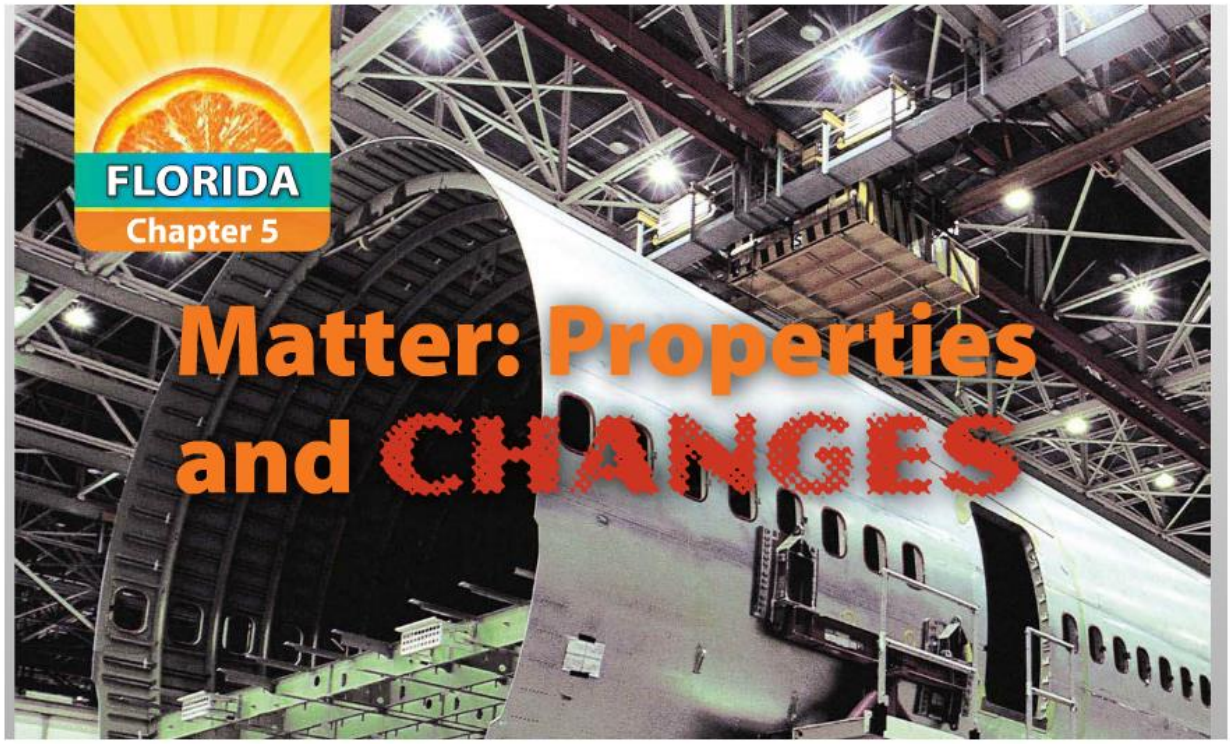

FLORIDA
Chapter 5
Matter: Properties and CHANGES


Esp.

**FLORIDA BIG IDEAS**

**1 The Practice of Science**
**8 Properties of Matter**
**9 Changes in Matter**

The Big Idea

Think About It!

## What gives a substance its unique identity?

**When designing a safe airplane, choosing materials with specific properties is important. Notice how the metal used in the outer shell of this airplane is curved, yet strong enough to hold its shape. Think about how the properties of the airplane's materials are important to the conditions in which it flies.**

1. What properties do you think would be important to consider when constructing the outer shell of an airplane?

2. Why do you think metal is used for electric wiring and plastic is used for the interior walls of the airplane?

Get Ready to Read

3. Why do you think different substances have different properties?

SUBMIT SHOW ANSWERS CLEAR

## What do you think about matter?

**Before you read, decide if you agree or disagree with each of these statements. As you read this chapter, see if you change your mind about any of the statements.**

| | AGREE | 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. | ☐ | ☐ |
| 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. | ☐ | ☐ |

SUBMIT CLEAR

Lesson 1

# Matter and Its PROPERTIES

**ESSENTIAL QUESTIONS**

- 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?

**Vocabulary**

**volume** p. 188
**solid** p. 188
**liquid** p. 188
**gas** p. 188
**physical property** p. 190
**mass** p. 190
**density** p. 191
**solubility** p. 192
**chemical property** p. 195

**Florida NGSSS**

**SC.8.P.8.1** Explore the scientific theory of atoms (also known as atomic theory) by using models to explain the motion of particles in solids, liquids, and gases.

**SC.8.P.8.2** Differentiate between weight and mass recognizing that weight is the amount of gravitational pull on an object and is distinct from, though proportional to, mass.

**SC.8.P.8.3** Explore and describe the densities of various materials through measurement of their masses and volumes.

**SC.8.P.8.4** Classify and compare substances on the basis of characteristic physical properties that can be demonstrated or measured; for example, density, thermal or electrical conductivity, solubility, magnetic properties, melting and boiling points, and know that these properties are independent of the amount of the sample.

**SC.8.N.1.1** Define a problem from the eighth grade curriculum using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

**Also covers: LA.8.2.2.3, MA.6.A.3.6**

SC.8.P.8.4

Inquiry **Launch Lab**

15 minutes

## How can you describe a substance?

Think about the different ways you can describe a type of matter. Is it hard? Can you pour it? What color is it? Answering questions like these can help you describe the properties of a substance. In this lab, you will observe how the properties of a mixture can be very different from the properties of the substances it is made from.

**Procedure**

1. Read and complete a lab safety form.
2. Using a **small plastic spoon,** measure two spoonfuls of **cornstarch** into a **clear plastic cup.** What does the cornstarch look like? What does it feel like?

3. Slowly stir one spoonful of **water** into the cup containing the cornstarch. Gently roll the new substance around in the cup with your finger.

### Think About This

1. **Identify** What were some properties of the cornstarch and water before they were mixed?

2. Key Concept **Differentiate** How were the properties of the mixture different from the original properties of the cornstarch and water?

SUBMIT SHOW ANSWERS CLEAR

**Inquiry** **What makes this possible?**

**1.** Scuba diving in the Florida Keys National Marine Sanctuary is a lot of fun, but you have to be prepared. Exploring below the water's surface has its dangers, and you need good equipment. What properties must a diver's wet suit, mask, flippers, and breathing apparatus have to make a safe dive possible?

**REVIEW VOCABULARY**

**matter**
anything that has mass and takes up space

## What is matter?

Have you ever experienced the excitement of scuba diving through a coral reef? The warm, pristine water can be absolutely breathtaking! As you drift through the quiet water, you are awestruck by the beautiful coral and colorful sea creatures. You may even discover an amazing shipwreck. Except for your air bubbles rising to the surface, there is not a sound.

Imagine looking around and asking yourself, "What is matter?" Sand, coral, fish, and all the things you might see during your dive are **matter** because they have mass and take up space. Air, even though you can't see it, is also matter because it too 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 also are not matter.

Think about the properties of matter around you below the water's surface. The face mask you wear is hard and clear. The hose from your air tank is soft and flexible. The colorful coral around you is alive. Matter has many properties. In this chapter, you will read about some of the properties of matter and how these properties help to identify many types of matter.

Active Reading **2. List** What are two examples of matter you can see in your classroom?

What are two examples of matter you cannot see?

What are two examples of things that are not matter?

SUBMIT SHOW ANSWERS CLEAR

## States of Matter

One property that is useful when you describe different materials is state of matter. Three familiar states of matter are solids, liquids, and gases. A fourth state of matter is plasma, which is made of positive and negative particles. You can determine a material's state of matter by answering the following questions: Does it have a definite shape? Does it have a definite volume?

**Volume** *is the amount of space a sample of matter occupies.* As shown in **Table 1,** a material's state of matter determines whether its shape and its volume change when it is moved from one container to another.

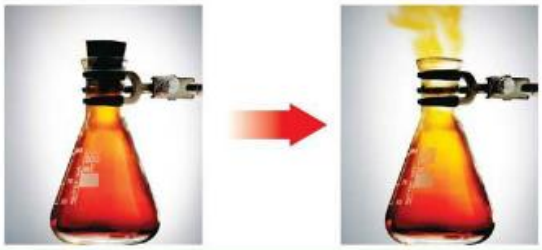
### Solids, Liquids, and Gases

Notice in **Table 1** that a **solid** *is a state of matter with a definite shape and volume.* The shape and volume of a solid do not change regardless of whether it is inside or outside a container. A **liquid** *is a state of matter with a definite volume but not a definite shape.* A liquid changes shape if it is moved to another container, but its volume does not change. *A state of matter without a definite shape or a definite volume is a* **gas**. A gas changes both shape and volume depending on the size and shape of its container.

Active Reading

**3. Recognize** Think of two examples each of solids, liquids, and gases. Write them in the table below. Do not use examples already listed in **Table 1.**

**Table 1 Solids, Liquids, and Gases**

| | |
|---|---|
| **Solid**<br>Solids, such as rocks, do not change shape or volume regardless of whether they are inside or outside a container. |  |
| **Liquid**<br>A liquid, such as fruit juice, changes shape if it is moved from one container to another. Its volume does not change. |  |
| **Gas**<br>A gas, such as nitrogen dioxide, changes both shape and volume if it is moved from one container to another. If the container is not closed, the gas spreads out of the container. |  |

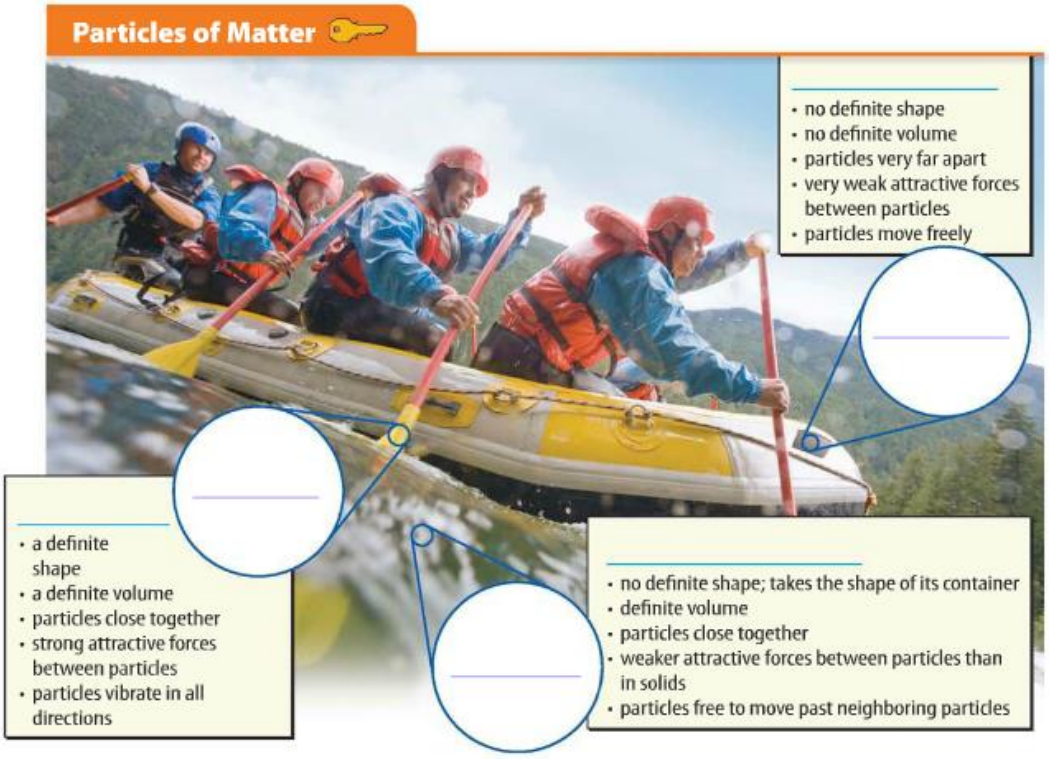



**Figure 1** The movement of particles and the attraction between them are different in solids, liquids, and gases.

## Moving Particles

All matter is made of tiny particles that are constantly moving. Notice in **Figure 1** how the movement of particles is different in each state of matter. In solids, particles vibrate back and forth in all directions. However, particles in a solid cannot move from place to place. In liquids, the distance between particles is greater. Particles in liquids can slide past one another, similar to the way marbles in a box slide around. In a gas, particles move freely rather than staying close together.

Click below.

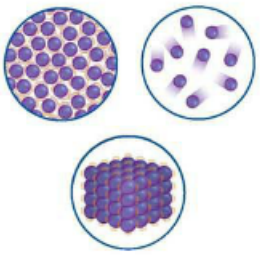
abc

**4. NGSSS Check** **Find** Highlight explanations of how particles move in solids, liquids, and gases.

## Attraction Between Particles

Particles of matter that are close together exert an attractive force, or pull, on each other. The strength of the attraction depends on the distance between particles. Think about how this attraction affects the properties of the objects in **Figure 1.** A strong attraction holds particles of a solid close together in the same position. Liquids can flow because forces between the particles are weaker. Particles of a gas are so spread apart that they are not held together by attractive forces.

Active Reading **5. Label** On the lines in each box in **Figure 1,** indicate whether the box is describing a solid, a liquid, or a gas. Then, in the circles, draw the correct particles in motion from the choices below.



SUBMIT SHOW ANSWERS CLEAR

Active Reading

FOLDABLES® LA.8.2.2.3

Fold and cut a sheet of paper to make a two-tab book. Label it as shown. Use it to organize your notes about properties of matter.


# What are physical properties?

Think again about the properties of matter you might observe on a rafting trip. The water feels cold. The raft is heavy. The helmets are hard. The properties of all materials, or types of matter, depend on the substances that make them up. Recall that a substance is a type of matter with a composition that is always the same. *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.

## Mass and Weight

Some physical properties of matter, 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 the mass of an object. To measure the mass of a rock, you can use a balance, as shown in **Figure 2.** If more particles were added to the rock, its mass would increase, and the reading on the balance would increase. The weight of the rock would also increase.

Weight depends on the location of an object, but its mass does not. For example, the mass of an object is the same on Earth as it is on the Moon. The object's weight, however, is greater on Earth because the gravitational pull on the object is greater on Earth than on the Moon.

Click below. Click below.

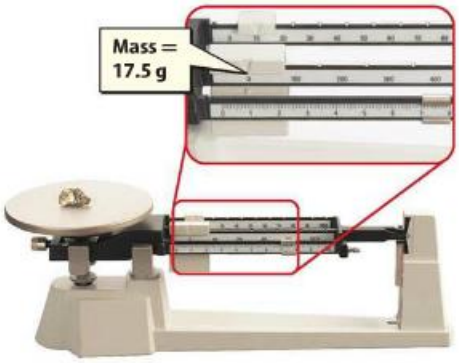
6. **NGSSS Check** **Differentiate** Underline the definition of *mass* and highlight the explanation of *weight*. SC.8.P.8.2

abc abc

SUBMIT SHOW ANSWERS CLEAR

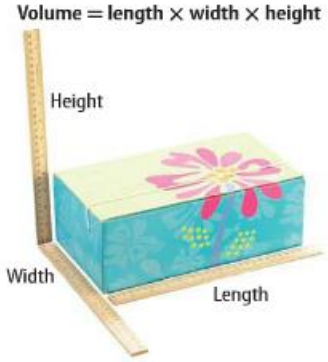
**Figure 2** You can measure a material's mass and volume and then calculate its density.

## Mass, Volume, and Density




**Mass**
A balance measures an object's mass by comparing it to the mass of the slides on the balance. Common units of mass are the kilogram (kg) and the gram (g).

**Volume = length × width × height**




**Volume of a Rectangular-Shaped Solid**
You find the volume of a rectangular solid by multiplying its length, its width, and its height together. A common unit of volume for a solid is the cubic centimeter ($cm^3$).

## Volume

Another physical property of matter that depends on the amount or size of the sample is volume. You can measure the volume of a liquid by pouring it into a graduated cylinder or a measuring cup and reading the volume mark. Two ways to measure the volume of a solid are shown in **Figure 2.** If a solid has a regular geometric shape, you can calculate its volume by using the correct formula. If a solid has an irregular shape, you can use the displacement method to measure its volume.

## Density

Density is a physical property of matter that does not depend on the size or amount of the sample. **Density** *is the mass per unit volume of a substance.* Density is useful when identifying unknown substances because it is constant for a given substance, regardless of the size of the sample. For example, imagine hiking in the mountains and finding a shiny yellow rock. Is it gold? Suppose you calculate that the density of the rock is 5.0 g/cm$^3$. This rock cannot be gold because the density of gold is 19.3 g/cm$^3$. A sample of pure gold, regardless of the size, will always have a density of 19.3 g/cm$^3$.

Inquiry LAB STATION SC.8.N.1.1, SC.8.P.8.3

**Try It!**

**MiniLab** *How can you find an object's mass and volume?* at connectED.mcgraw-hill.com

**Apply It!**

After you complete the lab, write a response to the following situation.

1. Suppose you have a bag of small glass beads. You want to measure the volume of one of the beads. However, when you place a bead in the water in the graduated cylinder, the water level does not rise enough for you to accurately read the volume. Using what you learned in the MiniLab, design a procedure you could follow to determine the volume of a single bead.

SUBMIT SHOW ANSWERS CLEAR


**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).

**Density Equation**

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

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

To find the density of the rock, first determine the mass and the volume of the rock:

mass: $m = 17.5$ g
volume: $V = 73.5$ mL $- 70.0$ mL $= 3.5$ mL

Then, divide the mass by the volume:

$$D = \frac{17.5 \text{ g}}{3.5 \text{ mL}} = 5.0 \text{ g/mL}$$

**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/cm$^3$). 1 mL = 1 cm$^3$.

## Conductivity

Another property that is independent of the sample size is conductivity. Electric conductivity is the ability to conduct an electric current. Copper often is used for electric wiring because it has high electric conductivity. Thermal conductivity is the ability of a material to conduct thermal energy. Metals tend to have high electric and thermal conductivity.

**SCIENCE USE V. COMMON USE**

**bond**

***Science Use*** a force between atoms or groups of atoms

***Common Use*** a monetary certificate issued by a government or a business that earns interest

## Solubility

You might have made lemonade by stirring a powdered drink mix into water. As you stir, the powder dissolves in the water. What would happen if you tried to dissolve sand in water? No matter how much you stir, the sand would remain solid. **Solubility** *is the ability of one substance to dissolve in another.* The powder is soluble in water, but sand is not.

## Melting and Boiling Point

Melting point and boiling point also are physical properties. The melting point is the temperature at which a solid changes to a liquid. Ice cream melts when it warms enough to reach its melting point. The boiling point is the temperature at which a liquid changes to a gas. If you heat a pan of water, the water will boil at its boiling point. These temperatures do not depend on the size or the amount of the material.

**Table 2** This table contains the descriptions of several physical properties.

**Active Reading** **7. Summarize** Review the physical properties of matter by completing the table below.

**Table 2** This table contains the descriptions of several physical properties.

**Active Reading** **7. Summarize** Review the physical properties of matter by completing the table below.

**Table 2 Physical Properties**

| Property | Mass  | Conductivity  | Volume  |
|---|---|---|---|
| **Description of property** | _____ _____ _____ | The ability of matter to conduct, or carry along, electricity or heat | _____ _____ _____ |
| **Size-dependent or size-independent** | _____ | Size-independent | Size-dependent |
| **How the property is used to separate a mixture (example)** | Mass typically is not used to separate a mixture. | Conductivity typically is not used to separate a mixture. | Volume could be used to separate mixtures whose parts can be separated by filtration. |



SUBMIT SHOW ANSWERS CLEAR

## Magnetism

Some matter can be described by the specific way it behaves. For example, some materials pull iron toward them. These materials are said to be magnetic. Attraction to iron is a physical property of these substances. The ability to attract a magnet is independent of the sample size.

## Separating Mixtures

Substances that make up mixtures are not held together by chemical **bonds**. When substances form a mixture, the properties of the individual substances do not change. One way a mixture and a compound differ is that the parts of a mixture often can be separated by physical properties. When salt and water form a solution, the salt and the water do not lose any of their individual properties. Therefore, you can separate the salt from the water by using differences in their boiling points. Other physical properties that can be used to separate different mixtures are described in **Table 2.**

Physical properties cannot be used to separate a compound into the elements it contains. The atoms that make up a compound are bonded together and cannot be separated by physical means. For example, you cannot separate the hydrogen atoms from the oxygen atoms in water by boiling water.

Click below.

abc

**Active Reading**

**9. Identify** What happens to the properties of individual substances when they are combined as a mixture? Find and highlight your answer in the text.

### Math Skills

MA.6.A.3.6

#### Solve a One-Step Equation

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

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

To solve an equation, place the variables you know into the equation. Then solve for the unknown variable. For example, if an object has a mass of 52 g and a volume of 4 $cm^3$, calculate its density:

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

**8. Practice**

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

| Boiling/Melting Points | State of Matter | Density | Solubility | Magnetism |
|---|---|---|---|---|
|  |  |  |  |  |
| _____ | Whether something is a solid, a liquid, or a gas | The amount of mass per unit of volume | _____ | Attractive force for some metals, especially iron |
| Size-independent | Size-independent | _____ | Size-independent | _____ |
| Each part of a mixture will boil or melt at a different temperature. | A liquid can be poured off a solid. | Objects with greater density sink in objects with less density. | Dissolve a soluble material to separate it from a material with less solubility. | Attract iron from a mixture of materials. |

SUBMIT SHOW ANSWERS CLEAR

**Table 3 Identifying an Unknown Material by Its Physical Properties**

| 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 |

## Identifying Matter Using Physical Properties

Physical properties are useful for describing types of matter, but they are also useful for identifying unknown substances. For example, look at the substances in **Table 3.** Notice how their physical properties are alike and how they are different. How can you use these properties to identify the unknown substance?

You cannot identify the unknown substance by its color. All of the substances are white. You also cannot identify the unknown substance by its mass or volume. Mass and volume are properties of matter that change with the amount of the sample present.

Recall that melting point and density are properties of matter that do not depend on the size or the amount of the sample. They are more reliable for identifying an unknown substance. Notice that both the melting point and the density of the unknown substance match those of table salt. The unknown substance must be table salt.

When you identify matter using physical properties, consider how the properties are alike and how they are different from known types of matter. It is important that the physical properties you use to identify an unknown type of matter are properties that do not change for any sample size. A cup of salt and a spoonful of salt will have the same melting point and density even though the mass and volume for each will be different. Therefore, melting point and density are physical properties that are reliable when identifying an unknown substance.

**Active Reading** **10. Evaluate** In the table below, indicate if the property can be useful in identifying an unknown substance.

**Active Reading** **10. Evaluate** In the table below, indicate if the property can be useful in identifying an unknown substance.

| Physical property | Useful in identifying a substance? (Y/N) | Why or why not? |
|---|---|---|
| boiling point | | |
| volume | | |
| solubility | | |
| color | | |



SUBMIT SHOW ANSWERS CLEAR

**Figure 3** Flammability and the ability to rust are examples of chemical properties.

**Flammability**
In 1937 the airship *Hindenburg* caught fire and crashed. It was filled with hydrogen, a highly flammable gas.

**Ability to rust**
The metal parts of this beached shipwreck soon rust because the metal contains iron. The ability to rust is a chemical property of iron.

## What are chemical properties?

Have you ever seen an apple turn brown? When you bite into or cut open apples or other fruits, substances that make up the fruit react with oxygen in the air. When substances react with each other, their particles combine to form a new, different substance. The ability of substances in fruit to react with oxygen is a chemical property of the substances. *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. For example, copper on the roof of a building turns green as it reacts with oxygen in the air. The ability to react with oxygen is a chemical property of copper. Two other chemical properties—flammability and the ability to rust—are shown in **Figure 3.**

Active Reading **11. Give examples** List two objects in your room that have the same chemical properties as those shown in **Figure 3**.

### Flammability

Flammability is the ability of a type of matter to burn easily. Suppose you are on a camping trip and want to light a campfire. You see rocks, sand, and wood. Which would you choose for your fire? Wood is a good choice because it is flammable. Rocks and sand are not flammable.

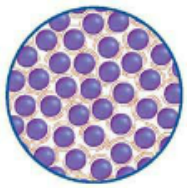
Materials are often chosen for certain uses based on flammability. For example, gasoline is used in cars because it burns easily in engines. Materials that are used for cooking pans must not be flammable. The tragedy shown in **Figure 3** resulted when hydrogen, a highly flammable gas, was used in the airship *Hindenburg*. Today, airships are filled with helium, a nonflammable gas.

### Ability to Rust

You have probably seen old boats that have begun to rust like the one in **Figure 3.** You might also have seen rust on bicycles or tools left outside. Rust is a substance that forms when iron reacts with water and oxygen in the air. The ability to rust is a chemical property of iron or metals that contain iron.

## Lesson Review 1

### Visual Summary



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.

### Use Vocabulary

1. A state of matter that has a definite volume but not a definite shape is a _____.
2. **Distinguish** between a physical property and a chemical property.

### Understand Key Concepts

3. **Analyze** Which can be used to identify an unknown substance: mass, melting point, density, volume, state of matter? SC.8.P.8.4
4. **Contrast** the movement of particles in a solid, a liquid, and a gas. SC.8.P.8.1
5. Which property is independent of sample amount? SC.8.P.8.4
   - (A) volume
   - (B) density
   - (C) mass
   - (D) weight

### Interpret Graphics

6. **Calculate** the density of each object. SC.8.P.8.3

| Object | Mass | Volume | Density |
|---|---|---|---|
| 1 | 6.50 g | 1.25 $cm^3$ | |
| 2 | 8.65 g | 2.50 mL | |

### Critical Thinking

7. **Design** an investigation you could use to find the density of a penny. SC.8.P.8.3

Inquiry LAB STATION SC.8.P.8.3, MA.6.A.3.6

**Try It!**

**Skill Lab** *How can you calculate density?* at connectED.mcgraw-hill.com

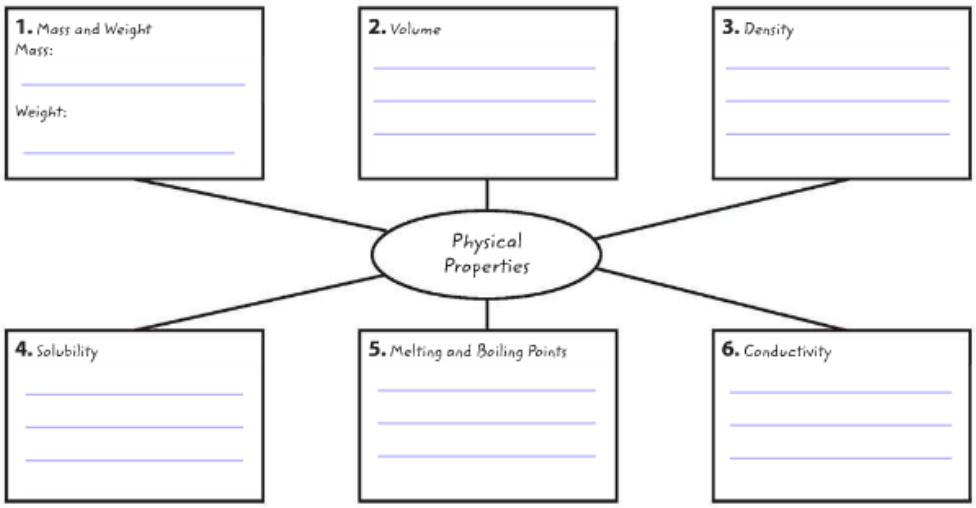
### Math Skills MA.6.A.3.6

SUBMIT SHOW ANSWERS CLEAR

8. The mass of a mineral is 9.6 g. The mineral is placed in a graduated cylinder containing 8.0 mL of water. The water level rises to 16.0 mL. What is the mineral's density?

SUBMIT SHOW ANSWERS CLEAR

**Describe** Complete the spider map to summarize the physical properties of matter.




7. **Distinguish** properties as chemical or physical. Circle the chemical properties. Underline the physical properties. Then tell how physical properties are different from chemical properties.

Click below. Click below.

abc abc

ability to be bent or rolled

ability to be attracted to a magnet

ability to rust

ability to burn

ability to conduct electricity

ability to react with oxygen

You can observe _____ without changing the identity of the substances that make up a substance. You can observe _____ only as a substance reacts with or changes into a different substance.

SUBMIT SHOW ANSWERS CLEAR