

Note Packet # 5

Matter

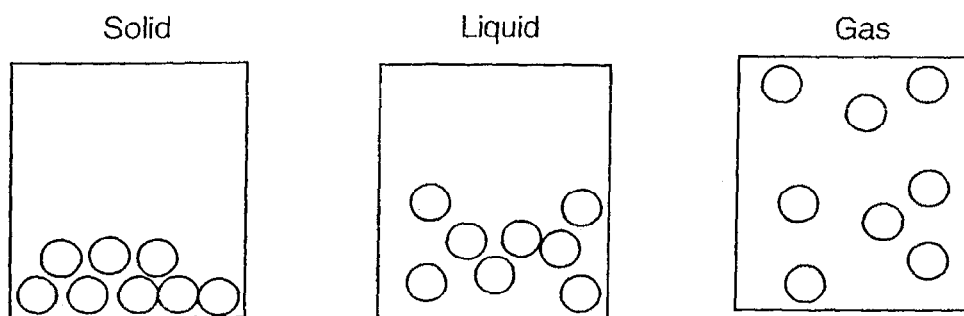
Matter is the physical material of our universe. Anything that has mass and volume is matter. Matter is classified as a pure substance or as a mixture of substances.

Substances are a pure form of matter with a constant (same) composition throughout and distinct chemical and physical properties. There are only 2 types of substances. Elements are substances and compounds are substances.

There are three common states of matter: solid, liquid and gas (also known as vapor).

Solids have a definite shape and a definite volume. A solid maintains its shape and volume with or without a container. **Liquids** have a definite volume but no definite shape. A liquid will take the shape of any container but the volume remains constant. **Gases** have no definite shape or volume. A gas will completely fill any size or shaped container.

Particle diagrams represent the particle arrangement of different phases. All matter exists as particles.



Solid particles are spaced close together in a regular geometric pattern.

Liquid particles have a medium amount of space between them and no pattern.

Gas particles fill the container completely with the maximum amount of space between the particles. There is no pattern in the arrangement of gas particles.

Physical Properties can be observed or measured without changing the substance itself. Physical properties include color, density, melting point, boiling point, solubility and hardness. Ex: The density of mercury is 13.500 g/cm^3

Physical Change describes how a substance can change its appearance without changing the identity of the substance itself. A physical change results in the rearrangement of existing particles in a substance. All changes of phase are physical changes.

Ex: As liquid water evaporates to form vapor it remains water.

$\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$ No new substance formed!

Chemical Properties refer to the way a substance can react to form another substance.

The ability of a substance to burn or rust is a chemical property.

Ex: Sodium reacts with water to form hydrogen gas and sodium hydroxide.

Chemical Change describes the way one substance is transformed into one or more other substances. A chemical change results in the formation of different substances with changed properties. Hydrochloric acid exhibits a chemical change when it reacts with zinc to form hydrogen gas and zinc chloride.

$\text{Zn}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{ZnCl}_2(\text{s}) + \text{H}_2(\text{g})$ New substances formed!

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Intensive Properties describe values which are not concerned with an amount of material. Temperature and density are examples of intensive properties.

Ex: The density of iron is 7.9 g/cm^3 regardless if there is 5 lbs or 5 tons of iron.

Extensive properties describe things that depend on the amount of material. Mass, volume, length, radius are extensive properties.

Ex: 5 grams of lead describe an extensive property of that amount of lead.

All matter can be placed into 1 of 3 categories: Elements, Compounds, or Mixtures.

Elements are substances that are composed of atoms that have the same atomic number. Elements can not be broken down into simpler substances by chemical means. The smallest unit of an element is the atom. Each element has its own unique atom identified by its number of protons. There are 92 naturally occurring elements and approximately 17 manmade elements presently known.

Ex: Carbon (C), iron (Fe) and lead (Pb) are elements. see pg. 3

Compounds are 2 or more different elements that are chemically combined. The elements in a compound are in a definite ratio. An exact percent composition by mass can be determined for all the elements in a compound. Compounds can be decomposed by chemical means into 2 or more compounds.

Ex: Water (H_2O), carbon dioxide (CO_2), and glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) are compounds.

See pg. 3

Mixtures are two or more different substances (elements or compounds) that can be separated by physical means. Each substance retains its own physical and chemical properties. See pg. 4

Mixtures are either heterogeneous or homogeneous.

The proportions of a mixture can vary.

Ex: A mixture of sugar-water can have a lot of sugar and a little water or a lot of water and a little sugar. See pg. 5

A **heterogeneous mixture** is a mixture that does not have the same composition throughout.

Ex: Oil and water is an example of a heterogeneous mixture.

A **homogeneous mixture** is all the same throughout. Homogeneous mixtures are also called **solutions**. see pg. 6

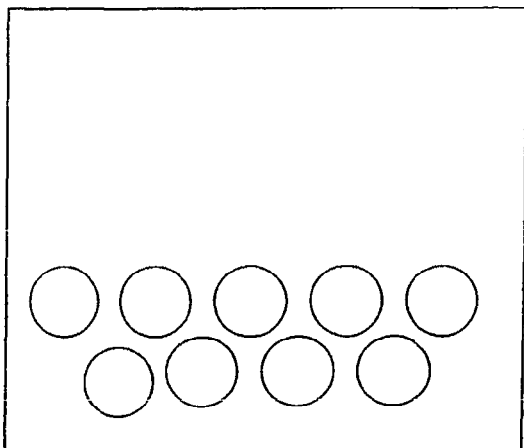
Ex: A solution of salt water is the same throughout, therefore it is homogeneous.

A solution consists of a **solute** and a **solvent**. A solute is an item which dissolves. The sugar in sugar water is the solute. The term solvent refers to the material that does the dissolving. The water in a sugar water solution is the solvent. You may have heard the expression "water is the universal solvent." It refers to the fact that water is capable of dissolving many natural earth materials.

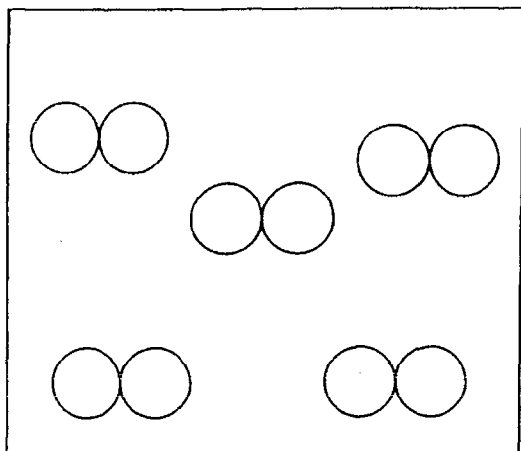
The ratios of substances in a mixture can be varied. Because mixtures are physical combinations they can be separated physically.

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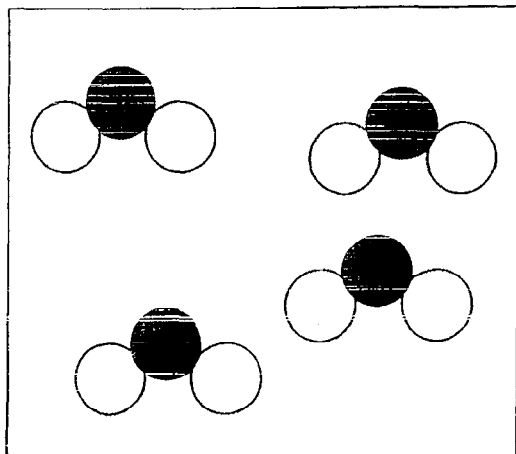
Element particle diagram.
Notice all the particles are the same. These particles represent all the same atoms.



Diatomic element diagram. A diatomic element is two of the **same** atoms bonded together.

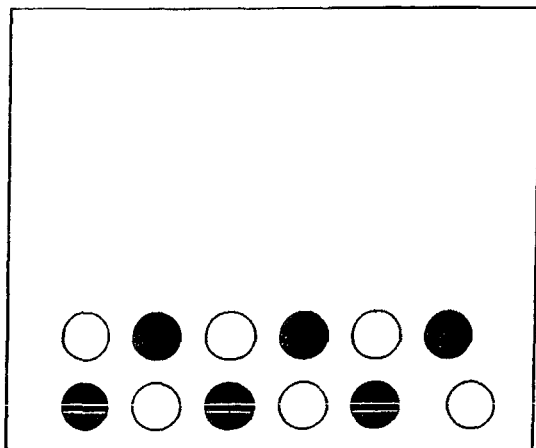


Compound particle diagram. Notice there are **different** atoms connected (chemically bonded).



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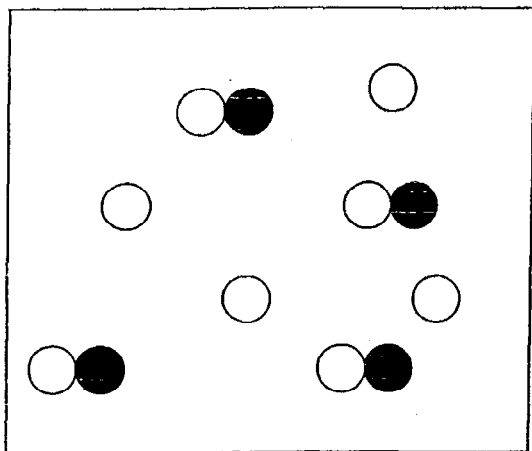
Remember! A mixture is 2 or more different substances physically together.
Remember! A substance is either an element or a compound.



**Mixture of 2 different elements
particle diagram.**

○ Element A

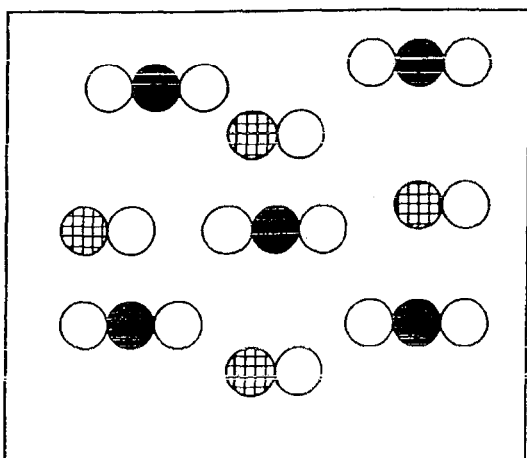
● Element B



**Mixture of an element and a compound
particle diagram.**

○● Compound

○ Element



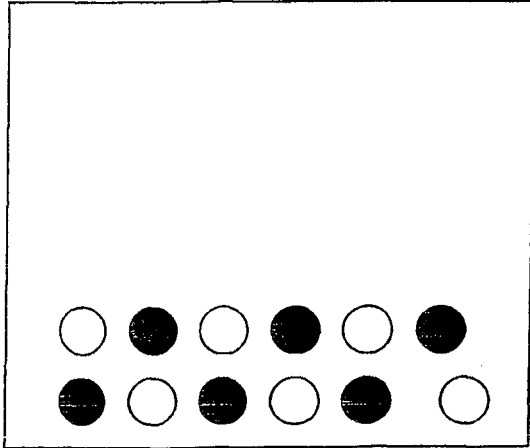
Mixture of 2 different compounds.

○● Compound A

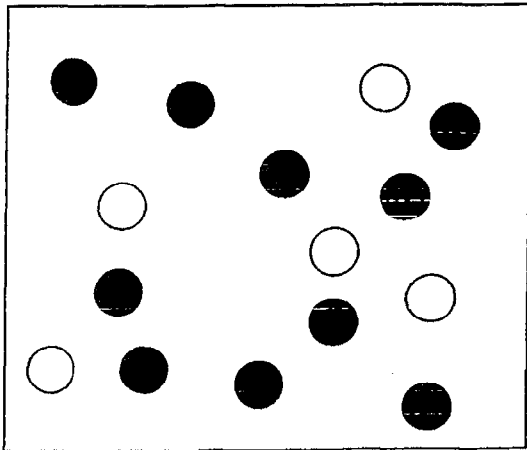
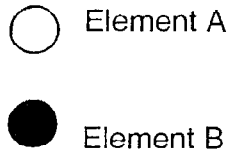
○● Compound B

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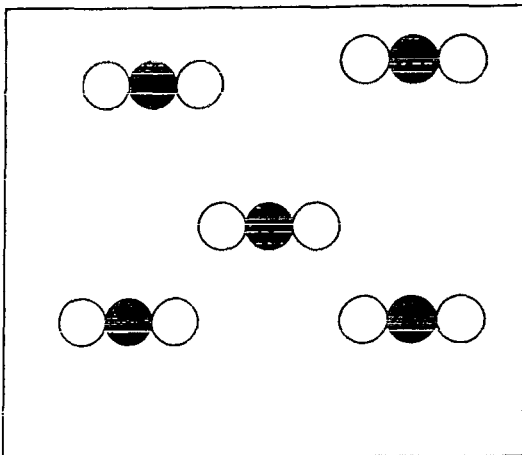
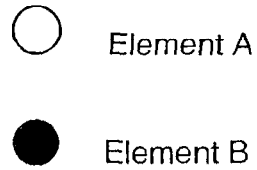
Remember! The proportions of components in a mixture can be varied.
The components can have different ratios.



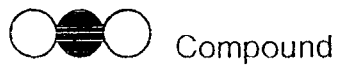
Mixture of 2 different elements
particle diagram. This mixture is
in a 1:1 ratio.



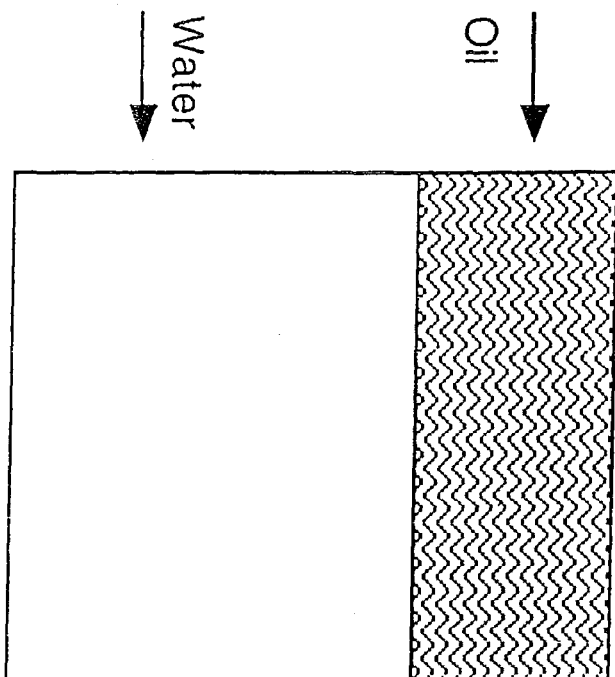
Mixture of 2 different elements. This
mixture is in a 2:1 ratio. ● ● to ○



Compound diagram. The components
in a compound can't be varied.
Compounds have a definite composition.

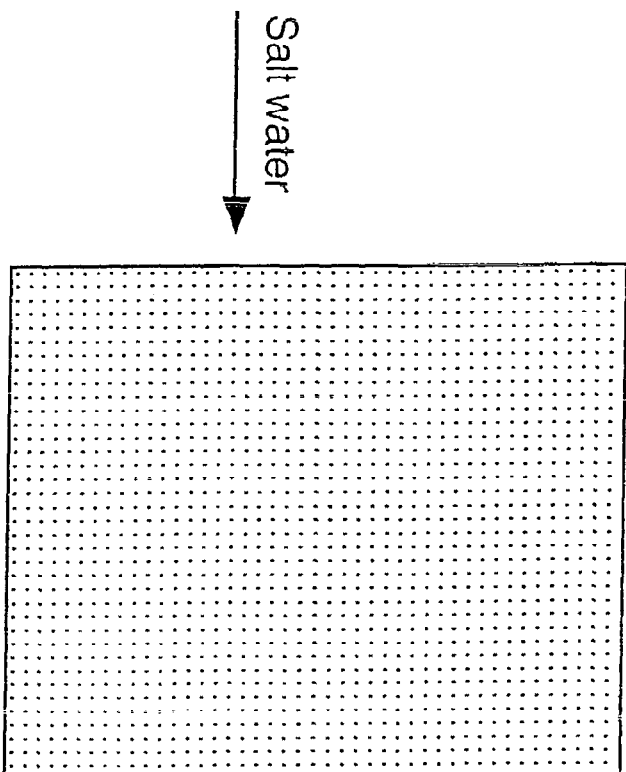


A Heterogeneous mixture contains different parts.



Oil and water mixture.

A Homogeneous mixture is the same throughout.



Salt water mixture.

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Separating Mixtures: Differences in physical properties such as size, molecular polarity, boiling point, freezing point, and solubility permit physical separation of the components of a mixture. **Mixtures** can be separated according to their different physical properties.

There are many different methods to separate mixtures.

Methods to separate mixtures are based on the components of the mixture having different physical properties.

Methods

1. Filtration
2. Chromatography
3. Distillation
4. Evaporation

Based on

- Particle size
- Adhesion
- Boiling point
- Vapor pressure

Filtration separates heterogeneous mixtures according to particle size. It uses a fine screen in the form of a permeable paper or mesh to separate components of heterogeneous mixtures. If a heterogeneous mixture contains particles of different sizes, they can be separated by a filter. Filters are usually used to separate solids from liquids in heterogeneous mixtures.

Filtration can not separate solutions. Liquid solutions are homogeneous and pass through filters.

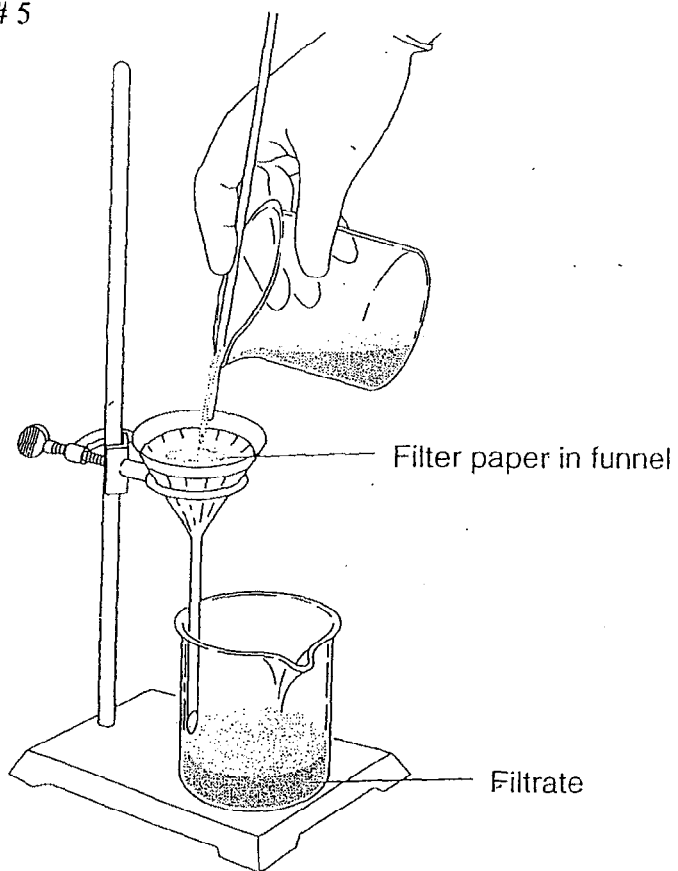
Chromatography separates homogeneous mixtures based on the components having a different degree of adhesion for a certain material. The most common materials separated using chromatography are inks or dyes. As an ink travels through a paper by capillary action its components travel at different rates.

Distillation separates homogeneous mixtures based on the different boiling points of its components. A homogeneous mixture (solution) of salt water can be separated by boiling the solution. Water boils at a much lower temperature than salt, therefore, water changes phase to vapor and leaves the solution. The salt remains in the solution. If the water vapor is collected and condensed (changed from vapor to liquid), pure distilled water is t

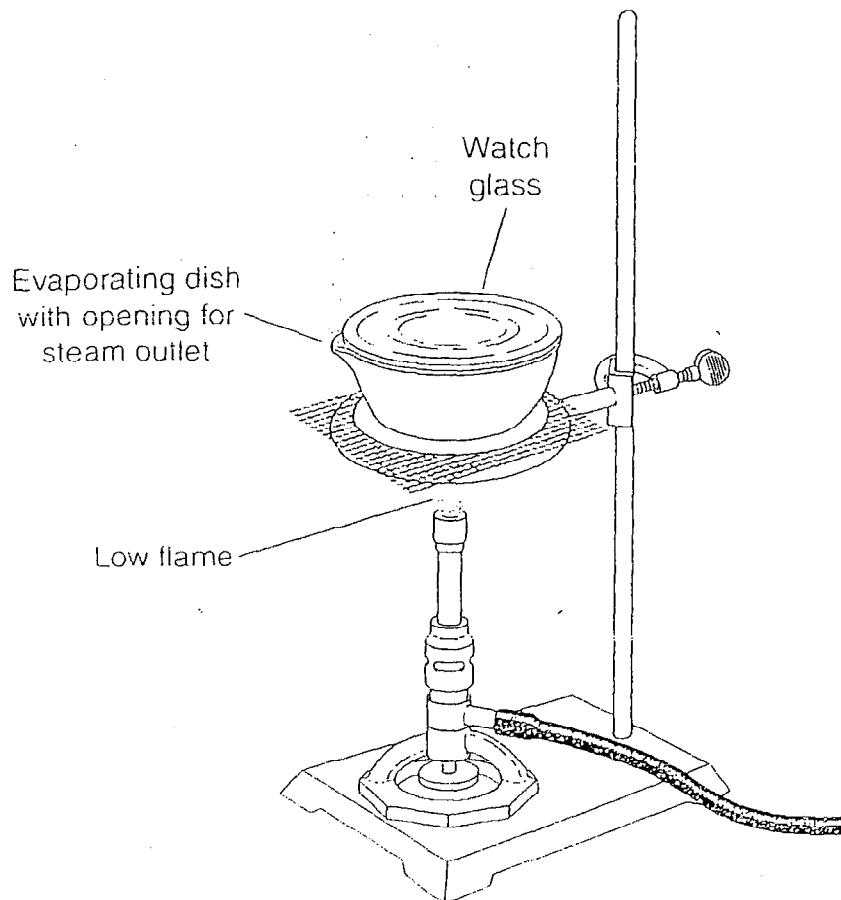
The following page shows diagrams of separation techniques.

Filtering Diagram

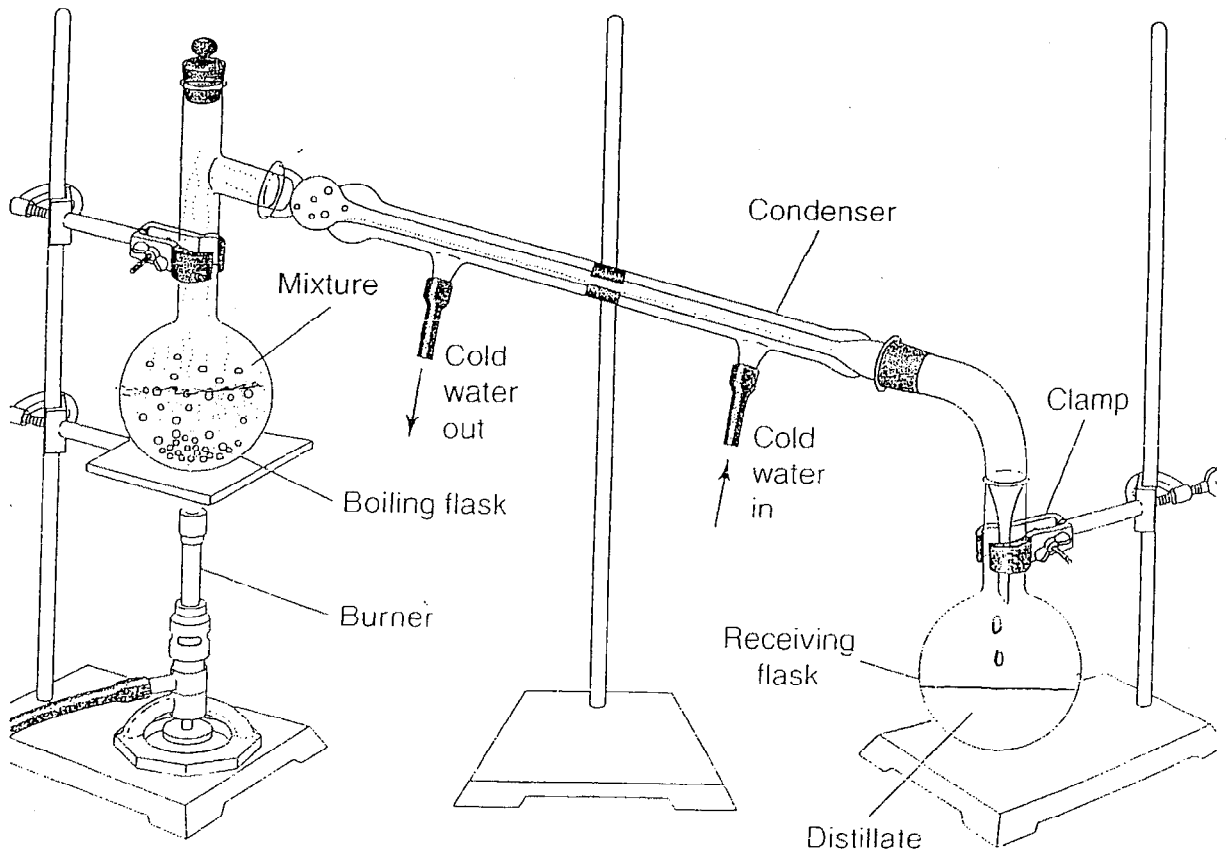
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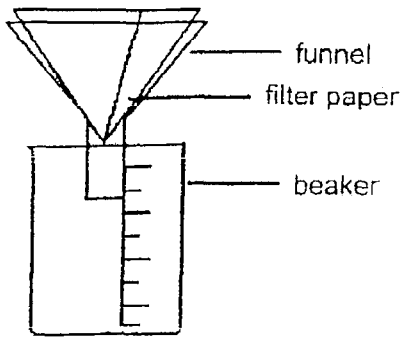
Evaporation Diagram



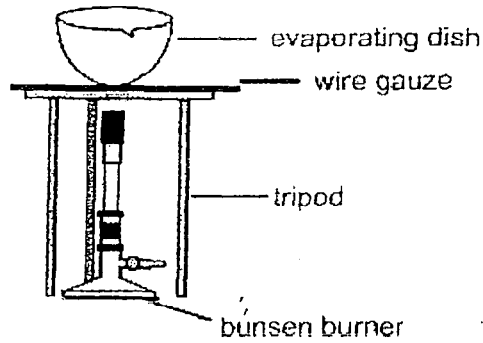
Distillation Diagram



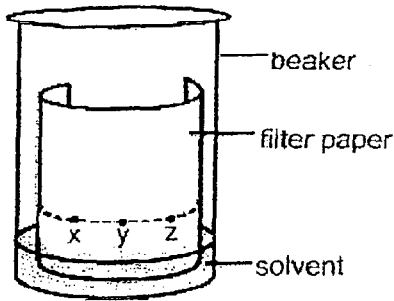
TECHNIQUES USED TO SEPARATE A MIXTURE



Filtration

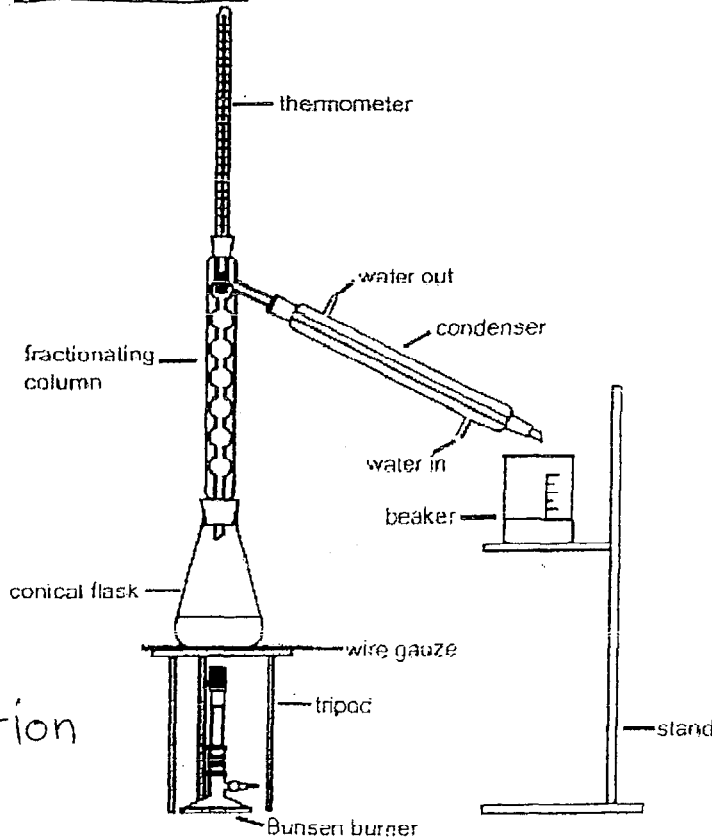


Evaporation



In chromatography technique, only a small amount of mixture samples are required, often as little as a drop. The concept behind this techniques is that different constituent in a mixture have different solubility. As the solvent moves up the paper the less soluble constituent will travel at a slower rate than those of more soluble constituents. Hence the mixture will eventually separate into different colored spots as the solvent moves to the top.

Chromatography



stillation

The diagram on the left shows equipment set-up for fractional distillation. For normal distillation, the set-up is similar, except that the fractionating column is being removed. The curving structure of the fractionating column is to increase the surface area and encourage condensation of liquids with higher boiling points. Sometimes the column consists of a tube tightly packed with glass beads.

Some porcelain chips should be added into the conical flask to prevent hot spots and sudden boiling. The thermometer reading ensures that suitable temperature is reached at the boiling point of the desired liquid to condense out.

Matter

What is it?

