1. PHYSICAL CHEMISTY

States of matter

Matter: The matter is that substance which occupies space, has a definite mass, can exert pressure, can produce physical resistance, has the virtue of inertia, states may be transformed through the energy, which can be decomposed or divided and whose existence be realised by our sence organs.

Types of matter

Broadly the matter has been divided into two categories:

(i) On the basis of physical composition.

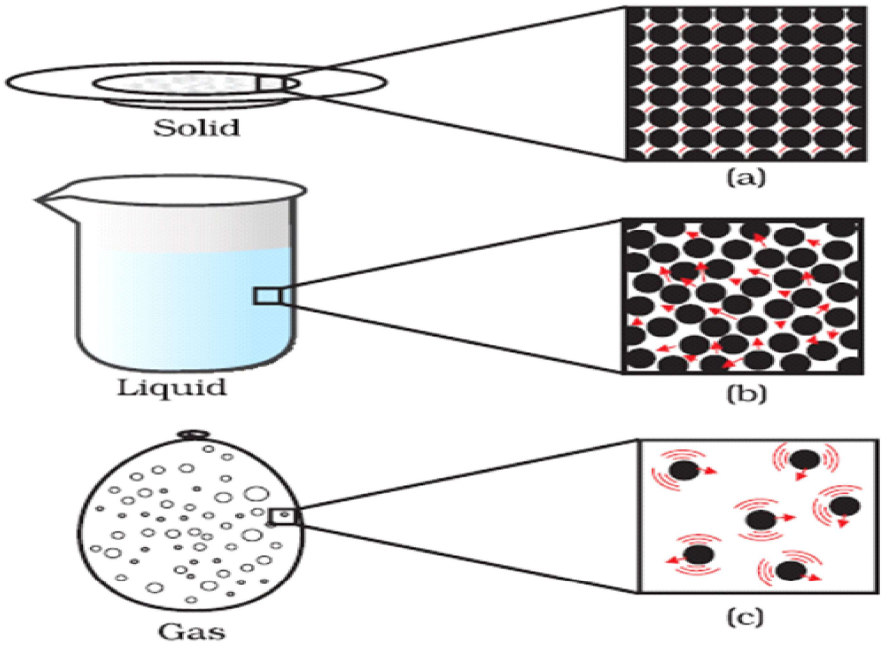
(ii) On the basis of Chemical composition.

(i) Physical composition of the matter: On the basis of physical composition, the matter is divided into three groups–solid, liquid and gas. The physical composition of matter totally depends on intermolecular forces existing among their molecules.

Solid: The solid is that state of a substance or a matter whose shape and volume (hence size) both are definite and fixed like table, book, stone pieces etc. When the intermolecular forces of attraction among the molecules of the substance is stronger than forces of separation then the substance is said to be in the solid state. Due to stronger intermolecular forces the molecules of the solid substance are compressed in dense form whose locations are fixed. At this position the molecules of the solid vibrate or oscillate about this position in intermolecular domain. That's why all solids have a definite shape and size.

Liquid: The liquid is that state of a substance or a matter whose volume (hence size) is definite but shape is not definite and fixed like water, milk, oil, wine etc. The substance which can flow is called fluid that's why all the liquids are fluids. It is also observed that whatever be the shape of the liquid but its upper surface is always plane. When the intermolecular forces of attraction among the molecules are only slightly greater than the corresponding forces of separation then the substance or matter is in the state of the liquid. Thus the molecules of the liquid are less densely compressed and these are free to move randomly but inside the substance. Although the intermolecular separation is not too large that's why it can change its shape but not its volume.

Gas: The gas is that state of the substance or matter whose shape and size (volume) both are indefinite and uncertain like air, H_2, N_2, O_2 etc. The gases also have no any own shape and size but only occupy the shape and size of the container in which these are kept. Also all gases are flowing, forces of attraction are weaker than corresponding forces of separation, the substance is found to be in the gaseous state. The molecules in the gas are remotely distributed and so intermolecular separation are too large and molecules are free to move randomly that's why it has no any definite shape and size.



(ii) Chemical composition of the matter: On the basis of the chemical composition, the matter is divided into three groups–element, compound and mixture.

Element: The element is that fundamental substance or matter which cannot be decomposed or divided into two or more different components which have different properties or characteristics by any physical or chemical process. In other words the element is that fundamental matter which is composed from identical atoms and any element also cannot be composed by any complex synthesis of two or more different components by any physical or chemical process.

On the basis of electronic configuration an element is that substance whose atoms have same nuclear charges. The examples of element are H_2, O_2, N_2, Fe, Cu, Ag etc. The element is of two types–Metals and Nonmetals. The metals are usually good conductors of electricity and heat and mostly found is solid states which are malleable and ductile. The examples of metals are Fe, Cu, Al, Ag, Pt, Au etc. The non-metals are usually bad conductors of electricity and heat, and these are brittle. One the basis of physical composition since matter is found to be in solid, liquid and gas that's why elements are also found in these three states.

Most of the elements found are solids like Fe, Cu, C, S, Ag, etc, while some are found as liquids like Hg, Br etc and some others are found as gases like H_2, O_2, N_2, Cl_2 etc. At present there are 114 elements which have been come into their existence. Out of 114 elements, 92 elements are naturally occurring and the rest elements are artificially made by the complex synthesis at the various laboratories in the world.

Compound: The compound is that pure substance which is formed by the chemical combination of two or more elements composed in a definite ratio. Also the physical and chemical properties of the formed compound are different than that of its constituents or component elements.

The examples of the compound are CO_2, H_2O, $KmnO_4$, H_2SO_4 etc. Obviously if we consider H_2O (water) then this compound is formed by the chemical combination of 2 atoms of hydrogen and 1 atom of oxygen but by weight it has the ration of 1:8. The physical and chemical properties of the water are different from hydrogen and oxygen.

Mixture: The mixture is that impure substance which is formed by two or more than two pure elements by the means of only a physical combination without any definite ratio. The examples of the mixture are air, brass (copper + zinc) etc, Air us the mixture of various gases like N_2, O_2, CO_2, etc. and water vapour.

Types of mixture: On the basis of the nature of constituents or components elements and on the properties and the composition of the mixture it is categorised into two groups–

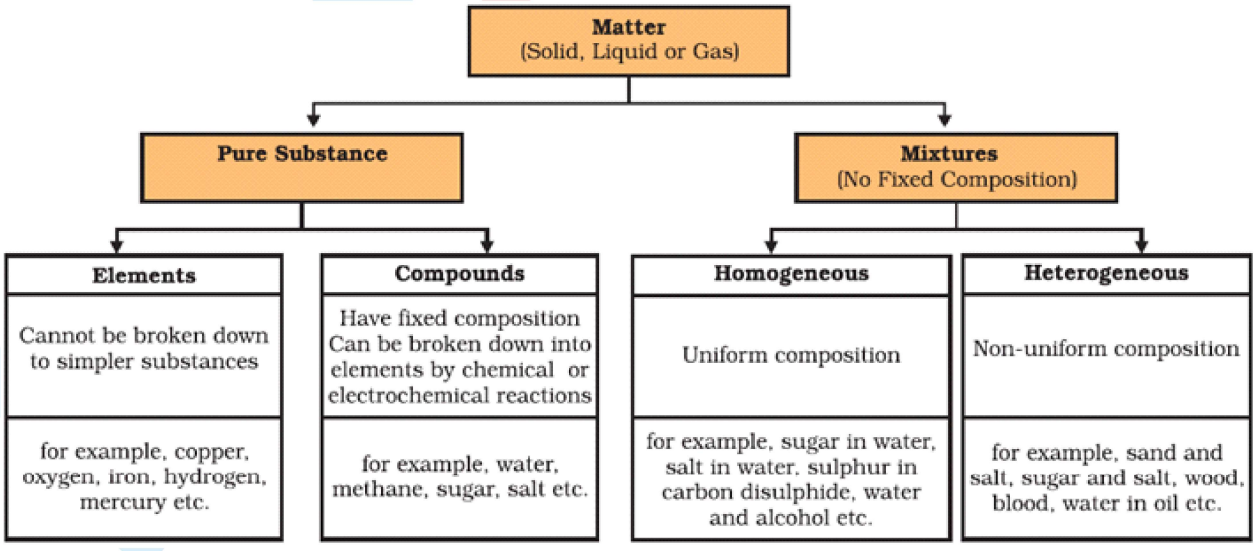
(i) Homogenous mixture: The mixture in which the every part has the same composition and properties as that of its component elements is called homogenous mixture.

The examples of homogeneous mixture are the electrolyte of sugar in water, the electrolyte of sulpher in carbon disulphide, the electrolyte of NH_3 in air etc.

(ii) Heterogeneous mixture: The mixture in which the every part has not the same composition and the properties as that of its component elements is called heterogeneous mixture.

The examples of heterogeneous mixture are the mixture of iron and sulpher, the mixture of silica (sand) and salt, the mixture of dust particles in air etc.

It is also observed that the component elements of the heterogeneous mixture can be easily separated than the component elements of the homogeneous mixture.



The component or constituent particles of the substance or matter:

Molecule: The smallest particle of the substance (element or compound) which can exist in free state but doesn't take part in chemical reactions and the properties of the substance (element or compound) are exactly present in it, called molecule.

The molecules of the substance are identical (same mass, shape, size) in every aspect but two different substances have different molecules in mass, shape and size.

For example water (H_2O) has all identical molecules and similarly common salt (NaCl) has also identical molecules but a molecule of H_2O is not identical as molecules of NaCl. The forces operative within these molecules are called intermolecular forces of attraction and due to these forces substances exist as solid or liquid, while in gas the existence of these forces become insignificant.

Types of molecule: There are two types of molecules—molecule of the element and the molecule of the compound. When the atoms of the same element are composed together then the smallest independent particles form and these particles are called molecules of the element. For example the molecule of the nitrogen (N_2) has been composed from two atoms of the nitrogen.

Also the atoms of the element are identical in every respect for a particular element.

But when the atoms of more than one elements compose the smallest independent particles then these particles are called molecules of the compound. For example, each molecule of ammonia (NH_3) has been composed from one atom of nitrogen and three atoms of hydrogen.

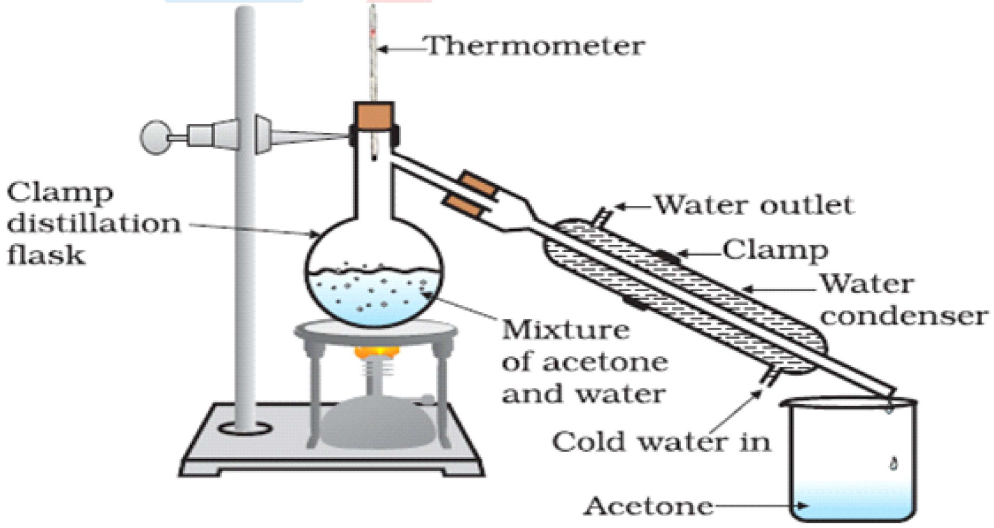
Atom: The smallest particle possible in any substance or element which doesn't exist in free state but takes part in chemical reactions and all characteristics of the substance or element are present in it is called the atom of the substance or the element.

Earlier theories of atomic models assumed that the atom is the ultimate smallest particle of the substance (matter) or element and it cannot be divided or decomposed further. Dalton also supported this view but later atomic theories clearly speculated and asserted that the atom is divisible and it is basically composed or constituted from electron, proton and neutron. The atoms of an element are identical in every respect but these are different from the atoms of other element. Thus the atoms of carbon is not identically same as the atoms of Nitrogen.

Separation of mixture: The components (constituents) of the mixture are separated by the various processes which are follows:

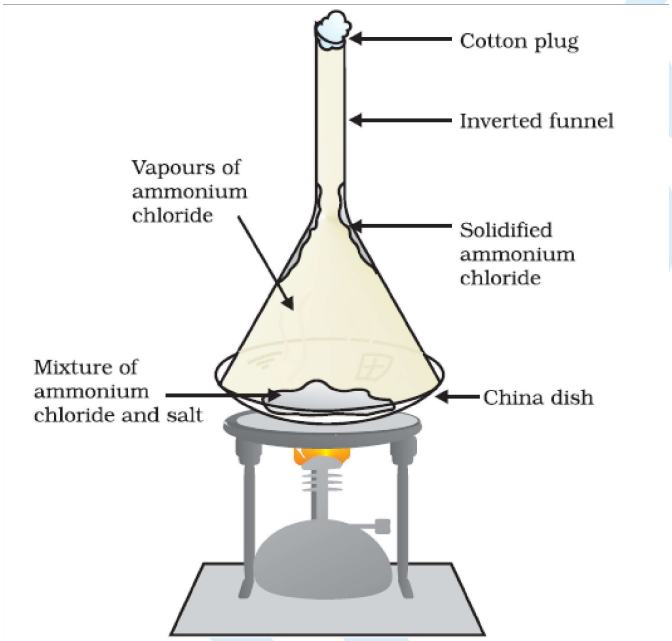
(i) Process of crystallisation: By the process of crystallisation the components present in inorganic solids are separated and purified. By this process impure solid or mixture is mixed with a suitable solvent and heated and at this position the solution is filtrated by a suitable filter (say, funnel). After filtration the solution is cooled and no cooling pure substance is separated in the form of crystal from the solution. The impurities of the mixture dissolve into the solution and these crystals are filtered, dried and separated.

(ii) Process of distillation: By the process of distillation mainly the mixture of the liquids are separated and especially those components mixtures are separated which have a substantial gap among the boiling points of the liquid mixture. In this process the component liquids are vapourised and transported to another place where these are cooled and transformed into the liquid state. Thus liquid mixtures are separated and purified and in the complete process two processes vapourisation and condensation are involved.



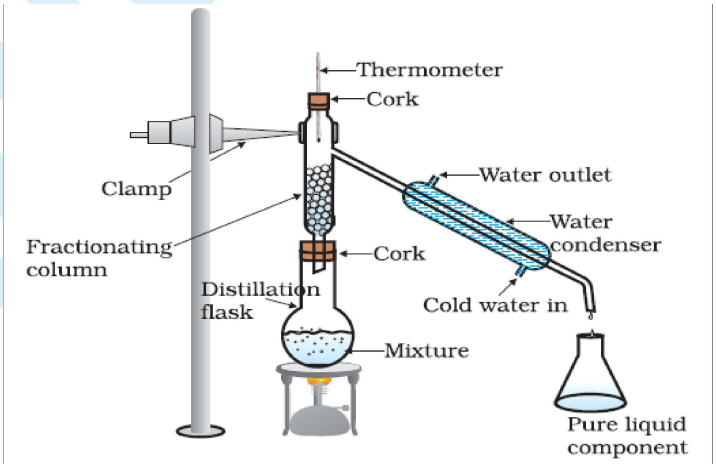
(iii) Process of sublimation: Normally when solid substances are heated, then it converts into liquid and on further heating this liquid is transformed into gas, but there are certain substances (solid) which are when heated convert directly into vapours or gases and on cooling (condensation) transform into solid directly. This is called sublimation and the corresponding substance is called sublimate.

Thus by the process of sublimation the mixture of two those solids are separated and purified in which one solid is sublimate. In this process the mixture is heated in which sublimate substance is vapourised and this vapour is collected separately and ultimately cooled. Thereby two solid substances are separated and the mixture is purified. The substances like Nefthelin, ammonium chloride, camphor Anthrasin, Benzoic acid etc. are sublimates.

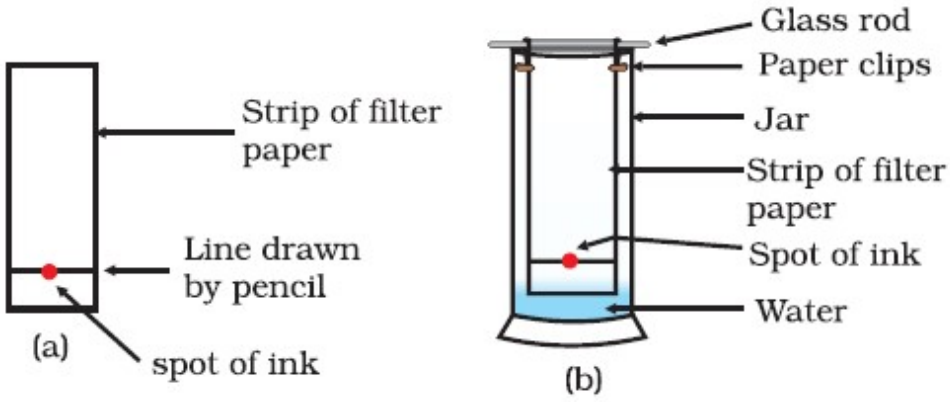


Separation of ammonium chloride and salt by sublimation

(iv) Process of fractional distillation: By the processes of fractional distillation those mixture of liquids are separated and purified which have a very narrow gap between their boiling points. Thus this process is applied for the mixture of those liquids which have nearly same boiling points. The extracted composite oil from the earth's crust through which petrol, diesel, K-oil etc are separated by the fractional distillation. The various gases from the aqueous air are also separated by this process.



(v) Process of chromatography: This process is basically applies for those mixtures whose various components have various absorption capacity and absorption is made at various distances and ultimately separated.



Separation of dyes in black ink using chromatography

(vi) Process of steam distillation: By the process of steam distillation those mixtures of organic substances are separated which are insoluble in water and vapourise with vapour. Also those organic substances are purified by this process which decompose at their respective boiling points. The organic substances (compounds) like Acetone, Acetaldehyde, Methyl alcohol etc. are purified by this process.

Difference between Mixtures and Compounds. In order to find out whether a given substance is a mixture or a compound, the following points of difference between the two may be kept in mind.

(i) A mixture can be separated into its constituents by physical processes, while this is not possible in case of compounds.

(ii) A mixture shows the properties of its constituents, while the properties of a compound are entirely differently from those of its constituents.

(iii) The preparation of a compound generally involves absorption or giving out of energy in the form of heat or light.

(iv) The composition of a mixture is variable; its consituents can be present in any proportion by weight. The composition of a compound is fixed, the constituents being present in fixed proportion by weight.

(v) A mixture does not have a fixed melting point, boiling point, etc., while a compound has a fixed melting point, boiling point, etc.

(vi) A mixture does not have a definite formula, whereas a compound has a definite formula.