CBSE Class 12 physics

Important Questions

Chapter 1

Solid State

3 Marks Questions

1. Differentiate between amorphous and crystalline solids with reference to

(1) Melting point

(2) Cleavage property

(3) Nature

Ans.

Property	Crystalline solids	Amorphous solids
1. Melting point	They have sharp melting point	They have a range of melting point.
2. Cleavage property	They split into pieces of plain and smooth surfaces when cut with a sharp edged tool.	When cut with a sharp edged tool, pieces of irregular surfaces are obtained.
3. Nature	They are true solids.	They are pseudo solids or super cooled liquids.

2. How are crystalline solids classified on the basis of nature of bonding? Explain with examples.

Ans. Classification of crystalline solids.

1. **Molecular solids:** The forces operating between molecules are dispersion or London forces, dipole – dipole interactions, hydrogen bounding e.g. CCl_4 , HCl, ice etc.

2. **Ionic solids:**The intermolecular forces are coulomibic or electrostatic forces, e.g. NaCl, MgO etc.

3. **Metallic solids:** The forces operating is metallic bonding e.g. Fe, Cu, Ag etc.

4. **Covalent or network solids:** The attractive forces are covalent bonding e.g. Diamond, Quartz etc.

3. In crystalline solid, anions C are arranged in cubic close – packing, cations A occupy 50% of tetrahedral voids & cations B occupy 50% of octahedral voids. What is the formula of solid?

Ans. Suppose no. of anions, C = 100

Suppose no. of cations, A = $\frac{50}{100}\times$ no. of tetrahedral voids

= $\frac{1}{2}\left(2\times C\right)$

No. of cations, B = $\frac{50}{100}\times$ no. of octahedral voids

$=\frac{1}{2}\times\left(C\right)$

= $\frac{1}{2}\times 100=50$

Ratio of ions A : B : C = 100 : 50 : 100

= 2 : 1 : 2

Formula = A_2BC_2

4. Which type of ionic substances show?

(a) Schottky defect

(b) Frenkel defect

Ans. (a) Schottky defect – ionic substances in which the cation and anion are of almost similar sizes eg. NaCl, KCl, CrCl.

(b) Feenkel Defect – Ionic substances in which there is large difference in size of ions eg. ZnS, AgCl, AgBr.

5. Aluminium crystallises in a cubic close-packed structure. Its metallic radius is 125 pm.

(i) What is the length of the side of the unit cell?

(ii) How many unit cells are there in 1.00 cm^3 of aluminium?

Ans. (i) For cubic close-packed structure:

$a = 22\sqrt{r} = 22\sqrt{\times 125}\,pm$

= 353.55 pm

= 354 pm (approximately)

(ii) Volume of one unit cell = $(354 \text{ pm})^3$

= $4.4\times107pm^3$

=$4.4\times10^7\times 10^{-30}cm^3$

= $4.4\times 10^{-23}cm^3$

Therefore, number of unit cells in 1.00 cm^3 =1.00cm $34.4\times10^{-23}cm^3$

= 2.27×10^{22}

6. If NaCl is doped with $10^{-3}mol\%$ of $SrCl^2$, what is the concentration of cation vacancies?

Ans. It is given that NaCl is doped with 10^{-3} % of $SrCl_2$.

This means that 100 mol of NaCl is doped with $10-^3$mol of $SrCl_2$.

Therefore, 1mol of NaCl is doped with103100mol of $SrCl_2$

= 10^{-5} mol of $SrCl_2$

Cation vacancies produced by one Sr^{2+} ion = 1

Therefore, Concentration of the cation vacancies

Produced by 10^{-5} mol of Sr^{2+} ions = $10^{-5} \times 6.022 \times 1023$

$= 6.022 \times 1018\, mol^{-1}$

Hence, the concentration of cation vacancies created by $SrCl_2$ is $6.022 \times 108\, mol$ of NaCl.

7. Silver crystallizes in fcc lattice. If edge length of the cell is $4.07 \times 10^{-8}\, cm$ and density is 10.5 g cm^{-3}, calculate the atomic mass of silver.

Ans. It is given that the edge length, $a = 4.077 \times 10^{-8}\, cm$

Density, $d = 10.5\, g\, cm^{-3}$

As the lattice is fcc type, the number of atoms per unit cell, *z*= 4

We also know that, $NA = 6.022 \times 1023\, mol^{-1}$

Using the relation:

$$d = zMa^3NA$$

$$M = da^3NAz = 10.5\, g\, cm^3 \times \left(4.077 \times 10^{-8}\, cm\right) \times 6.022 \times 1023\, mol^{-14}$$

$$= 107.13\, g\, mol^{-1}$$

Therefore, atomic mass of silver = 107.13 u

8. A cubic solid is made of two elements P and Q. Atoms of Q are at the corners of the cube and P at the body-centre. What is the formula of the compound? What are the coordination numbers of P and Q?

Ans. It is given that the atoms of Q are present at the corners of the cube.

Therefore, number of atoms of Q in one unit cell = $8 \times 18 = 1$

It is also given that the atoms of P are present at the body-centre.

Therefore, number of atoms of P in one unit cell = 1

This means that the ratio of the number of P atoms to the number of Q atoms, P:Q = 1:1

Hence, the formula of the compound is PQ.

The coordination number of both P and Q is 8.

9. Niobium crystallises in body–centred cubic structure. If density is 8.55 g cm^{-3}, calculate atomic radius of niobium using its atomic mass 93 u.

Ans. It is given that the density of niobium, *d*= 8.55 g cm $^{-3}$

Atomic mass, M = 93 g mol^{-1}

As the lattice is bcc type, the number of atoms per unit cell, *z*= 2

We also know that, $NA = 6.022 \times 1023\, mol^{-1}$

Applying the relation:

$$d = zMa^3 NA$$
$$a^3 = zMdNA$$

$$= 2 \times 93\, g\, mol^{-1} 18.55\, g\, cm^{-3} \times 6.022 \times 1023\, mol^{-1}$$

$$3.612 \times 10^{-23}\, cm^3$$

So, $a = 3.306 \times 10^{-8} cm$

For body-centred cubic unit cell:

$$r = 3\sqrt{4}a = 3\sqrt{4} \times 3.306 \times 10^{-8} cm$$

$= 1.432 \times 10^{-8} cm$

$= 14.32 \times 10^{-9} cm$

= 14.32 nm

10. If the radius of the octachedral void is r and radius of the atoms in close packing is R, derive relation between r and R.

Ans. A sphere with centre O, is fitted into the octahedral void as shown in the above figure. It can be observed from the figure that ΔPOQ is right-angled

$\angle POQ = 90^\circ$

Now, applying Pythagoras theorem, we can write:

$PQ^2 = PO^2 + OQ^2$

$\Rightarrow (2R)^2 = (R + r)^2 + (R + r)^2$

$\Rightarrow (2R)^2 = 2(R + r)^2$

$\Rightarrow 2R^2 = (R + r)^2$

$\Rightarrow 2\sqrt{R} = R + r$

$\Rightarrow r = 2\sqrt{R} - R$

$\Rightarrow r = (2\sqrt{-1})R$

$\Rightarrow r = 0.414R$

11. Copper crystallises into a fcc lattice with edge length $3.61 \times 10^{-8} cm$. Show that the calculated density is in agreement with its measured value of 8.92 g cm^3.

Ans. Edge length, $a = 3.61 \times 10^{-8} cm$

As the lattice is fcc type, the number of atoms per unit cell, z= 4

Atomic mass, M = 63.5 g mol^{-1}

We also know that, $NA = 6.022 \times 1023 \, mol^{-1}$

Applying the relation:

$$d = zMa^3 NA$$

$$= 4 \times 63.5 g \, mol^{-1} (3.61 \times 10^{-8} \, cm) 3 \times 6.022 \times 1023 mol^{-1}$$

$$8.97 \, g \, cm^{-3}$$

The measured value of density is given as $8.92 \, g \, cm^{-3}$. Hence, the calculated density $8.97 \, g \, cm^{-3}$ is in agreement with its measured value.

12. How can you determine the atomic mass of an unknown metal if you know its density and the dimension of its unit cell? Explain.

Ans. By knowing the density of an unknown metal and the dimension of its unit cell, the atomic mass of the metal can be determined.

Let 'a' be the edge length of a unit cell of a crystal, 'd' be the density of the metal, 'm' be the mass of one atom of the metal and 'z' be the number of atoms in the unit cell.

Now, density of the unit cell =Mass of the unit cell Volume of the unit cell

d=zma3……………………..(i)

[Since mass of the unit cell = Number of atoms in the unit $cell \times mass$ of one atom]

[Volume of the unit cell = (Edge length of the cubic unit cell)3]

From equation (*i*), we have:

m=da3z…………………….(ii)

Now, mass of one atom of metal (*m*) = Atomic mass (M) Avogadro's number (NA)

Therefore, M = da3NAz……………………..(iii)

If the edge lengths are different (say a, b and c), then equation (ii) becomes:

m = d(abc)NAz……………………………..(iv)

13. 'Stability of a crystal is reflected in the magnitude of its melting point'. Comment. Collect melting points of solid water, ethyl alcohol, diethyl ether and methane from a data book. What can you say about the intermolecular forces between these molecules?

Ans. Higher the melting point, greater is the intermolecular force of attraction and greater is the stability. A substance with higher melting point is more stable than a substance with lower melting point.

The melting points of the given substances are:

Solid water = 273 K

Ethyl alcohol = 158.8 K

Diethyl ether = 156.85 K

Methane = 89.34 K

Now, on observing the values of the melting points, it can be said that among the given substances, the intermolecular force in solid water is the strongest and that in methane is the weakest.