Name _____ Class _____ Date _____

CHAPTER 1 The Properties of Matter

SECTION 3

Chemical Properties

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What are chemical properties of matter?
- What is a chemical change?
- What is the effect of a chemical change?

National Science Education Standards

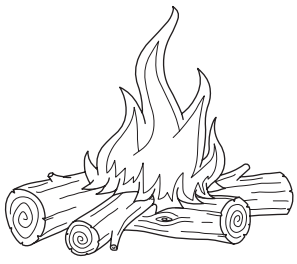
PS 1a

What Are the Chemical Properties of Matter?

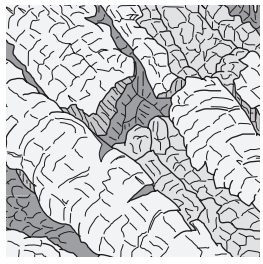
Physical properties are not the only properties that describe matter. **Chemical properties** describe matter based on its ability to change into new matter. One chemical property of matter is reactivity. *Reactivity* is the ability of a substance to change into a new substance.

One kind of reactivity is flammability. *Flammability* is the ability of a substance to burn. For example, wood burns easily. It has the chemical property of flammability. You may have seen wood burning in a fireplace, or in a campfire. ☑

When wood is burned, it becomes several different substances, such as ash and smoke. See the figure below. The properties of these new substances are different than the original properties of the wood. Ash and smoke cannot burn. This is because they have the chemical property of non-flammability.

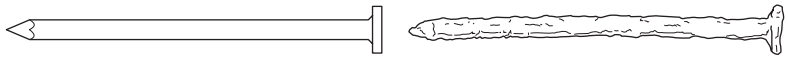


Wood burning in a fire



Ashes after the wood has burned

Rusting is another chemical property. Iron is the only substance that can rust. When iron combines with oxygen, it forms a new substance called iron oxide, or rust. ☑



Iron nail with no rust

Iron nail with rust

STUDY TIP

Compare Make a table with two columns, Chemical Property and Physical Property. List the chemical and physical properties that are discussed in this section.

READING CHECK

1. Identify Chemical properties of matter describe matter based on its ability to do what?

_____

READING CHECK

2. Identify What metal rusts?

_____

Critical Thinking

3. Compare Suppose you observe a physical property and a chemical property of a substance. Describe what happens to the substance when each kind of property is observed.

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STANDARDS CHECK

PS 1a A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample. A mixture of substances often can be separated into the original substances using one or more of the characteristic properties.

4. Applying Concepts A scientist measures three properties of a liquid. Its density is 0.8 g/cm^3, it does not mix with water, and its flash point is −35°C. Based on the information in the table, what is the most likely identity of the liquid? Explain your answer.

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_____

_____

COMPARING PHYSICAL AND CHEMICAL PROPERTIES

How can you tell the difference between a physical property and a chemical property? A physical property does not change the identity of a substance. Do you remember the silver and gold charms from the last section? The silver was pounded and the gold was melted to make the charms. After each charm was made, the silver charm was still silver and the gold charm was still gold.

The chemical properties of a substance can't be seen unless you change the identity of the substance. For example, you may not know a liquid is flammable until you try to light it. If it burns, it has the chemical property of flammability. However, the burned liquid has changed into new substances.

A substance always has chemical properties. A piece of wood is flammable even when it is not burning. Iron can form rust even though it has not rusted.

CHARACTERISTIC PROPERTIES

The properties that are most useful to identify a substance are called *characteristic properties*. These properties are constant. This means that they do not change. The characteristic properties of a substance can be physical, chemical, or both.

A piece of iron has characteristic properties that help identify it as iron. A good example of this would be density. Iron has a constant density when measured at the same temperature and pressure. Iron also rusts.

Scientists can identify a substance by studying its physical and chemical properties. The table below shows some characteristic properties of several liquids.

Property	Rubbing alcohol	Kerosene	Gasoline
Density (g/cm^3)	0.8	0.8	0.8
Dissolves or mixes with water	yes	no	no
Flash Point (°C) (The higher the flash point, the more flammable the liquid.)	12	40	−40

What Is a Chemical Change?

When substances change into new substances that have different properties, a **chemical change** has happened. Chemical *changes* and chemical *properties* are not the same. The chemical properties of a substance describe which chemical change can happen to the substance. For example, flammability is a chemical property. Burning is the chemical change that shows this property. ☑

A chemical change causes a substance to change into a new substance. You can learn about a substance's chemical properties by observing what chemical changes happen to that substance.

Chemical changes occur more often than you might think. For example, a chemical change happens every time you use a battery. Chemical changes also take place within your body when the food you eat is digested. The figure below describes other chemical changes.

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

The **Statue of Liberty** is made of copper, which is orange-brown. But this copper is green because of its interactions with moist air. These interactions are chemical changes that form copper compounds. Over time, the compounds turn the statue green.

READING CHECK

5. Describe What is a chemical change?

_____

_____

TAKE A LOOK

6. Identify What property of the milk told the girl that it had soured?

_____

WHAT HAPPENS DURING A CHEMICAL CHANGE?

A fun way to see what happens during a chemical change is to bake a cake. A cake recipe combines different substances. Eggs, cake mix, oil, and water are mixed to form a batter. When the batter is baked, you end up with a substance that is very different from the original batter.

The heat of the oven and the mixture of ingredients cause a chemical change. The result is a cake. The cake has properties that are different than the properties of the raw ingredients alone.

Critical Thinking

7. Applying Concepts How do you know that baking a cake is a chemical change?

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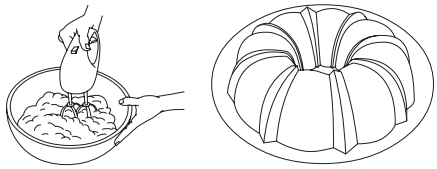

Cake mix batter becomes a cake.

SIGNS OF CHEMICAL CHANGES

A change in color, odor, or texture may show that a chemical change has happened. A chemical change often will produce or absorb heat.

An increase in temperature happens when a chemical change liberates or releases heat. Wood burning is a good example of a chemical change that gives off heat.

Some chemical changes cause a substance to absorb or gain heat. Sugar is broken down into carbon and water by heating. ☑

READING CHECK

8. Identify What are four changes that indicate that a chemical change has occurred?

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_____

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_____

MATTER AND CHEMICAL CHANGES

When matter has a chemical change, the identity of the matter changes. Chemical changes can only be reversed by other chemical changes. For example, water can be made by heating a mixture of hydrogen and oxygen. Water can also be broken up into hydrogen and oxygen when an electric current is passed through it. The electric current supplies the energy needed to pull the hydrogen away from the oxygen.

Physical Versus Chemical Changes

Sometimes it is hard to decide whether a physical change or a chemical change has happened to an object. Consider when something new formed as a result of the change.

Physical changes do not change the composition of an object. The *composition* of an object is the type of matter that makes up the object. 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.

Chemical changes change the composition of matter. For example, through a process called *electrolysis*, water is broken down into hydrogen and oxygen gases. The products of the electrolysis of water are very different from water. ☑

READING CHECK

9. Describe How can you tell that a physical rather than a chemical change has occurred?

_____

_____

In the figure below, baking soda is ground into a powder. This is a physical change. When vinegar is poured into the baking powder, gas bubbles are produced. This is a chemical change.

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.

REVERSING CHANGES

Most physical changes can be easily reversed, like freezing, melting, and boiling. Remember that the type or composition of matter does not change.

This is very different from a chemical change. During a chemical change the type or composition of matter does change. Many chemical changes cannot be easily reversed. Ash cannot be turned back into wood. The explosion of a firework cannot be reversed. ☑

READING CHECK

10. Identify Which kind of changes cannot be easily reversed?

_____

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Section 3 Review

NSES **PS 1a**

SECTION VOCABULARY

chemical change a change that occurs when one or more substances change into entirely new substances with new chemical properties	**chemical property** a property of matter that describes a substance's ability to participate in chemical reactions

1. Describe How is a chemical property different than a chemical change?

2. Explain Why is reactivity not a physical property?

3. Identify What can be absorbed or released as the result of a chemical reaction?

4. Complete Fill in the type of change in the table below.

Type of Change	Description of Change
	rusting
	boiling
	freezing
	burning

5. Identify What are four things that indicate that a chemical change may have taken place?

6. Identify and Explain Originally, the Statue of Liberty was copper-colored. After many years, it turned green. What kind of change happened? Explain.

7. Identify You see a burning candle. You feel heat above the flame, you see black smoke rising from the wick, and wax melts. List each of the changes that occurred and tell the type of change that caused it.

Chapter 1 The Properties of Matter

SECTION 1 WHAT IS MATTER?

1. Volume: liter
   Mass: kilogram
   Weight: newton
2. The amount of space that an object takes up is volume.
3. 1,900 mL
4. A meniscus is the curved surface of a liquid in a container.
5. The student should draw a line that curves downward from 7 mL to the 6 mL line, then back to the 7 mL line.
6. volume
7. area
8. 1 m^2
9. Put a known volume of water into a graduated cylinder. Put the car into the cylinder. Measure how much the volume increases.
10. the amount of matter in an object
11. weight
12.

	Mass	Weight
How is it measured?	with a balance	with a scale
What is measured?	the amount of matter	the force of gravity
SI measurement units	kilograms	newtons
Changes with the location of the object?	no	yes

13. kilograms, grams, milligrams
14. newton (N)
15. the ability of an object to resist a change in its motion
16. Objects with higher mass have more inertia.

Review

1. An apple has mass and takes up space.
2. Mass is a measure of how much matter is in an object. Weight is a measure of the force due to gravity on an object.
3. 19 mL
4. 40 mL
5. $V = A \times h$
   $V = 1{,}960\ \text{cm}^3 \times 23\ \text{cm} = 45{,}080\ \text{cm}^3$
   No, the luggage is too big.

SECTION 2 PHYSICAL PROPERTIES

1. properties that can be observed and measured without making a new substance
2. its mass or weight, its density, its compressibility
3. the amount of matter in a given volume
4. 23 times as much, or 44 g more
5. $D = \frac{m}{V}$
   $D = \frac{28\ \text{g}}{1.45\ \text{cm}^3} = 19.3\ \text{g/cm}^3$
6. when measured at the same temperature and pressure
7. zinc
8. If it is denser than water, it will sink.
9. The diet soda—objects less dense than water float in the water.
10. the liquid with the lowest density
11. a change that affects the physical properties of a substance
12. melting
13. a change of state
14. A gas can change into a liquid or into a solid.
15. nothing

Review

1. Divide the mass of the substance by its volume.
2. No, because all the substances are more dense than methanol.
3. $D = \frac{m}{V}$
   $D = \frac{135\ \text{g}}{50\ \text{cm}^3} = 2.7\ \text{g/cm}^3$
   aluminum
4. The ball with the smaller volume has the larger density.
5. Its volume must get larger.

SECTION 3 CHEMICAL PROPERTIES

1. change into new matter
2. iron
3. The identity of the substance does not change when the physical property is observed; when the chemical property is observed, the substance changes identity.

4. Gasoline—its properties match the properties in the table.
5. a change that produces a new substance
6. its bad smell
7. The cake has different properties than its ingredients do.
8. color change, change in texture, odor given off, heat absorbed or released
9. A new substance is not made.
10. chemical changes

Review

1. A chemical property of a substance describes the chemical change that can happen to the substance.
2. When a substance reacts, it changes into a new substance. For the property to be a physical property, the substance must be the same after it has undergone the change.
3. heat
4.

Type of change	Description of change
Chemical	rusting
Physical	boiling
Physical	freezing
Chemical	burning

5. a color change, a change in texture, an odor given off, heat absorbed or liberated
6. Chemical change—a color change indicates that a chemical change has taken place.
7. Heat felt above the flame: chemical change
   Smoke: chemical change
   Melted wax: physical change

Chapter 2 States of Matter

SECTION 1 THREE STATES OF MATTER

1. the physical forms of a substance
2. They move about the most in the gas state and the least in the solid state.
3. They vibrate.
4. They move past each other.
5. a force that acts on the particles at the surface of a liquid
6. water, cream, syrup
7. There is more space between particles.

Review

1. Solid: brick, penny, ice cube
   Liquid: water, milk, soda, oil
   Gas: air, oxygen, water vapor
2. They are always moving.
3. The particles of a liquid can move past one another, but the particles of a solid stay in fixed positions.
4. The particles of a gas can move far away from one another, but the particles of a liquid stay close to one another.
5. surface tension
6.

State of matter	Definite shape	Definite volume
Solid	yes	yes
Liquid	no	yes
Gas	no	no

SECTION 2 BEHAVIOR OF GASES

1. a measure of how fast the particles of an object are moving
2. when it is heated
3.

Temperature of gas particles	Energy of gas particles	Volume of gas particles
1) 20°C	Particles have the smallest amount of energy.	Volume is smallest.
2) 50°C	Particles have more energy than at 20°C, but not as much as at 80°C.	Volume is larger than at 20°C but smaller than at 80°C.
3) 80°C	Particles have the largest amount of energy.	Volume is largest.

4. the amount of force that is put on an area
5. temperature and pressure
6. It is one-third as much.
7. It is one-half as much.

Review

1. temperature, volume, and pressure
2. The balloon goes from a warm temperature in the house to a cold temperature outside. The volume of the balloon will decrease outside because the gas particles move more slowly and exert less pressure. The air particles in the balloon take up less space.
3. 9 L; according to Charles's law, at constant pressure, volume is directly related to temperature.