

CHEMISTRY STUDY MATERIALS FOR CLASS 12 (NCERT BASED QUESTIONS WITH ANSWERS)

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The Solid State (Intext Questions)

Question 1.13: Explain how much portion of an atom located at (i) corner and (ii) body-centre of a cubic unit cell is part of its neighbouring unit cell.

Answer:- (i) An atom located at the corner of a cubic unit cell is shared by eight adjacent unit cells. Therefore, $\frac{1}{8}$ th portion of the atom is shared by one unit cell.

(ii) An atom located at the body centre of a cubic unit cell is not shared by its neighbouring unit cell. Therefore, the atom belongs only to the unit cell in which it is present i.e., its contribution to the unit cell is 1.

Question 1.14: What is the two dimensional coordination number of a molecule in square close packed layer?

Answer:- In square close-packed layer, a molecule is in contact with four of its neighbours. Therefore, the two-dimensional coordination number of a molecule in square close packed layer is 4.

Question 1.15: A compound forms *hexagonal close-packed* structure. What is the total number of voids in 0.5 mol of it? How many of these are tetrahedral voids?

Answer:- Number of close-packed particles = $0.5 \times 6.022 \times 10^{23} = 3.011 \times 10^{23}$

Therefore, number of octahedral voids = 3.011×10^{23}

And, number of tetrahedral voids = $2 \times 3.011 \times 10^{23} = 6.022 \times 10^{23}$

Therefore, total number of voids = $3.011 \times 10^{23} + 6.022 \times 10^{23} = 9.033 \times 10^{23}$

Question 1.16: A compound is formed by two elements M and N. The element N forms *ccp* and atoms of M occupy $\frac{1}{3}$ rd of tetrahedral voids. What is the formula of the compound?

Answer:- The *ccp* lattice is formed by the atoms of the element N.

Here, the number of tetrahedral voids generated is equal to twice the number of

atoms of the element N.

According to the question, the atoms of element M occupy $2 \times \frac{1}{3} = \frac{2}{3}$ of the tetrahedral voids.

Therefore, the number of atoms of M is equal to of the number of atoms of N.

Therefore, ratio of the number of atoms of M to that of N is M: N = $\frac{2}{3}:1$

= 2:3 Thus, the formula of the compound is M₂ N₃.

Question 1.17: Which of the following lattices has the highest packing efficiency

(i) Simple cubic

(ii) Body-centred cubic and

(iii) Hexagonal close-packed lattice?

Answer:- Hexagonal close-packed lattice has the highest packing efficiency of 74%.

The packing efficiencies of simple cubic and body-centred cubic lattices are 52.4% and 68% respectively.

Question 1.18: An element with molar mass $2.7 \times 10^{-2} \text{ kg mol}^{-1}$ forms a cubic unit cell with edge length 405 pm. If its density is $2.7 \times 10^3 \text{ kg m}^{-3}$, What is the nature of the cubic unit cell?

Answer:- It is given that density of the element, $d = 2.7 \times 10^3 \text{ kg m}^{-3}$

Molar mass, $M = 2.7 \times 10^{-2} \text{ kg mol}^{-1}$

Edge length, $a = 405 \text{ pm} = 405 \times 10^{-12} \text{ m} = 4.05 \times 10^{-10} \text{ m}$

It is known that, Avogadro's number, $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$

Applying the relation,

$$\begin{aligned}d &= \frac{z \cdot M}{a^3 \cdot N_A} \\z &= \frac{d \cdot a^3 \cdot N_A}{M} \\&= \frac{2.7 \times 10^3 \text{ kg m}^{-3} \times (4.05 \times 10^{-10} \text{ m})^3 \times 6.022 \times 10^{23} \text{ mol}^{-1}}{2.7 \times 10^{-2} \text{ kg mol}^{-1}} \\&= 4.004 \\&= 4\end{aligned}$$

This implies that four atoms of the element are present per unit cell.

Hence, the unit cell is face-centred cubic (*fcc*) or cubic close-packed (*ccp*).

Question 1.19: What type of defect can arise when a solid is heated?

Which physical property is affected by it and in what way?

Answer:- When a solid is heated, vacancy defect can arise. A solid crystal is said to have vacancy defect when some of the lattice sites are vacant.

Vacancy defect leads to a decrease in the density of the solid.

Question 1.20: What type of stoichiometric defect is shown by:(i) ZnS (ii) AgBr

Answer:- (i) ZnS shows Frenkel defect.

(ii) AgBr shows Frenkel defect as well as Schottky defect.

Question 1.21: Explain how vacancies are introduced in an ionic solid when a cation of higher valence is added as an impurity in it.

Answer:- When a cation of higher valence is added to an ionic solid as an impurity to it, the cation of higher valence replaces more than one cation of lower valence so as to keep the crystal electrically neutral. As a result, some sites become vacant. For example, when Sr^{2+} is added to NaCl, each Sr^{2+} ion replaces two Na^+ ions. However, one Sr^{2+} ion occupies the site of one Na^+ ion and the other site remains vacant. Hence, vacancies are introduced.

Question 1.22: Ionic solids, which have anionic vacancies due to metal excess defect, develop colour. Explain with the help of a suitable example.

Answer:-The colour develops because of the presence of electrons in the anionic sites. These electrons absorb energy from the visible part of radiation and get excited. For example, when crystals of NaCl are heated in an atmosphere of sodium vapours, the sodium atoms get deposited on the surface of the crystal and the chloride ions from the crystal diffuse to the surface to form NaCl with the deposited Na atoms. During this process, the Na atoms on the surface lose electrons to form Na^+ ions and the released electrons diffuse into the crystal to occupy the vacant anionic sites. These electrons get excited by absorbing energy from the visible light and impart yellow colour to the crystals.

Question 1.23: A group 14 element is to be converted into n-type semiconductor by doping it with a suitable impurity. To which group should this impurity belong?

Answer:- An *n*-type semiconductor conducts because of the presence of extra electrons. Therefore, a group 14 element can be converted to *n*-type semiconductor by doping it with a group 15 element.

Question 1.24: What type of substances would make better permanent magnets, ferromagnetic or ferrimagnetic? Justify your answer.

Answer:- Ferromagnetic substances would make better permanent magnets.

In solid state, the metal ions of ferromagnetic substances are grouped together into small regions. These regions are called domains and each domain acts as a tiny magnet. In an unmagnetised piece of a ferromagnetic substance, the domains are randomly oriented. As a result, the magnetic moments of the domains get cancelled. However, when the substance is placed in a magnetic field, all the domains get oriented in the direction of the magnetic field and a strong magnetic effect is produced.

The ordering of the domains persists even after the removal of the magnetic field. Thus, the ferromagnetic substance becomes a permanent magnet.
