Substance & its Nature

Introduction

Chemistry is the branch of science which deals with the composition of matter and also the Physical and Chemical characteristics associated with the different material objects.

A French chemist, Lavoisier (1743–1793) is regarded as father of mode n chemistry.

Substance and its nature : Anything that occupies spac , pos sses mass and can be felt by any one or more of our senses is called ter.

Solid State : A solid possesses definite shape and efinite v ume which means that it can not be compressed on applying pressure. S lids are generally hard and rigid. Example—metals, wood, bricks, c pper tc.

Liquid State : A liquid possesses definite olume bu no definite shape. This means that the liquid can take up the shape f cont ner in which it is placed. Example—water, milk, oil, alcohol et

Gaseous State : A gas does not h ve eith r a definite volume or definite shape. It can be compressed to la e extent n applying pressure and also takes the shape of the container where t is enclosed. Examples— Air, Oxygen, Nitrogen, Ammonia, Carbondi xide etc.

Pure substances : A single s bstance (or matter) which can not be separated into other kind of ma er by ny physical process is called pure substance. Pure substanc s ha e been classified as elements and compounds.

E**leme ts :** T e simplest form of a pure substance which can neither be broken into nor b ilt from simpler substances by ordinary physical and chemical methods is called ele ent.

Elements are fu her classified into three types (i) Metals (ii) Non-metals and (iii) Metalloids.

Metals : Metals are solids (exception mercury which is liquid at room temperature) are normally hard. They have lustre, high mp and bp and also good conductor of electricity and heat. The conductivity of metal decreases with

increase in temperature due to vibration of positive ions at their Lattice points. Examples—Iron, Copper, Silver, Gold, Aluminium, Zinc etc.

Non-metals : Non-metals are the elements with properties opposite to those of the metals. They are found in all states of matter. They do not possess lustre (exception—iodine). They are poor conductors of electricity (exception-graphite) and they are not malleable and ductile. Examples—Hydrogen, Carbon, Oxygen, Nitrogen, Sulphur, Phosphorous etc.

Metalloids : Metalloids are the elements which have common prope ties f both metals and non-metals. Examples—Arsenic, Antimony, Bismuth e c.

Compounds : Compounds are pure substances that are com osed f two o more different elements in fixed proportion by mass. The roper es of a compound are entirely different from those of the elem s from w ich it is made. Example—Water, Sugar, Salt, chloroform, Alcohol, Ether e

Compounds are classified into two types

(i) Organic Compounds **(ii)** Inorganic Com ounds,

Organic Compounds : The Compoun s obta ed from living sources are called organic compounds. The term organ is now applied to hydrocarbons and their derivatives. Examples—Carbohydrates Proteins, Oils, Fats etc.

Inorganic Compounds : Th Compou ds obtained from non-living sources such as rocks and minerals are ca ed inorganic compounds. Examples—Common Salt, Marble, Washing Soda et

Mixtures : A materia obtained by mixing two or more substances in any indefinite proportion is c led a ixture The properties of the components in a mixture remain u cha ged. Example—Milk, Sea water, Petrol, Paint, Glass, Cement, Wood etc.

There ar two ty es of mixture—

(1) Homogen us mixture **(2)** Heterogeneous mixture.

1. Homogeneous mixture : A mixture is said to be homogeneous if it has a uniform composition through out and there are no visible boundaries of separation between constituents. More over, the constituents can not be seen even by a microscope. Examples—Common salt dissolved in water, sugar dissolved in water, iodine dissolved in CCl_4, benzene in toluene and methyl alcohol in water.

2. Heterogeneous mixture : A mixture is said to be heterogeneous if it does not have a uniform composition throughout and has visible boundaries of separation between the various constituents. The different constituents of the heterogeneous mixture can be seen even with naked eye. Example—-A mixture of Sulphur & Sand, A mixture of Iron filings & Sand etc.

Separation of mixture : Some methods of separation of mixtures are given below—

1. Sublimation : In this process, a solid substance passes direct int its v pours on application of heat. The vapours when cooled, give back the o ginal substance. This method can be used for the substances which ar su lime their separation from non-sublimate materials. Examples of blime are Naphthalene, Iodine, Ammonium Chloride etc.

2. Filtration : This is a process for quick and complet remo al of suspended solid particles from a liquid, by passing the suspen n throug a filter paper. Examples—(i) removed of solid particles from the eng e oil in car engine. (ii) filtration of tea from tea leaves in the prepar tion tea e c

3. Evaporation : If a solution of solid subst nce in a l uid is heated, the liquid gets converted into its vapours and s wly go s off ompletely. This process is called evaporation. Example—(i) Eva oration of water in summer from Ponds, wells & lakes. (ii) Preparation of ommo salt from sea water by evaporation of water.

4. Crystallization : This meth d is mostly used for separation and purification of solid substances. In his proces the impure solid or mixture is heated with suitable solvent (e. alcohol water, acetone, chloroform) to its boiling point and the hot solution is fi ered. Th clear filtrate is cooled slowly to room temperature, when pure sol crysta lizes ut. This is separated by filtration and dried.

For the sep ra on f more complex mixtures, fractional crystallization is used, in which e com onents of the mixtures crystallize out at different interval of time.

5. Distillatio : It is a process of converting a liquid into its vapour by heating and then condensi g the vapour again into the same liquid by cooling. Thus, distillation involv s vaporisation and condensation both

Distillation = Vaporisation + Condensation

This method is employed to separate the liquids which have different boiling points or a liquid from non-volatile solid or solids either in solution or suspension.

Example—A mixture of copper sulphate and water or a mixture of water (B.P 100°C) and methyl alcohol (B.P 45°C) can be separated by this method.

6. Fractional distillation : This process is similar to the distillation process except that a fractionating column is used to separate two or more volatile liquid which have different boiling points. Example-(i) Methyl alcohol (bp = 338 K) and acetone (bp = 329 K) can be separated by fractional distillation process. (ii) Separation of petrol, diesel oil, kerosene oil, heavy oil etc from crude petroleum. (iii) Separation of oxygen, nitrogen inert gasses and carbon dioxide from liquid air etc.

7. Chromatography : The name chromatography is derived from L tin word 'Chroma' meaning colour. The technique of chromatograph i bas on th difference in the rates at which the components of a mixtu e are bsorbed in the suitable absorbent.

There are many types of chromatography.

(a) Column (absorption) Chromatography
(b) Thin layer chromatography
(c) Paper - chromatography
(d) High pressure liquid chromatography
(e) In-exchange chromatography
(f) Gas chromatography

8. Sedimentation and Dec ation : T is method is used when one component is a liquid and other is an insolu le. Insoluble solid, heavier than liquid. i.e, mud and water.

If muddy water is al wed to s and undisturbed for sometime in a beaker, the particles of ea h (clay nd s nd) settle at the bottom. This process is called sedimen tion The clear liquid at the top can be gently transferred into another beaker. Thi p oc is known as decantation.

Concept f chan e in state : (a) Melting Point : The temperature at which solid and the liqu d forms of the substance exist at equilibrium or both forms have same vapour p essure is called melting point.

(b Boiling point : The temperature at which the vapour pressure of the liquid is equal to atmospheric pressure is called boiling point.

(c) Freezing Point : The temperature at which the vapour pressure of its liquid is equal to the vapour pressure of the corresponding solid is called freezing point.

(d) Evaporation : The process of conversion of a liquid into its vapours at room temperature is called evaporation. Evaporation causes cooling. Actually, during evaporation, the molecules having higher kinetic energy escape from the surface of the liquid. Therefore, average kinetic energy of the rest of the molecules decreases. Therefore cooling takes place during evaporation because of temperature of liquid is directly proportional to average kinetic Energy. Evaporation is affected by following factors,

(i) Nature of liquid (ii) Temperature (iii) Surface area.

(e) Vapour pressure : The pressure exerted by the vapours of liqu d in equilibrium with liquid at a given temperature is called vapour pressure. Vapo r p essur depends upon—(i) its nature and (ii) temperature.

Higher the vapour pressure of a particular liquid lesser i be the magnitude of intermolecular forces present in molecules. Vapour p essu of a liquid increases with increase in temperature.