Chapter Introduction

Lesson 1  Matter and Its Properties

Lesson 2  Matter and Its Changes

Chapter Wrap-Up
What gives a substance its unique identity?
What do you think?

Before you begin, decide if you agree or disagree with each of these statements. As you view this presentation, see if you change your mind about any of the statements.
Do you agree or disagree?

1. The particles in a solid object do not move.
2. Your weight depends on your location.
3. The particles in ice are the same as the particles in liquid water.
Do you agree or disagree?

4. Mixing powdered drink mix with water causes a new substance to form.

5. If you combine two substances, bubbling is a sign that a new type of substance might be forming.

6. If you stir salt into water, the total amount of matter decreases.
Matter and Its Properties

Key Concepts

- How do particles move in solids, liquids, and gases?
- How are physical properties different from chemical properties?
- How are properties used to identify a substance?
Matter and Its Properties

Vocabulary

- volume
- solid
- liquid
- gas
- physical property

- mass
- density
- solubility
- chemical property

Complete Vocab 5.1 on page of your ISN
What is matter?

- Matter is anything that has mass and takes up space.
- Matter can have both physical and chemical properties.
States of Matter

- **Volume** is the amount of space a sample of matter occupies.
• A **solid** is a state of matter with a definite shape and volume.
A **liquid** is a state of matter with a definite volume but not a definite shape.
• A **gas** is a state of matter without a definite shape or a definite volume.
CHEMISTRY TERM | PHASE CHANGE
--- | ---
Fusion (melting) | Solid to Liquid
Freezing | Liquid to Solid
Vaporization (boiling) | Liquid to Gas
Condensation | Gas to Liquid
Sublimation | Solid to Gas
Deposition | Gas to Solid
## States of Matter

<table>
<thead>
<tr>
<th>State of</th>
<th>Characteristics</th>
<th>Sketch of Molecules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gas</td>
<td>*</td>
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<tr>
<td>2. Liquid</td>
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<td>3. Solid</td>
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</tbody>
</table>
States of Matter (cont.)

In a gas, particles move freely rather than staying close together.

**Gas**
- no definite shape
- no definite volume
- particles very far apart
- very weak attractive forces between particles
- particles move freely
In liquids, the distance between particles is greater and they can slide past one another.

**Liquid**
- no definite shape; takes the shape of its container
- definite volume
- particles close together
- weaker attractive forces between particles than in solids
- particles free to move past neighboring particles
States of Matter (cont.)

- All matter is made of tiny particles that are constantly moving.
- In solids, particles vibrate back and forth in all directions.

Solid
- a definite shape
- a definite volume
- particles close together
- strong attractive forces between particles
- particles vibrate in all directions
States of Matter (cont.)

**Key Concept Check**

How do particles move in solids, liquids, and gases?
States of Matter (cont.)

- Particles of matter that are close together exert an attractive force on each other.

- The strength of the attraction depends on the distance between particles.
What are physical properties? (cont.)

- **Density** is the mass per unit volume of a substance.
- Density is constant for a given substance, regardless of the size of the sample.
Density Equation

Density (in g/mL) = \frac{mass \ (in \ g)}{volume \ (in \ mL)}

D = \frac{m}{V}

1) Volume = \frac{Mass}{Density}

2) Mass = Density \cdot Volume

3) Density = \frac{Mass}{Volume}

Density Calculation

Density can be calculated using the density equation. The common units of density are grams per milliliter (g/mL) or grams per cubic centimeter (g/cm³). 1 mL = 1 cm³.
Solve:

A student finds a rock on the way to school. In the laboratory he determines that the volume of the rock is 22.7 mL, and the mass in 39.943 g. What is the density of the rock?

\[ m = 39.943 \quad V = 22.7 \quad D = ? \]

\[ D = \frac{m}{V} \]

\[ D = \frac{39.943}{22.7} \]

\[ D = 1.8 \text{ g/cm}^3 \]
Solve:

The density of silver is 10.49 g/cm³. If a sample of pure silver has a volume of 12.993 cm³, what is the mass?

\[ m = ? \quad V = 12.993 \quad D = 10.49 \]

\[ m = DV \]

\[ m = 10.49 \times 12.993 \]

\[ m = 136.3 \text{ g} \]
Solve:

Pure gold has a density of 19.32 g/cm³. How large would a piece of gold be if it had a mass of 318.97 g?

\[ m = 318.97 \quad V = ? \quad D = 19.32 \]

\[ V = \frac{m}{D} \]

\[ V = \frac{318.97}{19.32} \]

\[ V = 16.5 \text{ cm}^3 \]
Solve:

A screwdriver has the density of 5.5 grams per cubic centimeter. It also has the mass of 2.3 grams. What is the screwdriver’s volume?

\[ m = 2.3 \quad V = \, ? \quad D = 5.5 \]

\[ V = \frac{m}{D} \]

\[ V = \frac{2.3}{5.5} \]

\[ V = 0.4 \text{ cm}^3 \]

1) Volume = \frac{Mass}{Density}

2) Mass = Density \cdot Volume

3) Density = \frac{Mass}{Volume}
Solve:

A mechanical pencil has the density of 3 grams per cubic centimeter. The volume of the pencil is 15.8 cubic centimeters. What is the mass of the pencil?

\[ m = ? \]
\[ V = 15.8 \]
\[ D = 3 \]

\[ m = D \times V \]
\[ m = 3 \times 15.8 \]
\[ m = 47.4 \text{ g} \]
A Journey through the Air

When you ride in the basket of a hot-air balloon, you really are floating in the air. You might travel over land or water, but you will always travel in the same direction that the wind is blowing.

1. How did this hot-air balloon get over the Red Sea?
2. Where is the "hot air" of a hot-air balloon? Why must the air be hot?
3. How are the properties of air different from those of land and water?
### Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass &amp; Weight</td>
<td></td>
</tr>
<tr>
<td>Volume</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td></td>
</tr>
<tr>
<td>Conductivity</td>
<td></td>
</tr>
<tr>
<td>Solubility</td>
<td></td>
</tr>
<tr>
<td>Melting &amp; Boiling Point</td>
<td></td>
</tr>
<tr>
<td>Magnetism</td>
<td></td>
</tr>
</tbody>
</table>
What are physical properties?

• Any characteristic of matter that you can observe without changing the identity of the substances that make it up is a **physical property**.

• State of matter, temperature, and the size of an object are all examples of physical properties.
What are physical properties? (cont.)

**SCIENCE USE v. COMMON USE**

*state*

*Science Use* a condition or physical property of matter

*Common Use* an organized group of people in a defined territory, such as one of the fifty states in the United States
Mass is the amount of matter in an object.

A balance measures an object’s mass by comparing it to the known mass of the slides on the balance. Common units for measuring mass are the kilogram (kg) and the gram (g).
What are physical properties? (cont.)

- Weight is the gravitational pull on the mass of an object.
- Weight depends on the location of an object, but its mass does not.
Volume depends on the amount or size of the sample of matter.

Volume of a Rectangular-Shaped Solid
If a solid has a rectangular shape, you can find its volume by multiplying its length, its width, and its height together. A common unit of volume for a solid is the cubic centimeter (cm³).
Solubility is the ability of one material to dissolve in another.

**Word Origin**

**solubility**

from Latin *solubilis*, means “capable of being dissolved”
• Melting point and boiling point are physical properties.

• The melting point is the temperature at which a solid changes to a liquid.

• The boiling point is the temperature at which a liquid boils, or changes to gas.

• Magnetism, malleability, and electrical conductivity are also physical properties.
What are chemical properties?

• A **chemical property** is the ability or inability of a substance to combine with or change into one or more new substances.

• A chemical property is a characteristic of matter that you observe as it reacts with or changes into a different substance.
### Chemical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammability</td>
<td></td>
</tr>
<tr>
<td>Ability to Rust</td>
<td></td>
</tr>
</tbody>
</table>
What are chemical properties? (cont.)

**Key Concept Check**

How do chemical properties and physical properties differ?
Flammability and the ability to rust are both chemical properties.

- Flammability is the ability of a type of matter to burn easily.
- Rust is a substance that forms when iron reacts with water and oxygen.
### Examples:

<table>
<thead>
<tr>
<th>Physical Changes</th>
<th>Chemical Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum foil is cut in half.</td>
<td>Milk goes sour.</td>
</tr>
<tr>
<td>Clay is molded into a new shape.</td>
<td>Jewelry tarnishes.</td>
</tr>
<tr>
<td>Butter melts on warm toast.</td>
<td>Bread becomes toast.</td>
</tr>
<tr>
<td>Water evaporates from the surface of the ocean.</td>
<td>Rust forms on a nail left outside.</td>
</tr>
<tr>
<td>A juice box in the freezer freezes.</td>
<td>Gasoline is ignited.</td>
</tr>
<tr>
<td>Rubbing alcohol evaporates on your hand.</td>
<td>Hydrogen peroxide bubbles in a cut.</td>
</tr>
<tr>
<td></td>
<td>Food scraps are turned into compost in a compost pile.</td>
</tr>
<tr>
<td></td>
<td>A match is lit.</td>
</tr>
<tr>
<td></td>
<td>You take an antacid to settle your stomach.</td>
</tr>
<tr>
<td></td>
<td>Your body digests food.</td>
</tr>
<tr>
<td></td>
<td>You fry an egg.</td>
</tr>
</tbody>
</table>
The explosion of fireworks is an example of chemical change.

During a chemical change, substances are changed into different substances.
Energy Absorbed

When you bake a cake, energy is absorbed by the batter as it changes form a runny mix into a cake. This is a chemical change.
As in the case of autumn leaves, a change in color is a clue to indicate a chemical change.
It only takes one experience with a rotten egg to learn that they smell different from fresh eggs. When eggs and food spoil, they undergo a chemical change.
Cannot Change Back

As wood burns, it turns into a pile of ashes and gases that rise into air. After the wood is burned, it cannot be restored to its original form as a log.
Can Change Back

Ice melting is an example of a physical change. The change can be “undone”. We can refreeze the water.
Physical Changes

Change Shape or Size

The tearing of paper and crushing a can only changing the shape and size, therefore these are physical changes.
Physical Changes

Change Shape or Size

The breaking of glass is only changing the shape and size, therefore this is a physical change.
Identifying Matter Using Physical Properties

- Physical properties are useful for identifying unknown substances.
- When you identify matter using physical properties, consider how the properties are alike and how they are different.
# Identifying an Unknown Material by its Physical Properties

<table>
<thead>
<tr>
<th>Substance</th>
<th>Color</th>
<th>Mass (g)</th>
<th>Melting Point (°C)</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table salt</td>
<td>white</td>
<td>14.5</td>
<td>801</td>
<td>2.17</td>
</tr>
<tr>
<td>Sugar</td>
<td>white</td>
<td>11.5</td>
<td>148</td>
<td>1.53</td>
</tr>
<tr>
<td>Baking soda</td>
<td>white</td>
<td>16.0</td>
<td>50</td>
<td>2.16</td>
</tr>
<tr>
<td>Unknown</td>
<td>white</td>
<td>16.0</td>
<td>801</td>
<td>2.17</td>
</tr>
</tbody>
</table>
Physical properties and chemical properties are useful for sorting materials.
Physical properties, such as a material’s melting point, are useful for separating different types of matter that are mixed.
The movement of particles is different in a solid, a liquid, and a gas.
Physical properties and chemical properties are used to describe types of matter.
Physical properties such as magnetism can be used to separate mixtures.

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<td>801</td>
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</tr>
</tbody>
</table>
Which of these refers to a state of matter with a definite volume but not a definite shape?

A. particle  
B. solid  
C. gas  
D. liquid
What is the amount of space a sample of matter occupies?

A. mass
B. volume
C. weight
D. density
Solubility refers to one substance’s ability to do what in the presence of another substance?

A. rust
B. burn
C. dissolve
D. change shape
Lesson Review

What do you think NOW?

Do you agree or disagree?

1. The particles in a solid object do not move.
2. Your weight depends on your location.
3. The particles in ice are the same as the particles in liquid water.