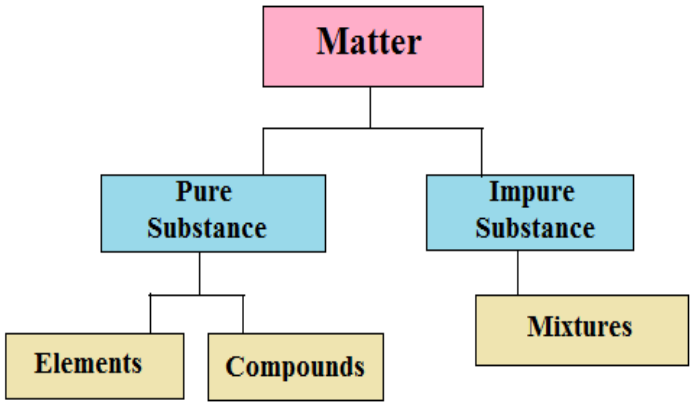
Matter

Anything which has mass and occupies space is called matter. It may be solid, liquid or gas.

Types of Matter

It is of two types:

1. Pure Substance
2. Impure substance



1. Pure Substance: It may be defined as a material which contains only one kind of atoms or molecules.

Pure substances are again of two types:

(a) Elements (b) Compounds

(a) Elements:

- Pure substances which are made up of only one kind of atoms are known as elements.
- They cannot be split up into two or more simpler substances by any of the usual chemical methods.
- For example, Iron, gold, silver, carbon, oxygen, nitrogen and sodium etc.

Elements are further grouped into the following three categories:

(i) Metals, for example: Iron, copper, gold, sodium, silver, mercury, etc.

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(ii) Non – metals, for example: Carbon, oxygen, sulphur, nitrogen, oxygen, hydrogen, etc.

(iii) Metalloids: Boron, silicon, germanium, etc.

Properties of Metals:

- These are lustrous (shine).
- They conduct heat and electricity.
- All metals are malleable and ductile.
- They are sonorous.
- All metals are hard except sodium and potassium.
- All metals are solids at room temperature except mercury which is a liquid.

Properties of Non-metals:

- These are dull in appearance.
- They are poor conductors of heat and electricity except diamond which is a good conductor of heat and graphite which is a good conductor of electricity.
- They are neither malleable nor ductile.
- They are generally soft except diamond which is the hardest natural substance known.
- They may be solids, liquids or gases at room temperature.

Metalloids:

The elements that have properties intermediate between those of metals and non-metals, are called metalloids.

(b) Compounds:

- It is a form of matter formed by combining two or more elements in a definite ratio by mass.
- It Can be decomposed into its constituent elements by suitable chemical methods
- For example: Water (H_2O), oxygen (O_2), Nitrogen dioxide (NO_2), etc.

2. Impure Substance:

It may be defined as a material which contains only one kind of atoms or molecules. It is also named as mixture.

Mixtures:

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A mixture is a material which contains two or more different kinds of particles (atoms or molecules) which do not react chemically but are physically mixed together in any proportion.

Types of mixture

It is of two types:

(a) Homogeneous mixture (b) Heterogeneous mixture

S. No.	Homogeneous mixture	Heterogeneous mixture
1.	All the components of the mixture are uniformly mixed.	All the components of the mixture are not thoroughly mixed.
2.	No separation boundaries are visible.	Separation boundaries are visible.
3.	It consists of a single phase.	It consists of two or more phases.
4.	Example: Sugar dissolved in water	Example: Air, sand and common salt.

Difference between mixtures and compounds:

S. No.	Mixtures	Compounds
1.	Various elements just mix together to form a mixture and no new compound is formed.	Elements react to form new compounds.
2.	A mixture has a variable composition.	The compound has a fixed composition.
3.	A mixture shows the properties of its constituents.	Properties of a compound are totally different from those of its constituents.
4.	They do not have a fixed melting point, boiling point,	They have a fixed melting point, boiling point, etc.

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	etc.	
5.	The constituents can be separated easily by physical methods	The constituents can be separated only by chemical processes.

Try the following questions:

Q1. Is air around us a compound or a mixture?
Q2. Water is a compound. Justify.
Q3. Differentiate between homogeneous and heterogeneous mixtures.
Q4. Give reasons for the following:
(a) Copper is used for making electric wires.

(b) Graphite is used for making electrode in a dry cell.

Q5. List any four characteristics by which compounds can be differentiated from mixtures.
Solution:
A solution is a homogeneous mixture of two or more substances. For example: Lemon water, sugar solution, soda water, etc.

Components of Solution:

(1) Solvent: The component of the solution that dissolves the other component in it and is usually present in larger amount, such component of solution is called the solvent. For example: Water, alcohol etc.
(2) Solute: The component of the solution that is dissolved in the solvent and is usually present in lesser quantity, such component is called the solute. For example: Salt, sugar, iodine etc.

Properties of solutions:

(i) It is a homogeneous mixture.
(ii) Particle size in a solution is less than 1 nm in diameter.
(iii) Particles of a solution cannot e seen even with a microscope.
(iv) A true solution does not scatter the light.
(v) Solution is stable.
(vi) The solute particles cannot be separated from the mixture by the process of filtration.

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Types of solutions:

Various types of solutions are:
(i) Solid in a solid solution: Alloys.
(ii) Solid in a liquid solution: Sugar solution, salt solution.
(iii) Liquid sin a liquid solution: Lemon water, vinegar (acetic acid in water)
(iv) Gas in a gas solution: Air.
(v) Gas in a liquid solution: Soda water.

Solubility:

The maximum amount of the solute which can be dissolved in 100 grams of a solvent at a particular temperature is known as its solubility in that particular solvent.

Conditions affecting solubility:

(i) Temperature: Solubility of solids in liquids increases with the increase in temperature, whereas solubility of gases in liquids decreases on increasing the temperature.
(ii) Pressure: Solubility of gases in liquids increases on increasing the pressure, whereas the solubility of solids in liquids remains unaffected by the change in pressure.

Saturated Solution

A solution in which no more quantity of solute can be dissolved at a particular temperature, is called saturated solution.

Unsaturated Solution

A solution in which more quantity of solute can be dissolved without raising its temperature, is called unsaturated solution.

Try the following questions:
Q1. What would it mean by saying a 15% of alcohol solution?
Q2. Calculate the concentration of a solution containing 2.5g of salt dissolved in 50g of water.
Q3. Name the different types of solutions along with an example for each.
Q4. Define (a) Solute (b) Solvent.

Physical and Chemical Change

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Physical Change	Chemical Change
• No new substance is formed. • Properties of constituent elements/ substance is retained. • Change does not involve loss or gain of heat. • This change is generally reversible.	A new substance is formed. Properties of constituent elements/substance changes. Loss or gain of heat may be involved in this reaction. This change is generally irreversible.

Solution

It is a homogeneous mixture of two or more substances.

Solute	Solvent
A substance which is dissolved in a solvent. *E.g.*, salt, sugar. Solute can be solid, liquid or gas.	Liquid part of solution in which a substance is dissolved. *E.g.*, water. Solvent can be liquid, solid or gas.

TYPES OF SOLUTION

Aqueous solution
A solution in which water is a solvent. E.g., salt + water

Non-aqueous solution
A solution in which water is not a solvent. E.g., sulphur + carbon disulphide.

True solution
Solute particles completely dissolve in solvent and are not visible. E.g., sugar + water

Solution can be dilute or concentrated
(Depending on the amount of solute dissolving in solvent).

Saturated solution
A solution in which no more solute can dissolve at given temperature.

Unsaturated solution
A solution in which more solute can dissolve at a given temperature.

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- Concentration of solution = $\frac{\text{Amount of solute}}{\text{Amount of solution}}$ or $\frac{\text{Amount of solute}}{\text{Amount of solvent}} \times 100$
- Mass by mass percentage of a solution

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

- Mass by volume percentage of a solution

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

Suspension	Colloidal Solution
• Size of solute particles are visible with naked eyes • Shows tyndall effect • Translucent • Solute particles settle down	Size of solute particles are not visible with naked eyes. Shows tyndall effect Translucent Colloidal particles do not settle down

Different Types of Colloids

Dispersed Phase	Dispersing Medium	Type	Example
Liquid	Gas	Aerosol	Fog, clouds, mist
Solid	Gas	Aerosol	Smoke, automobile exhaust
Gas	Liquid	Foam	Shaving cream
Liquid	Liquid	Emulsion	Milk, face cream
Solid	Liquid	Solution	Milk of magnesia, mud
Gas	Solid	Foam	Sponge, pumice
Liquid	Solid	Gel	Jelly, cheese, butter
Solid	Solid	Solid sol	Coloured gemstone, milky glass

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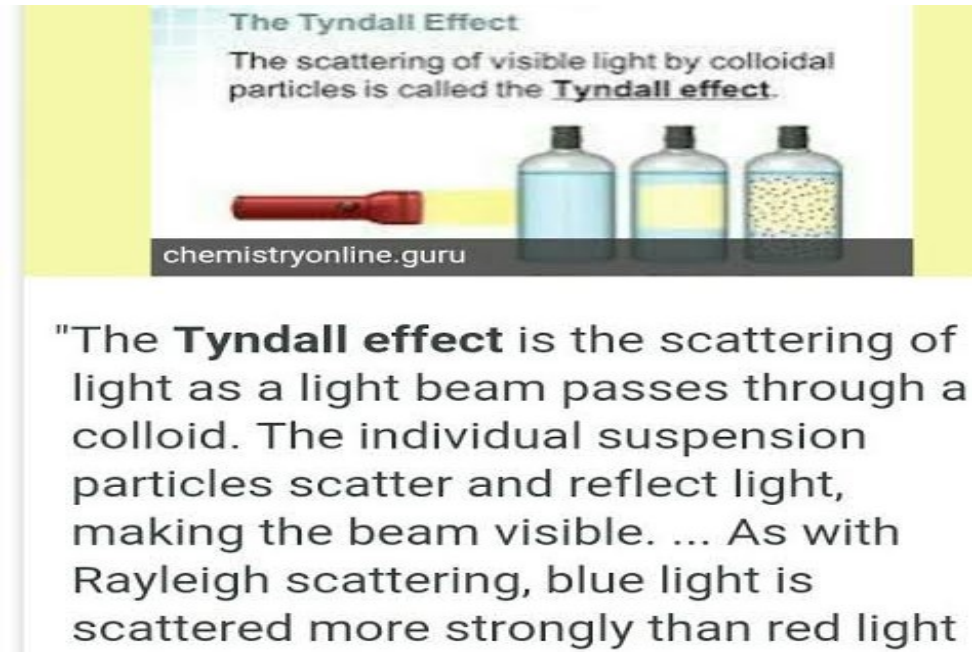

Separation process:

The process of separating the constituent substances of a mixture by physical methods, taking advantage of the differences in their physical properties is called separation process.

Commonly used separation methods are

Separation using magnets:
This method is used when one of the components is magnetic.
Example: The mixture of iron filings and sulphur powder can be separated by using magnets.

Evaporation:

Evaporation is the process of vaporizing the solvent to obtain the solute. Evaporation is used to separate a mixture containing a non-volatile, soluble solid from its volatile, liquid solvent.
We can separate salt from a solution by evaporating the water from the solution.

Filtration:

Filtration is a process by which insoluble solids can be removed from a liquid by using

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a filter paper.
A filter paper is a special type of paper which has pores that are tiny enough to let only liquids pass through it. If you pass a solution through filter paper, any undissolved solid particles will get left behind on the paper whereas the liquid will filter through.
The liquid that passes through is called the filtrate and the undissolved solid particles are called residue.
Example: A mixture of chalk powder and water can be separated by this method.

Centrifugation:

If the solid particles are very small and pass through a filter paper, then centrifugation process is used for the separation of insoluble solid particles from a solid-liquid mixture.

Principle involved in centrifugation:

The principle is that when the liquid is spun rapidly, the denser particles are forced to the bottom and the lighter particles stay at the top.
Example: Centrifugation is used for blood and urine testing in diagnostic laboratories, in dairies to separate butter from cream, and in washing machines to squeeze out water from clothes.

Separating funnel:

When two liquids do not mix, they form two separate layers and are known as immiscible liquids. These two liquids can be separated by using a separating funnel.

A separating funnel is a special type of glass funnel, which has a stop-cock in its stem to regulate the flow of liquid. It will separate the immiscible liquids into two distinct layers depending on their densities. The heavier liquid forms the lower layer while the lighter one forms the upper layer. Remove the stopper and open the tap to run the lower layer into a beaker. You will be left behind with just the upper layer in the funnel. Collect this liquid into another beaker.

Examples: Kerosene and water mixture is separated by using separating funnel method.

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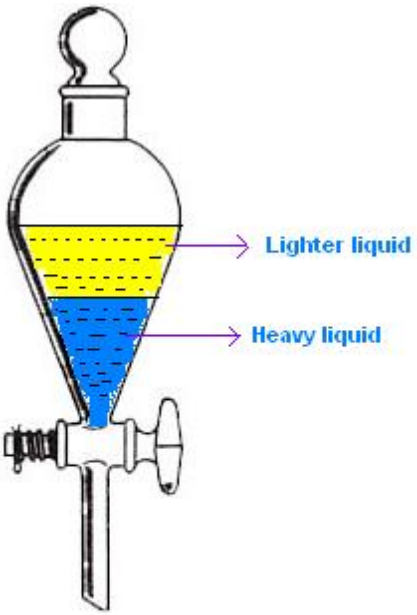
This method is also used to extract iron from its ore.



Separation of immiscible liquids using separating funnel

Sublimation:

Sublimation is the process in which solid directly changes to gaseous state.
Example: Salt and a sublimable solid such as ammonium chloride, can be separated by the process of sublimation.

Chromatography:

Chromatography is a method used to separate mixture that comprises solutes that dissolve in the same solvent. This method gets its name from the Greek word for colour —Kroma, as it was first used for separating colours.

Principle:

Chromatography is based on differential affinities of compounds towards two phases, i.e stationary and mobile phase.
The fraction with greater affinity towards stationary phase travels shorter distance while the fraction with less affinity towards stationary phase travels longer distance.
Chromatography is used for separating colors in a dye, pigments from natural colors and drugs from blood.
Based on nature of stationary and mobile phases chromatography is classified into following types

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- Paper chromatography
- Column chromatography
- Thin layer chromatography
- Gas chromatography

Paper chromatography:

In paper chromatography the stationary phase is paper and the mobile phase is any suitable liquid.

Separation of components of ink:

- First take a thin, long strip of filter paper. Use a pencil to draw a line on it, about 3 cm above the lower edge. Then, put a small drop of black ink.
- On the filter paper in the centre of the line and allow it to dry.
- Finally, lower the filter paper into a jar containing water so that the drop of ink on the paper is just above the water level. Don't disturb the jar.
- After some time you will observe different coloured spots on the paper.

The ink has water as the solvent and the dye is soluble in it. As the water rises, it takes the particles of dye along with it. Since a dye is made of two or more colours, the colour which is the most soluble rises faster and higher. This is why there are differently coloured spots on the paper.

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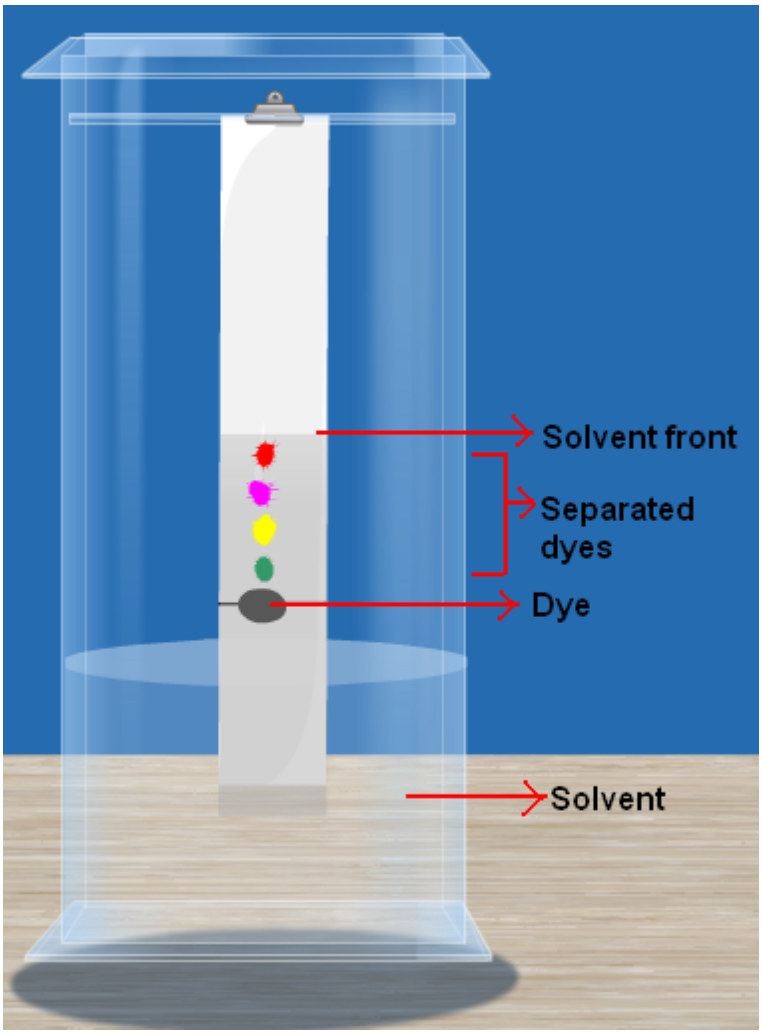

Distillation:

This method is used for the separation of a mixture containing two miscible liquids that boil without decomposing and have a large difference between their boiling points. Process of conversion of a liquid into vapour by boiling, and then recondensing the vapour into liquid is called distillation.

Apparatus:

Distillation process requires a distillation flask, thermometer, heating assembly, a receiver flask and condenser as the apparatus. A distillation flask is a round-bottomed flask with a tube at its neck. This tube is attached to a Liebig condenser. The Liebig condenser is a long glass tube within a glass jacket, with an inlet and outlet for water. The open end of the flask is fitted with a one-holed rubber cork through which a thermometer is introduced.

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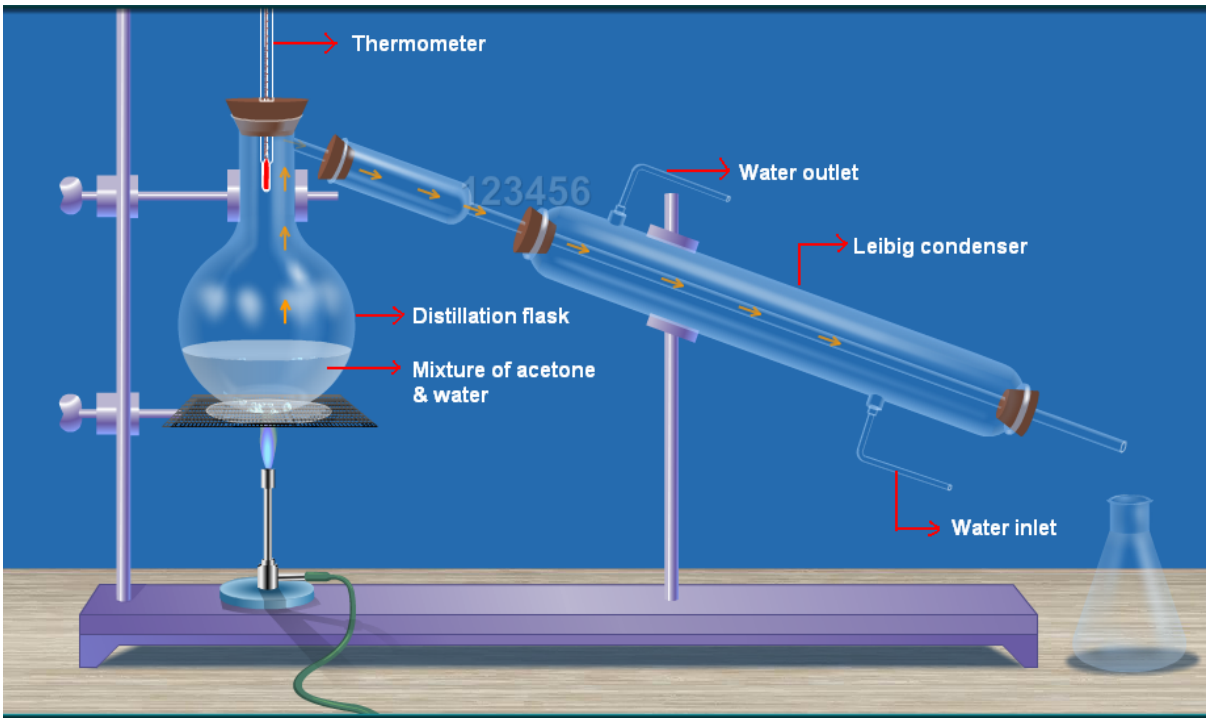

Principle:

Distillation process involves heating a liquid to its boiling point such that the liquid passes into its vapour state. The vapours are condensed in a condenser and transformed into liquid form. The pure liquid is collected from the condenser in a receiver.

Example: A mixture of acetone and water can be separated by the process of distillation.

Separation of mixture of water and acetone:

Put the mixture into a distillation flask. Heat the mixture. You will see that the acetone, which has a lower boiling point, vaporizes first and then condenses in the condenser. It can be collected from the condenser outlet. Water gets left behind in the flask.

Fractional distillation method:

In case the difference in the boiling points of the liquids is less than 25K temperature, we use the fractional distillation method.

The apparatus is almost the same as used in distillation. The only difference is that a fractioning column is fitted in between the distillation flask and the condenser. A simple

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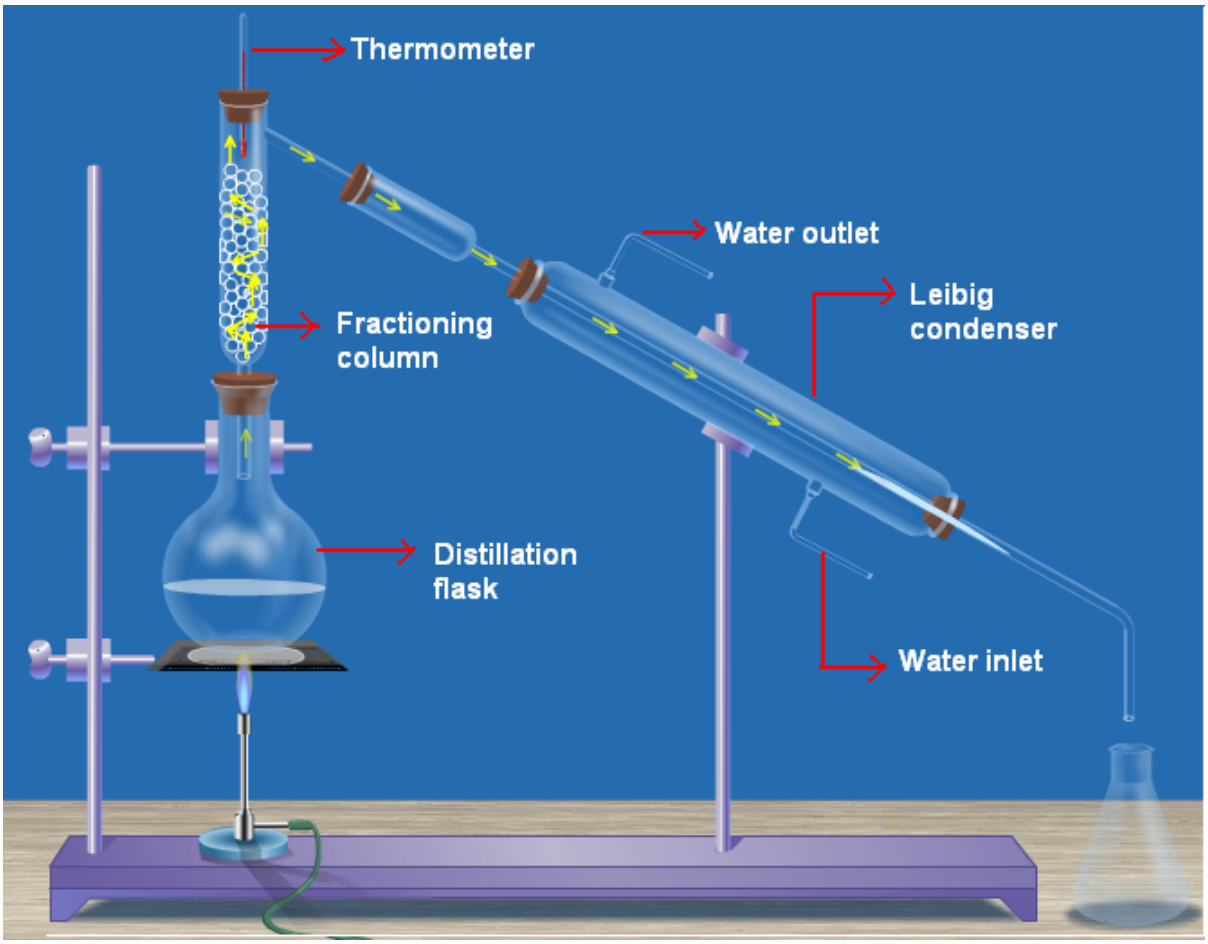
fractioning column is made up of a tube packed with glass beads. The beads provide the surface for the vapours to cool and condense again and again. The fractioning columns obstruct the smooth upward flow of vapours.

Example: A mixture of n-hexane and n-heptane can be separated through the process of fractional distillation.
Put the mixture into a distillation flask. Heat the mixture. The vapours of, n-hexane has a lower boiling point pass through and get condensed in the condenser. n-heptane, which has a higher boiling point, condenses and flows back into the distillation flask.



The gases in the air are separated from one another by the fractional distillation of liquid air.
Air is made up of different gases like nitrogen, oxygen and carbon dioxide. These gases are separated from one another by the fractional distillation of liquid air.

Steps involved are,

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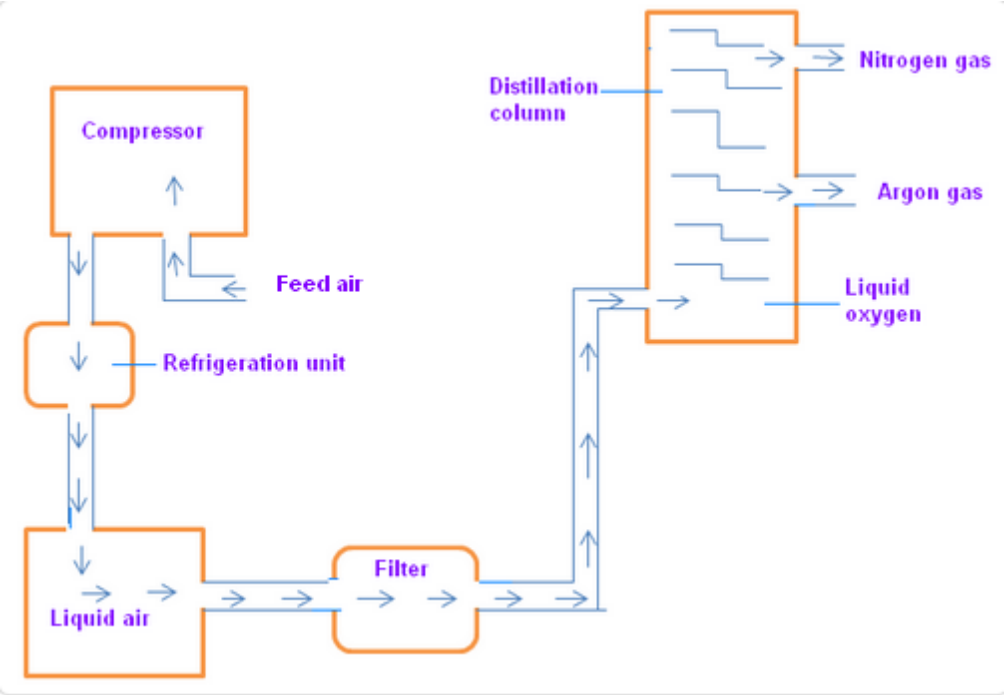
Air is compressed in the compressor and cooled in the refrigeration unit. Thus, the air gets liquefied.
The liquid air is passed through a filter to remove impurities and then fed into a tall fractional distillation column.
On warming, liquid nitrogen distils first because it has the lowest boiling point of -196 ^{0}C. Liquid argon has a slightly higher boiling point of -186 ^{0}C, so it distils next. Liquid oxygen has the highest boiling point of -183^{0}C, it left behind.



Crystallisation:

Crystallisation is a separation and purification method which involves the precipitating of solid crystals from its saturated solution on cooling.
In this process the impure sample is dissolved in minimum amount of suitable solvent. The formed solution is heated to get a saturated solution. On cooling, this saturated solution produces pure crystals of the sample.

Crystallisation is used for:

Purification of salt that we get from sea water and separation of crystals of alum from impure samples.

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