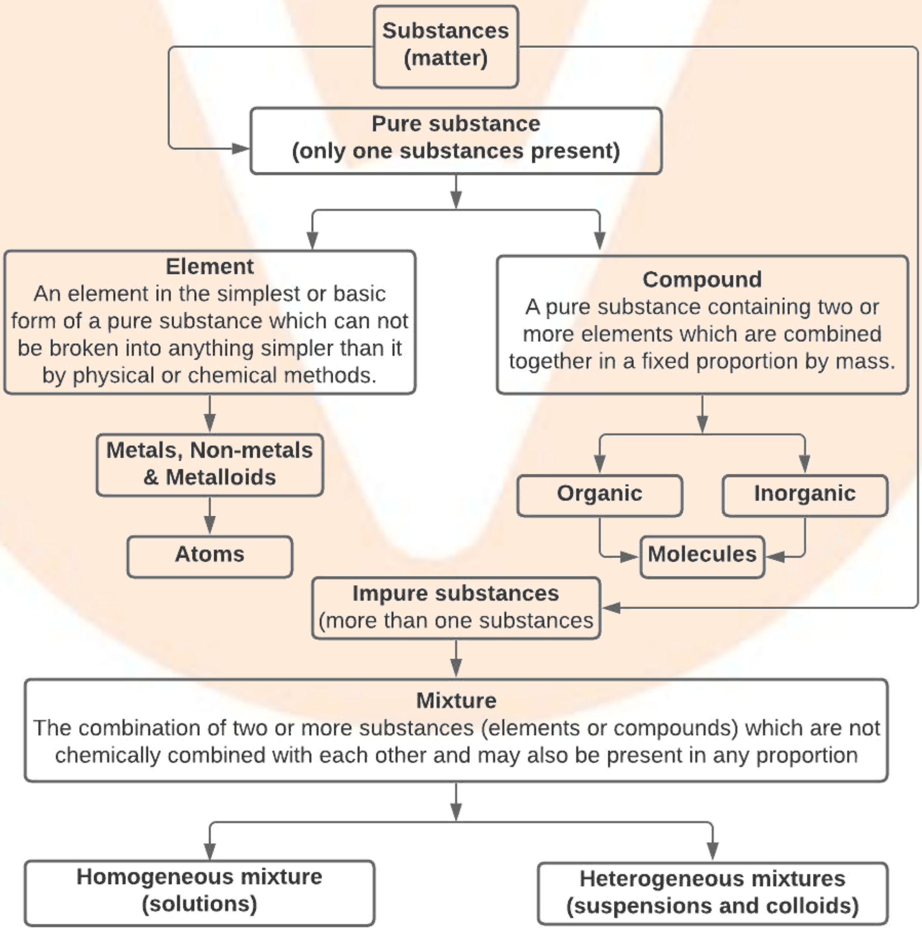
Revision Notes

Class - 9 Science

Chapter 2 - Is Matter Around Us Pure

Introduction:

- Substances are one or more components that make up matter.
- A substance is a sort of matter that cannot be divided into any other types of matter by physical means, according to science.
- The term "pure substance" refers to a substance that has only one component and nothing else.
- Substances are frequently mixed with one another, and the result is referred to as a mixture.



Pure and impure substances:

A. A **pure material** is one that has only one type of particle. Water, sulphur, hydrogen, carbon, and other pure substances (made up of only one type of particle) are known as pure substances since they can't be separated by any physical process. A pure substance has a constant composition, as well as a constant melting and boiling point.

B. **Impure Substances**: Impure substances are those that are made up of two or more types of particles (atoms or molecules) that may be separated using physical methods. All of the substances in the mixtures are impure. Salt solution, sugar solution, milk, seawater, air, sugarcane juice, soft beverages, sharbat, rocks, minerals, petroleum, LPG, biogas, tap water, tea, coffee, paint, wood, soil and bricks, are some examples of mixes. It is possible for a mixture to be homogeneous or heterogeneous. A mixture's composition, as well as its melting and boiling points, are not fixed.

Types of Pure Substances:

- Pure substances are divided into two categories. These are elements and compounds, respectively.
- A pure substance's simplest or basic form, which cannot be broken down into anything simpler than it by physical or chemical techniques, is called an element.
- Dalton's later research revealed that atoms are the simplest form of matter. It can now be defined as a pure substance made up of only one type of atom. Hydrogen, carbon, oxygen, and other elements are examples.
- Solids, liquids, and gases are all examples of elements. At room temperature, sodium and carbon elements, for example, are solids, mercury and bromine elements are liquids, and hydrogen and oxygen elements are gases. In reality, solids make up the vast majority of the elements. Elements are further divided into three types:
    a. Metals
    b. Non-metals
    c. Metalloids

Metals:

A metal is a malleable and ductile element that conducts electricity. Metals include Iron, Copper, Aluminium, Zinc, Silver, Gold, Platinum, Chromium, Sodium, Potassium, and Magnesium, to name a few.

Non-Metals:

Non-metals, as their name implies, are diametrically opposed to metals, implying that their properties are vastly different. They are relatively few in number, but they are vital to the survival of living organisms. Non-metals make up just approximately fourteen to fifteen percent of the elements in the periodic table. Carbon, Sulphur, Phosphorous, Hydrogen, and Oxygen are only a few examples.

Comparison among the Properties of Metals and Non-Metals:

Metals	Non-Metals
Metals are durable and powerful. They have an extremely high tensile strength.	Non-metals aren't very durable. Their tensile strength is modest.
Metals have a resonant quality to them. When struck, they generate a ringing sound.	Non-metals do not have a resonant quality.
Metals can be polished and are lustrous (bright).	Non-metals have a dull appearance and cannot be polished (except iodine which is a lustrous non-metals).
At normal temperature, metals are solids (except mercury which is a liquid metal).	At room temperature, non-metals might be solids, liquids, or gases.
Metals are excellent heat and electrical conductors.	Non-metals are poor heat and electrical conductors (except diamond which is a good conductor of heat, and graphite which is a good conductor of electricity).
Metals are ductile and malleable. Metals can be hammered into thin sheets and pulled into fine wires in this way.	Non-metallic materials are brittle. They aren't malleable or ductile in the least.

Metalloids:

There are a few elements that have properties that are similar to both metals and non-metals. Metalloids are elements that exist on the edge of existence. Boron (B), Silicon (Si), Germanium (Ge), Arsenic (As), Antimony (Sb), Bismuth (Bi), Tellurium (Te), and Polonium are some examples of metalloids (Po).

Illustration – 1:
Give two reasons why you believe copper is a metal and sulphur is not.
Ans: The following are the two qualities that indicate that copper is a metal and sulphur is a non-metal:

Copper

a. Copper is ductile and malleable. It can be pulled into wires and pounded into thin sheets.
b. Copper is a good heat and electrical conductor.

Sulphur

a. Sulphur is neither ductile nor malleable. It's fragile. When hammered or strained, sulphur fractures into fragments.
b. Sulphur is a poor heat and electrical conductor.

Types of Mixture:

- **Compounds:**

It's also a pure substance, similar to the elements. It does, however, indicate a chemically integrated mixture of two or more elements.
"A pure substance containing two or more elements mixed in a predetermined mass proportion"

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

- **Compound Types:** The compounds have been divided into two groups. These are the following:

(a) **Inorganic compounds:** These compounds are usually made up of non-living materials like rocks and minerals. Common salt, marble, washing soda, baking soda, carbon dioxide, ammonia, sulphuric acid, and other inorganic compounds are examples.

(b) **Organic compounds:** The term "organ" refers to several organs found in living organisms. As a result, organic chemicals are compounds derived from living organisms, such as plants and animals. It has been discovered that carbon is a fundamental component of all organic molecules. As a result, organic substances are frequently referred to as "**carbon compounds**."

- **Compound Characteristics:** The following are key compound characteristics:

a. A pure compound is made up of the same constituents.
b. The properties of a pure compound are completely different from the properties of the element from which it is created.

c. Because a compound is generated by a chemical process, it has qualities that are distinct from the elements from which it is formed. Hydrogen gas, for example, is combustible, but oxygen is a supporter of combustion. The chemical reaction between the two gases results in the formation of water. It isn't combustible and doesn't enable burning.
d. It puts an end to or extinguishes combustion. We frequently use water to put out fires.
e. Chemical compounds' constituents cannot be separated mechanically. Compound formation necessitates energy exchange.
f. Because of the following factors, water is termed a compound: Physical methods cannot separate water into its constituent's hydrogen and oxygen.
g. Water's properties are vastly different from those of its constituents, hydrogen and oxygen. Hydrogen is flammable, but oxygen promotes combustion. Water differs from the other two in that it extinguishes fire.
h. When hydrogen and oxygen are burned to make water, heat and light are released. The chemical make-up of water is constant.

i. The components hydrogen and oxygen are present in a $1:8$ mass ratio.
j. Under atmospheric pressure of 1 atmosphere, water has a stable boiling point of $100^\circ C$ (or $373\,K$) (or $760\,mm$).

Mixture:

- "A mixture is a combination of two or more substances (elements of compounds) that are not chemically combined but may also be present in any proportion." There are two different kinds of mixtures:

a. Homogeneous mixture
b. Heterogeneous mixture

- Compounds and elements are pure substances. In scientific terminology, mixtures are not pure substances.

Homogeneous mixture:

- "When diverse ingredients or substances in a combination exist in one single phase with no obvious borders of separation, it is said to be homogenous. The composition of a homogenous mixture is consistent throughout." Here are a few instances of homogenous mixtures:
- Because the dissolved salt is evenly distributed all through the salt water sample, it is a homogenous combination. All solutions are termed homogeneous since the dissolved component is present throughout the solution in the same quantity.

- Air is also a mixture of gases such as nitrogen, oxygen, carbon dioxide, water vapours, inert gases, and others. All of the gases in the air combine to form a single phase, the gaseous phase. Air can also be considered a solution.
- The term "solution" refers to any homogenous mixture.

Heterogeneous Mixtures:

- “If a combination does not have a homogeneous composition and visible borders of separation between parts, it is said to be heterogeneous.”
- Here are some instances of heterogeneous mixtures:
- A heterogeneous mixture is one that consists of sand and common salt. These are undoubtedly present in the same phase, namely the solid phase, yet they have distinct separation boundaries. The sand and ordinary salt particles are plainly visible in the combination.
- Oil and water, too, produce a heterogeneous mixture. Both constituents are liquids, but their separation boundaries are different.
- Oil and water can be found in different layers.

Distinction between compounds and a mixture:

Compounds	Mixtures
A compound is made up of two or more components that have been chemically joined. The elements of a compound are present in a set mass ratio. This proportion will not change. Compounds are always homogeneous, meaning that their makeup is the same throughout. The elements of a compound lose their identities, i.e., the constituting element's features are not visible in the compound.	Two or more elements or compounds are merely blended in the mixture rather than chemically combined. The ingredients of a mixture are present in a predetermined ratio. It can vary. In nature, mixtures can be either homogeneous or heterogeneous. The constituents of a mixture lose their identities, i.e., a mixture displays all of the constituents' qualities. In the development of a

Energy in the form of heat, light, or electricity is either absorbed or evolved during the synthesis of a compound. Physical separation of parts in a compound is impossible.	mixture, no energy change is observed. Physical means can easily separate the parts of a combination.

Illustration – 2:

I. Explain why air is a mixture rather than a compound.

Ans: Because of the following factors, air is considered a mixture:

a. By using a physical process or fractional distillation, air can be divided into its constituents such as oxygen, nitrogen, and other gases (or liquid air).
b. The properties of all the gases present in air can be seen. For example, oxygen and air both enable burning; carbon dioxide turns lime-water milky, and air turns lime-water milky as well, though at a far slower rate.
c. When air is generated by mixing the proper proportions of oxygen, nitrogen, carbon dioxide, argon, water vapour, and other gases, heat and light are neither given out nor absorbed.
d. Because different parts of the world have varied concentrations of various gases, air has a variable makeup. There isn't a set formula for it.
e. There is no fixed boiling point for liquid air.

II. Sort the following items into element, compound, and mixture categories: Sodium, Soil, Sugar Solution, Silver, Calcium Carbonate, Tin Silicon, Coal, Air, Soap, Methane, Carbon Dioxide, Blood

Ans: The following is how we can categorise the provided materials into elements, compounds, and mixtures:

a. Sodium, Silver, Tin, and Silicon are some of the **elements**.
b. Calcium carbonate, soap, methane, and carbon dioxide are examples of **compounds**.
c. Soil, Sugar Solution, Coal, Air, and Blood are examples of **mixtures**.

III. List the elements included in the following compounds and their names:

Quicklime (a), hydrogen bromide (b), baking soda (c), and potassium sulphate (d)

Ans: Calcium oxide (CaO) is quicklime. Calcium (Ca) and oxygen (O_2) are two of the elements found in it (O).

a. HBr stands for hydrogen bromide. Hydrogen (H) and Bromine (Br) are the elements present (Br).

b. Sodium hydrogen carbonate, or $NaHCO_3$, is the chemical formula for baking soda. It contains the elements sodium (Na), hydrogen (H), carbon (C), and oxygen (O).

c. K_2SO_4 is the chemical formula for potassium sulphate. It contains the elements potassium (K), sulphur (S), and oxygen (O).

Solutions, Suspensions and Colloids:

- The instance of Solution Solute: A solute is a substance that is dissolved to form a solution, such as salt or sugar.
- A solute's solubility is defined as its ability to dissolve in water. “A solute's solubility is defined as the greatest amount of solute that may be dissolved in 100 gm of solvent to form a saturated solution at a particular temperature.”
- It is directly proportional to temperature.

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

- On the basis of the solubility of the solute, solutions can be further split into two categories - **Saturated and Unsaturated Solutions.**
- A solution is considered to be **saturated** if it contains the maximum amount of the solute dissolved in it at a given temperature and no more solute can be dissolved.
- At a given temperature, a solution is said to be unsaturated if more solute can be dissolved in it.

Suspensions:

- Are made up of compounds that are insoluble in water. “A heterogeneous mixture is one in which minute solid particles are dispersed throughout a liquid without dissolving in it.” Examples include chalk water, muddy water, milk of magnesia, and fluorine water.
- Suspension Characteristics

a. A heterogeneous suspension is made up of two phases. One phase is made up of solid particles, while the other is made up of the liquid in which they are suspended or spread.

b. A suspension's particle size is greater than 100 microns (or 10^{-7} m).
c. A suspension's particles can be observed with the naked eye as well as under a microscope.
d. Ordinary filter sheets may easily separate the solid particles present in the suspension. For this reason, no specific filter sheets are required.
e. Suspension particles are inherently unstable. When the suspension is not disrupted, they settle down after a while. This is referred to as precipitate.
f. It's worth noting that the terms suspension and precipitate are interchangeable. Suspension is represented by the solid particles in their suspended state. When they settle, they form a precipitate.

Colloids:

- A colloid is a type of solution in which the size of the solute partials lies somewhere between real solutions and suspension. Colloidal solutions, like suspensions, are heterogeneous in nature, but the particles are smaller and more evenly dispersed. It is in the range of 1 nm to 100 nm, i.e., between real solution and suspension particle sizes. Because the particle sizes are so similar to what we see in solutions, most colloidal solutions appear to be homogeneous, just like genuine solutions. However, this is not the case.
- In everyday life, we come across a wide range of colloidal solutions. Typical examples include smoke from factory chimneys, tooth paste, ink, blood, soap solutions, jellies, and starch solution in water.
- Colloidal solutions are heterogeneous mixtures, as we already established. This signifies that the constituents aren't all present at the same time. In a colloidal solution, there are actually two phases. Dispersed phase and dispersion medium are the terms for these.

Characteristic of Colloidal Solutions:

- **Colloidal solutions appear to be homogeneous but are actually heterogeneous in nature.**

  This is due to the particle size (1 nm to 100 nm) in a colloidal solution, which is relatively near to the particle size in suspension. However, under a microscope, these can be seen.

- **Colloidal solutions are a two phase system**

We've already established that colloidal solutions are a two-phase system. Dispersed phase and dispersion medium are these terms. Because of this, colloidal solutions are diverse in character.

- **Colloidal particles pass through ordinary filter papers**

  Colloidal solutions flow through regular filter sheets like real solutions in the vast majority of circumstances. This is due to the dispersed phase's or colloidal particles' tiny size. To remove these particles from the dispersion media, special filter sheets called as ultra-filter papers must be utilised.

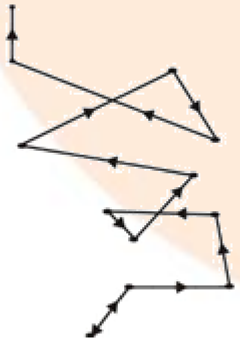
- **Colloidal particles carry charge**

  The dispersed phase particles in a colloidal solution remain scattered or suspended, as we have learned. They do not approach close to one other as they would if they were suspended. The presence of a charge (positive or negative) on these particles causes this. Please keep in mind that all of the particles in a colloidal solution have the same charge.

  As a result, these particles with identical charges repel one other and remain dispersed or suspended. Hemoglobin, starch, gelatin, and metals such as copper, silver, gold, and metal sulphides, for example, contain negative charge on their particles.

  Metal hydroxides, such as iron, aluminium, calcium, and others, have a positive charge on their particles.

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

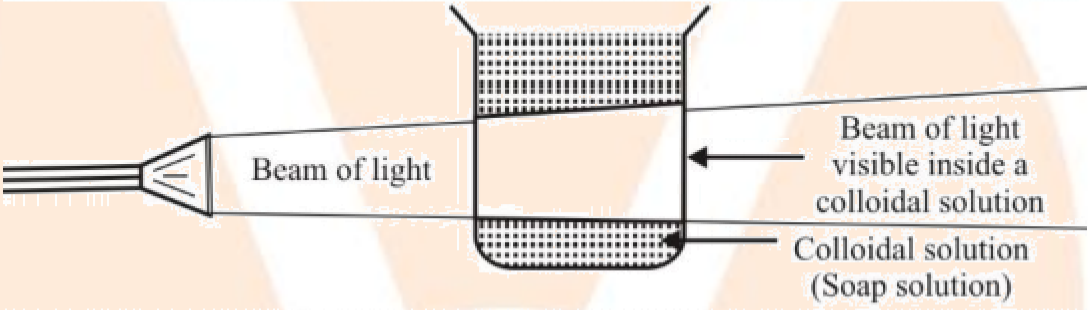


Because of their small size, colloidal particles are generally invisible. Their route, though, can be observed under a microscope. These particles travel in a zigzag pattern. This motion can be observed while viewing a movie in a theatre. Dust particles are present in the beam of light that falls on the screen from behind. They walk in a zigzag pattern.

In 1828, Robert Brown, an English physicist, was the first to detect such colloidal particle movement. **Brownian motion** is the name for this type of motion.

Tyndall effect: Scattering of light by colloidal particles:

- The particles in a colloidal solution are large enough to scatter light. This can be demonstrated as follows. When a light beam is focused on a colloidal solution (for example, soap solution) in a dark environment, the path of the light beam is lighted and visible when viewed from the side. Because colloidal particles are large enough to scatter light falling on them in all directions, the path of the light beam becomes visible. We can perceive the course of the light beam because of the scattered light that enters our eyes.



Property	Suspension	Colloidal solution	True solution
Particle size	> 100 nm	1 to 100 nm	< 1 nm
Separation by ordinary filtration	Possible	Not possible	Not possible
Settling of particles	Settle of their own	Settle only on centrifugation	Do not settle
Appearance	Opaque	Generally transparent	Transparent
Tyndall effect	Shows	Shows	Does not show
Diffusion of particles	Do not diffuse	Diffuse slowly	Diffuse rapidly

Brownian movement	May show	Show	May or may not shown
Nature heterogeneous	Heterogeneous	Homogeneous	

- **To tell the difference between a colloid and a solution.** The tyndall effect can be used to distinguish between colloids (or colloidal solutions) and real solutions. A soap solution, for example, scatters a ray of light travelling through it, making its path visible; thus, soap solution is a colloid (or colloidal solution). A beam of light travelling through salt solution, on the other hand, is not scattered.

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**
sol.	Solid	Liquid	Ink, soap solution, starch solution, most paints
solid sol.	Solid	Solid	Coloured gemstone (kike ruby glass)
aerosol	(i) solid (ii) liquid	Gas Gas	Smoke, automobile exhausts hairspray, fog, mist, clouds
emulsion	Liquid	Liquid	Milk, butter, face cream

foam	Gas	Liquid	Fire-extinguisher foam, soap bubbles, shaving cream, beer foam
solid foam	Gas	Solid	Insulating foam, foam rubber, sponge
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.

Ans: 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 the mass of solvent (water) = 370 g

So, Mass of solution = Mass of solute + Mass of solvent $= 30 + 370 = 400\text{g}$

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

Concentration of solution $= \frac{30}{400} \times 100 = \frac{30}{4} = 7.5\%$

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

Ans: Here, Mass of solute (salt) $= 110$ g and, Mass of solution $= 550$ g

Now, we know that; concentration of solution $= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$

$= \frac{110}{550} \times 100 = 20\%$

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

Ans: Here, volume of solute (acetone) = 2 mL and, volume of solution $= 45$ mL

Now, we know that: concentration of solution $= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$

$= \frac{2}{45} \times 100 = 4.4\%$

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

Ans: 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 $=\frac{12}{75}\times 100=16$ g of potassium sulphate.

Thus, the solubility of potassium sulphate in water is 16 g at $60°C$.

Separation of mixture:

- To tell the difference between a colloid and a solution. The tyndall effect can be used to distinguish between colloids (or colloidal solutions) and real solutions. A soap solution, for example, scatters a ray of light travelling through it, making its path visible; thus, soap solution is a colloid (or colloidal solution). A beam of light travelling through salt solution, on the other hand, is not scattered.

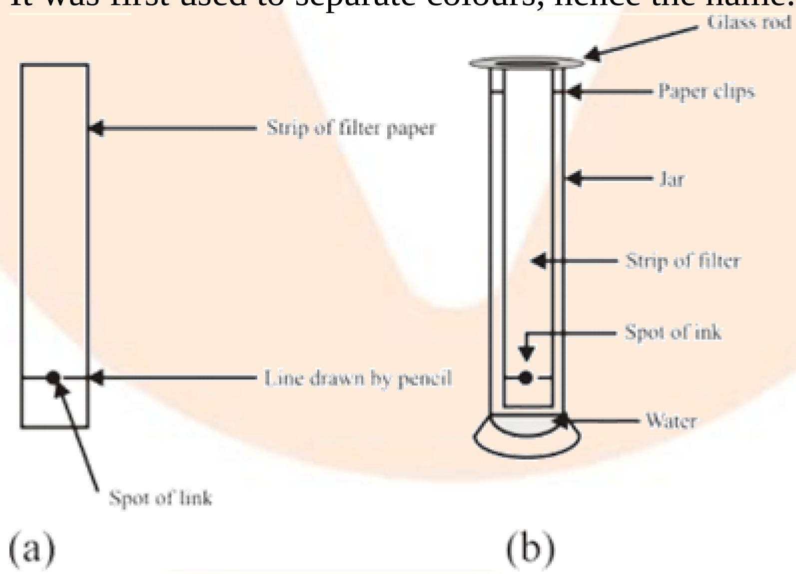
Commonly used process which are used to separate the constituents of mixture are:

a. Sublimation
b. Filtration
c. Centrifugation
d. Evaporation
e. Crystallization
f. Chromatography
g. Distillation
h. Fractional Distillation
i. Separating funnel

- We'll look at the following three scenarios to discover how to separate mixtures:
  1. A combination of two solids
  2. A solid and a liquid mixture
  3. A combination of two liquids.

- **Separation of a two-solid combination:**
  The following procedure is used to separate a mixture of two substances.
  a. Using a suitable solvent (a mixture of sugar and sand)
  b. Using the sublimation process (ammonium chloride and common salt)
  c. Using a magnet (mixture of iron filling and sulphur power)

- Separation of mixture of solid and a liquid
  a. By filtration
  b. By centrifugation
  c. By evaporation
  d. By crystallization
  e. By chromatography
  f. By distillation
  g. To Separate Cream From Milk
  h. **Centrifugation:** It is a method for separating suspended particles of a substance from a liquid in which the mixture (or sperm) is rotated at a high speed in a centrifuge, forcing denser particles to the bottom and lighter particles to the top layer.
  i. By the process of **chromatography:**
     Water serves as the solvent in our ink, and the dye is soluble in it. The dye particles are carried away by the rising water on the filter paper. A dye is usually a blend of two or more colours. The colour component that is more soluble in water rises faster, and the colours segregate as a result.
     Chromatography is the technique of separating the components of a mixture. The Greek word kroma means "colour." Chromatography is a technique for separating those solutes that dissolve in the same solvent. It was first used to separate colours, hence the name.



  j. **Separation of dyes in black ink using chromatography:**
     The two methods are used to separate a combination of two liquids: miscible liquid (which mixes together in all proportions and forms a

single layer) and immiscible liquid (which does not mix with each other and forms distinct layers).

k. **By the fractional distillation (for miscible liquid):**
Fractional distillation is used to separate a combination of two or more miscible liquids with a difference in boiling points of less than 25 K, such as for the separation of different gases from air, distinct factions from petroleum product, and so on.
The apparatus is similar to that used for simple distillation, except that between the distillation flask and the condenser is a fractionating column.
A simple fractionating column is a glass bead-filled tube. The beads serve as a surface for the vapour to cool and condense on multiple occasions.

l. **Separation of the Gases of the Air**
Nitrogen, oxygen, argon, carbon dioxide, helium, neon, krypton, and xenon, among other gases, make up air. Fractional distillation of liquid air separates the various gases of air from one another. This distinction is made due to the fact that the boiling points of the various gases in the atmosphere differ (when in liquid form).

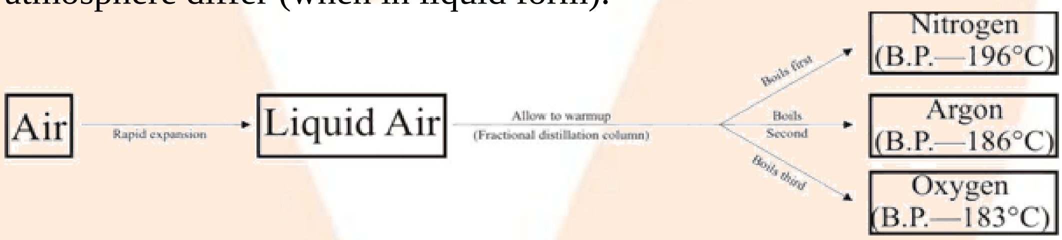


Illustration – 4: A mixture of sand, water, and mustard oil is administered to you. What method will you use to separate the various components of this mixture?
Ans: There are three ingredients in this mixture: sand, water, and mustard oil. Sand is now a solid that is insoluble in both water and mustard oil. Mustard oil and water are incompatible liquids.
(a) The sand, water, and mustard oil combination is filtered. As a residue, sand is left on the filter paper. The filtrate is made up of water and mustard oil.
(b) A separating funnel is used to collect the filtrate, which contains both water and mustard oil. In a separating funnel, the lower layer is water, and the upper layer is mustard oil. The bottom layer of water is removed first by opening the separating funnel's stop-cock. Mustard oil stays in the separating funnel and can be extracted individually.