

Chapter 2 Properties of Matter

Summary

2.1 Classifying Matter

Matter that always has exactly the same composition, or makeup, is classified as a pure substance, or simply a substance. Every sample of a given substance has the same properties because a substance has a fixed, uniform composition. Substances can be classified into two categories—elements and compounds.

An element is a substance that cannot be broken down into simpler substances. An atom is the smallest particle of an element. An element has a fixed composition because it contains only one type of atom. No two elements have the same type of atom. At room temperature, most elements are solid. Chemists use symbols to represent elements. For example, C represents carbon, and Au represents gold.

A compound is a substance that is made from two or more simpler substances and can be broken down into those simpler substances. The properties of a compound differ from those of the substances it is made from. Properties change when elements join and form compounds. A compound always contains two or more elements joined in a fixed proportion. In water, for example, there are always two hydrogen atoms for each oxygen atom.

The properties of a mixture are less uniform than the properties of a substance. The properties of a mixture can vary because the composition of a mixture is not fixed. Mixtures can be classified by how well the parts of the mixture are distributed throughout the mixture.

- In a heterogeneous mixture, the parts of the mixture are noticeably different from one another.

- In a homogeneous mixture, the substances are so evenly distributed that it is difficult to tell one substance in the mixture from another. A homogeneous mixture appears to contain only one substance.

A mixture can be classified as a solution, a suspension, or a colloid. This classification is based on the size of a mixture's largest particles.

- A solution forms when substances dissolve and form a homogeneous mixture.
- A suspension is a heterogeneous mixture that separates into layers over time.
- A colloid contains some particles that are intermediate in size between the small particles in a solution and the larger particles in a suspension.

2.2 Physical Properties

A physical property is any characteristic of a material that can be observed or measured without changing the composition of the substances in the material. Viscosity, conductivity, malleability, hardness, melting point, boiling point, and density are examples of physical properties.

Viscosity is the tendency of a liquid to keep from flowing. The greater the viscosity, the slower the liquid moves. Thick liquids have a high viscosity, and thin liquids have a low viscosity.

A material's ability for allowing heat to flow through it is called conductivity. Materials that have high conductivity, such as metals, are called conductors. Malleability is the ability of a solid to be hammered without shattering. Most metals are malleable. Solids that shatter when struck are brittle.

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The hardness of two materials can be compared by seeing which of the materials can scratch the other. Diamond is the hardest known material.

The temperature at which a substance changes from solid to liquid is its melting point. The temperature at which a substance boils is its boiling point.

Density is the ratio of the mass of a substance to its volume. Density can be used to test the purity of a substance.

Knowing the physical properties of matter can be useful in the following ways:

- identifying a material
- choosing a material for a specific purpose
- separating the substances in a mixture

Scientists follow these steps in using properties to identify a material:

1. Decide which properties to test.
2. Do tests on a sample of the unknown.
3. Compare the results with the data reported for known materials.

Properties determine which materials are chosen for which uses.

Some properties can be used to separate mixtures. Filtration and distillation are two common separation methods. Filtration is a process that separates materials based on the size of their particles. Distillation is a process that separates substances in a solution based on their boiling points.

A physical change occurs when some of the properties of a material change, but the substances in the material remain the same. Some physical changes can be reversed, and some cannot be reversed.

2.3 Chemical Properties

A chemical property is any ability to produce a change in the composition of matter. Chemical properties can be observed only when the substances in a sample of matter are changing into different substances.

Flammability and reactivity are two examples of chemical properties.

Flammability is a material's ability to burn in the presence of oxygen.

Reactivity is the property that describes how readily a substance combines chemically with other substances.

Oxygen is a highly reactive element, whereas nitrogen has an extremely low reactivity.

Oxygen reacts easily with most other elements. Rust forms when oxygen reacts with iron and water. A rusty chain or bolt is more likely to break than a new chain or bolt, because rust is weaker than iron.

A chemical change occurs when a substance reacts and forms one or more new substances. Three common types of evidence for a chemical change are

- change in color,
- the production of a gas,
- the formation of a precipitate, or a solid that separates from a liquid mixture.

Each of these changes is a clue that a chemical change has produced at least one new substance.

It is not always easy to tell a chemical change from a physical change. Even if you observe a color change, a gas, or a precipitate, you cannot be sure a chemical change has taken place. If different substances are present after the change takes place, then the change is chemical, not physical. If different substances are not present, then the change is physical, not chemical.

When matter undergoes a chemical change, the composition of the matter changes. When matter undergoes a physical change, the composition of the matter remains the same.