KTT 111 : Inorganic Chemistry 1 : Model Answers

Sem1_2004_2005_Q7 : SOLID STATE

Sem1_2004_2005_Q7a-Q7b

Q7 (a) Given: $r_{Sr^{2+}} = 1.13\text{ Å}$; $r_{F^-} = 1.36\text{ Å}$ for SrF_2

$$\text{Radius ratio} = \frac{r_{small\ ion}}{r_{large\ ion}} = \frac{1.13\text{ Å}}{1.36\text{ Å}} = 0.83$$

Ref:

Radius Ratio	Coordination number
0.225 – 0.414	4
0.415 – 0.732	6
0.733 – 1.0	8

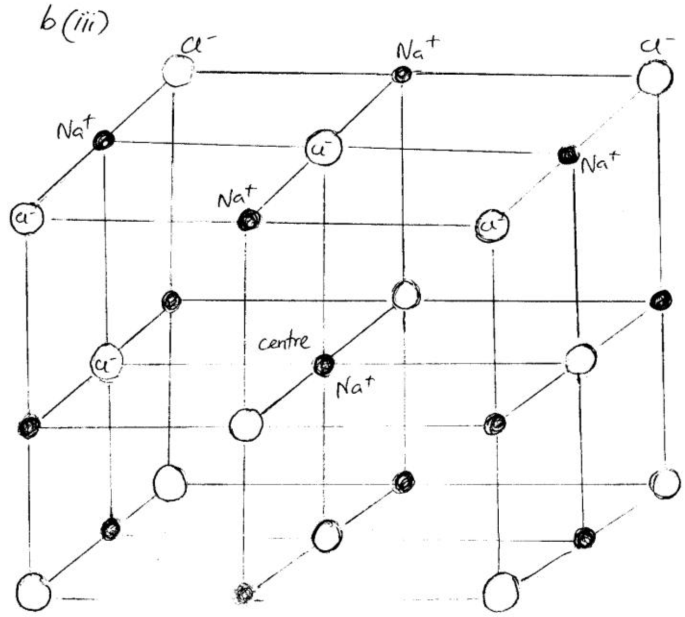
∴ Since the radius ratio ≥ 0.733, the coordination number = 8 //

Q7 (b)(i) 3 types of unit cell in cubic lattice.

( ) simple cubic
( ) face-centered cubic
( ) body-centered cubic

b(ii) For NaCl : face-centered cubic

b(iii)



Na^+ ions

We have parts along each of the 12 edges plus one whole Na^+ ion in the center of the unit cell.

No. of Na^+ ion = (12 edges × $\frac{1}{4}$ Na^+ per edge) + 1 Na^+ in the centre
= 3 Na^+ + 1 Na^+
= 4 Na^+ (total)

Cl^- ions

No. of Cl^- ions

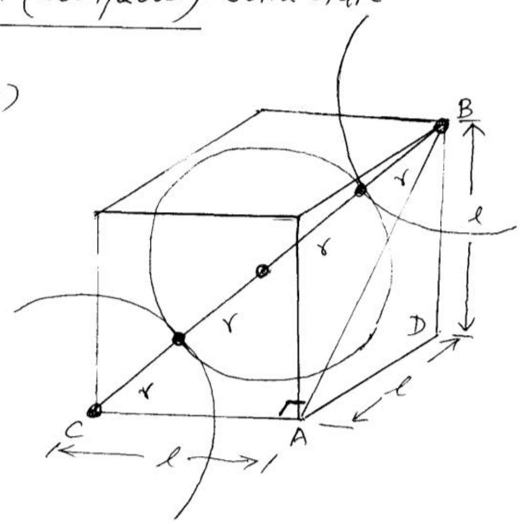
= (8 corners × $\frac{1}{8}$ Cl^- per corner) + (6 faces × $\frac{1}{2}$ Cl^- per face)
= 1 Cl^- + 3 Cl^-
= 4 Cl^- (total)

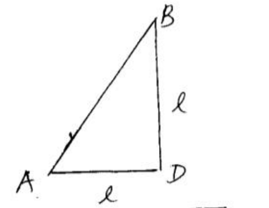
∴ Thus, in one unit cell, there are 4 chloride ions and 4 sodium ions.

Sem1_2004_2005_Q7c : Solid State

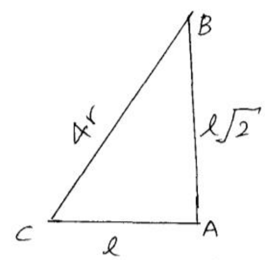
Sem 1 (2004/2005): Solid state

Q7 (c) (i)





$$AB = \sqrt{l^2 + l^2} = \sqrt{2l^2} = l\sqrt{2}$$



$$(4r)^2 = l^2 + (l\sqrt{2})^2$$
$$= l^2 + 2l^2$$
$$(4r)^2 = 3l^2$$
$$4r = l\sqrt{3}$$
$$\therefore r = \frac{l\sqrt{3}}{4}$$
$$= \frac{(2.86 \times 10^{-8})(\sqrt{3})}{4} \text{ cm}$$
$$r_{Fe} = 1.24 \times 10^{-8} \text{ cm (Ans)}.$$

Q7(c) (ii)

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

(unit cell contained $(\frac{1}{8} \times 8) + 1 = 2$ Fe atom)

$$\text{Mass of 2 atom Fe} = \left(\frac{2 \times 56}{6.022 \times 10^{23}}\right) g = 1.86 \times 10^{-22} g$$

$$\text{Volume unit cell} = l^3 = (2.86 \times 10^{-8})^3 \text{ cm}^3 = 2.34 \times 10^{-23} \text{ cm}^3$$

$$\therefore \text{Density} = \left(\frac{1.86 \times 10^{-22} g}{2.34 \times 10^{-23} \text{ cm}^3}\right) = 7.95 \text{ g cm}^{-3} \text{ (Ans)}$$

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