Characteristic Properties of Solids.

Solids can be distinguished from liquids and gases due to their characteristic properties. Some of these are as follows:

Solids have definite volume, irrespective of the size of the container.

Solids are rigid and have definite shape.

Solids are almost incompressible.

Many solids are crystalline in nature. These crystals have definite pattern of angles and planes.

The density of solids is generally greater than that of liquids and gases.

Solids diffuse very slowly as compared to liquids and gases.

Most solids melt on heating and become liquids. The temperature at which the solid melts and changes into liquid state under normal atmospheric pressure is called its normal melting point.

Solids are not always crystalline in nature.

Solids can be broadly classified into following two types:

(i) Crystalline solids/True solids
(ii) (ii) Amorphous solids/Pseudo solids

1. Difference between crystalline and amorphous solids

Property	Crystalline solids	Amorphous solids
Shape	They have long range order.	They have short range order.
Melting point	They have definite melting point	They do not have definite melting point
Heat of fusion	They have a definite heat of fusion	They do not have definite heat of fusion
Compressibility	They are rigid and incompressible	These may not be compressed to any appreciable extent
Cutting with a sharp edged tool	They are given cleavage i.e. they break into two pieces with plane surfaces	They are given irregular cleavage i.e. they break into two pieces with irregular surface
Isotropy and Anisotropy	They are anisotropic	They are isotropic
Volume change	There is a sudden change in volume when it melts.	There is no sudden change in volume on melting.

Symmetry	These possess symmetry	These do not possess any symmetry.
Interfacial angles	These possess interfacial angles.	These do not possess interfacial angles.

Note: Isomorphism and polymorphism: Two substances are said to be isomorphous if these possess similar crystalline form and similar chemical composition e.g., Na_2SeO_4 and Na_2SO_4. $NaNO_3$ And KNO_3 are not isomorphous because they have similar formula but different crystalline forms. The existence of a substance in more than one crystalline form is known as polymorphism e.g., sulphur shows two polymorphic forms viz. rhombic and monoclinic sulphur.

Glass is a super cooled liquid.

(2) Classification of solids: Depending upon the nature of interparticle forces the solids are classified into four types:

Types of Solid	Constituents	Bonding	Examples	Physical Nature	M.P.	B.P.	Electrical Conductivity
Ionic	Positive and negative ions network systematically arranged	Coulombic	NaCl, KCl, CaO, MgO, LiF, ZnS, BaSO4 and K2SO4 etc.	Hard but brittle	High (≃1000K)	High (≃2000K)	Conductor (in molten state and in aqueous solution)
Covalent	Atoms connected in covalent bonds	Electron sharing	SiO2 (Quartz), SiC, C (diamond), C(graphite) etc.	Hard Hard Hard	Very high (≃4000K)	Very high (≃500K)	Insulator except graphite
Molecular	Polar or non-polar molecules	(i) Molecular interactions (intermolecular-lar forces) (ii) Hydrogen	I2,S8, P4, CO2, CH4, CCl4 etc. Starch, sucrose, water, dry ice or drikold (solid CO2) etc.	Soft Soft	Low (≃300K to 600K) Low (≃400K)	Low (≃ 450 to 800 K) Low (≃373K to 500K)	Insulator Insulator

		bonding					
Metallic	Cations in a sea of electrons	Metallic	Sodium , Au, Cu, magnesium, metals and alloys	Ductile malleable	High (≃800K to 1000 K)	High (≃1500K to 2000K)	Conductor
Atomic	Atoms	London dispersion force	Noble gases	Soft	Very low	Very low	Poor thermal and electrical conductors

(i) Liquid Crystal: There are certain solids which when heated undergo two sharp phase transformations one after the other. Such solids first fuse sharply yielding turbid liquids and then further heating to a higher temperature these sharply change into clear liquids. The first temperature at which solids changes into turbid liquid is known as transition point and the second temperature at which turbid liquid changes into clear liquid is known as melting point. Such substances showing liquid crystal character are as follows:

p-chloesteryl benzoate, $p-$ Azoxyamisole, Diethylbenzidine etc.

$$\text{p-}\underset{\text{(Solid)}}{\text{Chloesteryl benzoate}} \xrightleftharpoons{145^{\circ}\text{C}} p-\underset{(liquid crystal)}{\text{Chloesteryl benzoate}} \xrightleftharpoons{178^{\circ}\text{C}} p-\underset{\text{(Liquid)}}{\text{Chloesteryl benzoate}}$$

A liquid crystal reflects only one color, when light falls on it. If the temperature is changed it reflects different color light. So, such liquid crystals can be used to detect even small temperature changes. The liquid crystals are of two types: (i) Nematic liquid crystals, (needle like), (ii) Smectic liquid crystals (soap like)

(ii) Dispersion forces or London forces in solids: When the distribution of electrons around the nucleus is not symmetrical then there is formation of instantaneous electric pole. Field produced due to this distorts the electron distribution in the neighboring atom or molecule so that it acquires a dipole moment itself. The two dipole will attract and this makes the basis of London forces or dispersion forces these forces are attractive in nature and the interaction energy due to this is proportional to $\left(\frac{1}{r^6}\right)$.

Thus, these forces are important as short distances $(\simeq 500\ pm)$. This force also depends on the Polaris ability of the molecules.

(3) Amorphous Solids (Supercooled liquid): Solids unlike crystalline solids, do not have an ordered arrangement of their constituent atoms or ions but have a disordered or random arrangement, are called amorphous solids. Ordinary glass (metal silicate), rubber and most of the plastics are the best examples of amorphous solids. In fact, any material can be made amorphous or glassy either by rapidly cooling or freezing its vapors for example, SiO_2 crystalizes or quartz in which SiO_4^{4-} tetrahedra are linked in a regular manner but on melting and then rapid cooling, it gives glass in which SiO_4^{4-} tetrahedron are randomly joined to each other.

Properties of Amorphous solids

(i) Lack of long range order/Existence of short range order: Amorphous solids do not have a long range order of their constituent atoms or ions. However, they do have a short range order like that in the liquids.

(ii) No sharp melting point/Melting over a range.

(iii) Conversion into crystalline form on heating.

Uses of Amorphous solids

(i) The most widely used amorphous solids are in the inorganic glasses which find application in construction, house ware, laboratory ware etc.

(ii) Rubber is amorphous solid, which is used in making tyres, shoe soles etc.

(iii) Amorphous silica has been found to be the best material for converting sunlight into electricity (in photovoltaic cells).