CHEMISTRY STUDY MATERIALS FOR CLASS 12
(NCERT BASED NOTES OF CHAPTER- 01)

GANESH KUMAR DATE:- 11/04/2021

The Solid State

Solids are substances having definite shape and definite volume. In solids, the particles are closely packed and the force of attraction between the particles is strong. So solids are rigid and incompressible. Their constituent particles (atoms, molecules or ions) have fixed positions and can only vibrate about their mean positions.

Classification of solids

On the basis of orderly arrangement of particles, solids can be classified into two – Crystalline solids and Amorphous solids

1. Crystalline solids

In these solids, the constituent particles have a well ordered arrangement throughout the solid, i.e., they have a long range order. They consist of a large number of small crystals. They have a definite geometrical shape, melting point and heat of fusion.

E.g.: *Quartz, Diamond, Graphite, fullerene, NaCl,* $CuSO_4.5H_2O$*, ice, naphthalene, SiC etc*.

2. Amorphous solids

In these solids, the ordered arrangement of constituent particles is only at some portions of the solid, i.e., they have only a short range order. The structure of these solids is similar to that of liquids. They have no definite geometrical shape, melting point and heat of fusion.

E.g.: *Plastic, Glass (quartz glass), Rubber, amorphous silica, coal, charcoal, coke, PVC etc*.

Like liquids amorphous solids have a tendency to flow, though very slowly. Therefore, sometimes these are also called *pseudo solids or super cooled liquids*.

Glass panes fixed to windows or doors of old buildings are slightly thicker at the bottom than at the top. This is because the glass flows down very slowly and makes the bottom portion slightly thicker.

Amorphous solids on heating become crystalline at some temperature. Some glass objects from ancient civilizations are found to become milky in appearance due to some crystallization.

Anisotropic and isotropic substances

Solids in which the physical properties like electrical conductance, refractive index etc are different when measured in different directions are said to be anisotropic in nature. This is due to the different arrangement of particles in different directions. Crystalline solids are anisotropic.

Solids in which the physical properties are same along any direction are said to be isotropic in nature.

This is due to the irregular arrangement of particles along different directions. Amorphous solids are isotropic.

Differences between Crystalline solids and Amorphous solids

Properties	Crystalline solids	Amorphous solids
Orderly arrangement of particles	Long range order	Only short range order
Geometrical shape	Definite characteristic geometrical shape	No definite Geometrical shape
Melting point	Definite m.pt.	No definite m.pt.
Heat of fusion	Definite	Not definite
Mode of cleavage	Give regular cleavage on cutting	Give irregular cleavage on cutting
Nature	True solids	Pseudo solids
Isotropy/anisotropy	Anisotropic in nature	Isotropic in nature

Classification of Based on the Nature of particles and Binding force

On the basis of nature of particles and binding force between the particles, crystalline solids are classified into four types- *molecular solids, ionic solids, metallic solids and covalent solids.*

1. **Molecular Solids**: Here the constituent particles are molecules. These are further sub-divided into three:

   (i) *Non-polar molecular solids*: Here the constituent particles are either atoms like Ar, He etc. or non-polar molecules like H_2, Cl_2, I_2 etc and the binding force between the particles is London dispersion forces or weak vander Waal's forces. These are soft solids and are non-conductors of electricity. They have low melting points and are usually liquid or gaseous state at room temperature and pressure.

   (ii) *Polar molecular solids*: Here the constituent particles are polar molecules like HCl, CO_2, SO_2 etc. and the binding force between the particles is relatively stronger dipole-dipole interactions. These are soft and non-conductors of electricity. Their melting points are higher than those of non-polar molecular solids. Most of them are gases or liquids at room temperature and pressure.

   (iii) *Hydrogen bonded molecular solids*: Here the constituent particles are molecules which contain atoms like H and F, O or N. The binding force between the particles is strong hydrogen bond. They are non- conductors of electricity and are volatile solids or soft solids at room temperature and pressure. E.g.: H_2O, NH_3 etc.

2. **Ionic Solids:** Here the constituent particles are ions and the binding force between the particles is strong electrostatic force of attraction (ionic bond). They are hard and brittle and have high m.p & b.p. They are electrical insulators in the solid state, since the ions are not free to move about. But in the molten or solution state, the ions become free to move about and they conduct electricity. E.g.: NaCl, KCl, $CaCl_2$ etc.

3. **Metallic Solids:** They contain a large number of metal ions which are surrounded by a sea of electrons. The particles are held together by strong electrostatic force of attraction (metallic bond). Due to the presence of a large number of free electrons, they are good conductors of heat and electricity, malleable and ductile and show metallic lustre. E.g. All metals

4. **Covalent or Network Solids:** Here the constituent particles are atoms and the binding force between the particles is strong covalent bond. They are very strong and brittle, have extremely high melting point and are electrical insulators. E.g. Diamond, Silicon Carbide (SiC, commonly known as Carborundum), Quartz, Graphite etc.

Graphite has exceptional properties i.e., it is soft and good conductor of electricity. In graphite carbon atoms are arranged in different layers and each atom is covalently bonded to three adjacent carbon atoms. The fourth electron is free to move about between different layers. So Graphite is a good conductor of electricity. The different layers are held together by weak van der Waal's force of attractions. So each layer can slide over the other and hence it is soft and used as a good lubricant.

Crystal lattice

The regular three dimensional arrangements of constituent particles of a crystal in space is called *crystal lattice* or *space lattice*.

The important characteristics of a crystal lattice are:

(a) Each point in a lattice is called lattice point or lattice site.

(b) Each point in a crystal lattice represents one constituent particle which may be an atom, a molecule (group of atoms) or an ion.

(c) Lattice points are joined by straight lines to bring out the geometry of the lattice.

There are only **14** possible three dimensional lattices. These are called **Bravais Lattices**.

****