Mixtures and Separation

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Overview

Matter can be classified into two main groups: pure substances and mixtures.

A pure substance contains only one type of material and has fixed properties, while a mixture consists of two or more substances physically combined in variable proportions. Understanding this distinction is essential, as it determines how substances behave and how they can be separated.

Pure Substances and Mixtures

A pure substance has a fixed composition and constant properties. It cannot be separated into simpler substances by physical means. Pure substances are divided into elements and compounds.

An element is the simplest form of matter and consists of only one type of atom. It cannot be broken down by ordinary chemical or physical methods. Examples include iron, copper, and oxygen.

A compound consists of two or more different elements chemically combined in fixed proportions. Its properties differ from those of the individual elements. For example, water is composed of hydrogen and oxygen, but its properties are very different from those gases.

A mixture, in contrast, consists of substances that are not chemically combined. Each component retains its own properties and can be separated by physical methods. The composition of a mixture is not fixed.

[DIAGRAM PLACEHOLDER: Classification of matter into elements, compounds, and mixtures]

Homogeneous and Heterogeneous Mixtures

Mixtures can be further classified based on their uniformity.

A homogeneous mixture has a uniform composition throughout, and its components cannot be distinguished. A solution is a common example, such as salt dissolved in water or air.

A heterogeneous mixture has a non-uniform composition, and its components can be distinguished. Examples include sand and salt or muddy water.

Solutions, Suspensions, and Colloids

Different types of mixtures can be distinguished based on particle size and behaviour.

- **Solution:** A homogeneous mixture in which a solute is dissolved in a solvent. The particles are very small, do not settle, and cannot be separated by filtration. Solutions are usually transparent.
- **Suspension:** A heterogeneous mixture containing visible particles. These particles settle over time and can be separated by filtration.
- **Colloid:** A heterogeneous mixture with particles intermediate in size between those of a solution and a suspension. The particles do not settle but can scatter light.

These differences arise from particle size and how particles interact with the surrounding medium.

Solubility

Solubility is the mass of solute that can dissolve in a fixed amount of solvent at a given temperature, usually expressed as grams per 100 g of water.

A solution becomes saturated when it contains the maximum amount of solute that can dissolve at a given temperature. Any additional solute remains undissolved.

For most solid solutes in water, solubility increases as temperature increases. When a saturated solution is cooled, excess solute may crystallise out.

[DIAGRAM PLACEHOLDER: Solubility curve showing solubility vs temperature]

Separating Mixtures

Mixtures can be separated because their components have different physical properties such as particle size, boiling point, density, and solubility.

- **Filtration:** Used to separate an insoluble solid from a liquid. The solid remains as the residue, while the liquid passes through as the filtrate.
- **Evaporation:** Used to obtain a dissolved solid by heating the solution so that the solvent evaporates.
- **Crystallisation:** Used to obtain a solid in crystalline form by allowing the solvent to evaporate slowly.
- **Simple distillation:** Used to separate a liquid from a solution. The liquid is vaporised and then condensed to form the distillate.
- **Fractional distillation:** Used to separate two or more miscible liquids with different boiling points.
- **Separating funnel:** Used to separate immiscible liquids based on differences in density.
- **Chromatography:** Used to separate dissolved substances based on differences in solubility and attraction to a medium.

[DIAGRAM PLACEHOLDER: Basic setups for filtration and distillation]

Each method depends on a specific physical property, so choosing the correct method requires identifying how the components differ.

Summary of Key Principles

- Matter is classified into pure substances and mixtures
- Elements and compounds are pure substances with fixed composition
- Mixtures have variable composition and can be separated physically
- Homogeneous mixtures are uniform; heterogeneous mixtures are not
- Solutions, suspensions, and colloids differ by particle size and behaviour
- Separation methods depend on differences in physical properties

A clear understanding of these distinctions allows for correct identification and separation of substances in both theory and practical applications.