CHEMISTRY

CLASS NOTES FOR CBSE

Chapter 15. Solid State

01. The Solid State

The solid are characterized by incompressibility, rigidity and mechanical strength. The molecules, atoms or ions in solids are closely packed i.e they are held together by strong forces and can not move about at random. Thus solids have definite volume, shape, slow definite, low vapour pressure and possesses the unique property of being rigid.

02. Differences Between Crystalline and Amorphous Solids

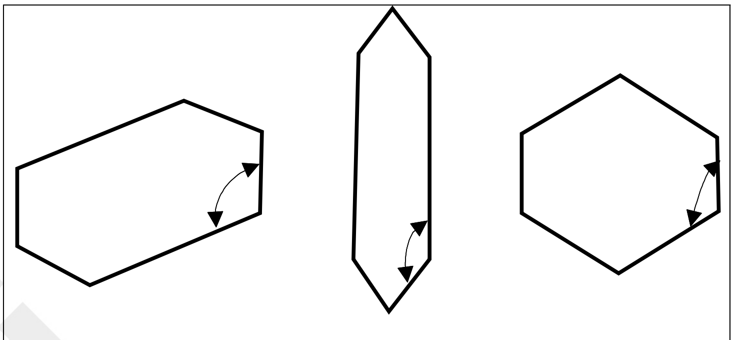
(i) **Characteristic Geometry**
In the crystalline solids the particles (atoms, ions, or molecules are definitely and orderly arranged thus these have characteristic geometry while amorphous solids do not have characteristic geometry.
Melting Points
A crystalling solids has a sharp melting point i.e. it changes into liquid state at a definite temperature. On the contrary an amorphous solid does not has a sharp melting point.

(ii) **Isotropy and Anisotropy**
Amorphous solids differ from crystalline solids and resemble liquids in many respects. The properties of amorphous solids, such as electrical conductivity, thermal conductivity, mechanical strength, refractive index, coefficient of thermal expansion etc. are same in all directions. Such solids are known as isotropic. **Gases and liquids are also isotropic.**
On the other hand crystalline solids show these physical properties different in different directions. Therefore crystalline solids are called anisotropic.

03. Crystalline State

"A crystal is a solid composed of atoms (ions or molecules) arranged in an orderly repetitive array"
"The smallest geometrical position of the crystal which can be used as repetitive unit to build up the whole crystal is called a unit cell." The unit cell should have same symmetry elements as the crystal and there should be no gaps between unit cells.
The angle between the two perpendiculars to the two intersecting faces is termed as the interfacial angle which may be same as the angle between the unit cell edges. Goniometer is used to measure the interfacial angle.

It is important to note that interfacial angle of a substance remains the same although its shape may be different due to conditions of formation.



Interfacial angles of crystal

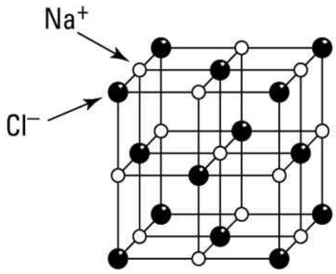
04. Types of the Crystals

Crystals are divided into four important types on the basis of chemical bonding of the constituent atoms.

(i) **Ionic Crystals**

These are formed by a combination of highly electro-positive ions (cations) and highly electronegative ions (anions). Thus strong electrostatic force of attraction acts with in the ionic crystals. Therefore, a large amount of energy is required to separate ions from one another.

e.g. NaCl, KF, CsCl etc.



(ii) **Covalent Crystals**

These are formed by sharing of valence electrons between two atoms resulting in the formation of a covalent bond. The covalent bonds extend in two or three dimensions forming a giant interlocking structure called network. Diamond and graphite are the good examples of this type.

(iii) **Molecular Crystals**

In these crystals, molecules occupy the lattice points of the unit cells, except in solidified noble gases in which the units are atoms, where the binding is due to vander Waal's' forces and dipole-dipole forces. Since vander Waal's' forces are non-directional hence structure of the crystal is determined by geometric consideration only. Solid H_2, N_2, O_2, CO_2, I_2, sugar etc. are well known examples of such crystal in which vander Waal's' forces are acting.

(iv) **Metallic Crystals**

These are formed by a combination of atoms of electropositive elements. These atoms are bound by metallic bonds. It may be defined as:

The force that binds a metal ion to a number of electrons within its sphere of influences is known as metallic bond.

05. SPACE LATTICE/CRYSTALLINE LATTICE/3-D LATTICE

Space lattice is a regular arrangement of lattice points showing how the particles are arranged at different sites in 3D-view.

"The three dimensional distribution of component particles in a crystal can be found by X-ray diffraction of different faces of the crystal. On the basis of the classification of symmetry, the crystals have been divided into seven systems. These can be grouped into 32 classes which in turn can be regrouped into 7 crystal systems. These seven systems with the characteristics of their axes (angles and intercepts) along with some examples of each are given in the following table.

The Seven Crystal System

Name of system		Axes	Angles	Bravais Lattices
1.	Cubic [Isometric]	a = b = c	$\alpha=\beta=\Upsilon=90^\circ$	Primitive, Face-centred, Body centred = 3
2.	Tetragonal	a = b ≠ c	$\alpha=\beta=\Upsilon=90^\circ$	Primitive, Body centred = 2
3.	Rhombohedral or Trigonal	a = b = c	$\alpha=\beta=\Upsilon\neq90^\circ$	Primitive = 1
4.	Orthorhombic or Rhombic	a ≠ b ≠ c	$\alpha=\beta=\Upsilon=90^\circ$	Primitive, Face-centred, Body centred End centred = 4
5.	Monoclinic	a ≠ b ≠ c	$\alpha=\Upsilon=90^\circ$; $\beta\neq90^\circ$	Primitive, End – centred = 2
6.	Triclinic	a ≠ b ≠ c	$\alpha\neq\beta\neq\Upsilon\neq90^\circ$	Primitive = 1
7.	Hexagonal	a = b ≠ c	$\alpha=\beta=90^\circ$ $\Upsilon=120^\circ$	Primitive = 1 Total = 14