SOLIDS

Solids are characterised by Incompressibility, rigidity & mechanical strength. This indicates that molecules, atoms or ions that make up solids are closely packed. They are held together by strong cohesive forces & cannot move at random. Thus in solid there is well ordered molecular, atomic or ionic arrangement. There are two types of solids i) Crystalline solids ii) Amorphous solids.

i) Crystalline Solid:- Some solids like sodium chloride, sulphur & sugar, beside being incompressible & rigid, have also characteristic geometrical forms. Such substances are said to be crystalline solid. In crystalline solids atoms molecules or ions are arranged in definite pattern throughout the entire three-dimensional network of crystal & extend over a large distance. This is termed as long range order.

ii) Amorphous Solids:- There is another class of solids which posses properties of incompressibility & rigidity to a certain extent but they do not have definite geometrical forms. These are known as amorphous solids. e.g. glass, rubber & plastics.

Amorphous solids are more closely related to liquids than to crystalline solids & are therefore regarded as supercooled liquid with high viscosity.

Difference b/w Crystalline & Amorphous Solids:

Crystalline Solids	Amorphous Solids.
1) A crystalline solid have definite & ordered arrangement due to regular arrangement of molecule in three dimensional network & is called long range order	1) In case of amorphous solids there exist no ordered arrangement of molecule, atoms or ions is there. If in any case ordered arrangement exists to a very small range (a few angstrom units)
2) A crystalline solid have sharp melting point	2) An amorphous solid does not have sharp melting point. They melt over a range of temperature
3) The physical properties of crystalline are different in different direction & this property is known as anisotropy	3) In amorphous solid the physical properties are same in all directions & it is known as isotropy.
4) The crystalline solid are solid at all temperature except the melting point	4) Amorphous solids are regarded as liquids at all temperature & are called supercooled liquid.
5) Cooling curves of molten solids have breaks	5) Cooling curves do not have breaks & give a smooth cooling curve.

Classification of Crystalline Solids :- Depending on the type of binding forces, the various crystalline solids are classified into following different types:

1) Ionic Crystals :- In these crystals the constituent particles occupying the lattice points are the positive & negative ions (e.g. Na^+ & Cl^- ions in case of NaCl crystal). These ions are held together by strong electrostatic forces of attraction. Some of the important characteristics of these crystals are:

i) Because of strong electrostatic forces of attraction existing among the ions, they have high melting & boiling points

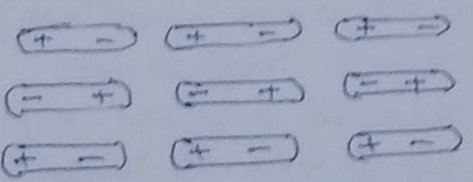
ii) They are good conductors of electricity in molten state or in solution (but not in crystalline state where the ions are not free to move)

iii) They are soluble in polar solvents but insoluble in non polar solvent

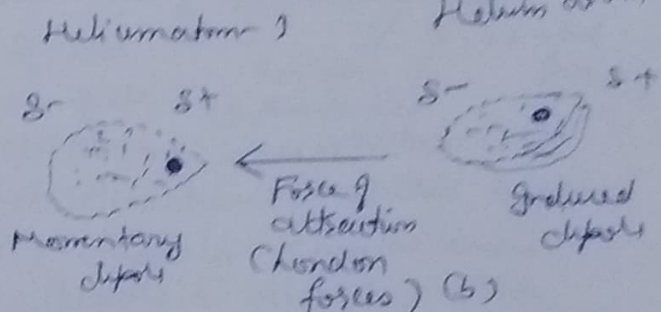
iv) Because of strong electrostatic forces of attraction the ions are closely packed & hence the Ionic crystals are hard. However, they are brittle because the stability of crystals depends upon preservation of their geometric pattern.

e.g. NaCl, KNO_3, LiF, $BaSO_4$ etc.

2) Molecular crystals :- The constituent particles occupying the lattice points in this case are the molecules. The intermolecular forces holding the molecules together in crystal lattice are weak vander waals forces. In case of polar molecules (e.g. HCl, H_2O, NH_3 etc.) these vander waals forces are the dipole - dipole attraction as shown in Fig (a)



a) Dipole - dipole attraction



(b)

In case of non-polar molecules (e.g H_2, Cl_2, CH_4 etc.) the vander waals forces are London dispersion forces.

These forces are believed to arise due to momentary dipole produced as a result of distortion of electron cloud of one molecule which produces an induced dipole in other molecule as shown (b).

The main characteristics of molecular crystals are as:

i) As the Vander Waals forces are much weaker than the electrostatic forces existing in Ionic crystal, the molecular crystals are soft & have low melting & boiling points.

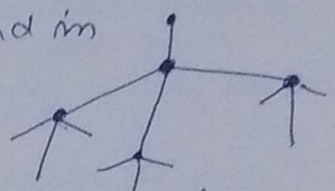
ii) They do not conduct electricity in solid or liquid state or in solution as there are no ions present.

iii) They are less soluble in water & more soluble in non-polar solvents. Polar molecular liquids acts as solvents for Ionic compounds.

iv) As dipole - dipole attractions are stronger than London forces, therefore, polar molecular crystals generally have higher melting points & boiling points than crystals of non polar molecules of comparable molecular size & shape.

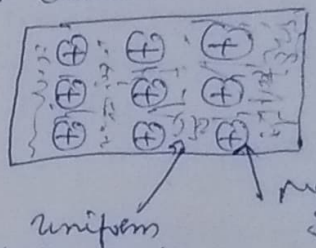
eg. Solid CO_2 & CH_4, wax, Iodine, Ice, Sulphur.

3.) Atomic or Network or Covalent Crystals :- In these crystals, the lattice points are occupied by atoms which are linked together by a network of covalent bonds to form a giant molecule. One of the most common example of crystals of this type is that of diamond in which carbon atoms are linked together by covalent bonds to give three dimensional structure as shown.



Substances of this type have high M.P, B.P, ~~points~~ low volatility & are extremly hard because of large number of covalent bonds that have to be broken to destroy the crystal structure. Further, they are non-conductors of electricity
eg. diamond, Silicon, quartz etc.

4.) Metallic crystals :- These crystals consists of positively charged metal ions (kernels) occupying lattice points which are held together by metallic bonds. The metallic bond arises due to the presence of mobile electrons (as Ionization energy of metal is low). These mobile electrons undergo simultenous attraction by number of positive ions & hence the ions are held together.



Unlike Ionic crystals, the positions of the positive ions can be altered without distroying the crystal because of uniform charge distribution provided by the freely moving electrons. Thus, metallic crystals can be easily deformed. That is why metals are malleable & ductile. The other properties of metals are like lustre, thermal & electrical conductivity can be explained on the basis of free moving electrons. Further, as positive ions are close packed in crystal lattice, most of the metals posses high melting points & high densities.

It may be noted that metallic bonds differ from covalent bond in the following two aspects.

i) Covalent bond is directional whereas metallic bond is non-directional.
ii) metallic bonds are weaker than covalent bonds.

e.g. All metals & some alloys.