Matter: Properties and Changes

Matter and Its Properties

Before You Read

What do you think? Read the three statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	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 water.	

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?

Read to Learn

What is matter?

Look around you. All the objects that you see are made of matter. Matter can be in different forms and can have different properties. As you read, you will learn about matter, its properties, and its uses.

Matter is anything that has mass and takes up space. You, your book, your desk, and the water you drink are matter because they have mass and take up space. The air you breathe is matter, even though you can't see it. Air has mass and takes up space. Light from the Sun is not matter because it does not have mass and does not take up space. Sounds, forces, and energy are not matter because they do not have mass and do not take up space.

Matter has many different properties. For example, a helmet you wear while biking is hard and shiny. The water in the stream is cool and clear. You will learn about some of the physical properties and chemical properties of matter in this chapter. Learning about these properties will help you to identify many types of matter and their uses.

Study Coach

Use an Outline As you read, make an outline to summarize the information in the lesson. Use the main headings in the lesson as the main headings in the outline. Complete the outline with the information under each heading.

REVIEW VOCABULARY

matter
anything that has mass and takes up space

States of Matter

One property of a substance is its state of matter. You can tell the state of a material by answering the following questions:

- Can its shape change?
- Can its volume change?

Volume *is the amount of space a sample of matter occupies*. Three states of matter are solids, liquids, and gases. The table below shows whether shape and volume change for a solid, a liquid, and a gas when moved from one container to another.

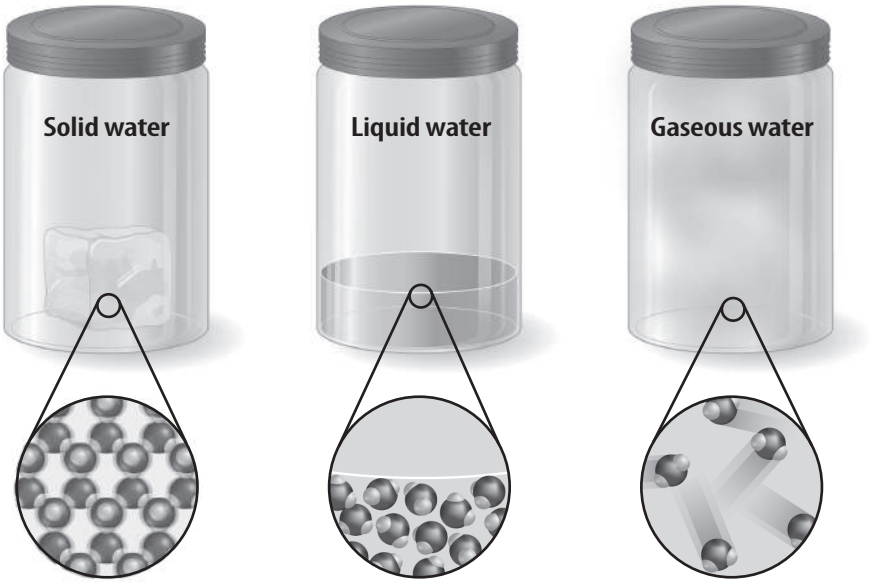
	Solid	Liquid	Gas
When moved from one container to another	does not change shape	does change shape	does change shape
	does not change volume	does not change volume	does change volume

Solids, Liquids, and Gases

The table above shows that *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.*

Moving Particles

All matter is made of tiny particles. The particles of matter are always moving. Particles in solids move quickly or vibrate back and forth in all directions. They can't move from place to place. In liquids, particles are farther apart. They can slide past each other. In a gas, particles move freely rather than staying close together.



Reading Check

1. Identify Which state of matter does not change shape or volume?

_____

Key Concept Check

2. Explain How do particles move in solids, liquids, and gases?

_____

_____

_____

_____

Visual Check

3. Identify Circle the matter that moves freely.

Attraction Between Particles

Particles of matter that are close to each other attract, or pull on, each other. The stronger the attraction on each other, the closer together the particles are. Because particles of a solid are close together, they attract each other strongly. Particles of a liquid can flow because the forces between the particles are weaker. Particles of a gas are so far apart that they are not held together by attractive forces.

What are physical properties?

Matter has physical properties. *A* **physical property** *is any characteristic of matter that you can observe without changing the identity of the substances that make it up*. Examples of physical properties are state of matter, shape, mass, volume, density, solubility, and temperature.

Mass and Weight

Some physical properties, such as mass and weight, depend on the size of the sample. **Mass** *is the amount of matter in an object*. Weight is the gravitational pull on an object.

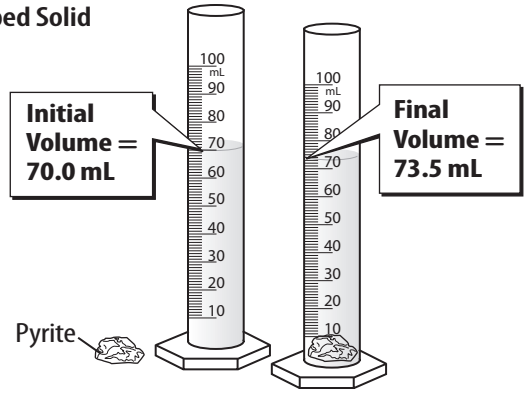
Weight depends on the location of an object. Mass does not. The mass of an object is the same on Earth as it is on the Moon. An object's weight, however, is greater on Earth than it is on the Moon because Earth's gravity is stronger than the Moon's gravity.

Volume

Like mass and weight, the volume of an object is a physical property. Volume depends on the size or amount of the sample. You can measure the volume of a liquid by pouring it into a measuring cup or a graduated cylinder. You can measure the volume of a solid in two ways. If a solid has a regular geometric shape, multiply its length, width, and height together. You can find the volume of a solid with an irregular shape by using the displacement method that is shown below.

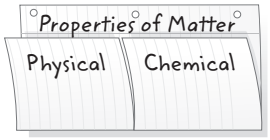
Volume of an Irregular-Shaped Solid

The volume of an irregular-shaped object can be measured by displacement. The volume of the object is the difference between the water level before and after placing the object in the water. The common unit for liquid volume is the milliliter (mL).



FOLDABLES®

Make the following two-tab book to organize your notes about the properties of matter.



Reading Check

4. Describe How do mass and weight differ?

Visual Check

5. Highlight the part of the water in the second cylinder that is equal in volume to the rock in the cylinder.

Density

Another physical property of matter is density. **Density** *is the mass of a substance divided by the volume of the substance*. Density does not depend on the size or amount of the sample. The density of a substance never changes.

Solubility

WORD ORIGIN
solubility
from Latin *solubilis*, means "capable of being dissolved"

You can observe another physical property of matter when a solid, such as sugar, dissolves in water. *To dissolve* means "to mix evenly." **Solubility** (sahl yuh BIH luh tee) *is the ability of one material to dissolve in another material*.

Melting and Boiling Point

Each material has a melting point and a boiling point. Melting point and boiling point do not depend on the size or the amount of the material. The melting point is the temperature at which a solid changes to a liquid. The boiling point is the temperature at which a liquid changes to a gas. Melting point and boiling point are physical properties.

Reading Check

6. Explain How does a material change at its melting point and at its boiling point?

Additional Physical Properties

There are many physical properties that make materials useful. Some materials conduct electricity, some are magnetic, and some are malleable. Malleable materials can be bent or pulled into different shapes.

What are chemical properties?

Substances undergo chemical reactions when they change into other substances. *A* **chemical property** *is the ability or inability of a substance to combine with or change into one or more new substances*. When substances react, their particles combine to form different substances.

Flammability

Flammability is a chemical property. Flammability is the ability of a type of matter to burn easily, as shown below. Some substances, such as wood and paper, are flammable. Rocks and sand are not flammable.

Chemical property

Visual Check

7. Identify What type of chemical property is shown in the figure?

Ability to Rust

You have probably seen objects, such as old cars, that have begun to rust. Rust is a substance that forms when iron reacts with oxygen and water in the air. The ability to rust is a chemical property of iron or metals that contain iron.

Identifying Matter Using Physical Properties

Physical properties can be used to identify unknown substances. Look at the table below of substances and their physical properties. You can identify the unknown substance by comparing its physical properties to the physical properties of the known substances.

Substance	Color	Mass g	Melting Point °C	Density g/cm^3
Table salt	white	14.5	801	2.17
Sugar	white	11.5	148	1.53
Baking soda	white	16.0	50	2.16
Unknown	white	16.0	801	2.17

All the substances are white. So, you cannot identify the unknown substance by its color. You also cannot identify it by its mass. Mass and volume are properties of matter that change with the amount of the sample. However, melting point and density are physical properties that do not depend on the size or amount of the sample. The unknown substance has the same melting point and density as table salt, so it must be table salt.

Sorting Materials Using Properties

Both physical properties and chemical properties are used for sorting materials. You probably often sort materials by their properties without realizing it. Objects are usually sorted based on the physical and chemical properties they have in common.

Separating Mixtures Using Physical Properties

Physical properties can be used to separate different types of matter that are mixed. Size, for example, can be used to separate a mixture of grains by sifting the mixture. Boiling point can be used to separate salt from water. The liquid water changes to gas, leaving the salt behind.

Key Concept Check

8. Contrast What is the difference between chemical properties and physical properties?

Math Skills

A statement that two expressions are equal is an equation. For example, look at the density equation:

$$D = \frac{m}{V}$$

This equation shows that density, D, is equal to mass, m, divided by volume, V. To solve a one-step equation, place the variables you know into the equation. Then solve for the unknown variable. For example, if

$$m = 52 \text{ g}$$
$$V = 4 \text{ cm}^3$$

the density would be:

$$D = \frac{52 \text{ g}}{4 \text{ cm}^3} = 13 \text{ g/cm}^3$$

9. Solve Equation A cube of metal measures 3 cm on each side. It has a mass of 216 g. What is the density of the metal?

Mini Glossary

chemical property (KEM ih kul • PRAH pur tee): the ability or inability of a substance to combine with or change into one or more new substances

density (DEN sih tee): the mass per unit volume of a substance

gas: a state of matter without a definite shape or a definite volume

liquid (LIH kwud): a state of matter with a definite volume but not a definite shape

mass: the amount of matter in an object

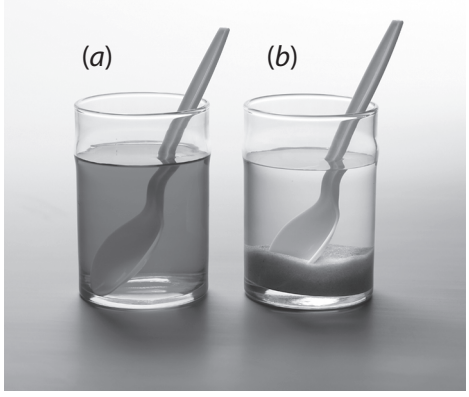
physical property (FIH zih kul • PRAH pur tee): any characteristic of matter that you can observe without changing the identity of the substances that make it up

solid (SAH lud): a state of matter with a definite shape and volume

solubility (sahl yuh BIH luh tee): the ability of one substance to dissolve in another

volume (VAHL yum): the amount of space a sample of matter occupies

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that describes how some of the physical properties of a substance might be measured.



2. Look at the picture above. Which of the two glasses, *a* or *b,* contains a dissolved mixture? Describe the difference between the particles in the dissolved mixture and the contents of the other glass.

What do you think NOW?

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?

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END OF LESSON

Mini Glossary

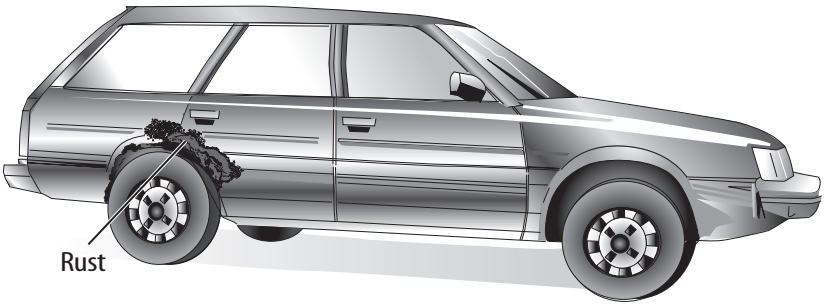
chemical change (KEM ih kum • CHANJ): a change in matter in which the substances that make up the matter change into other substances with different chemical and physical properties

law of conservation (kun SURV ay shun) of mass: states that the total mass before a chemical reaction is the same as the total mass after the chemical reaction

physical change (FIH zih kul • CHANJ): a change in the size, shape, form, or state of matter that does not change the matter's identity

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that describes some ways in which physical changes and chemical changes are similar and some ways in which they are different.

2. A chemical change is shown in the picture below. Name three signs that you could use to tell that it is a chemical change.



3. How did underlining the main ideas help you learn the material in this lesson?

What do you think NOW?

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?

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