

Chemical Properties

How would you describe a piece of wood before and after it is burned? Has it changed color? Does it have the same texture? The original piece of wood changed, and physical properties alone can't describe what happened to it.

What You Will Learn

- Describe two examples of chemical properties.
- Explain what happens during a chemical change.
- Distinguish between physical and chemical changes.

Vocabulary

chemical property
chemical change

READING STRATEGY

Reading Organizer As you read this section, create an outline of the section. Use the headings from the section in your outline.

chemical property a property of matter that describes a substance's ability to participate in chemical reactions

Chemical Properties

Physical properties are not the only properties that describe matter. **Chemical properties** describe matter based on its ability to change into new matter that has different properties. For example, when wood is burned, ash and smoke are created. These new substances have very different properties than the original piece of wood had. Wood has the chemical property of flammability. *Flammability* is the ability of a substance to burn. Ash and smoke cannot burn, so they have the chemical property of nonflammability.

Another chemical property is reactivity. *Reactivity* is the ability of two or more substances to combine and form one or more new substances. The photo of the old car in **Figure 1** illustrates reactivity and nonreactivity.

✓ Reading Check What does the term *reactivity* mean? (See the Appendix for answers to Reading Checks.)

Figure 1 Reactivity with Oxygen

The iron used in this old car has the chemical property of **reactivity with oxygen**. When iron is exposed to oxygen, it rusts.

The bumper on this car still looks new because it is coated with chromium. Chromium has the chemical property of **nonreactivity with oxygen**.



Figure 2 Physical Versus Chemical Properties

Physical property

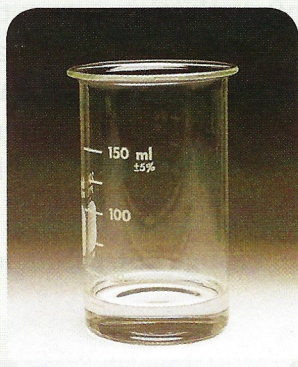


Shape Bending an iron nail will change its shape.

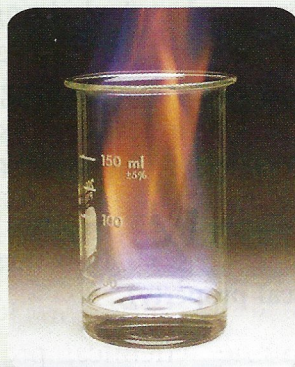
Chemical property



Reactivity with Oxygen
An iron nail can react with oxygen in the air to form iron oxide, or rust.



State Rubbing alcohol is a clear liquid at room temperature.



Flammability Rubbing alcohol is able to burn easily.

Comparing Physical and Chemical Properties

How do you tell a physical property from a chemical property? You can observe physical properties without changing the identity of the substance. For example, you can find the density and hardness of wood without changing anything about the wood.

Chemical properties, however, aren't as easy to observe. For example, you can see that wood is flammable only while it is burning. And you can observe that gold is nonflammable only when it won't burn. But a substance always has chemical properties. A piece of wood is flammable even when it's not burning. **Figure 2** shows examples of physical and chemical properties.

Characteristic Properties

The properties that are most useful in identifying a substance are *characteristic properties*. These properties are always the same no matter what size the sample is. Characteristic properties can be physical properties, such as density and solubility, as well as chemical properties, such as flammability and reactivity. Scientists rely on characteristic properties to identify and classify substances.

CONNECTION TO Social Studies

WRITING SKILL

The Right Stuff

When choosing materials to use in manufacturing, you must make sure their properties are suitable for their uses. For example, false teeth can be made from acrylic plastic, porcelain, or gold. According to legend, George Washington wore false teeth made of wood. Do research and find what Washington's false teeth were really made of. In your **science journal**, write a paragraph about what you have learned. Include information about the advantages of the materials used in modern false teeth.

Quick Lab

Changing Change

1. Place a folded **paper towel** in a small **pie plate**.
2. Pour **vinegar** into the pie plate until the entire paper towel is damp.
3. Place three shiny **pennies** on top of the paper towel.
4. Put the pie plate in a safe place. Wait 24 hours.
5. Describe and explain the change that took place.



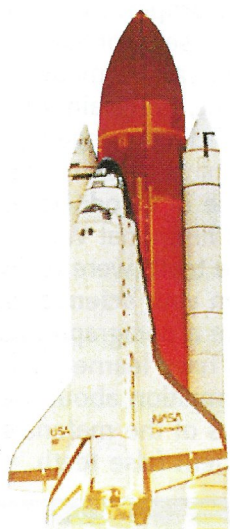
Chemical Changes and New Substances

A **chemical change** happens when one or more substances are changed into new substances that have new and different properties. Chemical changes and chemical properties are not the same. Chemical properties of a substance describe which chemical changes will occur and which chemical changes will not occur. But chemical changes are the process by which substances actually change into new substances. You can learn about the chemical properties of a substance by looking at the chemical changes that take place.

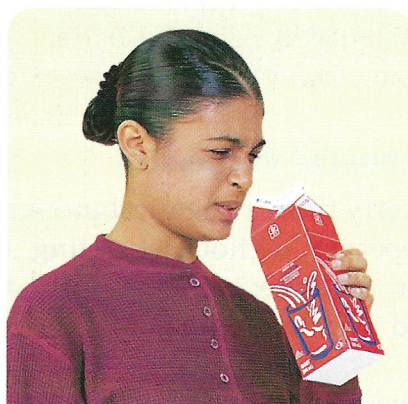
You see chemical changes more often than you may think. For example, a chemical reaction happens every time a battery is used. Chemicals failing to react results in a dead battery. Chemical changes also take place within your body when the food you eat is digested. **Figure 3** describes other examples of chemical changes.

✓ Reading Check How does a chemical change differ from a chemical property?

Figure 3 Examples of Chemical Changes



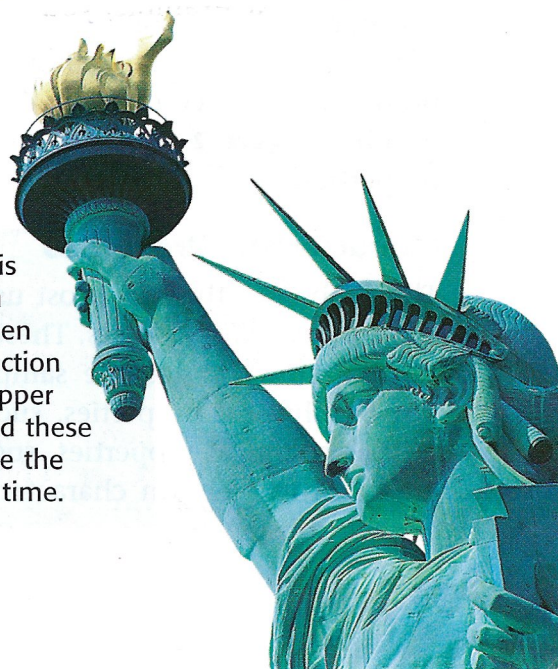
The **hot gas** formed when hydrogen and oxygen join to make water helps blast the space shuttle into orbit.



Soured milk smells bad because bacteria have formed new substances in the milk.



Effervescent tablets bubble when the citric acid and baking soda in them react in water.



The **Statue of Liberty** is made of orange-brown copper but it looks green from the metal's interaction with moist air. New copper compounds formed and these chemical changes made the statue turn green over time.



Figure 4 Each of the original ingredients has different physical and chemical properties than the final product, the cake, does!

What Happens During a Chemical Change?

A fun way to see what happens during chemical changes is to bake a cake. You combine eggs, flour, sugar, and other ingredients, as shown in **Figure 4**. When you bake the batter, you end up with something completely different. The heat of the oven and the interaction of the ingredients cause a chemical change. The result is a cake that has properties that differ from the properties of the ingredients.

Signs of Chemical Changes

Look back at **Figure 3**. In each picture, at least one sign indicates a chemical change. Other signs that indicate a chemical change include a change in color or odor, production of heat, fizzing and foaming, and sound or light being given off.

In the cake example, you would smell the cake as it baked. You would also see the batter rise and begin to brown. When you cut the finished cake, you would see the air pockets made by gas bubbles that formed in the batter. These signs show that chemical changes have happened.

Matter and Chemical Changes

Chemical changes change the identity of the matter involved. So, most of the chemical changes that occur in your daily life, such as a cake baking, would be hard to reverse. Imagine trying to unbake a cake. However, some chemical changes can be reversed by more chemical changes. For example, the water formed in the space shuttle's rockets could be split into hydrogen and oxygen by using an electric current.

chemical change a change that occurs when one or more substances change into entirely new substances with different properties

INTERNET ACTIVITY

For another activity related to this chapter, go to **go.hrw.com** and type in keyword **HP5MATW**.

Figure 5 Physical and Chemical Changes

Change in Texture

Grinding baking soda into a fine, powdery substance is a physical change.



Reactivity with Vinegar

Gas bubbles are produced when vinegar is poured into baking soda.



CONNECTION TO Environmental Science

Acid Rain When fossil fuels are burned, a chemical change takes place. Sulfur from fossil fuels and oxygen from the air combine to produce sulfur dioxide, a gas. When sulfur dioxide enters the atmosphere, it undergoes another chemical change by interacting with water and oxygen. Research this chemical reaction. Make a poster describing the reaction and showing how the final product affects the environment.

ACTIVITY

Physical Versus Chemical Changes

The most important question to ask when trying to decide if a physical or chemical change has happened is, Did the composition change? The *composition* of an object is the type of matter that makes up the object and the way that the matter is arranged in the object. **Figure 5** shows both a physical and a chemical change.

A Change in Composition

Physical changes do not change the composition of a substance. For example, water is made of two hydrogen atoms and one oxygen atom. Whether water is a solid, liquid, or gas, its composition is the same. But chemical changes do alter the composition of a substance. For example, through a process called *electrolysis*, water is broken down into hydrogen and oxygen gases. The composition of water has changed, so you know that a chemical change has taken place.

QUICK Lab



Physical or Chemical Change?

1. Watch as your teacher places a burning **wooden stick** into a **test tube**. Record your observations.
2. Place a mixture of **powdered sulfur** and **iron filings** on a **sheet of paper**. Place a **bar magnet** underneath the paper, and try to separate the iron from the sulfur.
3. Drop an **effervescent tablet** into a **beaker of water**. Record your observations.
4. Identify whether each change is a physical change or a chemical change. Explain your answers.

Reversing Changes

Can physical and chemical changes be reversed? Many physical changes are easily reversed. They do not change the composition of a substance. For example, if an ice cube melts, you could freeze the liquid water to make another ice cube. But composition does change in a chemical change. So, most chemical changes are not easily reversed. Look at **Figure 6**. The chemical changes that happen when a firework explodes would be almost impossible to reverse, even if you collected all of the materials made in the chemical changes.



Figure 6 This display of fireworks represents many chemical changes happening at the same time.

SECTION Review

Summary

- Chemical properties describe a substance based on its ability to change into a new substance that has different properties.
- Chemical properties can be observed only when a chemical change might happen.
- Examples of chemical properties are flammability and reactivity.
- New substances form as a result of a chemical change.
- Unlike a chemical change, a physical change does not alter the identity of a substance.

Using Key Terms

1. In your own words, write a definition for each of the following terms: *chemical property* and *chemical change*.

Understanding Key Ideas

2. Rusting is an example of a
 - a. physical property.
 - b. physical change.
 - c. chemical property.
 - d. chemical change.
3. Which of the following is a characteristic property?
 - a. density
 - b. chemical reactivity
 - c. solubility in water
 - d. All of the above
4. Write two examples of chemical properties and explain what they are.
5. The Statue of Liberty was originally a copper color. After being exposed to the air, she turned a greenish color. What kind of change happened? Explain your answer.
6. Explain how to tell the difference between a physical and a chemical property.

Math Skills

7. The temperature of an acid solution is 25°C . A strip of magnesium is added, and the temperature rises 2°C each minute for the first 3 min. After another 5 min, the temperature has risen two more degrees. What is the final temperature?

Critical Thinking

8. **Making Comparisons** Describe the difference between physical and chemical changes in terms of what happens to the matter involved in each kind of change.
9. **Applying Concepts** Identify two physical properties and two chemical properties of a bag of microwave popcorn before popping and after.

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For a variety of links related to this chapter, go to www.scilinks.org

Topic: **Chemical Changes**
SciLinks code: **HSM0266**



Chapter Review

USING KEY TERMS

- 1 Use each of the following terms in a separate sentence: *physical property*, *chemical property*, *physical change*, and *chemical change*.

For each pair of terms, explain how the meanings of the terms differ.

- 2 *mass* and *weight*
3 *inertia* and *mass*
4 *volume* and *density*

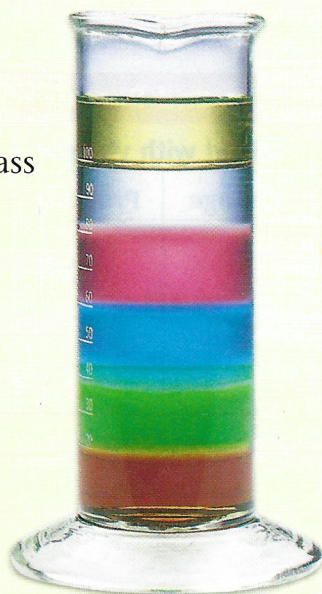
UNDERSTANDING KEY IDEAS

Multiple Choice

- 5 Which of the following properties is NOT a chemical property?
a. reactivity with oxygen
b. malleability
c. flammability
d. reactivity with acid
- 6 The volume of a liquid can be expressed in all of the following units EXCEPT
a. grams.
b. liters.
c. milliliters.
d. cubic centimeters.
- 7 The SI unit for the mass of a substance is the
a. gram.
b. liter.
c. milliliter.
d. kilogram.
- 8 The best way to measure the volume of an irregularly shaped solid is to
a. use a ruler to measure the length of each side of the object.
b. weigh the solid on a balance.
c. use the water displacement method.
d. use a spring scale.
- 9 Which of the following statements about weight is true?
a. Weight is a measure of the gravitational force on an object.
b. Weight varies depending on where the object is located in relation to the Earth.
c. Weight is measured by using a spring scale.
d. All of the above
- 10 Which of the following statements does NOT describe a physical property of a piece of chalk?
a. Chalk is a solid.
b. Chalk can be broken into pieces.
c. Chalk is white.
d. Chalk will bubble in vinegar.
- 11 Which of the following statements about density is true?
a. Density is expressed in grams.
b. Density is mass per unit volume.
c. Density is expressed in milliliters.
d. Density is a chemical property.

Short Answer

- 12 In one or two sentences, explain how the process of measuring the volume of a liquid differs from the process of measuring the volume of a solid.



- 13 What is the formula for calculating density?
- 14 List three characteristic properties of matter.

Math Skills

- 15 What is the volume of a book that has a width of 10 cm, a length that is 2 times the width, and a height that is half the width? Remember to express your answer in cubic units.
- 16 A jar contains 30 mL of glycerin (whose mass is 37.8 g) and 60 mL of corn syrup (whose mass is 82.8 g). Which liquid is on top? Show your work, and explain your answer.

CRITICAL THINKING

- 17 **Concept Mapping** Use the following terms to create a concept map: *matter, mass, inertia, volume, milliliters, cubic centimeters, weight, and gravity.*
- 18 **Applying Concepts** Develop a set of questions that would be useful when identifying an unknown substance. The substance may be a liquid, a gas, or a solid.
- 19 **Analyzing Processes** You are making breakfast for your friend Filbert. When you take the scrambled eggs to the table, he asks, "Would you please poach these eggs instead?" What scientific reason do you give Filbert for not changing his eggs?

- 20 **Identifying Relationships** You look out your bedroom window and see your new neighbor moving in. Your neighbor bends over to pick up a small cardboard box, but he cannot lift it. What can you conclude about the item(s) in the box? Use the terms *mass* and *inertia* to explain how you came to your conclusion.

- 21 **Analyzing Ideas** You may sometimes hear on the radio or on TV that astronauts are weightless in space. Explain why this statement is not true.

INTERPRETING GRAPHICS

Use the photograph below to answer the questions that follow.



- 22 List three physical properties of this aluminum can.
- 23 When this can was crushed, did it undergo a physical change or a chemical change?
- 24 How does the density of the metal in the crushed can compare with the density of the metal before the can was crushed?
- 25 Can you tell what the chemical properties of the can are by looking at the picture? Explain your answer.