Questions on Crystalline and Amorphous Solids

Q.1 Classify the following solids as crystalline and amorphous.

    Sodium chloride, quartz glass, quartz, rubber, polyvinyl chloride, Teflon

A.1 Crystalline solid: Sodium chloride, Quartz

    Amorphous solid: Quartz glass, rubber, polyvinyl chloride, Teflon.

Q.2 why glass is considered as super cooled liquid?

A.2 Glass shows the tendency to flow at slower rate like liquid. Hence they considered as super cooled liquid.

Q.3 why the window glass of old buildings show milky appearance with time?

A.3 Glass is an amorphous solid. Amorphous solid has the tendency to develop some crystalline character on heating. Due to heating in day over the number of years, glass acquires some crystalline character and show milky appearance.

Q.4 why the glass panes fixed to window or doors of old building become slightly thicker at bottom?

A.4 Glass is super cooled liquid. It has the tendency to flow down very slowly. Due to this glass pane becomes thicker at the bottom over the time.

Q.5 Sodium chloride is a crystalline solid. It shows the same value of refractive index along all the direction. True/False. Give reason.

A.5 False

Crystalline solid shows anisotropy in properties. That is, it shows different values for the given physical property in different direction. All the crystalline solids show anisotropy in refractive index. Therefore sodium chloride will show different values of refractive index on different directions.

Q.6 Crystalline solid are anisotropic in nature. What does this statement means?

A.6 Anisotropy is defined as" Difference in properties when measured along different axis or from different directions". Crystalline solid show different values of some of the physical properties like electrical resistance, refractive index etc.when measured along
the different directions. The anisotropy in crystalline solid arises due to the different arrangement of particles in different directions.

Questions on Classification of Solids

Intext Questions:
Q.1 Classify the following solids as Molecular, ionic, metallic or covalent solid.
\[ \text{P}_4\text{O}_{10}, \text{graphite}, (\text{NH}_4)_2\text{PO}_4, \text{brass}, \text{SiC}, \text{Rb, I}_2, \text{LiBr}, \text{P}_4, \text{Na}_2\text{SO}_4, \text{Cu, H}_2 \]
A.1 Ionic solid: LiBr, (NH₄)₂PO₄, Na₂SO₄
   Metallic solid: Brass, Rb, Cu
   Molecular solid: P₄O₁₀, I₂, P₄, H₂
   Covalent solid: Graphite, SiC

Q.2 what type of interactions hold the molecules together in a polar molecular solid.
A.2 The molecules in a solid are held together by van der Waals forces. The term van der Waals forces include hydrogen bonding, dipole-dipole attraction and London dispersion forces. All molecules experience London dispersion forces. In addition, polar molecules can also experience dipole-dipole interactions. So, the interactions that holds the molecule together in polar molecular solid are London dispersion force and dipole-dipole interactions.

Q.3 Write a feature that will distinguish a metallic solid from an ionic solid.
A.3 Metals are malleable and ductile whereas ionic solid are hard and brittle. Metallic solid has typical metallic lustre. But ionic solid looks dull.

Q.4 Write a point of distinction between a metallic solid and an ionic solid other than metallic lustre? [CBSE 2012]
A.4 Metals are malleable and ductile whereas ionic solid are hard and brittle.

Q.5 Write a distinguish feature of metallic solid.
A.5 The force of attraction in between the constituent particles is special kind of electrostatic attraction. That is the attraction of positively charged kernel with sea of delocalized electrons.

Q.6 which group of solid is electrical conductor as well as malleable and ductile?
A.6 Metallic solid
Q.7 why graphite is good conductor of electricity although it is a network (covalent solid)?

A.7 The exceptional property of graphite is due to its typical structure. In graphite, each carbon is covalently bonded with 3 atoms in same layer. The fourth valence electron of each atom is free to move in between different layers. This free electron makes the graphite a good conductor of electricity.

Questions on Coordination number of Solids

Q.1 A compound is formed by two element A and B. Element B occupy all the ccp position and element A occupy all the octahedral voids. Find the formula of compound.

A.1 In ccp number of atoms per unit cell = 4
Number of octahedral voids = same as number of atoms present at ccp = 4

Number of atoms of element B (at ccp) = 4
Number of atoms of element A (octahedral voids) = 4

Ratio of element A : B = 4 : 4 = 1 : 1

Formula of compound = AB

Q.2 A compound is formed by two elements A and B. The element B form ccp and element A occupy 2/3 of tetrahedral voids. What is the formula of compound?

A.2 Let the number of atoms of element B form ccp: N
The number of tetrahedral voids would be: 2N

Since 2/3 of tetrahedral voids are occupied therefore number of atom of element A would be: 2N x 2/3 = 4/3 N

Ratio of element A: B = 4/3: 1 or

Simple whole number ratio A: B = 4: 3

Formula of compound: A₄B₃.

Q.3 An oxide of aluminium is formed where oxide ions occupy all the hcp positions and aluminium ion occupy 2/3 of octahedral voids. What is the formula of compound?
A.3 Let the number of atoms of oxide form hcp: N
The number of aluminium ions in octahedral voids would be: N

Since 2/3 of octahedral voids are occupied therefore number of aluminium ion would be: N \times \frac{2}{3} = \frac{2}{3} N

Ratio of element Aluminium ion: oxide ion = \frac{2}{3}N: 1N or
Simple whole number ratio Aluminium ion: oxide ion = 2: 3

Formula of compound: \text{Al}_2\text{O}_3.

Q.4 What is the coordination number of each type of ion in rock-salt type crystal structure. \ [CBSE 2008]

A.4 Rock salt (NaCl) has fcc type of crystal structure.

In fcc the cations in voids touches 6 nearest neighbour as well as anion at lattice point also touches 6 nearest neighbour.

Coordination number of Na\(^+\) = 6
Coordination number of Cl\(^-\) = 6

Questions on Electrical properties and Imperfections in Solids

Q.1 what is a semi-conductor? Describe the two main types of semi-conductors and contrast their conduction mechanism.

A.1 Answer in text.

Q.2 What type of substances exhibit antiferromagnetism ?

A.2 Substances in which the domains are aligned in opposite direction. So, the net magnetic moment is zero.

Q.3 Which crystal defect lowers the density of solid?
A.3 Schottky defect.

Q.4 Name an element with which silicon may be doped to give p-type semi-conductor.

A.4 Boron.

Q.5 Which point defect in the crystal does not alter the density of solid?

A.5 Frenkel defect.

Q.6 Which point defect in its crystal unit increases the density of a solid?

A.6 Interstitial defect.

Q.7 How do metallic and ionic substances differ in conducting electricity?

A.7 In metallic substance the electrical conduction takes place by the movement of electrons. But in ionic solid it takes place by the movement of free ions.

Q.8 What are F-centres?

A.8 The free electrons at anionic vacancies are known as F-centres.

Q.9 What is meant by doping in a semi-conductor?

A.9 The electrical conductivity of semi-conductors can be increased by adding some electron rich impurity or electron deficient impurity. This is called doping.
Q.10 what type of substance would make better permanent magnet, ferromagnetic or ferromagnetic?

A.10 Ferromagnetic

Q.11 What type of stoichiometric defect is shown by AgCl?

A.11 Frenkel defect.

Q.12 what type of semi-conductor is obtained when silicon is doped with arsenic?

A.12 n-type semiconductor.

Q.13 How may the conductivity of an intrinsic semiconductor be increased?

A.13 The conductivity of semiconductor can be increased by doping it with electron rich impurity or electron deficient impurity.

Q.14 What is mean by intrinsic semiconductor?

A.14 The pure semiconductor also shows some amount of electrical conductivity. But that is very low and has no practical application. These type of semiconductors are known as intrinsic semiconductor. For example : pure silicon and germanium.

Q.15 what are n-type semiconductor?

A.15 when the semiconductor is doped with electron-rich impurity, it increases the electrical conductivity. These are known as n-type semiconductor. For example: Silicon is doped with Germanium.
Solids have definite mass, volume and shape. This is due to the fixed position of their constituent particles and strong intermolecular force of attraction.

Solids are classified as amorphous and crystalline.

In amorphous solids, the arrangement of constituent particles has only short range order. The melting point is not sharp. They are isotropic in nature.

In crystalline solids there is long range order in the arrangement of their constituent particles. The melting point is sharp. They are anisotropic in nature.

Properties of crystalline solids depend upon the nature of interactions between their constituent particles. On this basis, they can be divided into four categories, namely: molecular, ionic, metallic and covalent solids.

The constituent particles in crystalline solids are arranged in a regular pattern which extends throughout the crystal. This arrangement is often depicted in the form of a three dimensional array of points which is called crystal lattice. Each lattice point gives the location of one particle in space. In all, fourteen different types of lattices are possible which are called Bravais lattices. Each lattice can be generated by repeating its small characteristic portion called unit cell.
A unit cell is the smallest portion of space lattice which when repeated in different directions, generate the entire lattice. A unit cell is characterised by its edge lengths and three angles between these edges. Unit cells can be either primitive which have particles only at their corner positions or centred. The centred unit cells have additional particles at their body centre (body-centred), at the centre of each face (face-centred) or at the centre of two opposite faces (end-centred).

There are seven types of primitive unit cells. Taking centred unit cells also into account, there are fourteen types of unit cells in all, which result in fourteen Bravais lattices.

Close-packing of particles is obtained in two highly efficient lattices, hexagonal close-packed (hcp) and cubic close-packed (ccp). The latter is also called facecentredcubic (fcc) lattice. In both of these packings 74% space is filled. Other types of packing are not close-packings and have less efficient packing of particles. While in body-centred cubic lattice (bcc) 68% space is filled, in simple cubic lattice only 52.4% space is filled.

The remaining space is present in the form of two types of voids - octahedral voids and tetrahedral voids.

Solids are not perfect in structure. There are different types of imperfections or defects in them. Point defects and line defects are common types of defects.

Point defects are of three types - stoichiometric defects, impurity defects and non-stoichiometric defects.

Vacancy defects and interstitial defects are the two basic types of stoichiometric point defects. In ionic solids, these defects are present as Frenkel and Schottky defects.

Impurity defects are caused by the presence of an impurity in the crystal. In ionic solids, when the ionic impurity has a different valence than the main compound, some vacancies are created.

Nonstoichiometric defects are of metal excess defect and metal deficient defect.

On the basis of electrical conductivity solids are classified as conductor, semiconductor and insulator.

Sometimes calculated amounts of impurities are introduced by doping in semiconductors that change their electrical properties. Such materials are widely used in electronics industry. They are of two types namely, n-type semiconductor and p-type semiconductor.
Solids show many types of magnetic properties like paramagnetism, diamagnetism, ferromagnetism, antiferromagnetism and ferrimagnetism

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