

Class 12 Chemistry Chapter 1 - Solid State Important Questions with Answers

Short Answer Type Questions

1. Why are solids rigid?

Ans: Solids are rigid because the constituent particles are very closely packed. They do not have any translatory movement and can only oscillate about the mean position.

2. Why are solids incompressible?

Ans: Solids are incompressible because the constituent particles (atoms, ions or molecules) are very closely packed in spaces and interparticle spaces are very small. If we try to compress, the repulsive interactions will dominate in the electron clouds of the constituent particles.

3. In spite of the long range order in the arrangement of particles why are the crystals usually not perfect?

Ans: Crystals have long range order which means that the constituent particles have a regular orderly arrangement throughout. However, the crystals usually suffer from certain defects which are of different types and generally arise during the process of crystallisation. That is why, these are not perfect.

4. Why does table salt, NaCl, some times appear yellow in color?

Ans: Yellow colour of sodium chloride is due to metal excess defect as a result which electrons occupy anionic sites. These sites are known as F-centres. The electrons absorb radiation from the visible light and get excited. These excited electrons emit radiations corresponding to yellow colour.

5. Why is FeO (s) not formed in stoichiometric composition?

Ans: The FeO is not formed in stoichiometric compositions. It is found in non stoichiometric composition of $\text{Fe}_{0.95}\text{O}$. Because in the crystal lattice of ferrous oxide (FeO), some Fe^{2+} ions are missing and the loss of positive charge is made up by some Fe^{3+} ions. Since lesser number of Fe^{3+} ions are needed to maintain the electrical neutrality of the lattice.

6. Frenkel defect is not found in the halides of alkali metals. Assign reason.

Ans: Frenkel defect arises when certain ions (particularly cations) leave their normal sites and occupy positions in the interstitial space. The ions of the alkali metal halides are of large size and cannot be

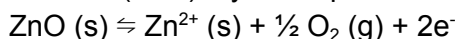
easily accommodated in the interstitial spaces. Therefore, the halides of alkali metals do not normally show Frenkel defect.

7. Why does the electrical conductivity of semiconductors increase with rise in temperature?

Ans: This is explained with the help of band theory. In semiconductor, the energy gaps between valence band and conduction bands are small. With rise in temperature, the kinetic energy of the electron increases. This means that more electrons can move from valence bands to conduction bands. So the electrical conductivity increases with rise in temperature.

8. Why does zinc oxide which is white in colour become yellow upon heating?

Ans: Zinc oxide (ZnO) crystals upon heating decompose as follows:



The excess of Zn^{2+} ions formed are trapped in the interstitial spaces and the electrons are also trapped in the neighborhood. These electrons absorb radiation corresponding to a certain specific colour from the light and emit yellow colour.

9. In a compound, nitrogen atoms (N) make cubic close-packed lattices and metal atoms (M) occupy one-third of the tetrahedral voids present. Determine the formula of the compound formed by M and N?

Ans: Number of N-atoms in ccp structure = 4. So, the number of tetrahedral voids in the ccp structure = 8. Now, $\frac{1}{3}$ rd of the tetrahedral voids are occupied by M-atoms. Hence, the number of M-atoms in the close-packed structure = $\frac{8}{3}$. Therefore, the ratio of M and N-atoms per unit cell of the crystal = $\frac{8}{3} : 4 = 2 : 3$. Hence the formula of the compound is M_2N_3 .

10. Under which situations can an amorphous substance change to crystalline form?

Ans: This can be achieved by slow heating followed by cooling over a long period. If an amorphous solid is maintained at a temperature just below its melting point for long periods of time, the component molecules, atoms, or ions can gradually rearrange into a more highly ordered crystalline form.

Matching Type Questions

Note: In the following questions match the items given in Column I with the items given in Column II. In some questions more than one item of Column I and Column II may match.

1. Match the defects given in Column I with the statements in Column II.

Column I	Column II
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(a) Simple vacancy defect	(i) shown by non-ionic solids and increases density of the solid.
(b) Simple interstitial defect	(ii) shown by ionic solids and decreases density of the solid.
(c) Frenkel defect	(iii) shown by non ionic solids and density of the solid decreases
(d) Schottky defect	(iv) shown by ionic solids and the density of the solid remains the same.

Solution: (a) - (iii); (b) - (i); (c) - (iv); (d) - (ii)

2. Match the type of unit cell given in Column I with the features given in Column II.

Column I	Column II
(a) Primitive cubic unit cell	(i) Each of the three perpendicular edges compulsorily have a different edge length i.e; $a \neq b \neq c$.
(b) Body centered cubic unit cell	(ii) Number of atoms per unit cell is one.
(c) Face centered cubic unit cell	(iii) Each of the three perpendicular edges compulsorily have the same edge length i.e; $a = b = c$
(d) End centered orthorhombic unit cell	(iv) The number of atoms present in a unit cell is two.
	(v) The number of atoms present in a unit cell is four.

Solution: (a)- (ii),(iii); (b)- (iii),(iv); (c)- (iii),(v); (d)- (i)

3. Match the types of defect given in Column I with the statement given in Column II

Column I	Column II
(a) Impurity defect	(i) NaCl with anionic sites called F-centers
(b) Metal excess defect	(ii) FeO with Fe^{3+}
(c) Metal deficiency defect	(iii) NaCl with Sr^{2+} and some cationic sites vacant

Solution: (a)- (iii); (b)- (i); (c)- (ii)

4. Match the items given in Column I with the items given in Column II.

Column I	Column II
(a) Mg in solid state	(i) p-Type semiconductor
(b) MgCl_2 in molten state	(ii) n-Type semiconductor
(c) Silicon with phosphorus	(iii) Electrolytic conductors
(d) Germanium with boron	(iv) Electronic conductors

Solution: (a)- (iv); (b)- (iii); (c)- (ii); (d)- (i)

5. Match the type of packing given in Column I with the items given in Column II.

Column I	Column II
(a) Square close packing in two dimensions	(i) Triangular voids
(b) Hexagonal close packing in two dimensions	(ii) Pattern of spheres is repeated in every fourth layer
(c) Hexagonal close packing in three dimensions	(iii) Coordination number 4
(d) Cubic close packing in three dimensions	(iv) Pattern of sphere is repeated in alternate layers

Solution: (a)- (iii); (b)- (i); (c)- (iv); (d)- (ii)

Assertion and Reason Type Questions

Note: In the following questions a statement of assertion followed by a statement. of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is the correct explanation for assertion.

(b) Assertion and reason both are correct statements but reason is not the correct explanation for assertion.

(c) Assertion is a correct statement but reason is wrong.

(d) Assertion is a wrong statement but the reason is a correct statement.

1. Assertion: The total number of atoms present in a simple cubic unit cell is one.

Reason: Simple cubic unit cell has atoms at its corners, each of which is shared between eight adjacent unit cells.

Solution: (a)

Both are correct statements and reason is the correct explanation for the assertion.

2. Assertion: Graphite is a good conductor of electricity however diamond belongs to the category of insulators

Reason: Graphite is soft in nature on the other hand diamond is very hard and brittle

Solution: (b)

Both are correct statements but reason is not the correct explanation for the assertion.

3. Assertion: Total number of octahedral voids present in a unit cell of cubic close packing including the one that is present at the body center, is four.

Reason: Besides the body center there is one octahedral void present at the center of each of the six faces of the unit cell and each of which is shared between two unit cells.

Solution: (c)

Assertion is a correct statement but reason is wrong.

4. Assertion: The packing efficiency is maximum for the fcc structure.

Reason: The coordination number is 12 in fcc structures.

Solution: (b)

Both are correct statements but reason is not the correct explanation for the assertion.

5. Assertion: Semiconductors are solids with conductivities in the intermediate range from 10^{-6} - $10^4 \text{ ohm}^{-1} \text{ m}^{-1}$.

Reason: Intermediate conductivity in semiconductors is due to a partially filled valence band.

Solution: (c)

Assertion is a correct statement but reason is wrong.

Long Answer Type Questions

1. With the help of a labeled diagram show that there are four octahedral voids per unit cell in a cubic close packed structure.

Solution:

In the cubic close packing (ccp) or fcc (face centered cubic unit cell) lattice the constituents particles (atoms, molecules or ions) are located at the corner of the unit cell as well as the face centered.

In the face- centered cubic unit, cell octahedral voids are located at the body-center and all the edge centers of the cube.

A body centered point lies entirely within the unit cell and contributes one complete point to the cell = 1

A point along an edge is shared by four unit cells and only one fourth contributes to one unit cell.

Number of octahedral voids (one at body center and twelve at edge- centers) = $1 + (\frac{1}{4} \times 12) = 4$

Number of constituent particles present in fcc unit cell = $(8 \times \frac{1}{8} + 6 \times \frac{1}{2}) = 4$

Each octahedral void is surrounded by six constituent particles. Shortest distance between two octahedral voids = $a/\sqrt{2}$

2. Show that in a cubic close packed structure, eight tetrahedral voids are present per unit cell.

Solution:

In cubic close packing, there are eight tetrahedral voids in each unit cell.

Tetrahedral voids are located on body diagonals.

Two tetrahedral voids are located on each body diagonal.

Tetrahedral voids divide the body diagonal in a 1:2:1 ratio. these are represented in figure

Number of constituent units at packing sites (corners and face-centers)

= $(8 \times \frac{1}{8} + 6 \times \frac{1}{2}) = 4$

Number of tetrahedral voids = 8

Thus, the number of tetrahedral voids is twice the number of constituent units present at packing sites and twice the octahedral voids

Tetrahedral voids = 2 x Octahedral voids

3. Calculate the density of a cubic crystal from its structure.

Solution:

The edge of a cubic crystal calculated from X-ray studies and the type of crystal whether it is simple cubic or body-centered cubic or face-centered cubic. If the number of particles present in a unit cell is known, the density of the crystal can be calculated.

Let the edge length of the cubic unit cell be = a cm

Volume of the cubic unit cell = $a^3 \text{ cm}^3$

Density of the unit cell = (Mass of the unit cell / Volume of the unit cell)

Mass of the unit cell = Number of atoms in unit cell $\times$ Mass of each atom
= $Z \times \text{Mass of each atom}$

Let the atomic mass of an element be M .

Mass of one atom = Atomic mass number / Avogadro's number = M/N_A

Density of unit cell (ρ) = $\{Z \times (M/N_A)\} / a^3 = (Z \times M) / (a^3 \times N_A)$

4. A sample of ferrous oxide has the actual formula $\text{Fe}_{0.93}\text{O}_{1.00}$. In this sample what fractions of metal ions are Fe^{2+} ions? What type of non stoichiometric defect is present in this sample?

Solution:

The ratio of the Fe and O atoms in pure oxide (FeO) = 1: 1

Let x ions of Fe^{2+} be replaced by Fe^{3+} ions

The number of Fe^{2+} atoms present = $0.93 - x$

Since the oxide is neutral,

Total charge on iron atoms = charge on oxygen atom

$$2(0.93 - x) + 3x = 2$$

$$1.86 - 2x + 3x = 2$$

$$x = 2 - 1.86 = 0.14$$

Number of Fe^{3+} ions in the sample = 0.14

Number of Fe^{2+} ions in the sample = $0.93 - 0.14 = 0.79$

Fraction of Fe^{2+} ions in the sample = $0.79/0.93 = 0.85$

It is the metal deficiency defect due to cation vacancy. In this defect, certain cations are missing from the lattice sites and their positive charges are balanced by the presence of extra charges on the neighboring or adjacent cations.