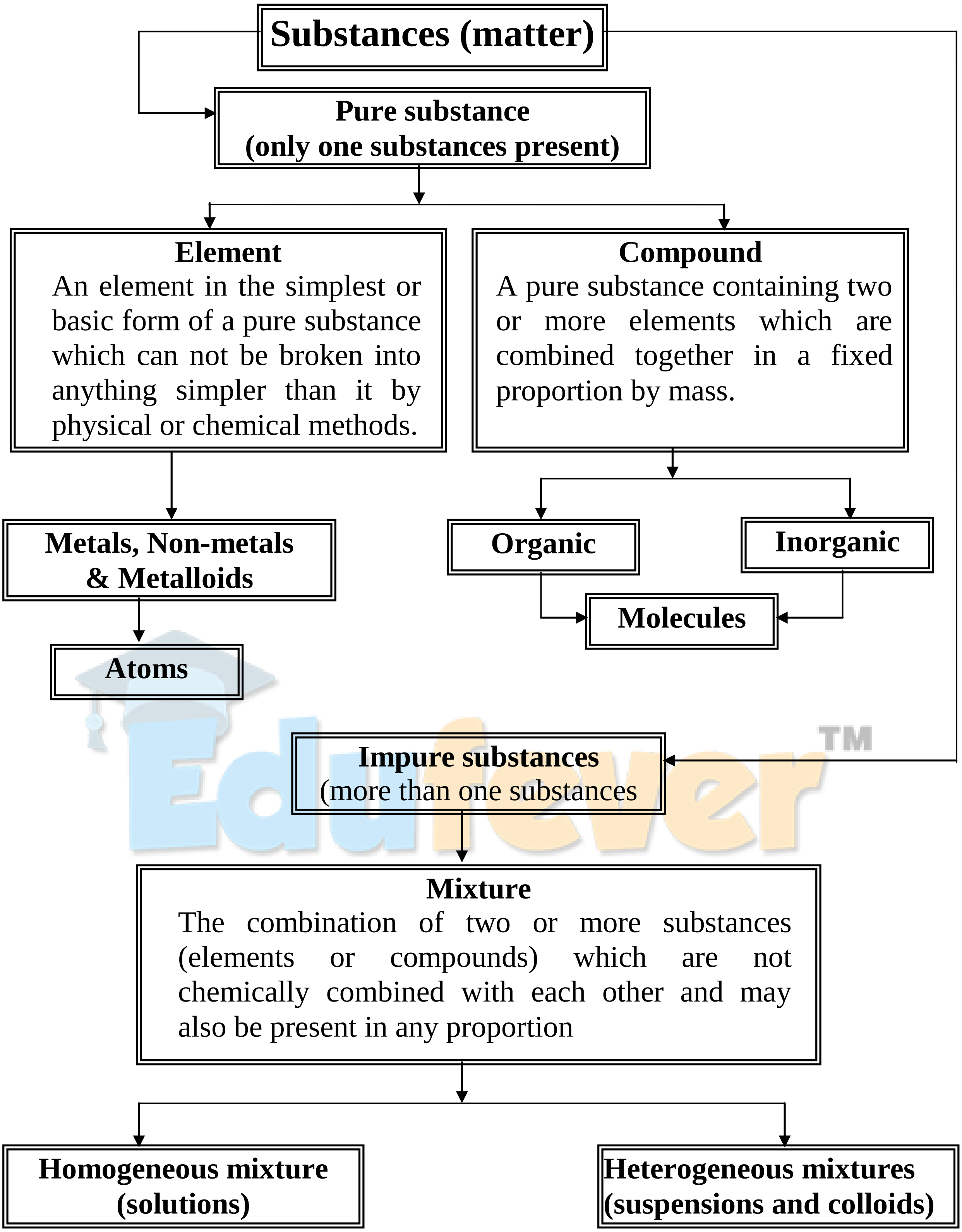
Chapter 2 - Is Matter Around Us Pure - Summary Note

SUB- TOPICS

- **Introduction**
- **Pure and impure substances**
- **Mixture and its types**
- **Solutions, suspensions and colloids**
- **Depuration of mixture**

- **INTRODUCTION**
  - Matter is made of one or more components known as substances.
  - In terms of science, a substance is a kind of matter which cannot be separated into any other types of matter by some physical means.
  - Such a substance which has only one component and nothing else in it is called a pure substance.
  - Substances are mostly mixed with one another and their combination is known as mixture.



- **PURE AND IMPURE SUBSTANCES**
  - **Pure substances:** A pure substance is one which is made up of only one kind of particles. These may be atoms or molecules and can't be separated by any physical method for example water, sulphur, hydrogen, carbon etc. are know as pure substances because they are made up of only one kind of particles. A pure substance has a fixed composition as well as a fixed melting point and boiling point.

- **Impure Substances:** An impure substances is that which made by two or more than two different kinds of particle (atoms or molecules) and can be separated by physical method. All the mixtures are impure substances. Some of the examples of the mixtures are: salt solution, sugar solution, milk, sea-water, air, sugarcane juice, soft drinks, sharbat, rocks, minerals, petroleum, LPG, biogas, tap water, tea, coffee, paint, wood, soil and bricks. A mixture may be homogeneous or heterogeneous. A mixture does not have a fixed composition or a fixed melting point and boiling point.

➢ **Types of pure Substances:** Pure substances have been classified into two types. These are elements and compounds.

➢ **An element is the simplest or basic form of a pure substance which cannot be broken into anything simpler than it by physical or chemical methods.**

The later studies by Dalton have shown that the simplest form of matter is atoms. It may now be defined as

The pure substance which is made up of one kind of atom only. Examples hydrogen, carbon, oxygen, etc.

Elements can be solids, liquids and gases. For example, sodium and carbon elements are solids; mercury and bromine elements are liquids, whereas hydrogen and oxygen elements are gases, at the room temperature. In fact, majority of the elements are solids. Elements further classified in to three forms:

- **Metals**
- **Non-metals**
- **Metalloids**

➢ **Metals**

A metal is an element that is malleable and ductile, and conducts electricity some of the **examples** of metals are: Iron, Copper, Aluminium, zinc,, Silver, Gold, Platinum, Chromium, Sodium, potassium, Magnesium,

➢ **Non-Metals**

Non-metals as the name suggests are opposite to metals, which means that their properties are quite different from the metals. They are comparatively less in number but they are very important for living organism. Only about fourteen to fifteen elements are non-metals. Eg. Carbon, Sulphur, Phosphorous, Hydrogen and Oxygen.

COMPARISON AMONG THE PROPERTIES OF METALS AND NON-METALS

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

➢ **Metalloids**

There are a few elements which possess the characteristics of both the metals and non-metals. These are actually **border-line** elements and are known as metalloids. A few common examples of metalloids are: Boron (B), Silicon (Si), Germanium (Ge), Arsenic (As), Antimony (Sb), Bismuth (Bi), Tellurium (Te) and Polonium (Po).

Illustration – 1: State two reasons for believing that copper is a metal and sulphur is a non-metal.

Solution: The two properties which tell us that copper is a metal and sulphur is a non metal are given below:-

a. Copper

1. Copper is malleable and ductile. It can be hammered into thin sheets and drawn into wires.
2. Copper is a good conductor of heat and electricity.

b. Sulphur

1. Sulphur is neither malleable nor ductile. It is brittle. Sulphur breaks into pieces when hammered or stretched.
2. Sulphur is a bad conductor of heat and electricity.

- **MIXTURE AND ITS TYPES**

Compounds:

It is also pure substance like elements. But it represents a combination of two or more than two elements which are combined chemically.

“A pure substance containing two or more elements which are combined together in a fixed proportion by mass”

Example: H_2O (water), CO_2 (Carbon dioxide),NH_3 (Ammonia) etc.

Types of Compounds:

The compounds have been classified into two types. These are:

(a) Inorganic compounds: These compounds have been mostly obtained from non-living sources such as rocks and minerals. A few examples of inorganic compounds are: common salt, marble, washing soda, baking soda, carbon dioxide, ammonia, sulphuric acid ect.

(b) Organic compounds: The word 'organ' relates to different organs of living beings. Therefore, organic compounds are the compounds which are obtained from living beings i.e., plants and animals. It has been found that all the organic compounds contain carbon as their essential constituent. Therefore, the organic compounds are quite often known as **'carbon compounds'.** A few common examples of organic compounds are: methane, ethane, propane (all constituents of cooking gas), alcohol, acetic acid, sugar, proteins, oils, fats etc.

- **Characteristic of compounds**
- The important characteristics of the compounds are:
- **A pure compounds is-composed of the same elements**
- A pure compounds is homogeneous in nature
- Properties of the compound are altogether different from the element "from which it is formed.
- Since a compound is formed as a result of chemical reaction, its properties quite different from the elements from which it is formed. For example, hydrogen gas is combustible while oxygen is a supporter of combustion. Water is formed as result of the chemical reaction between the two gases. It is neither combustible nor a supporter of combustion. It extinguishes or stops combustion. We often add water to extinguish fire.
- Constituents of a chemical compounds cannot be separated mechanically.
- Formation of compounds involves energy change.
- What is considered to be a compound due to the following reasons:
- Water cannot be separated into its constituent's hydrogen and oxygen by-physical methods.
- Properties of water are entirely different from its constituents' hydrogen and oxygen. Hydrogen is combustible while oxygen supports combustion. Water is quite different from the two and it extinguishes fire.
- Heat and light are given out when water is formed by burning hydrogen and oxygen.
- The composition of water is fixed. Its constituents hydrogen and oxygen are present in the ratio of 1: 8 by mass.
- Water has a fixed boiling point of 100°C (or 373 K) under atmospheric-pressure of 1 atmosphere (or 760 mm).

Mixture

"The combination of two or more substance (element of compounds) which are not chemically combined with each other and may also be present is any proportion is known as mixture". There are two type of mixture:

- Homogeneous mixture
- Heterogeneous mixture

Elements and compounds are pure substance. Mixtures are not pure substances in terms of science.

(1) Homogeneous Mixtures

"A mixture is said to be homogeneous the different constituents or substances present in it exist in one single phase without any visible boundaries of separation in them. A homogeneous mixture has a uniform composition throughout". A few examples of homogeneous mixture are as follows:

When we dissolve a salt like sodium chloride of sugar present in the solid phase water (liquid phase), the mixture formed as a result of mixing is in single phase only. It is the liquid phase known as solution. In the solution, the particles of sodium chloride or sugar lose their physical state but not their identity. A solution of sodium chloride has a bitter taste while sugar solution is sweet in taste.

- Air is also a homogenous mixture of a number of gases like nitrogen, oxygen, carbon dioxide, water vapours, inert gases etc. All the gases present in air constitute one single phase i.e., gaseous phase. Air is also regarded as solution.
  All homogeneous mixtures are regarded as solutions.

(2) Heterogeneous Mixtures

"A mixture is said to be heterogeneous if it does not have a uniform composition and also has visible boundaries of separation between the constituents."

A few examples of heterogeneous mixtures are:

- A mixture of sand and common salt is regarded as a heterogeneous mixture. No doubt, these are present in the same phase i.e., solid phase but have clear boundaries of separation. The particles of sand and common salt can be easily seen in the mixture.
- Similarly, oil and water form a heterogeneous mixture. Here also both the constituents are liquids but have different boundaries of separation. Both oil and water are present in different layers.

Distinction between compounds and a mixture:

ounds	**res**
1. In a compound, two or more elements are combined chemically.	In the mixture, two or more elements or compounds are simply mixed not combined chemically
2. In a compound, the elements are present in the fixed ratio by mass. This ratio cannot change.	In a mixture, the constituents are present in fixed ratio. It can very.

3.	Compounds are always homogeneous i.e., they have the same composition throughout.	Mixtures may be either homogeneous or heterogeneous in nature.
4.	In a compound, the constituents lose their identities i.e., a compound does not show that characteristics of the constituting element.	In a mixture, the constituents do lose their identities i.e., a mixture shows the characteristics of all the constituents.
5.	In the formation of a compound, energy in the form of heat, light or electricity is either absorbed or evolved.	No energy change is noticed in the formation of a mixture.
6.	In a compounds, the constituents cannot be separated by physical means.	The constituents from a mixture can be easily separated by physical mean.

Illustration – 2: *(i)* Explain why, air is considered a mixture and not a compound.

Solution

Air is considered a mixture because of the following reasons:

a. Air can be separated into its constituents like oxygen, nitrogen, etc., by the physical process or fractional distillation (or liquid air).

b. Air shows the properties of al the gases present in it. For example, oxygen supports combustion and air also supports combustion; carbon dioxide turns lime- water milky and air also turns lime-water milky, though very, very slowly.

c. Heat and light, etc., are neither given out nor absorbed when air is prepared by mixing the required proportions of oxygen, nitrogen, carbon dioxide, argon, water vapour, etc.

d. Air has a variable composition because air at different places contains different amounts of the various gases. It does not have a definite formula.

e. Liquid air does not have a fixed boiling point.

(ii) Classify the following into element, compounds and mixture: Sodium, Soil, Sugar solution, Silver, Calcium carbonate, tin Silicon, Coal, Air, Soap, Methane, Carbon Dioxide, Blood.

Solution:

We can classify the given materials into elements, compound and mixtures as follows:

a. Elements: Sodium, Silver, Tin, Silicon

b. Compounds: Calcium carbonate, Soap, Methane, Carbon dioxide.

c. Mixtures: Soil, Sugar Solution, Coal, Air, Blood.

(iii) Give the names of the elements present in the following compounds: ***(a)*** Quicklime ***(b)*** Hydrogen bromide, ***(c)*** Baking soda ***(d)*** Potassium sulphate

Solution:

a. Quicklime is calcium oxide, CaO. The elements present in it are: Calcium (Ca) and Oxygen (O).

b. Hydrogen bromide is HBr. The elements presen tin it are: Hydrogen (H) and Bromine (Br).

c. Baking soda is sodium hydrogencarbonate, $NaHCO_3$. The elements present in it are: Sodium (Na), Hydrogen (H), Carbon (C) and Oxygen (O).
d. Potassium sulphate is K_2SO_4. The elements present in it are: Potassium (K), Sulphur (S) and oxygen (O).

- **SOLUTION, SUSPENSIONS AND COLLOIDS**

The case of Solution

Solute: The substance which is dissolved to make solution known as solute like: salt, sugar etc.,

Solubility of a solute: "The maximum amount of solute which can be dissolved is 100 gm of the solvent of form a saturated solution at a given temperature is known as a solubility of a solute."

It is directly proportional to temperature.

$$\text{Solubility} = \frac{\text{mass of solute}}{\text{mass of solvent}} \times 100$$

Solution can be further divided in to two types on the basic of solubility of solute

SATURATED AND UNSATURATED SOLUTIONS

Saturated solution: A solution is said to be saturated if it has maximum amount of the solute dissolved in it at a given temperature and no solute can be dissolve further.

Unsaturated solution: A solution is said to be unsaturated if the more amount of solute can be dissolved in it at a given temperature.

Suspensions

The substances which are insoluble in water form suspension. " It is a heterogeneous mixture in which the small particles of a solid are spread throughout a liquid without dissolving in it'. **Example**: Chalk water mixture, muddy water milk of magnesia, fluorine water etc.

Characteristic of Suspension

- A suspension is of heterogeneous nature- There are two phase. The solid particles represent one phase while the liquid in which these are suspended or distributed forms the other phase
- The particle size in a suspension is more than 100 mn (or 10^{-7} m).
- The particles in a suspension can be seen with naked eyes and also under a microscope.
- The solid particles present in the suspension can be easily separated by ordinary filter papers. No special filter papers are needed for the purpose.
- The particles in a suspension are unstable. They settle down after sometime when the suspension is kept undisturbed. This is known as precipitate.
- *It should be noted that suspension-and precipitate are actually the same. The particles of the solid in the suspended form represent suspension. When they settle, a precipitate result.*

Colloids

- Colloid is a kind of solution in which the size of solute partials is intermediate between those the true solutions and those are in suspension. Colloidal solutions are also heterogeneous in nature like suspensions, but they have smaller size of the particles, which are distributed. It ranges between 1 nm to 100 nm i.e., in between the particles size in true solution and suspension. Since the particles sizes are close two what we notice in solutions most of the colloidal solutions appear to be homogeneous like true solutions. But actually these are not.
- We come across a large variety of the colloidal solutions in daily life. Smoke coining out of the chimneys of factories, tooth paste, ink, blood, soap solutions, jellies, starch solution in water are a few common examples.

- We have stated earlier that the colloidal solutions are the heterogeneous mixtures. This means that, the constituents are not present in a single phase. Actually there are two phases in a colloidal solution. These are known as dispersed phase and dispersion medium.

Characteristic of Colloidal Solutions

- **Colloidal solutions appear to be homogeneous but are actually heterogeneous in nature.**
  This happens because of particle size (1 nm to 100 nm), which is quite close to particle in a colloidal solution as we do in case of suspension. But these can be seen under a microscope.

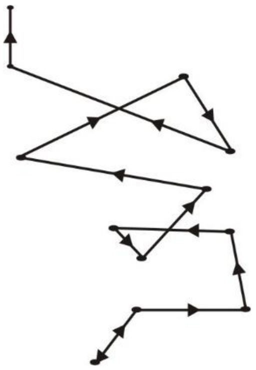
- **Colloidal solutions are a two phase system**
  We have discussed above that the colloidal solutions represent a two-phase system. These are dispersed phase and dispersion medium. That is why, the colloidal solutions are of heterogeneous nature.

- **Colloidal particles pass through ordinary filter papers**
  In most of the cases, the colloidal solutions pass through ordinary filter papers like true solutions. This is because of the fine size of the dispersed phase or colloidal particles. Special filter papers known as ultra filter papers have to be used to separate these particles from the dispersion medium.

- **Colloidal particles carry charge**
  We have learnt that the dispersed phase particles in a colloidal solution remain dispersed or suspended. They do not come close to one another as in case of suspension. This happens due to the presence of some charge (positive or negative) on these particles. Please remember that all the particles belonging to a particular colloidal solution carry the same charge. That is why, these similarly charged particles repel each other and remain dispersed or suspended. For **example**,
  Hemoglobin, starch, gelatin, metal like copper, silver, gold, metal sulphides have negative charge on their particles.

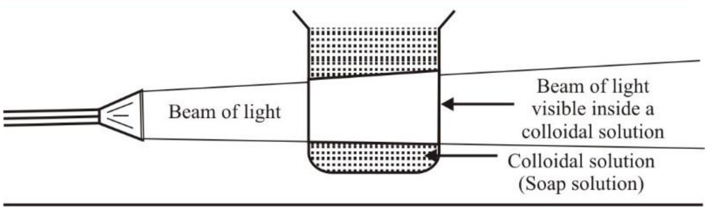
The hydroxides of metals like iron, aluminium, calcium etc. Have positive charge on their particles.

- **Particles in a colloidal solution follow zigzag path**



It is normally not possible to see the colloidal particles because of their very small size. However, their path can be seen under a microscope. These particles follow a zig-zag path. You can observe this motion while watching a film in a theater. The beam of light which falls on the screen from behind has dust particles present in it. They follow zig-zag path. Such type of movement of the colloidal particles was noticed for the first by Robert particles was noticed for the first by Robert Brown, English scientist in 1828. This is known as Brownian motion.

- **Tyndall effect:**
In a colloidal solution, the particles are big enough to scatter light. This can be shown as follows. If a beam of light is put on a colloidal solution (say, soap solution), kept in a beaker in a dark room, the path of light beam is illuminated and becomes visible when seen from the side. The path of light beam becomes visible because the colloidal particles are big enough to scatter light falling on them in all the direction. This scattered light enters our eyes and we are able to see the path of light beam.



- The particles in a colloidal solution scatter light
"The scattering of light by colloidal particles is known as Tyndall effect."
- Difference between suspension, colloidal and true solution

Property	Suspension	Colloidal solution	True solution
1. Particle size	> 100 nm	1 to 100 nm	< 1 nm
2. separation by ordinary filtration	Possible	Not possible	Not possible
3. settling of particles	Settle of their own	Settle only on centrifugation	Do not settle
4. appearance	Opaque	Generally transparent	Transparent

5. Tyndall effect	Shows	Shows	Does not show
6. diffusion of particles	Do not diffuse	Diffuse slowly	Diffuse rapidly
7. Brownian movement	May show	Show	May or may not shown
8. Nature heterogeneous	Heterogeneous	Homogeneous	

- To distinguish a colloid from a solution. We can distinguish between colloids (or colloidal solutions0 and true solutions by using tyndall effect. For example, a soap solution scatters a beam of light passing through it and render its path visible, therefore, soap solution is a colloid (or colloidal solution). On the other hand, salt solution does not scatter a beam of light passing through it and does not render, its path visible, therefore, salt solution is a true solution.
- Classification of Colloids
  Colloids are classified according to the physical state of dispersed phase (solute) and the dispersion medium (solvent). These are
  (i) Sol.
  (ii) Solid sol.
  (iii) Aerosol
  (iv) Emulsion
  (v) Foam
  (vi) Solid foam
  (vii) Gel

Technical name of colloid	**Dispersed phase**	**Dispersion medium**	**Examples**
1. sol.	Solid	Liquid	Ink, soap solution, starch solution, most paints
2. solid sol.	Solid	Solid	Coloured gemstone (kike ruby glass)
3. aerosol	(i) solid (ii) liquid	Gas Gas	Smoke, automobile exhausts hairspray, fog, mist, clouds
4. emulsion	Liquid	Liquid	Milk, butter, face cream
5. foam	Gas	Liquid	Fire-extinguisher foam, soap bubbles, shaving cream, beer foam
6. solid foam	Gas	Solid	Insulating foam, foam rubber, sponge
7. gel	Solid	Liquid	Jellies, gelatin

Illustration – 3: (i) A solution contains 30 g of sugar dissolved in 370 g of water. Calculate the concentration of this solution.

Solution: We know that concentration of solution $= \frac{\text{Mass of Solute}}{\text{Mass of solution}} \times 100$ Here,

Mass of solute (sugar) = 30 g and , Mass of Solvent (water) = 370 g

So, Mass of solution = Mass of solute + Mass of solvent = 30 + 370 = 400g Now, putting the values of 'mass of solute' and 'mass of solution' in the above formula, we get:

Concentration of solution = $\frac{30}{400} \times 100 = \frac{30}{4}$ = 7.5 percent (or 75%)

(ii) If 110 g of salt is present in 550 g of solution, calculate the concentration of solution.

Solution: Here, Mass of solute (salt) = 110 g and, Mass of solution = 550 g Now, we know that; concentration of solution

$= \frac{\text{Mass of Solute}}{\text{Mass of solution}} \times 100 = \frac{110}{550} \times 100 = \frac{100}{5} = 20$ percent (or 20%)

(iii) If 2 mL of acetone is present in 45 mL of its aqueous solution calculate the concentration of this solution.

Solution: Here, volume of solute (acetone) = 2 mL and, volume of solution = 45 mL Now, we know that: concentration of solution

$= \frac{\text{Mass of Solute}}{\text{Mass of solution}} \times 100 = \frac{2}{45} \times 100 = \frac{200}{45}$ = 4.4 percent (by volume)

(iv) 12 grams of potassium sulphate dissolves in 75 grams of water 60°C. What is its solubility in water at that temperature?

Solution: Here we have been given that 75 grams of water dissolves 12 grams of potassium sulphate. We have to find how much potassium sulphate will dissolve in 100 grams of water. Now, 75 g of water dissolves = 12 g of potassium sulphate So, 100 g of water will dissolve = $\frac{12}{75} \times 100\text{g}$ of potassium sulphate = 16 g of potassium sulphate. Thus, the solubility of potassium sulphate in water is 16 g at 60°C.

- **SEPARATION OF MIXTURE**

These mixtures have two or more than two substance or constituents mixed. We may require only one or two separate constituents of a mixture for one use. So tey need to be separated the process which is used for it is based on the various physical properties of the constituents like boling point, melting point, volatility density etc.

Commonly used process which are used to separate the constituents of mixture are

- Sublimation
- Filtration
- Centrifugation
- Evaporation
- Crystallization
- Chromatography
- Distillation
- Fractional Distillation
- Separating funnel

In order to learn the separation of mixtures, we will consider the following three cases:

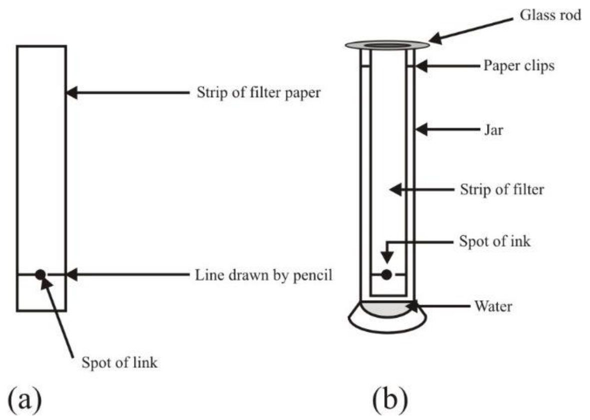
1. Mixture of two solids
2. Mixture of a solid and a liquid
3. Mixture of two liquids.

- **Separation of mixture of two solids**
  Mixture of two solids are separated by the following method
  a. By using a suitable solvent (sugar and sand mixture)
  b. By the process of sublimation (Ammonium chloride and common salt)
  c. By using a magnet (mixture of iron filling and sulphur power)

Separation of mixture of solid and a liquid

- By filtration
- By centrifugation
- By evaporation
- By crystallization
- By chromatography
- By distillation
- To Separate Cream From Milk

- **By centrifugation**
  It is a method for separating the suspended particle of a substance from a liquid in which the mixture is rotated (or sperm) at a high speed in centrifuge and force to denser particles to bottom and lighter on above layer.
- **By the process of chromatography**
  The ink that we use has water as the solvent and the dye is soluble in it. As the water rises on the filter paper it takes along with it the dye particles. Usually, a dye is a mixture of two or more colours. The coloured component that is more soluble in water rises faster and in this way the colours get separated.
  This process of separation of components of a mixture is known as chromatography. Kroma in Greek means colour. This technique was first used for separation of colours, so this name was given, chromatography is the technique used for separation of those solutes that dissolve in the same solvent.



- **Separation of dyes in black ink using chromatography**
  Separation of mixture of two liquids the miscible liquid (which mix together) in all proportion and form single layer) and immiscible liquid (which do not mix with each other and form a separate layers) are separated by the two method).

- **By the fractional distillation (for miscible liquid)**
  To separate a mixture of two or more miscible liquids for which the difference in boiling points is less than 25 K, fractional distillation process is used, for example, for the separation of different gases from air, different factions from petroleum product etc. The apparatus is similar to that for simple distillation, except that a fractionating column is fitted in between the distillation flask and the condenser.
  A simple fractionating column is a tube packed with glass beads. The beads provide surface for the vapor to cool and condense repeatedly.
- **Separation of the Gases of the Air**
  Air is a mixture of gases like nitrogen, oxygen, argon, carbon dioxide, helium, neon, krypton, and xenon, etc. The various gases of air are separated from one another by the fractional distillation of liquid air. This separation is based on the fact that the different gases of air have different boiling points (when in liquid form). A flow diagram showing the main processes involved in obtaining different gases from air is given below:

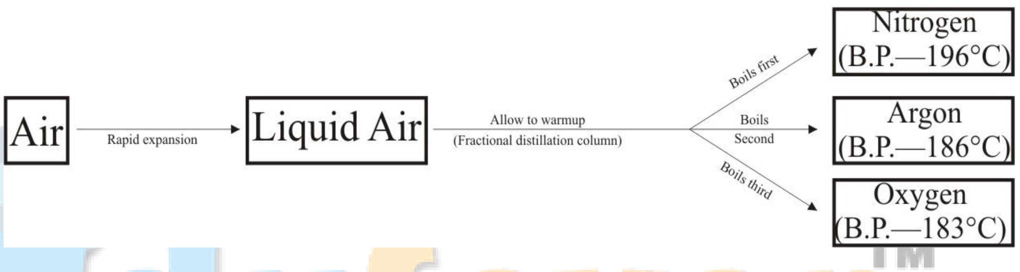


Illustration – 4: You are given a mixture of sand, water and mustard oil. How will you separate the components of this mixture?

Solution This mixture contains three components: sand, water and mustard oil. Now, sand is a solid which is insoluble in water as well as mustard oil. Water and mustard oil are immiscible liquids.

(a) The mixture of sand, water and mustard oil is filtered. Sand is left on the filter paper as residue. Water and mustard oil collect as filtrate.

(b) The filtrate containing water and mustard oil is put in a separating funnel. Water forms the lower layer and mustard oil forms the upper layer in separating funnel. The lower layer of water is fun out first by opening the stop-cock of the separating funnel. Mustard oil remains behind in the separating funnel and can be removed separately.