

Chapter 3

Matter

States of Matter

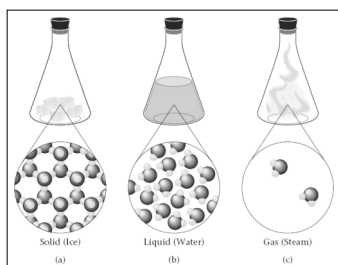
Table 3.1 The Three States of Matter

State	Definition	Examples
solid	rigid; has a fixed shape and volume	ice cube, diamond, iron bar
liquid	has a definite volume but takes the shape of its container	gasoline, water, alcohol, blood
gas	has no fixed volume or shape; takes the shape and volume of its container	air, helium, oxygen

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States of Matter (cont.)



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Properties

- Characteristics of the substance under observation
- Properties are:
 - Directly observable
 - The way something interacts with other substances in the universe

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Universe Classified

- **Matter:** the part of the universe that has mass and volume
- **Chemistry is the study of matter**
 - The properties of different types of matter
 - The way matter changes and behaves when influenced by other matter and/or energy

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Properties of Matter

- **Physical Properties:** the characteristics of matter that can be changed without changing its composition
 - Characteristics that are directly observable
- **Chemical Properties:** the characteristics that determine how the composition of matter changes as a result of contact with other matter or the influence of energy
 - Characteristics that describe the behavior of matter

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Chemical Properties

- One commonly cited chemical property is flammability, the ease with which a substance burns in a flame. Burning is a chemical reaction.

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Classify Each of the following as a Physical or Chemical Property (cont.)

- Ethyl alcohol boils at 78°C.
 - Physical property: boiling point is associated with a phase change. It describes an inherent characteristic of alcohol.
- Hardness of a diamond.
 - Physical property: describes an inherent characteristic of diamond – hardness
- Sugar can ferment to form ethyl alcohol.
 - Chemical property: describes behavior of sugar – forming a new substance (ethyl alcohol) through a chemical reaction

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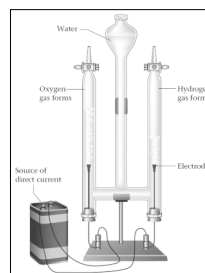
Changes in Matter

- **Physical changes:** changes to matter that do not result in a change to the fundamental components that make up the substance
 - State changes: boiling, melting, condensing
- **Chemical changes:** changes that involve a change in the fundamental components of the substance
 - Produce new substances
 - Chemical reactions occur
 - Reactants → Products

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Chemical Change



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Chemical Change (cont.)

- Chemical change involves a chemical reaction. At least one new substance is formed.

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Classify Each of the following as a Physical or Chemical Change (cont.)

- Iron metal melting.
 - Physical change: describes a state change, but the material is still iron
- Iron combining with oxygen to form rust.
 - Chemical change: describes how iron and oxygen react to make a new substance, rust
- Sugar fermenting to form ethyl alcohol.
 - Chemical change: describes how sugar forms a new substance (ethyl alcohol) via a chemical reaction

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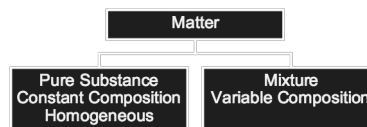
Elements and Compounds

- **Elements:** substances that cannot be broken down into simpler substances by chemical reactions
- Most substances are chemical combinations of elements. These combinations are called **compounds**.
 - Compounds are made of elements
 - Compounds can be broken down into elements
 - Properties of the compound not related to the properties of the elements that compose it
 - Same chemical composition at all times

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Classification of Matter



- **Homogeneous:** uniform throughout, appears to be one thing
 - Pure substances
 - Solutions (homogeneous mixtures)
- **Heterogeneous:** non-uniform, contains regions with different properties than other regions

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Pure Substances

- **Pure substances**
 - All samples have the same physical and chemical properties
 - Constant composition: all samples have the same composition
 - Homogeneous
 - Separate into components based on **chemical properties**

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Mixtures

- **Mixtures**
 - Different samples may show different properties
 - Variable composition
 - Homogeneous or heterogeneous
 - Separate into components based on **physical properties**
- **All mixtures are made of pure substances**

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Solutions

- A solution is a **homogeneous mixture**.
- Phase can be gaseous, liquid, or solid.

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Identify Each of the following as a Pure Substance, Homogeneous Mixture, or Heterogeneous Mixture (cont.)

- Gasoline
 - A homogenous mixture
- A stream with gravel on the bottom
 - A heterogeneous mixture
- Copper metal
 - A pure substance (all elements are pure substances)

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Separation of Mixtures

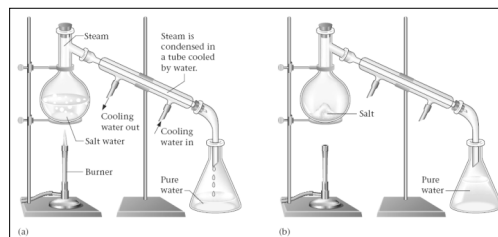
- Mixtures can be separated based on different physical properties of the components
 - Physical change

Different Physical Property	Technique
Boiling point	Distillation
State of matter (solid/liquid/gas)	Filtration
Adherence to a surface	Chromatography
Volatility	Evaporation

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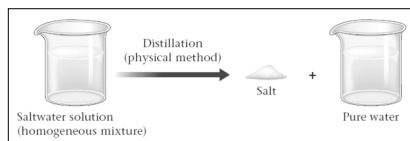
Separation of Mixture (cont.)



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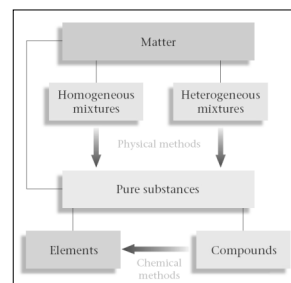
Separation of a Mixture (cont.)



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Another Look at Matter



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