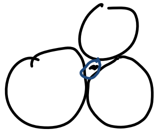
Study of ionic crystals:

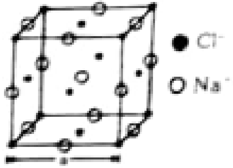
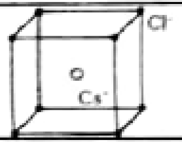
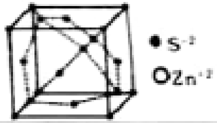
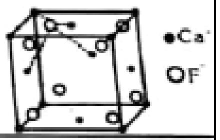
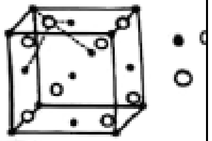


Limiting radius ratio = $\frac{r_{cation}}{r_{Anion}} = \frac{r^+}{r^-}$

		C.N.
Triangular	$0.155 \leq \frac{r^+}{r^-} \leq 0.225$	3
Tetrahedral	$0.225 \leq \frac{r^+}{r^-} < 0.414$	4
Octahedral	$0.414 \leq \frac{r^+}{r^-} < 0.732$	6
Cubical	$0.732 \leq r^+/r^- < 1.00$	8

v.v. imp.

TYPES OF IONIC CRYSTAL

	Type of Ionic Crystal	Geometry	Co-ordination Number	No. of formula's per U.C.C.	Examples
1.	NaCl (1 : 1) (Rock Salt Type)	$Na^+ \rightarrow$ O.H.V. $Cl^- \rightarrow$ C.C.P	6 : 6	$4Na^+ + 4Cl^-$ 4NaCl (4)	Halides of (Li, Na, K, Rb) Oxides and sulphides of alkaline, earth metals (Except BeS) AgCl, AgBr, NH_4X 
2.	CsCl Type (1 : 1)	$Cs^+ \rightarrow$ Cubical Void in B.C.C. $Cl^- \rightarrow$ at Corners B.C.C.	8 : 8	$1Cs^+ + 1Cl^-$ 1CsCl (1)	Halides of 'Cs' TlCl, TlBr, CaS 
3.	ZnS Type (1 : 1) (Zinc Blende Type) (Sphalerite)	$Zn^{+2} \rightarrow$ 50% T.H.V. $S^{2-} \rightarrow$ C.C.P.	4 : 4	$4Zn^{+2} + 4S^{-2}$ 4ZnS (4)	BeS, BeO, CaO, AgI, CuCl, CuBr, CuI 
4.	CaF_2 Type (1 : 2) (Fluorite Type)	C.C.P. $Ca^{+2} \rightarrow$ Every element of C.C.P; $F^- \rightarrow$ At every T.H.V.	$4Ca^{+2}$, $8F^-$ 8 : 4	$4Ca^{+2} + 8F^-$ $4CaF_2$ (4)	$BaCl_2$, BaF_2 $SrCl_2$, SrF_2 $CaCl_2$, CaF_2 
5.	Na_2O Type (2 : 1) (Antiflourite)	C.C.P. $Na^+ \rightarrow$ At every T.H.V.; $O^{-2} \rightarrow$ Every element of C.C.P.	$8Na^+$, $4O^{-2}$ 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	$Zn^{2+} \rightarrow$ 50% T.H.V. $S^{2-} \rightarrow$ H.C.P.	4 : 4	$6Zn^{+2} + 6S^{-2}$ 6ZnS (6)	Same as sphalerite

NaCl ⇒ Na^+ → O.H.V
Cl^- → C.C.P/F.C.C.
(Corner + Face centre)

Na^+ → edge centre + Body centre

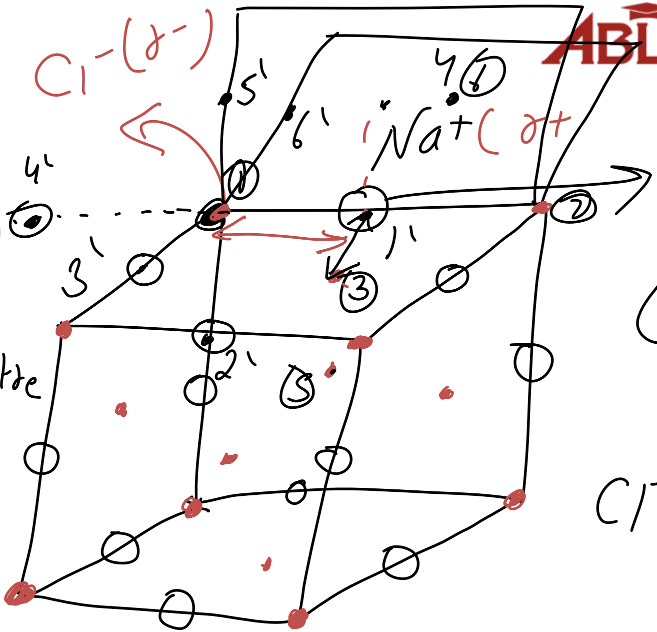
$12 \times \frac{1}{4} + 1 \times 1$

$= 4 Na^+$

$Cl^- \Rightarrow Z = 4 Cl$

$4 Na^+ + 4 Cl^-$

$= 4 (NaCl)$



Na^+
C.N. = 6

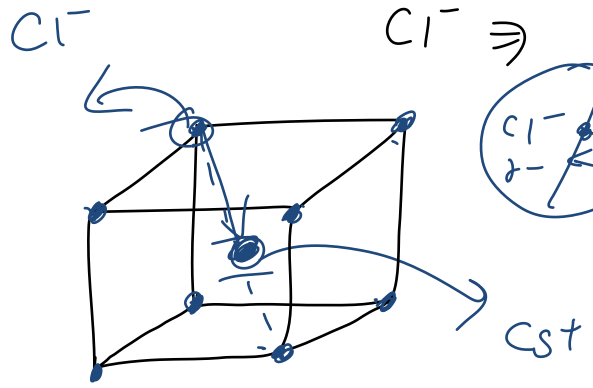
$Cl^- = 6$

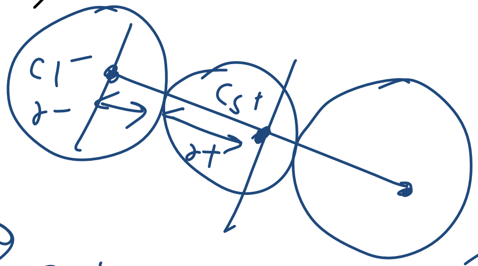
Nearest distance $r^+ + r^- = \frac{a}{2}$

$CsCl$:

$Cs^+ \Rightarrow$ Cubical Void

$Cl^- \Rightarrow$ Corner





→ Nearest distance.

$$r^+ + r^- = \frac{\sqrt{3}a}{2}$$

$Cs^+ \rightarrow$ C.N. = 8

$Cl^- \rightarrow$ C.N. = 8

Z = $Cs^+ \rightarrow$ Body centre = 1 × 1 = 1

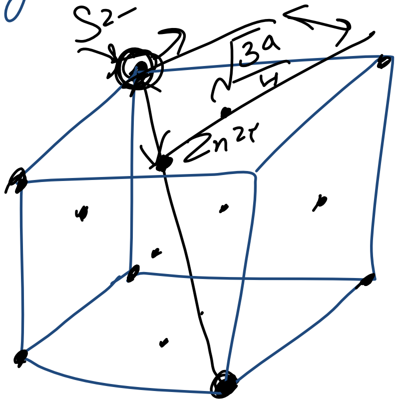
$Cl^- \Rightarrow$ Corner $\Rightarrow 8 \times \frac{1}{8} = 1$

No. of formula units / U.C.

= 1 Cs^+ + 1 Cl^-

= 1 (CsCl)

ZnS Type ⇒ Zn^{2+} → 50 % T.H.V.



S^{2-} ⇒ C.C.P / F.C.C.

Zn^{2+} = 4
S^{2-} = 4] → C.N.

No. of formula U.C/

Zn^{2+} ⇒ 50 % T.H.V. ⇒ 4

S^{2-} ⇒ C.C.P. ⇒ Z = 4

$4Zn^{2+} + 4S^{2-}$
= 4(ZnS)

Defects ⇒ NCert Refer

Ques. 1. In an ionic crystal, $r^+ = 50\,pm$, & $r^- = 150\,pm$ then find out type of void ?

Sol.

$$\frac{r^+}{r^-} = \frac{50}{150} = 0.33 \Rightarrow 0.225 - 0.414$$

T.H.V.

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Q.2. In NaCl type Crystal edge length is 100 pm & $r^+ = 10$ p.m. Then find r^- & nearest distance.

Sol:

$a = 100$; $r^+ = 10$ p.m.

$r^+ + r^- = \frac{a}{2}$

$10 + r^- = \frac{100}{2}$ 50

$r^- = 40$

Nearest distance

$= r^+ + r^-$

$= 10 + 40 = 5$

Q.3. $A \rightarrow$ H.C.P. then emprical formula of U.C.

$B \Rightarrow$ 50% T.H.V. of H.C.P.

$C \Rightarrow$ 25% O.H.V. of H.C.P.

Sol.

$A \rightarrow H.C.P \Rightarrow Z = 6$

$B \Rightarrow$ 50% T.H.V. $= 2Z \times 50\%$

$B = 2 \times 6 \times \frac{50}{100}$

$B = 6$

$C = 25\%$ O.H.V of H.C.P.

$= \frac{25}{100} \times 6 = 3/2$

$A \rightarrow 6 \times 2 = 12$

$B \rightarrow 6 \times 2 = 12$

$C \rightarrow 3/2 \times 2 = 3$

A_4B_4C

Bravais lattices are

(1) 10 types

(2) 8 types

(3) 7 types

(4) 14 types

Which of the following systems has/have not been correctly characterized?

(1) cubic $a = b = c$, $\alpha = \beta = \gamma = 90°$

(2) cubic $a = b \neq c$, $\alpha = \beta = \gamma = 90°$

(3) monoclinic $a \neq b \neq c$, $\alpha = \gamma = 90°$, $\beta \neq 90°$

(4) tetragonal $a = b \neq c$, $\alpha = \beta = \gamma = 90°$

The number of atoms per unit cell in a simple cubic, face-centred cubic and body-centred cubic are, respectively,

(1) 1, 4, 2

(2) 1, 2, 4

(3) 8, 14, 9

(4) 8, 4, 2

1, 4, 2.

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A Compound contains two types of atoms X and Y. Its crystal structure is a cubic lattice with X atoms at the corners of the cube and Y atoms are at the face centre. The simplest formula of the compound is

(1) X_2Y (2) XY_3

(3) XY_2 (4) X_3Y

$X \rightarrow 8 \times 1/8 = 1$

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

XY_3

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A solid has a structure in which X atoms are located at the cube corners of the unit cell, Y atoms are located at the cube edges and Z atoms at the cube centre. What is the formula of the compound?

(1) ZXY_3 (2) XYZ

(3) XYZ_3 (4) ZYX_3

$X \rightarrow 8 \times 1/8 = 1$

$Y \rightarrow 12 \times \frac{1}{4} = 3$

$Z = 1 \times 1 = 1$

$X Y_3 Z$

An alloy of copper, silver and gold is found to have copper constituting the ccp lattice. If silver atoms occupy the edge centres and gold is present at body centre, then the alloy has the formula

(1) Cu_4Ag_2Au
(2) Cu_4Ag_4Au
(3) Cu_4Ag_3Au
(4) $CuAgAu$

Cu → Z → 4

Ag → 12 × 1/4 = 3

Au → 1 × 1 = 1

$Cu_4Ag_3Au_1$

Platinum crystallizes in face-centred cubic crystal with a unit cell length 'a'. The distance between nearest neighbour is

(1) a

(2) $a\frac{\sqrt{3}}{2}$

(3) $a\frac{\sqrt{2}}{2}$

(4) $a\frac{\sqrt{2}}{4}$

$\frac{\sqrt{2}a}{2}$

Calcium crystallizes in fcc lattice. The axial length of one unit cell is 556 pm. Calculate the radius of a calcium atom.

(1) 278 pm (2) 241 pm

(3) 481 pm (4) 197 pm

$a = 556\ pm$

$4r = \sqrt{2}\, a$

$r = \frac{\sqrt{2}}{4} \times 556$

$= 1.414 \times 139$

$= 1.5 \times 140 = \frac{3}{2} \times 140 = 210$

Suppose 'a' is the axial length of the body-centred cubic unit cell, then the distance between nearest neighbours is

(1) $a/2$

(2) $a/\sqrt{2}$

(3) $\frac{\sqrt{2}}{4}a$

(4) $\frac{\sqrt{3}}{2}a$

Close packing is maximum in

(1) simple cubic (2) bcc

(3) fcc 74% (4) None

1	2	3	4	5	6	7	8	9	10
4	2	1	2	1	3	3	4	4	3