CHAPTER-3

ELEMENTS, COMPOUNDS AND MIXTURES

INTRODUCTION

There are millions of substances in this world such as iron, aluminium, water, common salt and air etc. They are different from one another in their composition, properties and uses.

- They are made up of different kinds of matter
- They may be pure and impure

To study these substances accurately and conveniently, they have been classified on the basis of similarities and dissimilarities into three main classes:

- Elements
- Compounds
- Mixtures

SUBSTANCE

- It is of two types:
  1. Pure Substance
  2. Impure substance

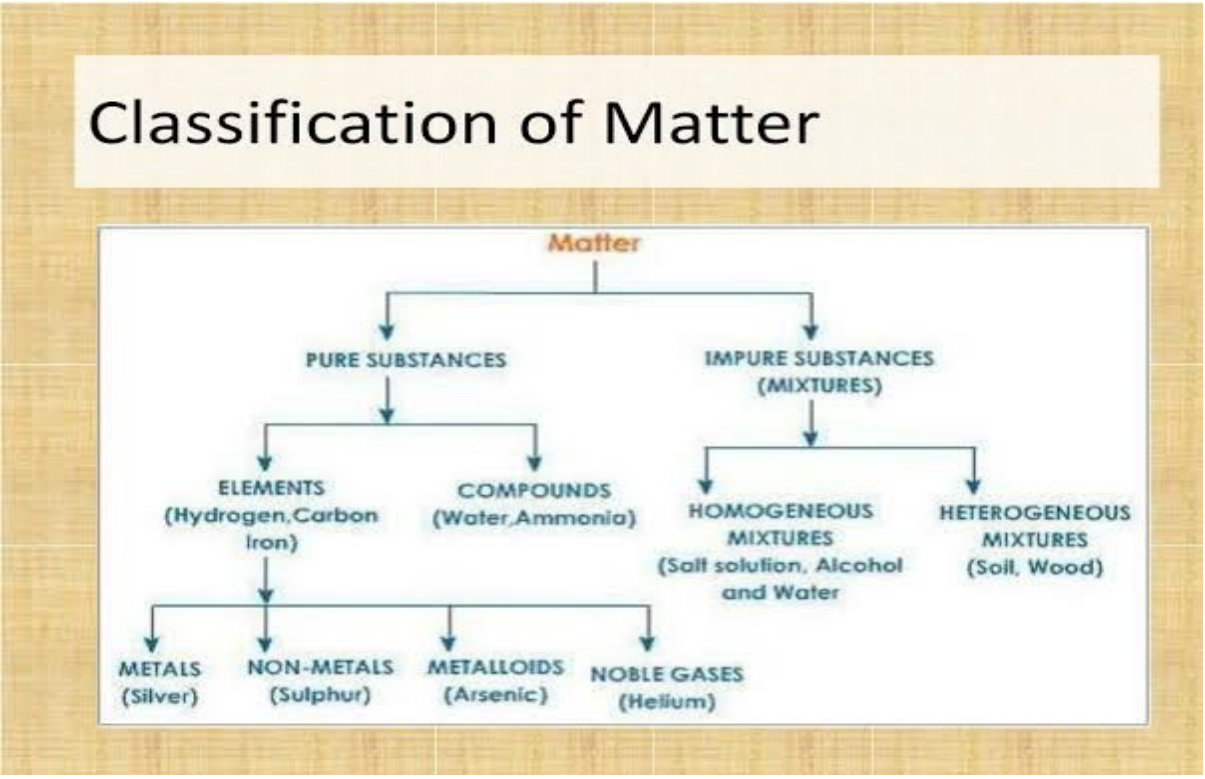
1. Pure Substance: It may be defined as a material which contains only one kind of atoms or molecules.
   Pure substances are again of two types:

(a) Elements (b) Compounds

2. Impure Substance:

(b) It may be defined as a material which contains only one kind of atoms or molecules.

(c) It is also named as mixture.



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.

(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.

INERT OR NOBLE GASES

- These Elements do not react chemically with other elements or compounds, so they are known as noble or inert gases.
- They are found in air in traces.
- They are six in number-------- Helium, Neon, Argon, Krypton, Xenon, Radon.

SYMBOLS OF ELEMENTS

Method by which Elements are given Name

- ✔ Each element is denoted by a symbol which is usually the first letter of its name in English or Latin. (always in capital letter)
- ✔ If the first letter of more than two elements is same, the symbol is denoted by two letters, first letter is written in capital while the second letter is written in small letter.
- ✔ Some symbols have been taken from the Latin, German, or Greek.
- ✔ These symbols also represent an atom of that element.

1 - Hydrogen H	21 - Scandium Sc	41 - Niobium Nb
2 - Helium He	22 - Titanium Ti	42 - Molybdenum Mo
3 - Lithium Li	23 - Vanadium V	43 - Technetium Tc
4 - Beryllium Be	24 - Chromium Cr	44 - Ruthenium Ru
5 - Boron B	25 - Manganese Mn	45 - Rhodium Rh
6 - Carbon C	26 - Iron (Ferrum) Fe	46 - Palladium Pd
7 - Nitrogen N	27 - Cobalt Co	47 - Silver (Argentum) Ag
8 - Oxygen O	28 - Nickel Ni	48 - Cadmium Cd
9 - Fluorine F	29 - Copper (Cuprum) Cu	49 - Indium In
10 - Neon Ne	30 - Zinc Zn	50 - Tin (Stannum) Sn
11 - Sodium (Natrium) Na	31 - Gallium Ga	51 - Antimony (Stibium) Sb
12 - Magnesium Mg	32 - Germanium Ge	52 - Tellurium Te
13 - Aluminium (Aluminum) Al	33 - Arsenic As	53 - Iodine I
14 - Silicon Si	34 - Selenium Se	54 - Xenon Xe
15 - Phosphorus P	35 - Bromine Br	55 - Caesium (Cesium) Cs
16 - Sulfur S	36 - Krypton Kr	56 - Barium Ba
17 - Chlorine Cl	37 - Rubidium Rb	57 - Lanthanum La
18 - Argon Ar	38 - Strontium Sr	58 - Cerium Ce
19 - Potassium (Kalium) K	39 - Yttrium Y	59 - Praseodymium Pr
20 - Calcium Ca	40 - Zirconium Zr	60 - Neodymium Nd

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.

CHARACTERISTICS OF COMPOUNDS

Elements react to form new compounds.
The compound has a fixed composition.
Properties of a compound are totally different from those of its constituents.
They have a fixed melting point, boiling point, etc.
The constituents can be separated only by chemical processes.

Mixtures:

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.

CHARACTERISTICS OF MIXTURE

Various elements just mix together to form a mixture and no new compound is formed.
A mixture has a variable composition.
A mixture shows the properties of its constituents.
They do not have a fixed melting point, boiling point, etc.
The constituents can be separated easily by physical methods

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, etc.	They have a fixed melting point, boiling point, etc.
5.	The constituents can be separated easily by physical methods	The constituents can be separated only by chemical processes.

FORMATION OF MIXTURE

- Various types of mixtures can be formed by mixing solid, liquid, and gaseous substances in different proportions.
- Mixtures may be any three states of matter i.e., solid, liquid or gas, depending on the physical states of its components.

TYPES OF MIXTURES ALONG WITH EXAMPLES

Sl. No	States of Components	Types of Mixtures	Examples
1	Solid + Solid	Heterogenous Homogenous	Sand and sugar Brass, Bronze
2	Solid + Liquid	Heterogenous Homogenous	Sand and Water Sugar in water
3	Liquid + Liquid	Heterogenous Homogenous	Oil in water Alcohol in water
4	Gas + Liquid	Homogenous	Aerated drinks
5	Gas + Gas	Homogenous	Pure air
6	Solid+ Gas	Heterogenous	Smoke

NEED FOR THE SEPARATION OF THE COMPONENTS OF MIXTURES

- ❖ To remove undesirable and harmful substances.

- To get useful substances.
- To get completely pure substances for preparing other useful substances.

METHODS OF SEPARATION

The process by which constituents of a mixture are set apart from one another to get pure substances is called separation.

The principle of separation depends upon: -

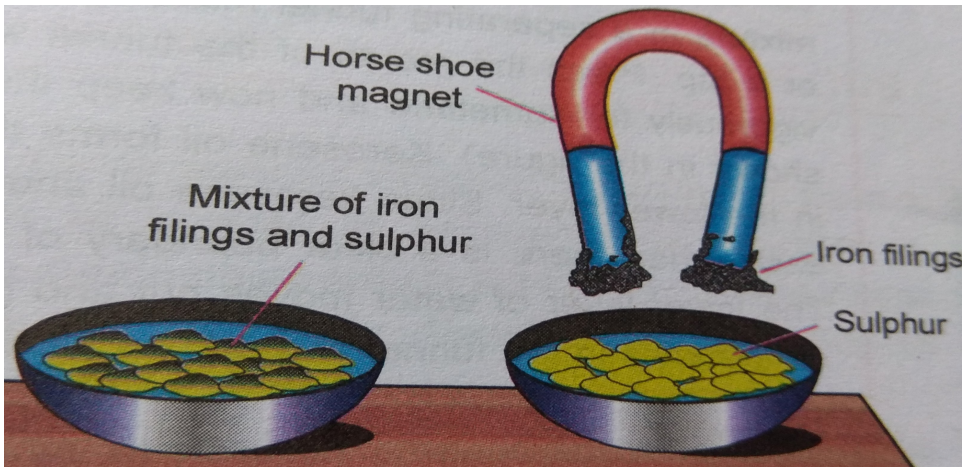
- Type of mixture.
- Characteristic properties of mixture like size, colour, density, melting point and boiling point etc.

SEPARATION OF SOLID-SOLID MIXTURE

- HAND- PICKING: - This method is used when the quantity of a mixture is small and the substances to be separated from a small portion of the mixture. Examples-small stones are picked from rice, pulses etc.

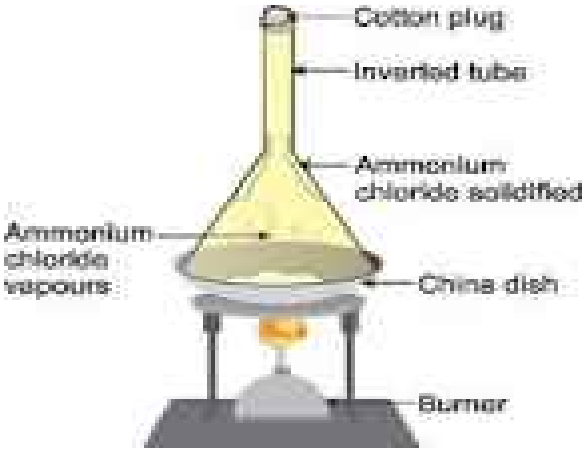
- WINNOWING: - The process of separation of grain from husk with the help of wind is called Winnowing. Example: -separation of rice from husk.

- MAGNETIC SEPARATION: -This method is used when one of the components of the mixture is magnetic in nature. Example: Iron and Sulphur



- GRAVITATIONAL METHOD: -This method is used when one of the components is much heavier than water and other is much lighter than water. Examples: - Mixture of sand, saw-dust put in water

- 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.



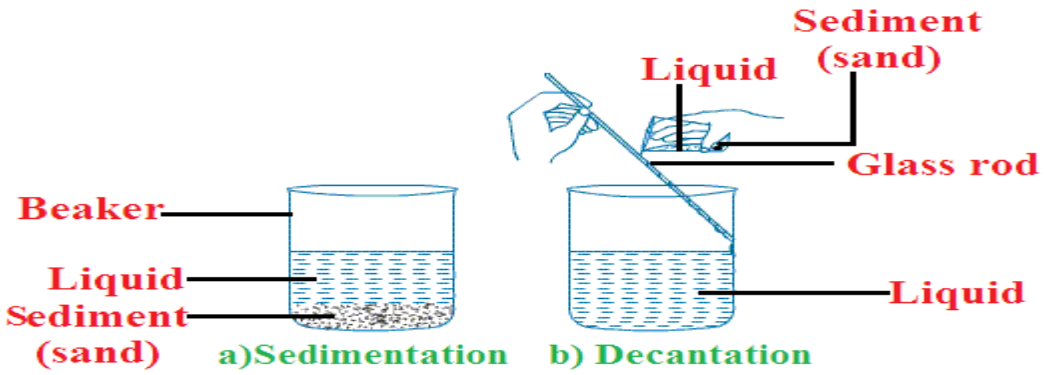
- SOLVENT EXTRACTION METHOD: -This method is used when one of the solid components is soluble in water. Example: - A mixture of sand and salt.

SEPARATION OF SOLID-LIQUID MIXTURE

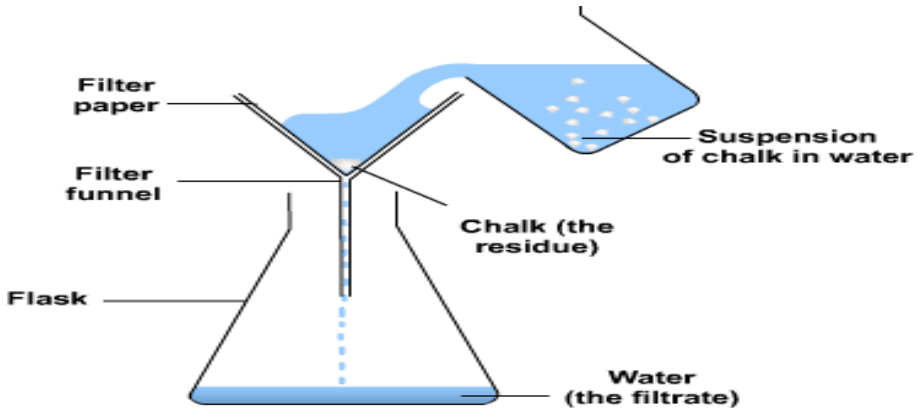
- SEDIMENTATION AND DECANTATION: -The settling down of suspended insoluble, heavy solid particles in a solid- liquid mixture when left undisturbed is called Sedimentation. The solid that settles down is sediment while the clear liquid above is called supernatant liquid.

  The process of pouring out the clear liquid, without disturbing the sediment is called Decantation.

  Example: - A mixture of sand and water, rice and water



- FILTRATION: - Filtration is a process by which insoluble solids can be removed from a liquid by using 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.



- 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.

- 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.

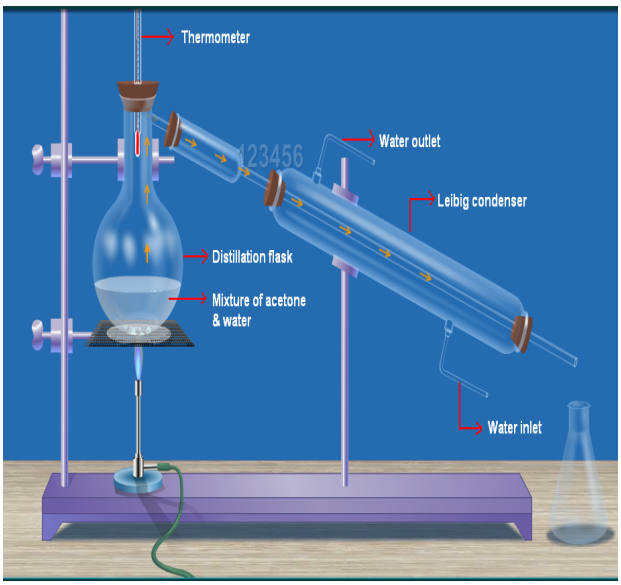
Crystallisation is used for:

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

- **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.

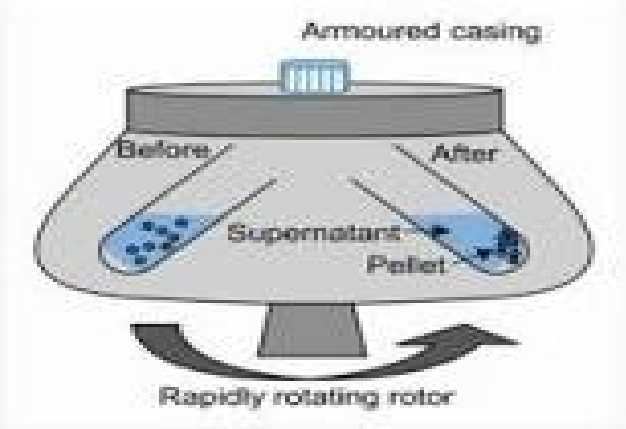


CENTRIFUGATION:- If the solid particles are very small and pass through a filter paper, then centrifugation process is used for the separation of insoluble solid particles from

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.

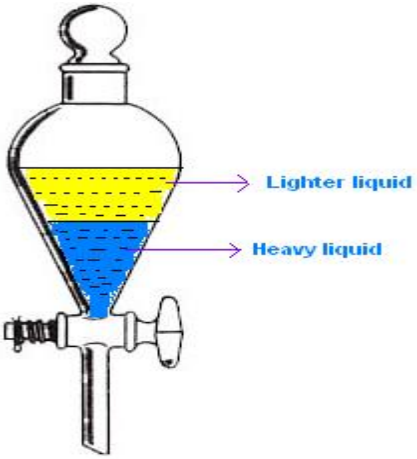


SEPARATION OF LIQUID-LIQUID MIXTURE

- **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.

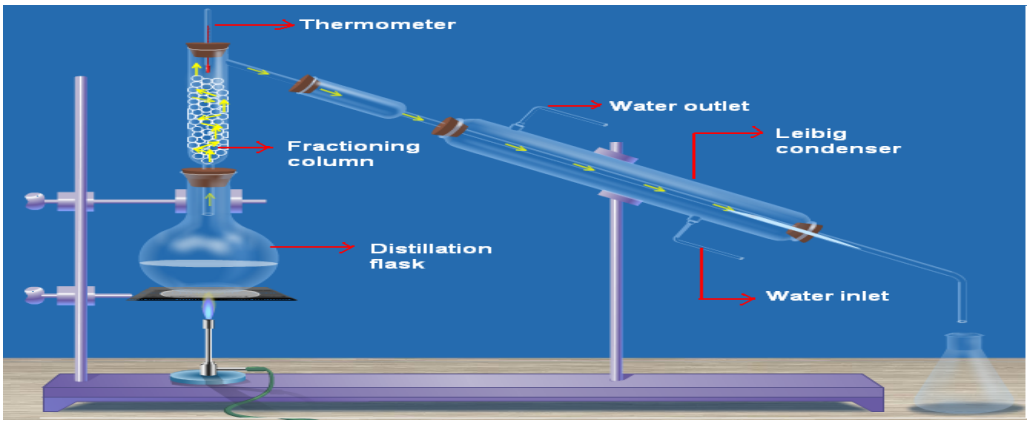
This method is also used to extract iron from its ore.



Separation of immiscible liquids using separating funnel

- FRACTIONAL DISTILLATION: - 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 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.



SEPARATION OF LIQUID-LIQUID MIXTURE

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.

Paper chromatography:

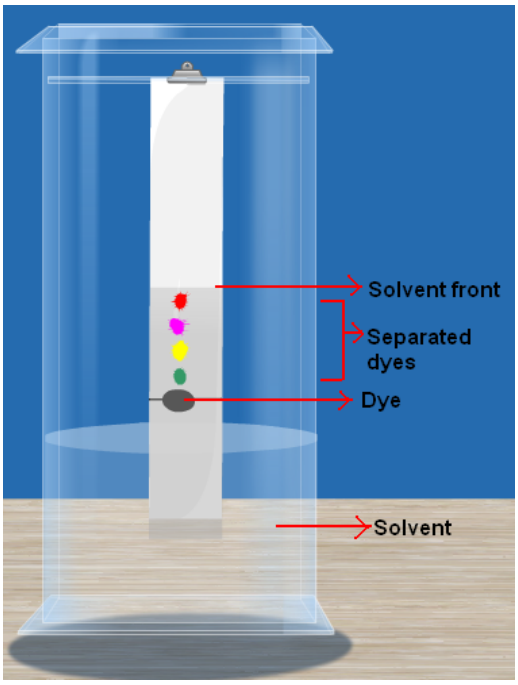
In paper chromatography the stationary phase is paper and the mobile phase is any suitable liquid.

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.



ADVANTAGES OF CHROMATOGRAPHY

- A very small quantity of the substance can be separated.
- Components with very similar physical and chemical properties can be separated.
- It identifies the different constituents of a mixture.

USE OF CHROMATOGRAPHY

- Used to separate pigments from natural colours.
- Drugs from blood.

- Colours in the dye

SEPARATION OF CONSTITUENTS OF THE MIXTURES WITH MORE THAN TWO CONSTITUENTS

- **Sand, Saw-dust and Salt: -** It involves three methods i.e., Sedimentation, Decantation and Evaporation.

- **Iron fillings, Sulphur and Common Salt: -** It involves three methods i.e., Magnetic Separation, Filtration and Evaporation