We do know that matter is made up of particles which are arranged in a certain way. Gases particles are well separated and can freely move about, solids, on the other hand, have particles that are tightly packed, usually with no scope to move around.

Purity

Pure substances

- **Pure substances** are elements or compounds.
- They are made up of only one kind of entity.
- They cannot be broken down into simpler entities by chemical or physical methods.
- They have a fixed composition.
- **Example**: Diamond, carbon dioxide.
- A substance that only contains one type or class of atom is said to be an element. Since it cannot be altered through physical or chemical means to break down or create new substances, an element is a pure material. The majority of elements are metals, nonmetals, or metalloids.
- Pure substances typically only include one type of atom or molecule and are homogeneous in nature.
- Most of the time, the composition of these chemicals is constant or uniform.
- The boiling and melting points of the substances are constant.
- In a chemical reaction, a pure substance often takes part to produce predictable results.

Compounds

Compounds are the substances consisting of two or more different types of elements in a fixed ratio of its atoms.

Difference between mixtures and compounds

Compound	Mixture
Compounds are substances which can be formed by chemically combining two or more elements.	Mixtures are substances that are formed by physically mixing two or more substances.
Compounds fall under pure substances.	Mixtures can be categorized as impure substances.
The chemical composition of compounds is always fixed.	A mixture can have a variable composition of the substances forming it.

Compounds are always homogeneous in nature	Mixtures can either be homogeneous or heterogeneous in nature.
A new substance is formed after the constituents are chemically combined. So, a compound has different properties from its constituents.	No new substances are formed in mixtures and their properties are dependent on the properties of their respective constituents.

Example of compounds includes water (H_2O), Hydrogen Peroxide (H_2O_2), etc. You could see water's chemical formula, it says it has 2 atoms of Hydrogen combined with 1 atom of oxygen and in hydrogen peroxide, it has 2 atoms of hydrogen and two atoms of oxygen.

Elements

- **Elements** are species of atoms which have the same number of protons in their atomic nuclei.
- Elements are represented by **symbols** e.g.Hydrogen (H), Boron (B), Carbon (C), Silicon (Si) etc.

Metals

- **Metal** is a solid material which is typically hard, shiny, malleable, fusible, and ductile, with good electrical and thermal conductivity.
- **Examples**: Aluminium, Copper, Iron, Tin, Gold

Nonmetals

- **Non-metals** are brittle and are not malleable or ductile.
- They are poor conductors of heat and electricity.
- **Examples**: Carbon, Boron etc.

Metalloids

- **Metalloids** exhibit some properties of metals as well as of non-metals.
- **Examples**: Boron, silicon, germanium, arsenic, antimony, and tellurium

Mixtures

A mixture in chemistry is a substance made up of two or more unrelated chemical components. A mixture is a physical combination of two or more distinct substances that can take the form of solutions, suspensions, or colloids.

- Crude oil: A mixture of organic compounds (mainly hydrocarbons)

- Seawater: A mixture of various salt and water.

Mixtures are formed by just mixing two or more pure substances (components) such that each substance retains its own chemical identity.

Types of Mixtures:

Heterogeneous and homogeneous mixtures are the two types of mixtures. While homogeneous mixtures seem consistent throughout, heterogeneous mixtures have clearly discernible components. A solution, which can be a solid, liquid, or gas, is the most typical kind of homogenous mixture.

1. Homogeneous mixture

A mixture which has a uniform composition throughout is called a **homogeneous mixture or solution.**

- **Examples:** sugar in water, salt in water.

Heterogeneous mixture

A mixture which contains physically distinct parts and has a non-uniform composition is called a **heterogeneous mixture.**

- **Examples**: Mixture of salt and iron filings, sand and sugar.

Physical vs Chemical Changes

The nature of the substance, the particles that make up it, and the quantity of particles all stay unaltered after a physical change. Chemical changes result in new compounds with different properties from the original ones, as well as new particles and maybe altered particle numbers.

Physical and chemical changes

- A substance is said to undergo a **physical change** when only the physical properties such as the shape, size, colour or state of the substance change. No new substance is formed.
- Example: Melting of ice, boiling water.
- A substance is said to undergo a **chemical change** when a new substance with completely new properties (physical and chemical) is formed.
- Example: Burning of wood or paper, souring of milk.

Solutions

Solutions and their properties

Anything dissolved in a solution is referred to as a solute. In a fluid solution, the amount of solvent always outweighs the amount of solute. Two of the most prevalent solutes in our daily lives are salt and water. Salt is the solute because it dissolves in water.

Examples of solute include Sugar, dissolved carbon dioxide, Oxygen, water vapour, carbon dioxide, argon

Solvent refers to the component of a solution that is most prevalent. It is the fluid in which the solute has been dissolved. Typically, a solvent is a liquid. The Latin term solv, which meaning "to loosen or untie," is the source of the English word "solvent."

Examples of the solvent include Water, Ethanol, Methanol, Acetone, tetrachloroethylene, Toluene, Methyl acetate, Ethyl acetate.

- A **solution** is a homogeneous mixture of two or more substances.

Properties:

- Its particles are too tiny and have a diameter less than 1 nm.
- The particles are not visible to naked eyes.
- Particles do not scatter a beam of light passing through it and hence do not show the Tyndall effect.

- The solute particles never settle down on keeping undisturbed.
- The components of a solution cannot be separated using filtration.

Alloys

Alloys are homogeneous mixtures of metals or a mixture of a metal and another element that cannot be separated into their components by physical methods.

Examples:

- Steel, a combination of iron (metal) and carbon (non-metal).
- Bronze, a combination of copper (metal) and tin (metal).
- Brass, a mixture of copper (metal) and zinc (metal).

Concentration of Solutions

The amount of solute that has dissolved in a specific amount of solvent or solution is measured as solution concentration. A concentrated solution is one that has a significant amount of dissolved solute in it. A diluted solution is one that has a small amount of dissolved solute in it.

Solubility

Unsaturated solutions, on the other hand, are those that contain less solute than the maximum that can be dissolved. A saturated solution is one that contains the maximum quantity of solute that can be dissolved. The amount of a solute that dissolves in a solvent is known as its solubility. The majority of solutes become more soluble when the solvent's temperature rises.

- Solubility is the property showing the ability of a given substance, which is the solute, to dissolve in a solvent.
- It is measured in terms of the maximum amount of solute dissolved in a solvent at equilibrium.
- The resulting solution is called a saturated solution.
- **Factors Affecting Solubility:**
- Temperature - Solubility increases with temperature. The situation is different for gases. With the increase in temperature, they became less soluble in each other and in water, but more soluble in organic solvents.
- Pressure - For the majority of solid and liquid solutes, pressure does not affect solubility. The solubility of gas is directly proportional to the pressure of this gas.

Types of solutions based on the concentration of the solution

There are 2 main types of solutions based on the definition. Dilute Solution is a solution that contains a little amount of solute. Concentrated Solution is a solution that contains a lot of solute.

- **Three types** of solutions exist based on the concentration of the solution:

Dilute

Concentrated

saturated solution.

Ways of representing the concentration of a solution

The concentration of a solution can be represented in many ways

(i) **Mass by the mass percentage of a solution** = (Mass of solute / Mass of solution) × 100

(ii) **Mass by volume percentage of a solution** = (Mass of solute/ volume of solution)×100

For example, if a solution of NaCl in water is said to be 10 % by volume that means a 100 ml solution will contain 10 ml NaCl.

Suspensions

Suspension and its properties

> A **suspension** is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium.

- The solute particles settle down when a suspension is left undisturbed.
- They can be separated from the mixture by **filtration.**
- A suspension is a heterogeneous mixture.
- The size of solute particles in a suspension is quite large. It is larger than 100 mm in diameter.
- The particles of a suspension can be seen easily.
- The particles of a suspension do not pass through a filter paper. So a suspension can be separated by filtration.

Colloids

Types of mixtures based on particle size

Classified into:

- Solution
- Suspension.
- Colloidal solution.

Colloidal Solutions

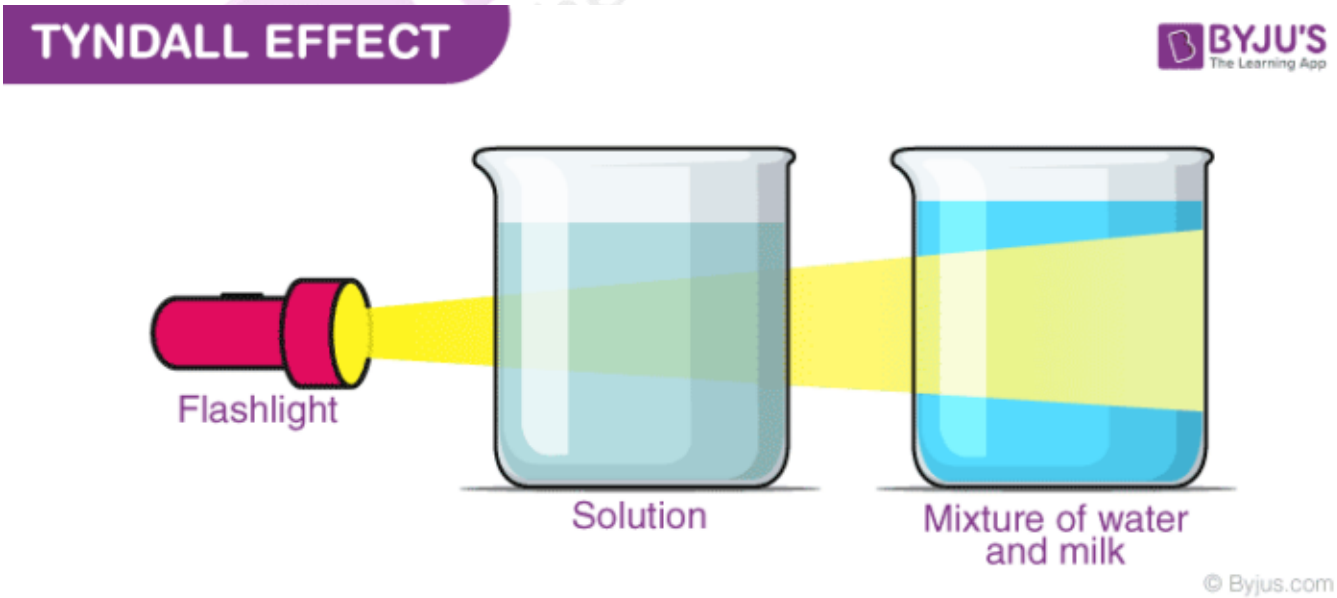
A **colloidal solution** is a mixture in which the substances are regularly suspended in a fluid.

Properties of colloids and their variation are a well-known area ever since the primitive age. The best example to prove their familiarity with us is that we know from very early times that coagulation of milk results in the formation of curd.

- Classified into: Foam, Emulsion, Sol

Tyndall Effect

Tyndall effect is the scattering of light by particles in a colloid or else particles in a very fine suspension.



- e.g.It can be observed when sunlight passes through the canopy of a dense forest.

Dispersed phase

The solute-like component of the dispersed particles in a colloid form the **dispersed phase.**

Dispersion medium

The component in which the dispersed phase is suspended is known as the **dispersing medium.**

Aerosol

A colloidal solution with dispersed phase solid/liquid and dispersing medium gas is called **Aerosol**. e.g. clouds

Foam

A colloidal solution with dispersed phase gas and dispersing medium solid/liquid is called **Foam.** e.g.Shaving cream.

Sols

A colloidal solution with dispersed phase solid and dispersing medium liquid is called **Sol.** e.g. Milk of magnesia, mud.

Gels and emulsions

- A colloidal solution with dispersed phase liquid and dispersing medium solid is called **Gel.**
- A colloidal solution with dispersed phase liquid and dispersing medium liquid is called **Emulsion.**

Emulsion and gel are two distinct chemical compounds. A gel is a semisolid substance, but an emulsion is a liquid, which is the main distinction between the two. Nevertheless, depending on their intended use, some emulsions can exist in a semisolid condition. Fruit jellies, a gelatinous substance, creams, etc.

Evaporation

The process of conversion of water into water vapour is known as **evaporation.**

Examples:

Clothes drying in the sun.

Tea and other hot liquids are cooled down.

Dry Floors

Ice cubes melting

- It can be used to separate the volatile component (solvent) from its non-volatile solute.

Introduction to Separation

Separation of components of a mixture

- Heterogeneous mixtures can be separated into their constituents by simple **physical methods.**
- **Methods include**: handpicking, sieving, filtration.


Handpicking


Sieving

Separation of Two Immiscible Liquids

Separation of a mixture of two immiscible liquids

- Separation of a mixture of two immiscible liquids is done by using a separating funnel.

- **Applications:** To separate a mixture of oil and water, in the extraction of iron from its ore.

Immiscible liquids break out into layers according to their densities, which is the basic idea behind the separation of immiscible liquids using a separating funnel.

Centrifugation

- **Centrifugation** uses centrifugal force for the separation of two liquids in a mixture.
- Here, a denser component of the mixture migrates away from the axis, and lighter component migrates towards the axis.

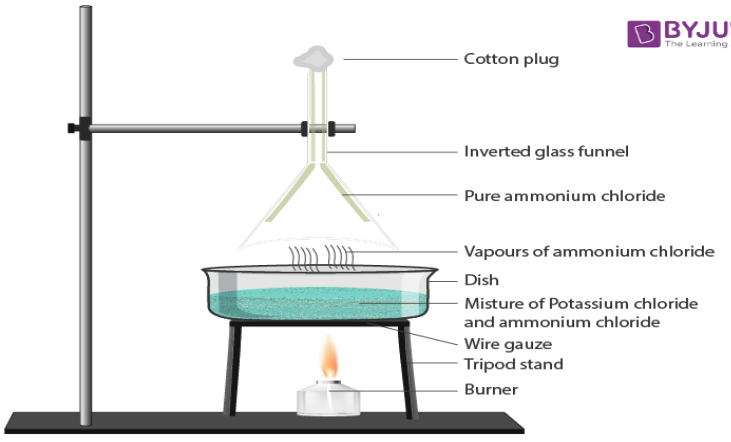
Applications

- Used for blood and urine tests in diagnostic facilities.
- Used to separate butter from cream in dairies and at home.
- Utilised in washing machines to extract water from drenched clothing.

Sublimation

Sublimation is the transition of a substance from **solid phase to gaseous phase** without changing into liquid phase.

- **Example**: Naphthalene balls undergo sublimation.



Solid undergoing sublimation

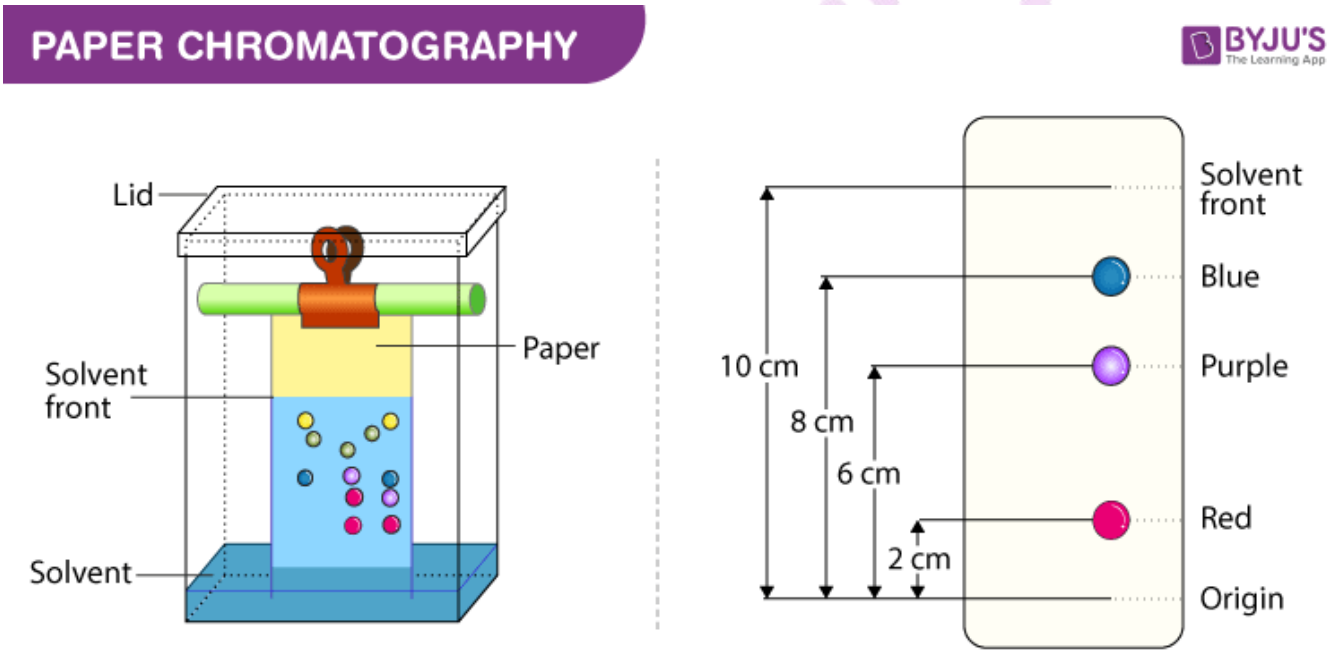
Chromatography

- **Chromatography** is used to separate the different components in a liquid mixture.

- It is based on the different properties of compounds in **two phases**: stationary and mobile phase.

Applications

- The technique of chromatography is extensively employed in the pharmaceutical industry in order to analyze and identify the presence of any trace amounts of chemicals and elements in a given sample.
- In the food industry, the technique of chromatography plays a vital role in the determination of the shelf life of food substances by helping in the analysis of the point at which food spoils.
- In the field of molecular biology, the study of proteomics and metabolomics often involve the use of various hyphenated chromatographic techniques (the most notable of which being EC-LC-MS).

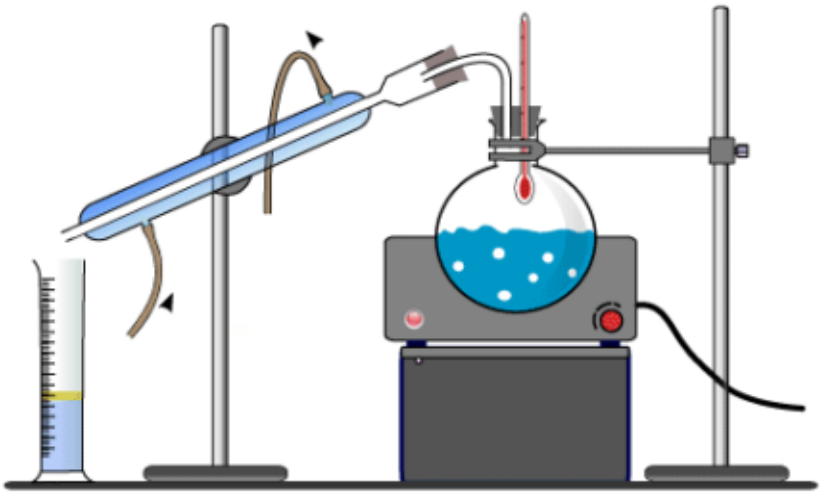


Distillation

Distillation is a method for separating the component substances from a liquid mixture by selective evaporation and condensation.

- **Used in**: Production of gasoline, distilled water, xylene, alcohol, paraffin, kerosene etc.

DISTILLATION

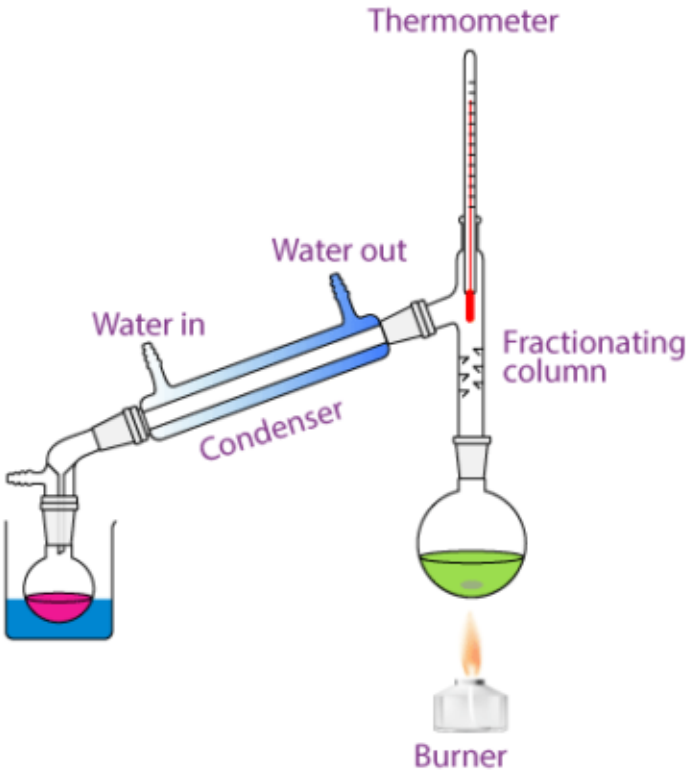


Fractional Distillation

Fractional Distillation is the separation of a mixture into its component parts or fractions by their melting points.

- This is the process of separation of chemical compounds by their **boiling point.**
- The mixture is heated to a temperature at which one or more fractions will vaporize.

FRACTIONAL DISTILLATION



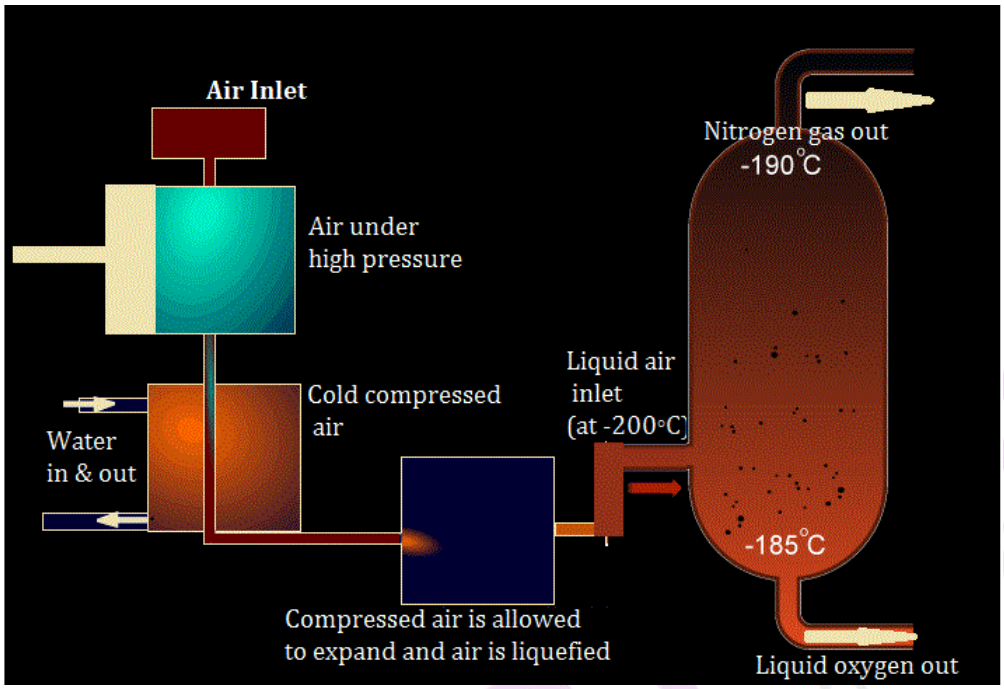
Separation of Air into Its Components

Process of obtaining different gases from the air

Air is a homogeneous mixture and can be separated into its components by **fractional distillation**.

Mixtures are substances made up of two or more different kinds of material. Homogeneous and heterogeneous mixtures are the two types of mixtures. There is no particle level homogeneity and the components in a heterogeneous mixture are not dispersed uniformly. As a result, we may simply divide a heterogeneous mixture into its various components.

A few popular separation methods for the heterogeneous mixture include sieving, filtration, hand-picking, etc. We must employ specialised separation procedures when dealing with homogeneous mixtures, as well as occasionally heterogeneous mixtures. Special separation techniques include evaporation, centrifugation, chromatography, sublimation, separating funnels, etc.

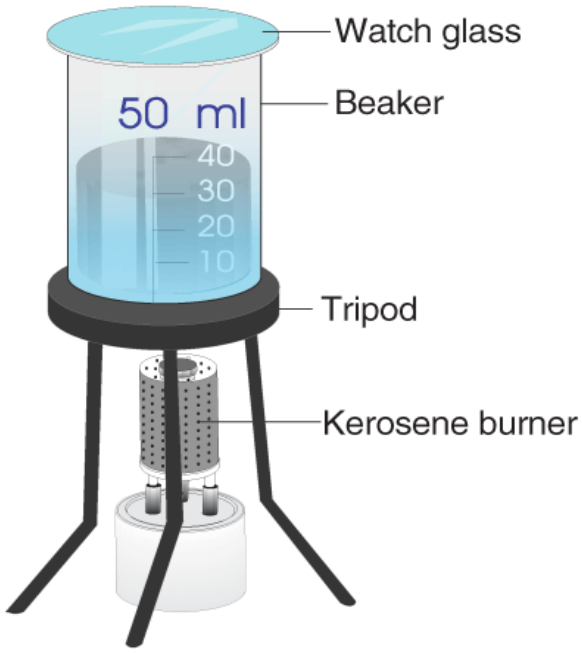


Fractional distillation

Crystallization

- **Crystallisation** is a separation technique in which solids are separated from a solution.
- In this technique, the solvent molecules start evaporating, leaving behind the solutes when the solution is heated in an open container.

Crystallisation is better than evaporation because during Evaporation. Some solids decompose or some, like sugar, may get charred on heating to dryness. Some impurities may remain dissolved in the solution even after filtration which on evaporation contaminates the solid.



Separation of substances by crystallization technique

Water Purification

Applications of crystallisation

Purification of seawater, separation of alum crystals from impure samples etc.

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