

6

Solid State

TOPIC 1

Classification of Solid

- 01** A pure crystalline substance on being heated gradually first forms a turbid liquid at constant temperature and still at higher temperature turbidity completely disappears. The behaviour is a characteristic of substance forming
[CBSE AIPMT 1993]

- (a) allotropic crystals
(b) liquid crystals
(c) isomeric crystals
(d) isomorphous crystals

Ans. (b)

Such type of phenomenon is only exhibited by liquid crystals.

- 02** Most crystals show good cleavage because their atoms, ions or molecules are
[CBSE AIPMT 1991]

- (a) weakly bonded together
(b) strongly bonded together
(c) spherically symmetrical
(d) arranged in planes

Ans. (d)

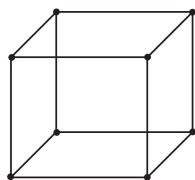
In crystals the constituents (atoms, ions or molecules) are arranged in definite orderly arrangement. When these crystals are cleaved they cut into regular patterns.

- 03** For orthorhombic system axial ratios are $a \neq b \neq c$ and the axial angles are
[CBSE AIPMT 1991]

- (a) $\alpha = \beta = \gamma \neq 90^\circ$
(b) $\alpha = \beta = \gamma = 90^\circ$
(c) $\alpha = \gamma = 90^\circ, \beta \neq 90^\circ$
(d) $\alpha \neq \beta \neq \gamma \neq 90^\circ$

Ans. (b)

Orthorhombic crystal has three unequal axis which are at right angle to each other $a \neq b \neq c$, all angles $= 90^\circ$



So, axial distances $a \neq b \neq c$ and axial angles $\alpha = \beta = \gamma = 90^\circ$.

- 04** The ability of a substance to assume in two or more crystalline structure is called
[CBSE AIPMT 1990]

- (a) isomerism (b) polymorphism
(c) isomorphism (d) amorphism

Ans. (b)

Some substances adopt different structural arrangement under different conditions. Such arrangements are called polymorphs and this phenomenon is called polymorphism.

TOPIC 2 Unit Cell and Packaging and Solid

- 05** Right option for the number of tetrahedral and octahedral voids in hexagonal primitive unit cell are
[NEET 2021]

- (a) 8, 4 (b) 6, 12
(c) 2, 1 (d) 12, 6

Ans. (d)

Number of octahedral and tetrahedral voids are equal to N and $2N$ respectively, where N is the number of atoms in unit cell.

Number of atoms per unit cell in hexagonal primitive unit cell $= 6$.

Number of tetrahedral voids
 $= 2N = 2 \times 6 = 12$.

Number of octahedral voids $= N = 6$.

- 06** The correct option for the number of body centred unit cells in all 14 types of Bravais lattice unit cell is
[NEET 2021]

- (a) 7 (b) 5 (c) 2 (d) 3

Ans. (d)

Crystal system	Bravais lattice
Cubic	Primitive, body centred, face centred, end centred
Orthorhombic	Primitive, body centred, face centred, end centred
Tetragonal	Primitive, body centred
Monoclinic	Primitive, end centred
Triclinic	Primitive
Rhombohedral	Primitive
Hexagonal	Primitive

Body centred unit cell exists in three systems, i.e. cubic, orthorhombic and tetragonal.

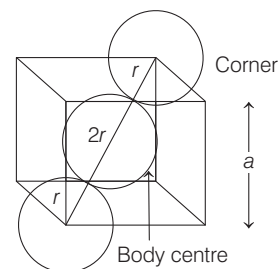
- 07** An element has a body centered cubic (bcc) structure with a cell edge of 288 pm. The atomic radius is
[NEET (Sep.) 2020]

- (a) $\frac{\sqrt{2}}{4} \times 288$ pm (b) $\frac{4}{\sqrt{3}} \times 288$ pm
(c) $\frac{4}{\sqrt{2}} \times 288$ pm (d) $\frac{\sqrt{3}}{4} \times 288$ pm

Ans. (d)

In bcc crystal,

$$\therefore 4r = \sqrt{3}a; r = \frac{\sqrt{3}a}{4} = \frac{\sqrt{3} \times 288}{4} \text{ pm}$$



where, r = radius of atoms,
 a = edge length of the unit cell.

- 08** A compound is formed by cation C and anion A. The anions form hexagonal close packed (hcp) lattice and the cations occupy 75% of octahedral voids. The formula of the compound is

[NEET (National) 2019]

- (a) C_3A_2 (b) C_3A_4 (c) C_4A_3 (d) C_2A_3

Ans. (b)

Anions (A) form hexagonal close packed (hcp) lattice, so
 Number of anions (A) = 6
 Number of octahedral voids = Number of atoms in the close packed structure = 6.
 Cations (C) occupy 75% of octahedral voids, so number of cations (C) = $6 \times \frac{75}{100}$

$$= 6 \times 3/4 = 9/2$$

\therefore The formula of compound = $C_{9/2}A_6$
 $= C_9A_{12} = C_3A_4$

Thus, option (b) is correct.

- 09** Iron exhibits bcc structure at room temperature. Above 900°C , it transforms to fcc structure. The ratio of density of iron at room temperature to that at 900°C (assuming molar mass and atomic radii of iron remains constant with temperature) is

[NEET 2018]

- (a) $\frac{3\sqrt{3}}{4\sqrt{2}}$ (b) $\frac{4\sqrt{3}}{3\sqrt{2}}$ (c) $\frac{\sqrt{3}}{\sqrt{2}}$ (d) $\frac{1}{2}$

Ans. (a)

$$\text{Density of unit cell } d = \frac{Z \times M}{N_A \times a^3}$$

where, Z = Number of atoms per unit cell
 M = Molar mass

a^3 = Volume of unit cell [a = edge length]

N_A = Avogadro's number = 6.022×10^{23}

For bcc, $Z = 2$, radius (r) = $\frac{\sqrt{3}a}{4}$

$$a = \frac{4r}{\sqrt{3}}$$

For fcc, $Z = 4$, $r = \frac{a}{2\sqrt{2}} \Rightarrow a = 2\sqrt{2}r$

According to question

$$\frac{d_{\text{room temp.}}}{d_{900^\circ\text{C}}} = \frac{\left(\frac{ZM}{N_A a^3}\right)_{\text{bcc}}}{\left(\frac{ZM}{N_A a^3}\right)_{\text{fcc}}}$$

On substituting the given values, we get

$$\frac{d_{\text{room temp.}}}{d_{900^\circ\text{C}}} = \frac{2 \times M}{N_A \times \left(\frac{4r}{\sqrt{3}}\right)^3} \bigg/ \frac{4 \times M}{N_A \times (2\sqrt{2}r)^3}$$

[\because Given, M and r of iron remains constant with temperature]

$$= \frac{2 \times 3\sqrt{3}}{64r^3} \times \frac{16\sqrt{2}r^3}{4}$$

$$\frac{d_{\text{bcc}}}{d_{\text{fcc}}} = \frac{3}{4} \sqrt{\frac{3}{2}}$$

- 10** The ionic radii of A^+ and B^- ions are 0.98×10^{-10} m and 1.81×10^{-10} m.

The coordination number of each ion in AB is

[NEET 2016, Phase I]

- (a) 4 (b) 8
 (c) 2 (d) 6

Ans. (d)

Given, ionic radius of cation (A^+) = 0.98×10^{-10} m

Ionic radius of anion (B^-) = 1.81×10^{-10} m

\therefore Coordination number of each ion in AB = ?

Now, we have

$$\begin{aligned} \text{Radius ratio} &= \frac{\text{Radius of cation}}{\text{Radius of anion}} \\ &= \frac{0.98 \times 10^{-10} \text{ m}}{1.81 \times 10^{-10} \text{ m}} \\ &= 0.541 \end{aligned}$$

If radius ratio range is in between 0.441 – 0.732, ion would have octahedral structure with coordination number 'six'.

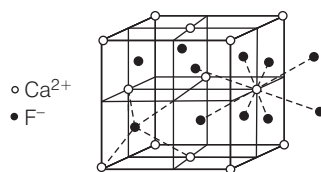
- 11** In calcium fluoride, having the fluorite structure, the coordination numbers for calcium ion (Ca^{2+}) and fluoride ion (F^-) are

[NEET 2016, Phase II]

- (a) 4 and 2 (b) 6 and 6
 (c) 8 and 4 (d) 4 and 8

Ans. (c)

In CaF_2 (Fluorite structure), Ca^{2+} ions are arranged in ccp arrangement (Ca^{2+} ions are present at all corners and at the centre of each face of the cube) while F^- ions occupy all the tetrahedral sites.



From the above figure, you can clearly see that coordination number of F^- is 4 while that of Ca^{2+} is 8.

- 12** The vacant space in bcc lattice cell is

[CBSE AIPMT 2015]

- (a) 26% (b) 48%
 (c) 23% (d) 32%

Ans. (d)

\therefore Packing efficiency in bcc lattice = 68%.

\therefore Vacant space in bcc lattice = $100 - 68 = 32\%$

- 13** A given metal crystallises out with a cubic structure having edge length of 361 pm. If there are four metal atoms in one unit cell, what is the radius of one atom?

[CBSE AIPMT 2015]

- (a) 40 pm (b) 127 pm
 (c) 80 pm (d) 108 pm

Ans. (b)

Given, edge length = 361 pm

Four metal atoms in one unit cell

i.e. effective number in unit cell (z) = 4 (given)

\therefore It is a FCC structure

\therefore Face diagonal = $4r$

$$\begin{aligned} \sqrt{2}a &= 4r \\ r &= \frac{\sqrt{2} \times 361}{4} \\ &= 127 \text{ pm} \end{aligned}$$

- 14** Lithium metal crystallises in a body centred cubic (bcc) crystal. If the length of the side of the unit cell of lithium is 351 pm, the atomic radius of the lithium will be

[CBSE AIPMT 2009]

- (a) 240.8 pm (b) 151.8 pm
 (c) 75.5 pm (d) 300.5 pm

Ans. (b)

In case of body centred cubic (bcc) crystal,

$$a\sqrt{3} = 4r$$

Given, edge length, $a = 351$ pm

Hence, atomic radius of lithium,

$$\begin{aligned} r &= \frac{a\sqrt{3}}{4} = \frac{351 \times 1.732}{4} \\ &= 151.98 \text{ pm} \end{aligned}$$

- 15** Copper crystallises in a face centred cubic (fcc) lattice with a unit cell length of 361 pm. What is the radius of copper atom in pm?

[CBSE AIPMT 2009]

- (a) 128 pm (b) 157 pm
 (c) 181 pm (d) 108 pm

Ans. (a)

In case of face centred cubic (fcc) lattice,

$$\text{radius} = \frac{\sqrt{2}a}{4}$$

∴ Radius of copper atom (fcc lattice)

$$= \frac{\sqrt{2} \times 361}{4} = 128 \text{ pm}$$

16 Percentage of free space in body centred cubic (bcc) unit cell is
[CBSE AIPMT 2008]

(a) 30% (b) 32% (c) 34% (d) 28%

Ans. (b)

In bcc unit cell, the number of atoms = 2

Thus, volume of atoms in unit cell

$$(V) = 2 \times \frac{4}{3} \pi r^3$$

For bcc structure $(r) = \frac{\sqrt{3}}{4} a$

$$(V) = 2 \times \frac{4}{3} \pi \left(\frac{\sqrt{3}}{4} a \right)^3 = \frac{\sqrt{3}}{8} \pi a^3$$

Volume of unit cell $(V) = a^3$

Percentage of volume occupied by unit cell

$$\begin{aligned} &= \frac{\text{Volume of the atoms in unit cell}}{\text{Volume of unit cell}} \\ &= \frac{\frac{\sqrt{3}}{8} \pi a^3}{a^3} \times 100 = \frac{\sqrt{3}}{8} \pi \times 100 = 68\% \end{aligned}$$

Hence, the free space in bcc unit cell = 100 - 68 = 32%

17 If 'a' stands for the edge length of the cubic systems : simple cubic, body centred cubic and face centred cubic, then the ratio of radii of the spheres in these systems will be respectively,
[CBSE AIPMT 2008]

(a) $\frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a$

(b) $\frac{1}{2}a : \sqrt{3}a : \frac{1}{\sqrt{2}}a$

(c) $\frac{1}{2}a : \frac{\sqrt{3}}{2}a : \frac{\sqrt{2}}{2}a$

(d) $1a : \sqrt{3}a : \sqrt{2}a$

Ans. (a)

If a = edge length of cubic systems

For simple cubic structure, radius = $\frac{a}{2}$

For body centred cubic structure, radius

$$= \frac{\sqrt{3}}{4} a$$

For face centred cubic structure, radius

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

Hence, the ratio of radii

$$= \frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a$$

18 Which one of the following statements is incorrect?
[CBSE AIPMT 2008]

- (a) The fraction of the total volume occupied by the atoms in a primitive cell is 0.48
(b) Molecular solids are generally volatile
(c) The number of carbon atoms in an unit cell of diamond is 4
(d) The number of Bravais lattices in which a crystal can be categorised is 14

Ans. (a)

Volume of atoms in a unit cell $(V) = \frac{4}{3} \pi r^3$

For primitive cell, $r = \frac{a}{2}$

$$V = \frac{4}{3} \pi \left(\frac{a}{2} \right)^3 = \frac{\pi a^3}{6}$$

Volume of the unit cell $(V) = a^3$

Thus, total volume occupied by the atoms

$$\begin{aligned} &= \frac{\text{Volume of the atoms in unit cell}}{\text{Volume of unit cell}} \\ &= \frac{\pi a^3}{6} \times \frac{1}{a^3} = \frac{\pi}{6} = 0.52 = 100 - 0.52 = 0.48 \end{aligned}$$

19 The fraction of total volume occupied by the atoms present in a simple cube is [CBSE AIPMT 2007]

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{3\sqrt{2}}$

(c) $\frac{\pi}{4\sqrt{2}}$ (d) $\frac{\pi}{4}$

Ans. (a)

For simple cube,

Radius $(r) = \frac{a}{2}$ [a = edge length]

Volume of the atom = $\frac{4}{3} \pi \left(\frac{a}{2} \right)^3$

∴ Packing fraction = $\frac{\frac{4}{3} \pi \left(\frac{a}{2} \right)^3}{a^3} = \frac{\pi}{6}$

20 In a face centred cubic (fcc) lattice, a unit cell is shared equally by how many unit cells? [CBSE AIPMT 2005]

- (a) 8 (b) 4
(c) 2 (d) 6

Ans. (d)

In a face centred cubic (fcc) lattice, a unit cell is shared equally by six unit cells.

21 A compound formed by elements X and Y crystallises in a cubic structure in which the X-atoms are at the corners of a cube and the Y-atoms are at the face centres. The formula of the compound is

[CBSE AIPMT 2004]

- (a) XY_3 (b) X_3Y
(c) XY (d) XY_2

Ans. (a)

In unit cell, X-atoms at the corners

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

Y-atoms at the face centres = $\frac{1}{2} \times 6 = 3$

Ratio of X and Y = 1:3.

Hence, formula is XY_3 .

22 Zn converts from its melted state to its solid state, it has hcp structure, then find out the number of nearest atoms.

[CBSE AIPMT 2001]

- (a) 6 (b) 8
(c) 12 (d) 4

Ans. (c)

HCP is a closed packed arrangement, in which the unit cell is hexagonal and coordination number is 12.

23 A compound formed by elements A and B crystallises in the cubic structure, where A atoms are present at the corners of a cube and B atoms are present at the face centres. The formula of the compound is [CBSE AIPMT 2000]

- (a) A_2B_2 (b) AB_3
(c) AB (d) A_3B

Ans. (b)

A-atoms are present at the corners of a cube. So, the number of A-atoms per unit cell = $8 \times \frac{1}{8} = 1$

Similarly, B-atoms are present at face centres of a cube.

So, the number of B-atoms per unit cell

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

Hence, the formula of compound is AB_3 .

- 24** The edge length of face centred unit cubic cell is 508 pm. If the radius of the cation is 110 pm, the radius of the anion is

[CBSE AIPMT 1998]

- (a) 288 pm (b) 398 pm
(c) 144 pm (d) 618 pm

Ans. (c)

Edge length $(a) = 2r^+ + 2r^-$

$$a = 2(r^+ + r^-)$$

$$a = 508 \text{ pm}$$

$$r^+ = 110 \text{ pm}$$

$$\frac{508}{2} = r^+ + r^-$$

$$254 = 110 + r^-$$

$$r^- = 254 - 110 = 144 \text{ pm}$$

- 25** The intermetallic compound LiAg crystallises in cubic lattice in which both lithium and silver have coordination number of eight. The crystal class is [CBSE AIPMT 1997]

- (a) simple cube
(b) body centred cube
(c) face centred cube
(d) None of the above

Ans. (b)

In body centered cubic, each atom/ion has a coordination number of 8.

- 26** The edge length of a centred unit cubic cell is 508 pm. If the radius of the cation is 100 pm, the radius of the anion is [CBSE AIPMT 1996]

- (a) 288 pm (b) 398 pm
(c) 154 pm (d) 618 pm

Ans. (c)

For centred unit cell,

$$2(r^+ + r^-) = a$$

$$r^+ = \text{radii of cation}$$

$$r^- = \text{radii of anion}$$

$$2(100 + r^-) = 508$$

$$100 + r^- = \frac{508}{2}$$

$$r^- = \frac{508}{2} - 100$$

$$= 254 - 100$$

$$= 154 \text{ pm}$$

- 27** In the fluorite structure, the coordination number of Ca^{2+} ion is [CBSE AIPMT 1993]

- (a) 4 (b) 6
(c) 8 (d) 3

Ans. (c)

In fluorite structure each Ca^{2+} ion is surrounded by eight F^- ions. Thus, the coordination number of Ca^{2+} is eight.

- 28** The number of atoms contained in a fcc unit cell of a monoatomic substance is [CBSE AIPMT 1993]

- (a) 1 (b) 2
(c) 4 (d) 6

Ans. (c)

Face centred cubic is also called **cubic close packed arrangement**. It has points at all the corners as well as at the centre of each of the six faces.

The number of atoms present at corners

$$\text{per unit cell} = 8 \times \frac{1}{8} = 1.$$

The number of atoms present at faces

$$\text{per unit cell} = 6 \times \frac{1}{2} = 3$$

\therefore Total number of atoms in ccp or

$$\text{fcc arrangement} = 1 + 3 = 4$$

TOPIC 3

Density and Imperfection in Solid

- 29** Which one of the following compounds show both, Frenkel as well as Schottky defects? [NEET (Oct.) 2020]

- (a) AgBr (b) AgI
(c) NaCl (d) ZnS

Ans. (a)

Frenkel defect is shown by ionic substances in which there is a large difference in size of ions.

e.g., AgBr, AgI, ZnS

Schottky defect is shown by ionic substances in which the cation and anion are of almost similar sizes.

e.g. : AgBr, NaCl, KCl, CsCl

So, AgBr shows both, Frenkel as well as Schottky defects.

- 30** Formula of nickel oxide with metal deficiency defect in its crystal is $\text{Ni}_{0.98}\text{O}$. The crystal contains Ni^{2+} and Ni^{3+} ions. The fraction of nickel existing as Ni^{2+} ions in the crystal is [NEET (Odisha) 2019]

- (a) 0.96 (b) 0.04
(c) 0.50 (d) 0.31

Ans. (a)

Let, in the given crystal $\text{Ni}_{0.98}\text{O}$
 $\text{Ni}^{2+} = x$ and $\text{Ni}^{3+} = 0.98 - x$

$$\begin{aligned} \text{Total charge on } M^{2+} \text{ and } M^{3+} \\ &= (+2)x + (+3)(0.98 - x) \\ &= 2x + 2.94 - 3x = 2.94 - x \end{aligned}$$

As metal oxide is neutral. Therefore,

total charge on cations = total charge on anions.

$$2.94 - x = 2$$

[\therefore Charge of oxygen atom = -2]

$$x = 2.94 - 2 = 0.94$$

So, the fraction of Ni^{2+} ions in the crystal

$$= \frac{0.94}{0.98} = 0.96$$

- 31** Which is the incorrect statement? [NEET 2017]

- (a) $\text{FeO}_{0.98}$ has non-stoichiometric metal deficiency defect
(b) Density decreases in case of crystals with Schottky's defect
(c) NaCl(s) is insulator, silicon is semiconductor, silver is conductor, quartz is piezoelectric crystal
(d) Frenkel defect is favoured in those ionic compounds in which sizes of cation and anions are almost equal

Ans. (a,d)

- (a) $\text{FeO}_{0.98}$ has non-stoichiometric metal excess defect. It occurs due to missing of a negative ion from its lattice site, thus leaving a hole which is occupied by an electron.

Non-stoichiometric ferrous oxide is $\text{FeO}_{0.93-0.96}$ and it is due to metal deficiency defect. Thus, statement (a) is incorrect.

- (b) In an ionic crystal of A^+B^- type, if equal number of cations and anions are missing from their lattice sites, the defect is called Schottky defect. Due to such defect, density of solid decreases. Thus, statement (b) is correct.

- (c) NaCl-insulator; Silicon (Si) - semiconductor, Silver (Ag) - conductor; Quartz - piezoelectric crystal.

Thus, statement (c) is correct.

- (d) In an ionic crystal when an ion is missing from its lattice site and occupies interstitial site, the defect is called Frenkel' defect. This type of defect is seen in those crystals where the difference in the size of cations and anions is very large and their coordination number is low. Thus, statement (d) is incorrect.

- 32** Lithium has a bcc structure. Its density is 530 kg m^{-3} and its atomic mass is 6.94 g mol^{-1} . Calculate the edge length of a unit cell of lithium metal. ($N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$)

[NEET 2016, Phase I]

- (a) 352 pm (b) 527 pm
(c) 264 pm (d) 154 pm

Ans. (a)

Given, Li has a bcc structure.

Density (ρ) = 530 kg m^{-3}

Atomic mass (M) = 6.94 g mol^{-1}

Avogadro's number (N_A)
= $6.02 \times 10^{23} \text{ mol}^{-1}$

We know that, number of atoms per unit cell in bcc (Z) = 2.

\therefore We have the formula for density,

$$\rho = \frac{ZM}{N_A a^3}$$

where a = edge-length of a unit cell.

$$\begin{aligned} \text{or } a &= \sqrt[3]{\frac{ZM}{\rho N_A}} \\ &= \sqrt[3]{\frac{2 \times 6.94 \text{ g mol}^{-1}}{0.53 \text{ g cm}^{-3} \times 6.02 \times 10^{23} \text{ mol}^{-1}}} \\ &= \sqrt[3]{4.35 \times 10^{-23} \text{ cm}^3} \\ &= 3.52 \times 10^{-8} \text{ cm} \\ a &= 352 \text{ pm} \end{aligned}$$

- 33** The correct statement regarding defects in the crystalline solid is [CBSE AIPMT 2015]

- (a) Schottky defects have no effect on the density of crystalline solids
(b) Frenkel defects decreases the density of crystalline solids
(c) Frenkel defect is a dislocation defect
(d) Frenkel defect is found in halides of alkaline metals

Ans. (c)

In Frenkel defect, ions in solids dislocate from their positions. Hence, Frenkel defect is a dislocation defect.

- 34** If NaCl is doped with 10^{-4} mol % of SrCl_2 , the concentration of cation vacancies will be ($N_A = 6.023 \times 10^{23} \text{ mol}^{-1}$)

[CBSE AIPMT 2007]

- (a) $6.023 \times 10^{15} \text{ mol}^{-1}$
(b) $6.023 \times 10^{16} \text{ mol}^{-1}$
(c) $6.023 \times 10^{17} \text{ mol}^{-1}$
(d) $6.023 \times 10^{14} \text{ mol}^{-1}$

Ans. (c)

Doping of NaCl with 10^{-4} mol% of SrCl_2 means, 100 moles of NaCl are doped with 10^{-4} mol of SrCl_2 .

\therefore 1 mol of NaCl is doped with

$$\text{SrCl}_2 = \frac{10^{-4}}{100} = 10^{-6} \text{ mole}$$

As each Sr^{2+} ion introduces one cation vacancy.

\therefore Concentration of cation vacancies

$$\begin{aligned} &= 10^{-6} \text{ mol/mol of NaCl} \\ &= 10^{-6} \times 6.023 \times 10^{23} \text{ mol}^{-1} \\ &= 6.023 \times 10^{17} \text{ mol}^{-1} \end{aligned}$$

- 35** The appearance of colour in solid alkali metal halides is generally due to [CBSE AIPMT 2006]

- (a) F-centres
(b) Schottky defect
(c) Frenkel defect
(d) Interstitial positions

Ans. (a)

F-centres are the sites where anions are missing and instead electrons are present and the appearance of colour in solid alkali metal halides is generally due to F-centres.

- 36** CsBr crystallises in a body centred cubic lattice. The unit cell length is 436.6 pm. Given that the atomic mass of Cs = 133 u and that of Br = 80 u and Avogadro number being $6.023 \times 10^{23} \text{ mol}^{-1}$, the density of CsBr is [CBSE AIPMT 2006]

- (a) 42.5 g/cm^3
(b) 0.425 g/cm^3
(c) 8.25 g/cm^3
(d) 4.25 g/cm^3

Ans. (d)

$$\text{Density of CsBr} = \frac{Z \times M}{a^3 \times N_0}$$

$Z \rightarrow$ number of atoms in the bcc unit cell = 2

$M \rightarrow$ molar mass of CsBr = $133 + 80 = 213$

$a \rightarrow$ edge length of unit cell = 436.6 pm
= $436.6 \times 10^{-10} \text{ cm}$

$$\begin{aligned} \therefore \text{Density} &= \frac{2 \times 213}{(436.6 \times 10^{-10})^3 \times 6.023 \times 10^{23}} \\ &= 8.49 \times 10^{-7} \times 10^7 \text{ g/cm}^3 \\ &= 8.50 \text{ g/cm}^3 \end{aligned}$$

$$\begin{aligned} \text{For a unit cell} &= \frac{8.50}{2} \\ &= 4.25 \text{ g/cm}^3 \end{aligned}$$

- 37** The pycnometric density of sodium chloride crystal is 2.165 $\times 10^3 \text{ kg m}^{-3}$ while its X-ray density is $2.178 \times 10^3 \text{ kg m}^{-3}$. The fraction of unoccupied sites in sodium chloride crystal is [CBSE AIPMT 2003]

- (a) 5.96×10^{-1}
(b) 5.96×10^{-3}
(c) 5.96
(d) 5.96×10^{-2}

Ans. (b)

The fraction of unoccupied site in sodium chloride crystal

$$\begin{aligned} &= \frac{\text{X-ray density} - \text{pycnometric density}}{\text{X-ray density}} \\ &= \frac{2.178 \times 10^3 - 2.165 \times 10^3}{2.178 \times 10^3} \\ &= \frac{0.013 \times 10^3}{2.178 \times 10^3} \\ &= \frac{13}{2178} \\ &= 5.96 \times 10^{-3}. \end{aligned}$$

- 38** The second order Bragg diffraction of X-rays with $\lambda = 1.0 \text{ \AA}$ from a set of parallel planes in a metal occurs at an angle 60° . The distance between the scattering planes in the crystals is [CBSE AIPMT 1998]

- (a) 0.575 \AA (b) 1.00 \AA
(c) 2.00 \AA (d) 1.17 \AA

Ans. (d)

According to Bragg's equation,

$$n\lambda = 2d \sin\theta$$

$$n = 2$$

$$\lambda = 1$$

deflected angle $\theta = 60^\circ$

$$d = ?$$

Distance between two plane of crystal.

$$2 \times 1 = 2 \times d \times \sin 60^\circ$$

$$2 \times 1 = 2 \times d \times \frac{\sqrt{3}}{2}$$

$$d = \frac{2}{\sqrt{3}}$$

$$= \frac{2}{1.7} = 1.17 \text{ \AA}$$

- 39** Schottky defect in a crystal is observed when [CBSE AIPMT 1998]

- (a) an ion leaves its normal site and occupies an interstitial site
(b) unequal number of cations and anions are missing from the lattice

- (c) density of the crystal is increased
- (d) equal number of cations and anions are missing from the lattice

Ans. (d)

Schottky defect in crystals is observed when equal number of cations and anions are missing from the lattice. So, the crystal remains neutral, e.g. NaCl.

- 40** When electrons are trapped into the crystalline anion vacancy, the defect is known as

[CBSE AIPMT 1994]

- (a) Schottky defect
- (b) Stoichiometric defect
- (c) Frenkel defect
- (d) F-centres

Ans. (d)

When the electrons are trapped in anion vacancy, then the defect is called F-centres. This defect is observed in LiCl, NaCl, KCl, etc.

TOPIC 4

Electrical and Magnetic Properties of Solids

- 41** With which one of the following elements silicon should be doped so as to give *p*-type of semiconductor?

[CBSE AIPMT 2008]

- (a) Germanium
- (b) Arsenic
- (c) Selenium
- (d) Boron

Ans. (d)

p-type of semiconductor are obtained by doping silicon or germanium with elements of group 13 like B, Al, Ga or In so silicon is doped with boron.

- 42** A solid with high electrical and thermal conductivity from the following is

[CBSE AIPMT 1994]

- (a) Si
- (b) Li
- (c) NaCl
- (d) ice

Ans. (b)

In lithium crystal free electrons are present so, Li have high thermal and electrical conductivity.

- 43** On doping Ge metal with a little of In or Ga, one gets

[CBSE AIPMT 1993]

- (a) *p*-type semiconductor
- (b) insulator
- (c) *n*-type semiconductor
- (d) rectifier

Ans. (a)

When we add some of In or Ga (group 13 element) into Ge (group number 14 element), then electron vacancy is created which is called **holes**. In this type of semiconductor the charge carrier are holes (positive), so it is called ***p*-type semiconductor**.