SOLID STATE

1. Which of the following compounds is likely to show both Frenkel and Schottky defects in its crystalline form?

(1) AgBr (2) ZnS

(3) KBr (4) CsCl

2. An element with molar mass 2.7×10^{-2} kgmol^{-1} forms a cubic unit cell with edge length 405 pm. If its density is 2.7×10^{3} kgm^{-3}, the radius of the element is approximately ____ $\times 10^{-12}$ m (to the nearest integer).

3. An element crystallises in a face-centred cubic (fcc) unit cell with cell edge a. The distance between the centres of two nearest octahedral voids in the crystal lattice is

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

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

4. A crystal is made up of metal ions 'M_1' ana 'M_2' and oxide ions. Oxide ions form a ccp lattice structure. The cation 'M_1' occupies 50% of octahedral voids and the cation 'M_2' occupies 12.5% of tetrahedral voids of oxide lattice. The oxidation numbers of 'M_1' and 'M_2' are, respectively :

(1) +2, +4 (2) +3, +1

(3) +1, +3 (4) +4, +2

SOLUTION

1. NTA Ans. (1)

Sol. Since AgBr has intermediate radius ratio

$\therefore$ it shows both schottky & Frenkel defects

ZnS $\rightarrow$ Frenkel defects

KBr, CsCl $\rightarrow$ Schottky defects

2. Official Ans. by NTA (143)

Sol. $d = \dfrac{z\left(\dfrac{M}{N_A}\right)}{a^3}$

$$2.7\times10^3 = z\frac{\left(\dfrac{2.7\times10^{-2}}{6\times10^{23}}\right)}{\left(405\times10^{-12}\right)^3}$$

$$2.7\times10^3 = z\frac{\left(2.7\times10^{-2}\right)}{6\times10^{23}\left(4.05\times10^{-10}\right)^3}$$

$$2.7\times10^3 = z\frac{\left(2.7\times10^{-2}\right)}{6\times10^{23}\times66.43\times10^{-30}}$$

3.98 = z

$z \approx 4$ structure is fcc

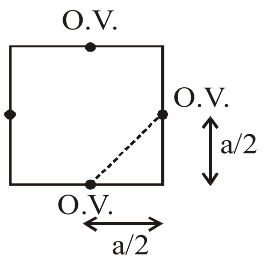
$\dfrac{a}{\sqrt{2}} = 2r$

$$r = \frac{a}{2\sqrt{2}} = \frac{\sqrt{2}a}{4} = \frac{1.414\times405\times10^{-12}}{4}$$

$r = 143.16 \times 10^{-12}$

3. Official Ans. by NTA (3)

Sol.



distance between nearest octahedral voids(O.V.)

$= \sqrt{\left(\dfrac{a}{2}\right)^2 + \left(\dfrac{a}{2}\right)^2} \quad \Rightarrow \quad = \dfrac{a}{\sqrt{2}}$

4. Official Ans. by NTA (1)

Sol. O^{-2} ions form ccp. O_4 $\downarrow$ (–8 charge)

M_1 = 50% of O.V. $\Rightarrow \dfrac{50}{100}\times4 = 2 : (M_1)_2$

M_2 = 12.5% of T.V. $\Rightarrow \dfrac{12.5}{100}\times8 = 1 : (M_2)_1$

So formula is : $(M_1)_2\ (M_2)_1O_4$

This must be neutral. Both metals must have +8 charge in total.

From given options : $\left\{\begin{array}{l} \text{O.N. of } M_1 = +2 \\ M_2 = +4 \end{array}\right\}$