{8} = 1$

$Y = 6 \times \frac{1}{2} = 3$

XY_3

6. Calculate radius of an atom (in Å) the crystal which has a density equal to $\frac{3.2\pi}{3}$ gm/ml and the edge length of the cubic unit cell is 5 Å if atomic mass of the metal is 40 π.
[**Take :** $N_A = 6 \times 10^{23}$]

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

$\frac{0.16}{3} = Z \times \frac{40}{6 \times 10^{23}} \times \frac{1}{(5 \times 10^{-8})^3}$

$Z = 2$

BCC

$4r = a\sqrt{3}$

$r = \frac{a\sqrt{3}}{4} = 2.165\ A^0$

7. A metal crystallizes in such a lattice in which only 70% of the total space of the crystal is occupied by the atoms. If the atomic mass of the metal is 32π g/mol and the atomic radius is 0.2 nm, the density of the metal is
(a) 7.0 g/cm^3 (b) 3.5 g/cm^3
(c) 10.5 g/cm^3 (d) 14.0 g/cm^3

$d \times \frac{4}{3}\pi r^3 = (PF) \times \frac{M}{N_A}$

$d = 0.7 \times \frac{32\pi \times 8 \times 4}{\frac{4}{3}\pi (0.2 \times 10^{-7})^3 \times 6 \times 10^{23}}$

$d = \frac{0.7 \times 4 \times 10^5}{8} = 3.5\ \frac{gm}{cm^3}$

8. A metal exist as face centered cubic crystals. If the atomic radius is $100\sqrt{2}$ pm and the density of metal is 12,500 kg/m^3, the metal is : (**Given :** Ca = 40, Co = 58.9, Sn = 119.8, Pb = 208.4, $N_A = 6 \times 10^{23}$)
(a) Ca (b) Co
(c) Sn (d) Pb

$12.5\ \frac{gm}{cm^3} = \frac{4 \times M}{6 \times 10^{23} \times (400 \times 10^{-10})^3}$

$12.5 = \frac{40\ M}{6 \times 4 \times 4 \times 4} \Rightarrow M = 120$

$4r = a\sqrt{2}$

$400\sqrt{2} = a\sqrt{2} \Rightarrow a = 400\ pm$

Voids in crystals

→ Vacant spaces created in packing of particle.

→ Shape is spherical and Size is equal to max^m radius sphere that can be put inside without disturbing lattice.

→ In ionic Crystals, Cation generally occupy position at void while anion create Crystal lattice.

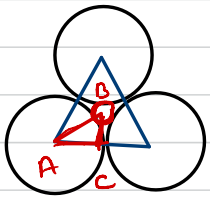
→ Name of void depend on arrangement of particles around it.

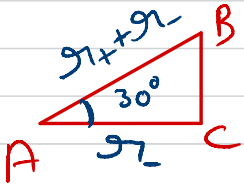
Type of void

① Triangular void :-

r_- = Radius of particle (or Anion)

r_+ = Radius of void (or Cation)

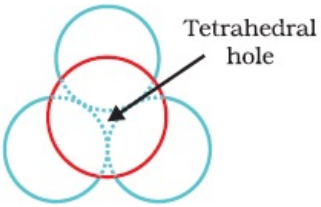


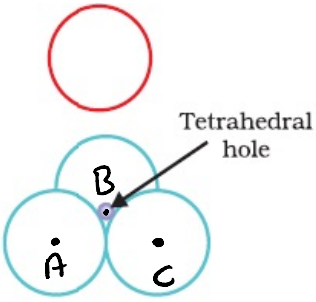


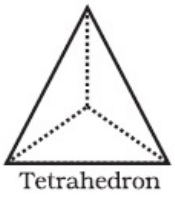
$$\cos 30^\circ = \frac{AC}{AB} = \frac{r_-}{r_+ + r_-} = \frac{\sqrt{3}}{2}$$

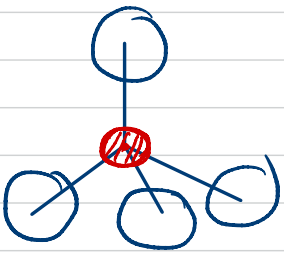
$$\boxed{\frac{r_+}{r_-} = 0.155}$$

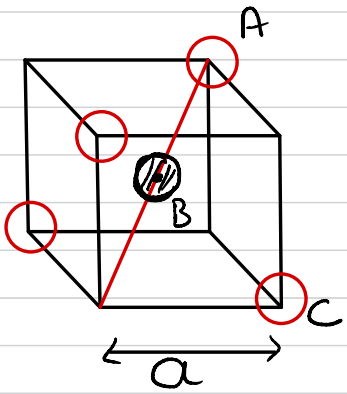
② Tetrahedral Void :-











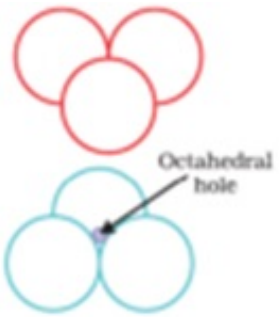
$$AB = \frac{a\sqrt{3}}{2} = r_+ + r_- \quad -(I)$$

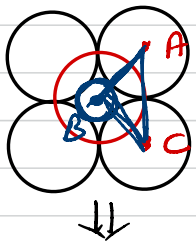
$$AC = a\sqrt{2} = 2r_- \quad -(II)$$

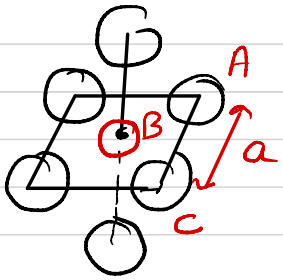
Eqn (I)/(II)

$$\boxed{\frac{r_+}{r_-} = 0.225}$$

④ Octahedral Void :-





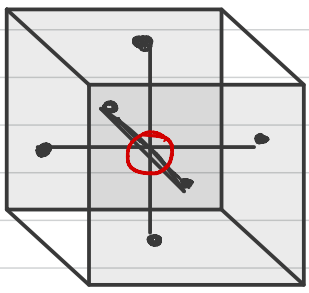


$$AC = a = 2r_- \quad -(I)$$

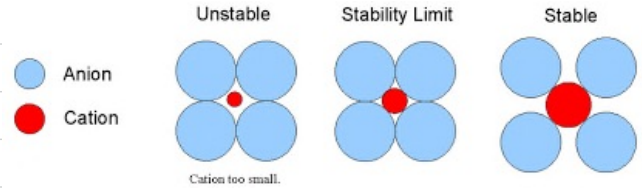
$$AB = \frac{a}{\sqrt{2}} = r_+ + r_- \quad -(II)$$

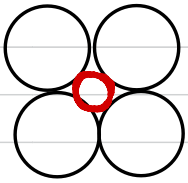
Eqn (II)/(I)

$$\boxed{\frac{r_+}{r_-} = 0.414}$$



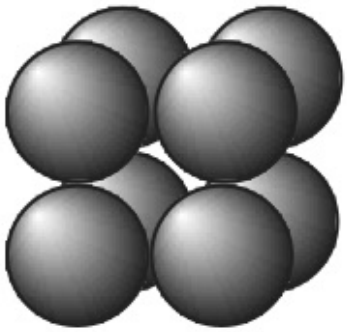
Square planer void :-

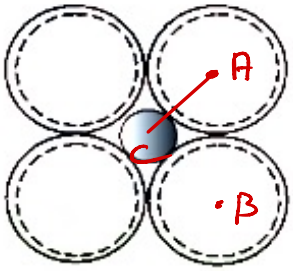


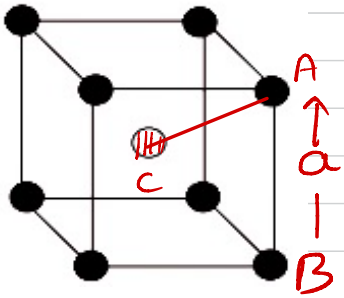


$$\frac{r_+}{r_-} = 0.414$$

Cubical void :-







$AB = 2r_- = a$ —(I)

$AC = r_+ + r_- = \frac{a\sqrt{3}}{2}$ —(II)

Eqn (II)/(I)

$$\frac{r_+}{r_-} = 0.732$$