IS MATTER AROUND US PURE

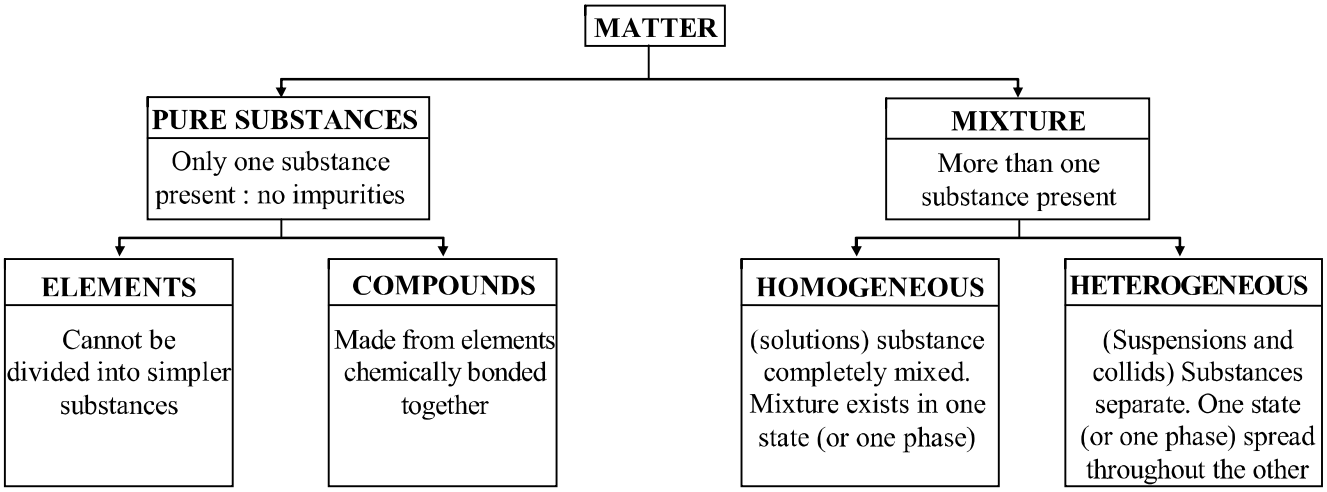
CONTENTS

Introduction

All the matter around us is not pure. The matter around us is of two types.

In the previous chapter, we have learnt about the three states of matter. Before, understanding the chemical nature of matter, let us first understand the scientific meaning of the term **chemical substance.**

The scientific meaning of the term **chemical substance** is different from its everyday meaning. In terms of science, **substance is a kind of matter that cannot be separated into other kinds of matter by any physical process.** In other words, **substance is a pure form of matter** and not a mixture of several different kinds of matter. Most of the things that we use in our day-to-day life are in the form of mixtures. Pure substances are rare. For example, the dissolved sugar can be separated from its solution by some physical process (evaporation or distillation). However, sugar is itself a substance and cannot be separated by physical processes into its constituents. Similarly, common salt (sodium chloride), iron, mercury, calcium oxide, hydrochloric acid are substance.



➢ Pure substances

- A pure substance consists of a single type of particles.
- Pure substances are always homogeneous.
- All the elements and compounds are pure substances because they contain only one kind of particles.
- A pure substance cannot be separated into other kinds of matter by any physical process.
- A pure substance has a fixed composition as well as a fixed boiling point and melting point.

Ex. Hydrogen, Oxygen, Copper, Gold, Silver.

◈ Pure substances can be divided into two types.

(A) Elements

(B) Compounds

(A) Elements :

- An element is a substance which cannot be split up into two or more simpler substances by the usual chemical methods of applying heat, light or electric energy.
- An element cannot be split up into two (or more) simpler substances because it is made of only one kind of atoms.

Ex. Hydrogen is an element because it cannot be split up into two or more simpler substances by the usual methods of carrying out chemical reactions by applying heat, light or electricity.

Element	**Symbol**
Aluminium	Al
Arsenic	As
Barium	Ba
Bromine	Br
Cadmium	Cd
Calcium	Ca
Chlorine	Cl
Chromium	Cr
Cobalt	Co
Fluorine	F
Hydrogen	H
Iodine	I
Magnesium	Mg
Manganese	Mn
Nitrogen	N
Oxygen	O
Phosphorus	P
Sulphur	S
Uranium	U
Zinc	Zn
(symbols from latin names)	
Antimony (stibium)	Sb
Copper (Cuprum)	Cu
Gold (Aurum)	Au
Iron (Ferrum)	Fe
Lead (Plumbum)	Pb
Mercury (Hydrogyrum)	Hg
Potassium (Kalium)	K
Silver (Argentum)	Ag
Sodium (Natrium)	Na
Tin (Stannum)	Sn

◈ All the Elements can be divided into three groups.

(a) Metal

(b) Non-metal

(c) Metalloid

(a) Metals : -

A metal is an element that is malleable and ductile, and conducts electricity. All the metals are solids except one metal mercury, which is a liquid.

Ex. Iron, Copper, Aluminium, Zinc.

◈ Properties of metals

- **Metals are malleable :** This means that metals can be beaten into thin sheets with a hammer (without breaking).

Ex. Aluminium metal is quite malleable and can be converted into thin sheets called aluminium foils. Aluminium foils are used for packing food items like biscuits, chocolates, medicines, cigarettes, etc.

- **Metals are ductile :** This means that metals can be drawn (or stretched) into thin wires. All the metals are not equally ductile. Some are more ductile than the other.

Ex. Copper and aluminium metals are also very ductile and can be drawn into thin wires which are used in electrical wiring.

- **Metals are good conductors of heat and electricity :** This means that metals allow heat and electricity to pass through them easily. Silver metal is the best conductor of heat. It has the highest thermal conductivity.

Ex. The cooking utensils and water boilers, etc., are usually made of copper or aluminium metals because they are very good conductors of heat.

Ex. The electric wires are made of copper and aluminium metals because they are very good conductors of electricity.

- **Metals are lustrous (or shiny), and can be polished :** The property of a metal of having a shining surface is called metallic lustre (chamak). The shiny appearance of metals makes them useful in making jewellery and decoration pieces

Ex. Gold and silver are used for making jewellery because they are bright and shiny. The shiny surface of metals makes them good reflectors of light. Silver metal is an excellent reflector of light.

- **Metals are generally hard :**

  Most of the metals are hard. But all the metals are not equally hard. The hardness varies from metal to metal they can not cut with a knife. (except sodium and potassium which are soft metals).

Ex. Iron, copper, aluminium.

- **Metals are usually strong. They have high tensile strength :** This means that metals can hold large weights without breaking.

Ex. Iron metal (in the form of steel) is very strong having a high tensile strength. Due to this iron metal is used in the construction of bridges, buildings, railway lines, girders, machines, vehicles and chains etc.

- **Metals are solids at the room temperature :**

  All the metals like iron, copper, aluminium, silver and gold, etc., are solids at the room temperature. Only one metal, mercury, is in liquid state at the room temperature.

- **Metals generally have high melting points and boiling points :** This means that most of the metals melt and vaporise at high temperatures.

Ex. Iron is a metal having a high melting point of 1535ºC. This means that solid iron melts and turns into liquid iron on heating to a high temperature of 1535ºC.

- **Metals have high densities :** This means that metals are heavy substances.

Ex. The density of iron metal is 7.8 g/cm^3 which is quite high.

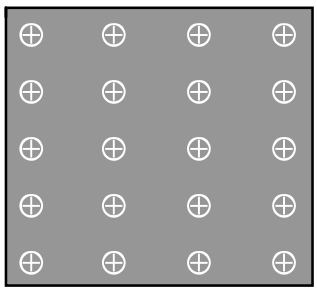
- **Metals are sonorous :** This means that metals make a ringing sound when we strike them.

Ex. Plate type musical instruments like cymbals (manjira), and wires (or strings) for stringed musical instruments such as violin, guitar, sitar and tanpoora, etc.

- **Metals usually have a silver or grey colour :** (except copper and gold). Copper has a reddish-brown colour whereas gold has a yellow colour.

- **Metallic Bonding**

  The bonding which holds the metal atoms firmly together on account of force of attraction between metal ions and the mobile electron is called metallic bonding.



Mobility of electrons forming metallic bonds

X-rays analysis of metal crystal has revealed that each atom in metal crystal is surrounded by 8 or 12 other metal atoms. In metal atoms, the valency electrons are few (1, 2, and 3) and thus, it is not possible for a metal atom to form 8 to 12 covalent bonds with neighbouring atoms. Thus, it was assumed that the atoms in metal crystal are bonded with each other with a special type of bonding known as **metallic bonding**. Drude in 1900 proposed the theory of metallic bonding which was later on modified by Lorentz. According to these authors, metals having 1, 2 or 3 electrons in outermost shells, being electropositive lose their electron readily because of low IE values to form free electrons and remainder portion of atom with a Kernel (core of stable nature) carrying positive charge. The free electrons are mobile in nature and move from the one Kernel to another which are closely packed in regular fashion throughout the crystal lattice. thus, the metal crystal is represented by an arrangement of positively charged Kernels in a sea of mobile electrons (Figure) shared by each Kernal to give metallic bonds. Ad the shared electrons are delocalized, the metallic bonds have neither direction nor saturation. There are two essential conditions for metallic bonding :

1. The metal atoms should have low ionization energy.

2. There should be sufficient number of vacant orbitals.

   The strength of metallic bonds increases with increase in :

   (i) Number of valence electrons

   (ii) Charge on the nucleus.

It is therefore, explained that alkali metals are soft and have low melting point, boiling point in comparison to transition metals which are hard and have high m.p., b.p. since, transition metals possess higher number of valence electrons as well as the higher charge on nucleus.

It is metallic bonding which explains the electrical and thermal conductance, metallic luster, malleability, ductility m.pt., b.pt., hardness in metals.

(b) Non–Metals : -

A non-metal is an element that is neither malleable nor ductile, and does not conduct electricity. All the non-metals are solids or gases, except bromine which is a liquid non-metal at room temperature.

Ex. Some of the examples of non-metals are : Carbon, Sulphur, Phosphorus, Hydrogen, Oxygen, Nitrogen, Chlorine, Bromine, Iodine, Helium, Neon, Argon, Krypton, and Xenon. Diamond and graphite are also non-metals.

◈ Properties of non-metals

The physical properties of non-metals are just the opposite of the physical properties of metals.

- Non-metals are not malleable.
- Non-metals are brittle.
- Non-metals are not ductile. This means that non-metals cannot be drawn into wires. They are easily snapped on stretching.
- Non-metals are bad conductors of heat and electricity.
- Non-metals are not lustrous (not shiny). They are dull in appearance.
- Non-metals are generally soft
- Non-metals are not strong. They have low tensile strength.
- Non-metals may be solid, liquid or gases at the room temperature.
- Non-metals have comparatively low melting points and boiling points
- Non-metals have low densities.
- Non-metals are not sonorous.
- Non-metals have many different colours.
- Comparison Among the Properties of metals and non-metals.

Metals	Non-Metals
1. Metals are malleable and ductile. That is, metals can be hammered into thin sheets and drawn into thin wires.	**1.** Non-metals are brittle. They are neither malleable nor ductile.
2. Metals are good conductors of heat and electricity.	**2.** Non-metals are bad conductors of heat and electricity (except diamond which is a good conductor of heat, and graphite which is a good conductor of electricity)
3. Metals are lustrous (shiny) and can be polished	**3.** Non-metals are non-lustrous (dull) and cannot be polished (except iodine which is a lustrous non-metals)
4. Metals are solids at room temperature (except mercury which is a liquid metal).	**4.** Non-metals may be solid liquid or gases at the room temperature
5. Metals are strong and tough. They have high tensile strength.	**5.** Non-metals are not strong. They have low tensile strength.
6. Metals are sonorous. They make a ringing sound when struck.	**6.**Non-metals are not sonorous.

(c) Metalloids : -

The elements which show some properties of metals and some other properties of non-metals are called metalloids. Their properties are intermediate between the properties of metals and non-metals. Metalloids are also sometimes called semi-metals.

Ex. Boron (B), Silicon (Si), and Germanium (Ge).

(B) Compounds :

- A compound is a substance made up of two or more elements chemically combined in a fixed proportion by mass. A compound is formed as a result of chemical reaction, between the constituent elements. The properties of compound are different from the properties of the elements from which it is formed.

Ex. Water (H_2O) is a compound made up of two elements, hydrogen and oxygen, chemically combined in a fixed proportion of 1 : 8 by mass

- **Compounds can be further divided into three classes :** acids, bases and salts, on the basis of their properties.

Ex. Sulphuric acid is an acid, sodium hydroxide is a base whereas sodium sulphate is a salt.

◈ Characteristics of a compound

- In a compound constituents are present in definite proportion by mass
- The properties of a compound are different from the properties of its constituents.
- The constituents of a compound cannot be separated by simple physical processes
- Formation of a compound is generally accompanied by evolution of energy in the form of heat or light.
- A compound has a fixed melting point and boiling point.
- A compound is always homogeneous in nature.

➢ Mixtures

- A mixture is a substance which consists of two or more elements or compounds not chemically combined together. All the solutions are mixtures. The various substances present in a mixture are known as "constituents of the mixture" or "components of the mixture".

Ex. Lemonade (nimbu pani) is a mixture of water, lemon juice, sugar and salt.

- A mixture consists of two or more different type of particles having different chemical nature. Mixture may be homogeneous or heterogeneous. All the mixtures are impure substances. A mixture does not have a fixed composition or a fixed melting point and boiling point.

Types of mixtures

Mixtures are of two types **:**

(A) Homogeneous mixtures.

(B) Heterogeneous mixtures.

(A) Homogeneous mixtures :

- Those mixtures in which the substances are completely mixed together and are indistinguishable from one another, are called homogeneous mixtures.
- All the homogeneous mixtures are called solutions.

Ex. A mixture of sugar in water (called sugar solution) is a homogeneous mixture because all the parts of sugar solution have the same sugar-water composition and appear to be equally sweet. There is no visible boundary of separation between sugar and water particles in a sugar solution.

(B) Heterogeneous mixtures

Those mixtures in which the substances remain separate and one substance is spread throughout the other substance as small particles, droplets or bubbles, are called heterogeneous mixtures.

Ex. The mixture of sugar and sand is a heterogeneous mixture because different parts of this mixture will have different sugar-sand compositions. Some parts of this mixture will have more of sugar particles whereas other parts will have more of sand particles. There is a visible boundary of separation between sugar and sand particles. The suspensions of solids in liquids are also heterogeneous mixtures. A mixture containing two (or more) immiscible liquids is also a heterogeneous mixture.

Properties of mixture

- A mixture can be separated into its constituents by physical processes.
- A mixture shows the properties of all the constituents present in it.
- Energy is usually neither given out nor absorbed in the preparation of a mixture. So, the formation of a mixture is a physical change.
- The composition of a mixture is variable, the constituents can be present in any proportion by mass.
- A mixture does not have a definite melting point, boiling point.
- A mixture is usually heterogeneous.

Differences between mixtures and compounds

	Mixture		Compound
1	A mixture can be separated into its constituents by the physical processes (Like filtration, evaporation etc.) sublimation, distillation, solvents, magnet, etc.)	1	A compound cannot be separated into its constituents by physical processes (It can only be separated into its constituents by chemical
2	A mixture shows the properties of its constituents.	2	The properties of a compound are entirely different from those of its constituents.
3	Energy (in the form of heat, light, etc.) is usually neither given out nor absorbed in the preparation of a mixture	3	Energy (in the form of heat, light, etc.) is usually given out or absorbed during the preparation of a compound.
4	The composition of a mixture is variable, the constituents can be present in any proportion by mass. A mixture does not have definite formula	4	The composition compound of a compound is fixed, the constituents are present in fixed proportion by mass.
5	A mixture does not have a fixed melting point, boiling point.	5	A compound has a fixed melting point, boiling point.

Solutions

Solutions are of Three types.

(A) True Solutions

(B) Suspension

(C) Colloids

(A) True Solutions :

- A solution is a homogeneous mixture of two or more pure substances. A solution is made up of two parts i.e., a solute and a solvent. Usually the component which is present in larger amount is called solvent and the other is called solute.

Ex. In case of solution of sugar and water, sugar is the solute and water is the solvent.

- **Aqueous solutions**

  The solutions made by dissolving various solutes in water are called aqueous solutions.

Properties of solutions

- A solution is homogeneous in nature.
- The solute particles in a solution easily pass through a filter paper. Thus, a true solution passes through a filter paper.
- The solute particles in a solution cannot be seen by naked eyes.
- The properties of solute are retained in the true solution. Thus a sugar solution is sweet in taste and a solution of salt in water is saline in taste.
- A true solution does not scatter light and hence does not show tyndall effect. In other words, solutions are transparent to light.
- The solute particles in a solution do not settle on keeping.
- The diameter of solute particles in a solution is about 10^{-9} m.

Types of solutions

- **Solution of solid in a solid :** Metal alloys are the solutions of solids in solids.

Ex. Brass is a solution of zinc in copper. Brass is prepared by mixing molten zinc with molten copper and cooling their mixture.

- **Solution of solid in a liquid :** This is the most common type of solutions. Sugar solution and salt solution are the solutions of solids in liquids. A solution of iodine in alcohol called 'tincture of iodine' is also a 'solid in a liquid' type of solution. This is because it contains a solid (iodine) dissolved in a liquid (alcohol) solution.
- **Solution of liquid in a liquid :** Vinegar is a solution of acetic acid (ethanoic acid) in water
- **Solution of gas in a liquid :** Soda-water is a solution of carbon dioxide gas in water
- **Solution of gas in a gas :** Air is a solution of gases like oxygen, argon, carbon dioxide and water vapour, etc., in nitrogen gas. Nitrogen is the solvent in air and all other gases are solutes.

(B) Suspensions :

A suspension is a heterogeneous mixture in which the small particles of a solid are spread throughout a liquid without dissolving in it.

Ex. Chalk-water mixture, Muddy water, Milk of magnesia, Sand particles suspended in water, and Flour in water.

Properties of suspensions

- A suspension is a heterogeneous mixture.
- The particles of a suspension do not pass through a filter paper. Hence, it is possible to separate them by ordinary filtration.
- The particles of suspension can be seen with naked eyes or with the help of a simple microscope.
- The particles of suspension settle down when a suspension is left undisturbed. Thus, a suspension is unstable.
- The size of particles in a suspension is greater than 100 nm in diameter.
- A suspension is not transparent to light.

(C) Colloids :

- A colloid is a kind of solution in which the size of solute particles is intermediate between those in true solutions and those in suspensions. The size of solute particles in a colloids is bigger than that of a true solution but smaller than those of a suspension.

◈ Dispersed particles

The solute particles are also called 'dispersed particles'

◈ Dispersion medium

- Solvents are also known as dispersion medium.
- Solution, suspensions and colloids differ in the size of solute particles, the size of particles being minimum in solutions and maximum in suspensions.

◈ Properties of colloidal solutions

- **Heterogeneous Nature :** A colloidal solution is heterogeneous in nature. It consists of two phases : dispersed phase and dispersion medium.
- **Filtrability :** The size of the colloidal particles is less than the pores of a filter paper, and, therefore, they easily pass through a filter paper. Colloidal particles however, cannot pass through the parchment paper or an animal membrane or ultra-filter.
- **Tyndall Effect :** When a strong beam of light is passed through a colloidal solution placed in dark place, the path of the beam gets illuminated by a bluish light . This phenomenon is called **Tyndall effect.** The phenomenon is due to the scattering of light by the colloidal particles.
- The same phenomenon is noticed when a beam of sunlight enters a dark room through a small slit, due to scattering of light by dust particles in the air.
- **Visibility :** Colloidal particles are too small to be seen by the naked eye. They however, scatter light and become visible when viewed through an **ultra microscope**.
- **Brownian movement :** When colloidal particles are seen under an ultra microscope, the particles are found to be in constant motion in zig-zag path in all possible directions. This zig-zag motion of colloidal particles is called Brownian movement. The movement of the particles is due to the collisions with the molecules of the dispersion medium.
- **Diffusion :** Colloidal particles diffuse from a region of higher concentration to that of lower concentration. However, because of their bigger sizes colloidal particles move slowly and hence diffuse at slower rate.
- **Sedimentation or settling :** Under the influence of gravity, the solute particles tend to settle down very slowly. This rate of settling down or sedimentation can be accelerated by the use of high speed centrifuge called ultra-centrifuge.

◈ Classification of colloids

Colloids are classified according to the physical state of dispersed phase (solute) and the dispersion medium (solvent). Most of the colloids can be classified into the following seven groups.

- **Sol :** Sol is a colloid in which tiny solid particles are dispersed in a liquid medium.

Ex. Ink, Soap solution, starch solution and most paints.

- **Solid sol :** Solid sol is a colloid in which solid particles are dispersed in a solid medium.

Ex. Coloured gemstones (like ruby glass).

- **Aerosol :** An aerosol is a colloid in which a solid or liquid is dispersed in a gas (including air).

Ex. The examples of aerosols in which a solid is dispersed in a gas are : Smoke (which is soot in air) and Automobile exhausts. The examples of aerosols in which a liquid is dispersed in a gas are : Hairspray, Fog, Mist and clouds.

- **Emulsion :** An emulsion is a colloid in which minute droplets of one liquid are dispersed in another liquid which is not miscible with it.

Ex. Milk, butter and Face cream.

- **Foam :** The foam is a colloid in which a gas is dispersed in a liquid medium.

Ex. Fire-extinguisher foam ; Soap bubbles, shaving cream and Beer foam.

- **Solid foam :** The solid foam is a colloid in which a gas is dispersed in a solid medium.

Ex. Insulating foam, foam rubber and Sponge.

- **Gel :** The gel is a semi-solid colloid in which there is a continuous network of solid particles dispersed in a liquid.

Ex. Jellies and Gelating.

◈ **Differences between the true solutions, colloidal solutions and suspensions :**

	Name of the property	True solutions	Colloidal solutions	Suspensions
1	**Size of particles**	The solute particle in true solutions are molecules having diameter less than 1 nm	The particle size in colloidal solution lies in the range 1nm to 100 nm.	The size of the particles in the case of suspension is greater than 100 nm
2	**Visibility or Appearance**	The solute particles are invisible to the naked eye as well as under the most powerful microscope	The solute particles are invisible to the naked eye but their scattering effect can be viewed with the help of a microscope.	The solute particles are visible even to the naked eye or can be seen with the help of a microscope
3	**Setting**	The solute particles in the true solution do not settle.	The solute particles in the colloidal solution can be made to settle by centrifugation.	The solute particles in the suspension settle under gravity
4	**Filterability**	The solute particles in the true solution diffuse rapidly, pass through a parchment membrance as well as filter paper.	The solute particles in the colloidal solution do not pass through a parchment membrane, but pass through a filter paper.	The solute particles in the suspension cannot pass through a parchment membrane or a filter paper.
5	**Tyndall effect**	True solution does not show tyndall effect.	Colloidal solution shows tyndall effect.	Suspension may or may not show tyndall effect.
6	**Brownian movement**	True solution does not show Brownian movement.	Colloidal solution shows Brownian movement.	Suspension may show Brownian movement.

◈ **Concentration of solution**

◆ **Dilute solution :** The solution having small amount of solute is said to have low concentration. it is known as a dilute solution.

◆ **Concentrated solution :** The solution having a large amount of solute is said to be of high concentration. It is known as a concentrated solution. The concentration of a solution is amount of solute present in a given quantity of the solution. The most common way of expressing the concentration of a solution is the 'percentage method'.

Ex. A 10 per cent solution of common salt means that 10 grams of common salt are present in 100 grams of the solution.

We can calculate the concentration of a solution in terms of mass percentage of solute by using the following formula.

concentration of solution

$$= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

The mass of solution is equal to the mass of solute plus the mass of solvent. That is :

Mass of solution = Mass of solute + Mass of solvent

So, we can obtain the mass of solution by adding the mass of solute and the mass of solvent.

In the above given example :

Mass of solute (salt) = 10 g

And, Mass of solvent (water) = 90 g

So, Mass of solution = Mass of solute + Mass of solvent
= 10 + 90 = 100 g

Now, putting these values of 'mass of solute' and 'mass of solution' in the above formula, we get :

$$\text{Concentration of solution} = \frac{10}{100} \times 100$$
= 10 per cent (by mass)

- **The case of a liquid solute dissolved in a liquid solvent :** In the case of a liquid solute dissolved in a liquid solvent : The concentration of a solution is defined as the volume of solute in millilitres present in 100 millilitres of the solution.

Ex. A 20 per cent solution of alcohol means that 20 millilitres of alcohol are present in 100 millilitres of solution.

Concentration of solution

$$= \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

◈ Solubility

- The maximum amount of a solute which can be dissolved in 1 litre of a solution at a specified temperature is known as the solubility of that solute in that solvent (at that temperature).

◈ Effect of temperature and pressure on solubility

- The solubility of solids in liquids usually increases on increasing the temperature; and decreases on decreasing the temperature.
- The solubility of solids in liquids remains unaffected by the changes in pressure.
- The solubility of gases in liquids usually decreases on increasing the temperature; and increases on decreasing the temperature.
- The solubility of gases in liquids increases on increasing the pressure; and decreases on decreasing the pressure.

➢ PHYSICAL AND CHEMICAL CHANGES

On the basis of whether new substances are formed or not we can classify all the changes into two groups.

◈ Physical change

- A change in which no new substances are formed but physical form of the substance changes is known as physical change.
- The product formed in such changes is chemically identical to the starting substance.

Ex. When ice is heated, it changes into liquid water, on further heating it changes into steam. But water in the solid form (ice) or liquid form or in gaseous form (steam) is chemically the same substance.

Thus, this transformation represents a physical change. Physical changes can be reversed easily.

Ex. Steam on colling forms liquid water, which on further cooling changes into ice.

◈ Chemical change

- A change in which one or more substances change into new substances is known as chemical change.
- Such a change cannot be reversed easily. Chemical changes are also known as chemical reactions.

Ex. When electricity is passed through water. it decomposes into two new substances, hydrogen and oxygen. Thus, it represents a chemical change. Similarly, burning of candle, rusting or iron and calcination of lime-stone are also examples of chemical changes.

◈ Differences between physical and chemical changes

	Physical change		Chemical change
1	No new substance is formed in a physical change	1	A new substance is formed in a chemical change
2	A physical change is a temporary change.	2	A chemical change is a permanent change
3	A physical change is easily reversible.	3	A chemical change is usually irreversible.
4	Very little heat (or light) energy is usually absorbed or given out in a physical change	4	A lot of heat (or light) energy is absorbed or given out in a chemical change
5	The mass of a substance does not alter in a physical change.	5	The mass of a substance does alter in a chemical change.

Separation of mixtures

- Many of the materials around us are mixtures. These mixtures have two or more than two substances mixed in them. It may not be possible to use a mixture as such in homes and in industries. We may require only one (or two) separate constituents of a mixture for our use. So, we have to separate the various mixtures into their individual constituents to make them useful in our daily life.

Separation of mixture of two solids

All the mixtures containing two solid substance can be separated by one of the following methods**:**

- **Separation by a suitable solvent :** In some cases, one constituent of a mixture is soluble in a particular liquid solvent whereas the other constituent is insoluble in it. This difference in the solubilities of the constituents of a mixture can be used to separate them.

Ex. Sugar is soluble in water whereas sand is insoluble in it, so a mixture of sugar and sand can be separated by using water as solvent.

- **Separation by sublimation :** The changing of a solid directly into vapours on heating, and of vapours into solid on cooling is called sublimation. The solid substance which undergoes sublimation is said to 'sublime'. The process of sublimation is used to separated those substances from a mixture which sublime on heating. The solid substance obtained by cooling the vapour is known as sublimate.

Ex. Ammonium chloride, Iodine, Camphor,. can be separated from a mixture by sublimation.

- **Separation by a magnet :** Iron is attracted by a magnet. This property of iron is used to separate it from a mixture. So, if a mixture contains iron as one of the constituents, it can be separated by using a magnet.

Ex. A mixture of iron filings and sulphur power can be separated by using a magnet. This is because iron filings are attracted by a magnet but sulphur is not attracted by a magnet.

Separation of mixture of a solid and a liquid

All the mixtures containing a solid and a liquid are separated by one of the following processes:

- **Separation by filtration :** The process of removing insoluble solids from a liquid by using a filter paper is known as filtration. Filtration is used separating insoluble substances from a liquid. The liquid passes through the filter paper and collected in the beaker kept below the funnel. The solid particles do not pass through the filter paper and remain behind on the filter paper. The solid substance left behind on the filter paper is called residue. The clear liquid obtained is called filtrate.

Ex. A mixture of chalk and water is separated by filtration.

- **Separation by centrifugation :** We can separate the suspended particles of a substance in a liquid very rapidly by using the method of centrifugation. Centrifugation is done by using a machine called centrifuge. Centrifugation is a method for separating the suspended particles of a substance from a liquid in which the mixture is rotated at a high speed in a centrifuge.

- In the method of centrifugation, the mixture of fine suspended particles in a liquid is taken in a test-tube. The test-tube is placed in a centrifuge machine and rotated rapidly for some time. As the mixture rotates round rapidly, a force acts on the heavier suspended particles in it and brings them down to the bottom of the test-tube. The clear liquid, being lighter, remains on top

Ex. We can separate the clay particles suspended in water very rapidly by the method of centrifugation. The suspension of clay particles in water is taken in a test tube and rotated very fast in a centrifuge machine. the clay particles settle down at the bottom of the test-tube and clear water remains at the top.

- **Separation by Evaporation :** The changing of liquid into vapours is called evaporation. Evaporation is used to separate a solid substance that has dissolved in water (or any other liquid). The dissolved substance is left as a solid residue when all the water (or liquid) has evaporated. The use of process of evaporation for separating a mixture is based on the fact that liquids vapourise easily whereas solids do not vapourise easily. Though evaporation of a liquid can take place even at room temperature but it is very slow at room temperature. Evaporation can be made quicker by heating the solution.
- If we have a mixture of common salt and water, then we cannot separate common salt from water by filtration or centrifugation. This is because common salt is completely dissolved in water and not insoluble in it. We can recover common salt from salt-water mixture (or salt solution) by the process of evaporation.

Ex. The common salt dissolved in water can be separated by the process of evaporation. The solution of common salt and water is taken in a china dish and heated gently by using a burner. The water present in salt solution will form water vapours and escape into atmosphere. When all the water present in the solution of common salt and water gets evaporated, then common salt is left behind in the china dish as a white solid.

The process of evaporation is used on a large scale to obtain common salt from sea-water.

- **Purification by crystallisation** : The process of cooling a hot, concentrated solution of a substance to obtain crystals is called crystallisation. The process of crystallisation is used for obtaining a pure solid substance from impure sample.

(a) The impure solid substance is dissolved in the minimum amount of water to form a solution.

(b) The solution is filtered to remove insoluble impurities.

(c) The clear solution is heated gently on a water bath till a concentrated solution or saturated solution is obtained (This can be tested by dipping a glass rod in hot solution from time to time. When small crystals form on the glass rod, the solution is saturated). Then stop heating.

(d) Allow the hot, saturated solution to cool slowly.

(e) Crystals of pure solid are formed. Impurities remain dissolved in solution.

(f) Separate the crystals of pure solid by filtration and dry.

- **Separation by chromatography :**

Chromatography is a technique of separating two (or more) dissolved solids which are present in a solution in very small quantities. By using paper chromatography, we can separate two (or more) different substance present in the same solution. This separation is based on the fact that though two (or more) substances are soluble in the same solvent but their solubilities may be different. Some may be more soluble than the others.

Ex. Black ink is a mixture of several coloured substances which can be separated by paper chromatography.

- **Separation by distillation :** Distillation is the process of heating a liquid to form vapour, and then cooling the vapour to get back liquid. Distillation can be represented as :

$$\text{Liquid} \underset{\text{Cooling}}{\overset{\text{Heating}}{\rightleftharpoons}} \text{Vapour (or Gas)}$$

The liquid obtained by condensing the vapour is called 'distillate'. When the homogeneous mixture of solid and a liquid is heated in a closed distillation flask, the liquid, being volatile, forms vapour. the vapours of liquid are passed through a 'condenser' where they get cooled and condense to form pure liquid. This pure liquid is collected in a separate vessel. The solid, being non-volatile, remains behind in the distillation flask.

Ex. Salt-solution can be separated into salt and water by distillation.

- **Separation of mixture of two or more liquid**

All the mixtures containing two (or more) liquids can be separated by the following two methods:

(i) By the process of fractional distillation.

(ii) By using a separating funnel.

(A) Miscible liquids :

- Those liquids which mix together in all proportions and form a single layer are called miscible liquids.

Ex. Alcohol and water are miscible liquids because they mix together in all proportions and form a single layer on mixing. A mixture of miscible liquids is separated by the process of fractional distillation.

(B) Immiscible liquids :

Those liquids which do not mix with each other and form separate layers are called immiscible liquids.

Ex. Oil and water are immiscible liquids because they do not mix with each other., and form separate layers on mixing. Water being heavier forms the lower layer, and oil being lighter forms the upper layer. A mixture of immiscible liquids is separated by using an apparatus called separating funnel.

(i) Separation by fractional distillation :

Fractional distillation is the process of separating two (or more) miscible liquids by distillation, the distillate being collected in fractions boiling at different temperatures. A mixture of two miscible liquids can be separated by the process of fractional distillation. The separation of two liquids by fractional distillation depends on the difference in their boiling points. Fractional distillation is carried out by using a fractionating column.

Ex. Alcohol and water are miscible liquids. The boiling point of alcohol is 78ºC and the boiling point of water is 100ºC. Since the boiling points of alcohol and water different, therefore, a mixture of alcohol and water can be separated by fractional distillation. The mixture of alcohol and water is heated in a distillation flask fitted with a fractionating column. When the mixture is heated, both alcohol and water form vapours as their boiling points approach. The alcohol vapour and water vapour rise up in the fractionating column. The upper part of the fractionating column is cooler, so as the hot vapours rise up in the column, they get cooled, condense and trickle back into the distillation flask.

The more volatile liquid distils over first, and the less volatile liquid distils over later. A mixture of alcohol and water can be separated by fractional distillation.

(ii) Separation by a separating funnel :

A mixture of two immiscible liquids can be separated by using a separating funnel. A separating funnel is a special type of funnel which has a stop-cock in its stem to allow the flow of a liquid from it, or to stop the flow of liquid from it. The separation of two immiscible liquids by a separating funnel depends on the difference in their densities.

The mixture of two immiscible liquids is put in a separating funnel and allowed to stand for some time. The mixture separates into two layers according to the densities of the liquids in it. The heavier liquid or denser liquid forms the lower layer whereas the lighter liquid forms the upper layer. On opening the stop-cock of separating funnel, the lower layer of heavier liquid comes out first and collected in a beaker. When the lower layer of heavier liquid has completely run off, the stop-cock is closed. The lighter liquid in the upper layer is collected in a separate beaker by opening the stop-cock again.

Ex. Water and kerosene oil are two immiscible liquids. So, a mixture of water and kerosene can be separated by using a separating funnel.