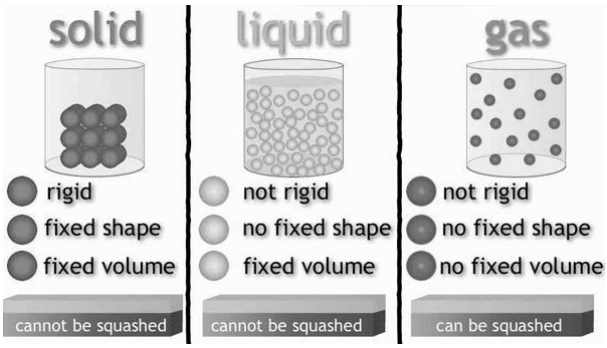
Chapter 7

Solid State

Day - 1

PROPERTIES OF SOLIDS

1. Solids have definite mass.
2. Solids have definite Volume
3. Solids have definite shape



PROPERTIES OF SOLIDS

1. Intermolecular distances are short.
2. Intermolecular forces are strong.
3. Their constituent particles (atoms, molecules or ions) have fixed positions and can only oscillate about their mean positions.
4. In general they are incompressible and rigid

Solids are classified as crystalline and amorphous

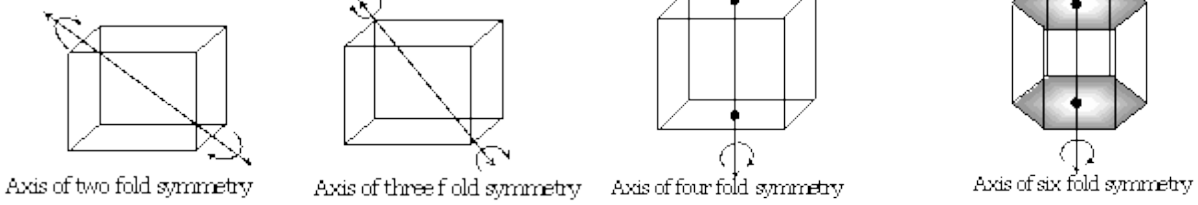
Property	Crystal	Amorphous solid
Shape	Definite 3D geometrical shape	Random or Irregular shape
M.P.	Melts at a sharp and characteristic temperature	Gradually soften over a range of temperature
Properties	Anisotropic; their physical properties show different values when measured along different directions in the same crystal.	Isotropic; their physical properties are the same in all directions.
Heat of fusion	Definite and Characteristic	Heat of fusion in a range
Cleavage plains	Are present. ; When cut with a sharp edged tool, they split into two pieces and the newly generated surfaces are plain and	Are not present. When cut with a sharp edged tool, they cut into two pieces with irregular surfaces.

	smooth.	
Type of solid	True solid	pseudo solid or super cooled liquid
Order and Symmetry	Long range order 1.Axis of symmetry 2.Plain of symmetry 3.centre of symmetry	short range order No symmetry
Examples	Diamond, Graphite, NaCl, Metal (Fe, Cu, Ag etc) ice.	Glass, rubber, plastics, Quartz glass

AXIS OF SYMMETRY

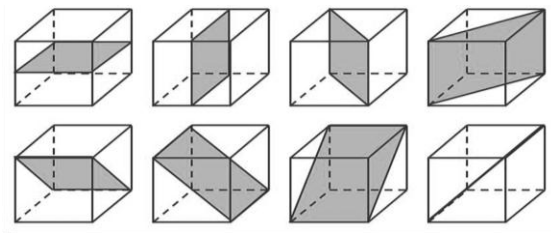
- An imaginary axis through which if we rotate the solid then same figure is seen more than once before completing 360o
- For a cube we have
  - Two fold symmetry
  - Three fold symmetry
  - four fold symmetry

Axis of symmetry



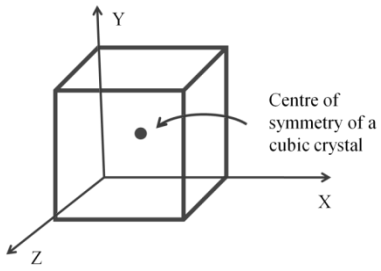
PLANE OF SYMMETRY

An imaginary plane through if we cut the solid the two parts will be mirror image of each other



Centre of symmetry

- An imaginary point through if we pass an imaginary line it will touch the opposite plane, edge or vertices at equal distance



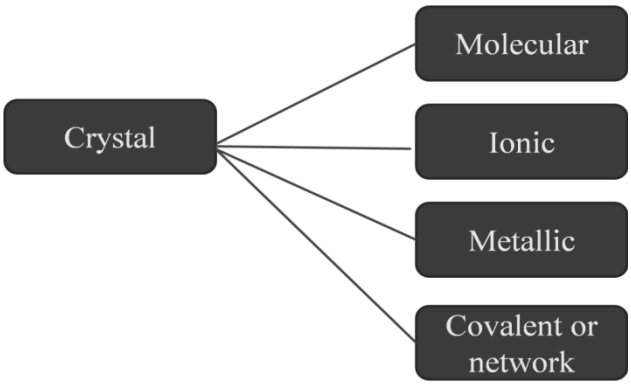
PROPERTIES OF SOLIDS

1. **Cleavage plains:** *Cleavage* is the tendency of a mineral to break along smooth *planes* parallel to zones of weak bonding. Crystals have cleavage plains where as amorphous solids do not have these plains

2. Crystals are called true solids whereas amorphous solids are called pseudo solids or super cooled liquid.

Polymorphic forms or polymorphs: The different crystalline forms of a same substance are known as polymorphic forms or polymorphs. For example: graphite and diamond are polymorph's of carbon

Crystals classification based on the nature of intermolecular forces



Molecular crystals

They have constituent particles as molecules and are divided into three parts

1. Non polar: here the intermolecular forces are weak Vanderwaal's forces (Dispersion or London forces) . They are soft, do not conduct electricity and have very low melting point. Ex: Argon, CCl_4

2. Polar: here the intermolecular forces are Dipole-dipole interactions. They are soft, do not conduct electricity and have low melting point. Ex: HCl, SO_2

3. Hydrogen bonding: here the intermolecular forces are Hydrogen bonds. They are hard, do not conduct electricity and have low melting point. Ex: Ice(H_2O)

4. Ionic crystals: The constituent particles are ions. These have strong columbic intermolecular forces. They are hard but brittle. They do not conduct electricity in solid state but are good conductors on molten and aqueous state. They have very high melting point. Ex: Rock salt (NaCl), $MgCl_2$

5. Metallic solid: The constituent particles are positive ions floating in sea delocalized electrons. These have strong metallic intermolecular forces. They are hard but ductile and malleable. They are good conductor of electricity. They have high melting point. Ex: Iron, Copper etc

6. Covalent or network solids: The constituent particles are atoms. These have strong covalent bonding. They are hard .They do not conduct electricity. They have very high melting point. Ex: Silica, Diamond etc. Graphite is an exception because it is soft and conducts electricity.

Type of solid	**Particles**	**Attractive Forces**	**Examples**	**Nature**	**Electrical Conductivity**	**Melting Point**
(1) Molecular (i) Non-polar ii) Polar (iii) H. bonding	Molecules	Disp. or London forces Dipole-dipole interactions Hydrogen bonding	Ar, CCl_4, HCl, SO_2 H_2O (ice)	Soft Soft Hard	Insulator Insulator Insulator	Very low Low Low
(2) Ionic solids	Ions	Columbic	NaCl, MgO, ZnS, CaF_2	Hard but brittle	insulators: conductors in molten state and aqueous solutions	High
(3) Metallic solids	positive ions in a sea of delocalised electrons	Metallic bonding	Fe, Cu, Ag, Mg	Hard but malleable and ductile	Conductors	Fairly high
(4) Covalent or network solids	Atoms	Covalent bonding	SiO_2(quartz) SiC. C (diamond) C (graphite)	Hard soft	insulator conductor	Fairly high