

Physical and Chemical Changes

As You Read

What You'll Learn

- **Compare** several physical and chemical changes.
- **Identify** examples of physical and chemical changes.

Vocabulary

physical change
chemical change
law of conservation of mass

Why It's Important

Physical and chemical changes affect your life every day.

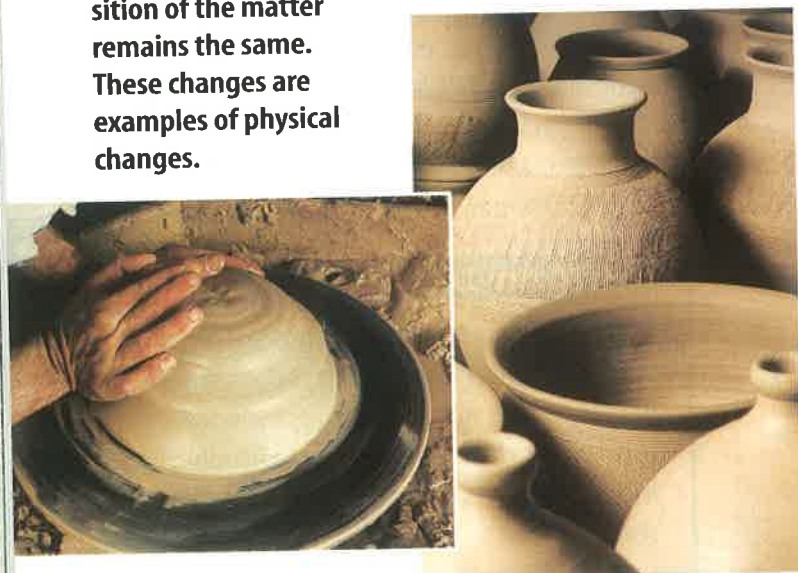
Figure 7

Although each sample looks quite different after it experiences a change, the composition of the matter remains the same. These changes are examples of physical changes.

Physical Changes

What happens when the artist turns the lump of clay shown in **Figure 7** into a work of art? The composition of the clay does not change. Its appearance, however, changes dramatically. The change from a lump of clay to a work of art is a physical change. A **physical change** is one in which the form or appearance of matter changes, but not its composition. The lake in **Figure 7** also experiences a physical change. Although the water changes state due to a change in temperature, it is still made of the elements hydrogen and oxygen.

Changing Shape Have you ever crumpled a sheet of paper into a ball? If so, you caused physical change. Whether it exists as one flat sheet or a crumpled ball, the matter is still paper. Similarly, if you cut fruit into pieces to make a fruit salad, you do not change the composition of the fruit. You change only its form. Generally, whenever you cut, tear, grind, or bend matter, you are causing a physical change.



Dissolving What type of change occurs when you add sugar to iced tea, as shown in **Figure 8**? Although the sugar seems to disappear, it does not. Instead, the sugar dissolves. When this happens, the particles of sugar spread out in the liquid. The composition of the sugar stays the same, which is why the iced tea tastes sweet. Only the form of the sugar has changed.



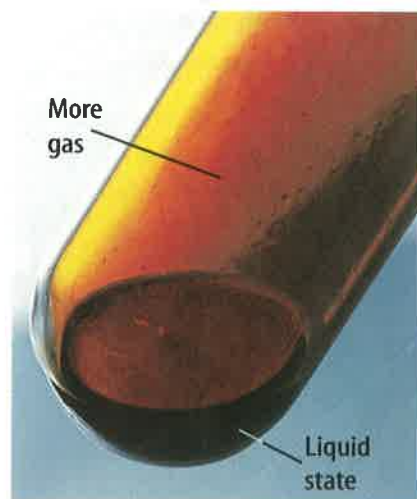
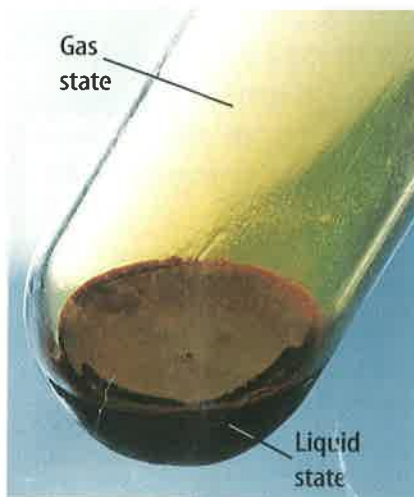
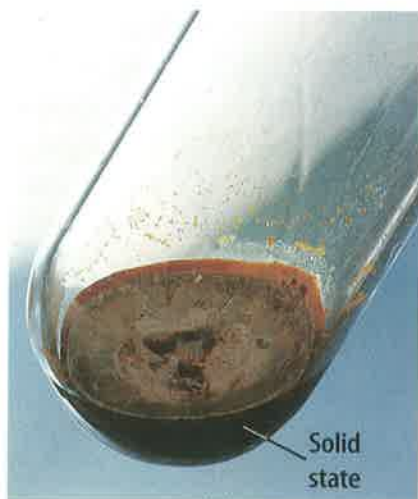
Figure 8
Physical changes are occurring constantly. The sugar blending into the iced tea is an example of a physical change.

Changing State Another common physical change occurs when matter changes from one state to another. When an ice cube melts, for example, it becomes liquid water. The solid ice and the liquid water have the same composition. The only difference is the form.

Matter can change from any state to another. Freezing is the opposite of melting. During freezing, a liquid changes into a solid. A liquid also can change into a gas. This process is known as vaporization. During the reverse process, called condensation, a gas changes into a liquid. **Figure 9** summarizes these changes.

In some cases, matter changes between the solid and gas states without ever becoming a liquid. The process in which a solid changes directly into a gas is called sublimation. The opposite process, in which a gas changes into a solid, is called deposition.

Figure 9
Look at the photographs below to identify the different physical changes that bromine undergoes as it changes from one state to another.



Bob was HERE
I was here too



Figure 10
These brilliant fireworks result from chemical changes. What is a chemical change?

Chemical Changes

It's the Fourth of July in New York City. Brilliant fireworks are exploding in the night sky. When you look at fireworks, such as these in **Figure 10**, you see dazzling sparkles of red and white trickle down in all directions. The explosion of fireworks is an example of a chemical change. During a **chemical change**, substances are changed into different substances. In other words, the composition of the substance changes.

You are familiar with another chemical change if you have ever left your bicycle out in the rain. After a while, a small chip in the paint leads to an area of a reddish, powdery substance. This substance is rust. When iron in steel is exposed to oxygen and water in air, iron and oxygen atoms combine to form the principle component in rust. In a similar way, coins tarnish when exposed to air. These chemical changes are shown in **Figure 11**.



Reading Check

How is a chemical change different from a physical change?

Figure 11
Each of these examples shows the results of a chemical change. In each case, the substances that are present after the change are different from those that were present before the change.



Figure 12

The brilliant colors of autumn result from a chemical change.



Signs of Chemical Changes

Physical changes are relatively easy to identify. If only the form of a substance changes, you have observed a physical change. How can you tell whether a change is a chemical change? If you think you are unfamiliar with chemical changes, think again.

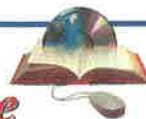


Life Science INTEGRATION

You have witnessed a spectacular change if you have seen the leaves of trees change colors in autumn, but you are not seeing a chemical change. Chemicals called pigments give tree leaves their color. In **Figure 12**, the pigment that is responsible for the green color you see during the summer is chlorophyll (KLOHR uh fihl). Two other pigments result in the colors you see in the red tree. Throughout the spring and summer, chlorophyll is present in much greater amounts than these other pigments, so you see leaves as green. In autumn, however, changes in temperature and rainfall amounts cause trees to stop producing chlorophyll. The chlorophyll that is already present undergoes a chemical change in which it loses its green color. Without chlorophyll, the red and yellow pigments, which are always present, can be seen.

Color Perhaps you have found that a half-eaten apple turns brown. The reason is that a chemical change occurs when food spoils. Maybe you have toasted a marshmallow or a slice of bread and watched them turn black. In each case, the color of the food changes as it is cooked because a chemical change occurs.

SCIENCE Online



Research Visit the Glencoe Science Web site at science.glencoe.com for more information about how to recognize chemical changes. Choose one example not mentioned in the chapter and present it to the class as a poster or in an oral report.

TRY AT HOME

Mini LAB

Comparing Changes

Procedure



1. Separate a piece of fine steel wool into two halves.
2. Dip one half in tap water.
3. Place each piece of steel wool on a separate paper plate and let them sit overnight.

Analysis

1. Did you observe any changes in the steel wool? If so, describe them.
2. If you observed changes, were they physical or chemical? How do you know?



Figure 13
Cake batter undergoes a chemical change as it absorbs energy during cooking.

Energy Another sign of a chemical change is the release or gain of energy by an object. Many substances must absorb energy in order to undergo a chemical change. For example, energy is absorbed during the chemical changes involved in cooking. When you bake a cake or make pancakes, energy is absorbed by the batter as it changes from a runny mix into what you see in **Figure 13**.

Another chemical change in which a substance absorbs energy occurs during the production of cement. This process begins with the heating of limestone. Ordinarily, limestone will remain unchanged for centuries. But when it absorbs energy during heating, it undergoes a chemical change in which it turns into lime and carbon dioxide.

Energy also can be released during a chemical change. The fireworks you read about earlier released energy in the form of light that you can see. As shown in **Figure 14A**, a chemical change within a firefly releases energy in the form of light. Fuel burned in the camping stove shown in **Figure 14B** releases energy you see as light and feel as heat. You also can see that energy is released when sodium and chlorine are combined and ignited in **Figure 14C**. During this chemical change, the original substances change into sodium chloride, which is ordinary table salt.

Figure 14

A Energy is released when a firefly glows, **B** when fuel is burned in a camping stove, and **C** when sodium and chlorine undergo a chemical change to form table salt.

B



A



C



Odor It takes only one experience with a rotten egg to learn that they smell much different than fresh eggs. When eggs and other foods spoil, they undergo chemical change. The change in odor is a clue to the chemical change. This clue can be used to save lives. When you smell an odd odor in foods, such as chicken, pork, or mayonnaise, you know that the food has undergone a chemical change. You can use this clue to avoid eating spoiled food and protect yourself from becoming ill.

Gases or Solids Look at the antacid tablet in **Figure 15A**. You can produce similar bubbles if you pour vinegar on baking soda. The formation of a gas is a clue to a chemical change. What other products undergo chemical changes and produce bubbles?

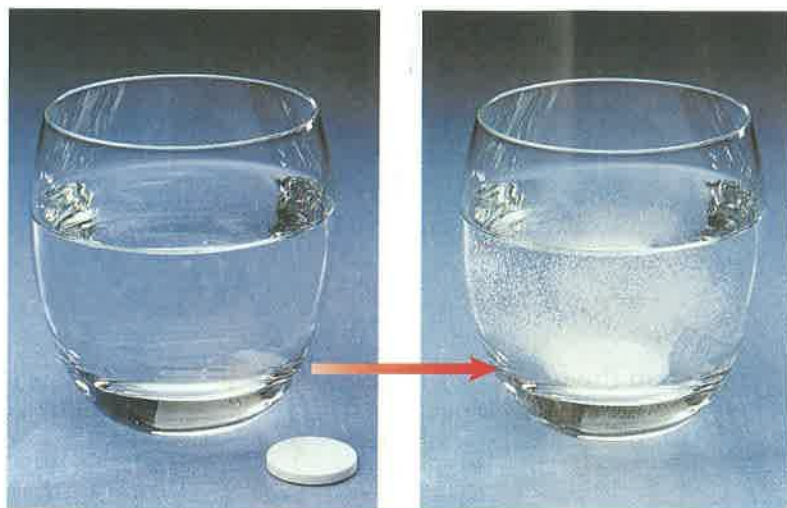
Figure 15B shows another clue to a chemical change—the formation of a solid. A solid that separates out of a solution during a chemical change is called a precipitate. The precipitate in the photograph forms when a solution containing sodium iodide is mixed with a solution containing lead nitrate.



Astronomy INTEGRATION

A meteoroid is a chunk of metal or stone in space. Every day, meteoroids enter Earth's atmosphere. When this happens, the meteoroid burns as a result of friction with gases in the atmosphere. A streak of light produced during this chemical change is known as a meteor or shooting star. In your Science Journal, infer why most meteoroids never reach Earth's surface.

A



B

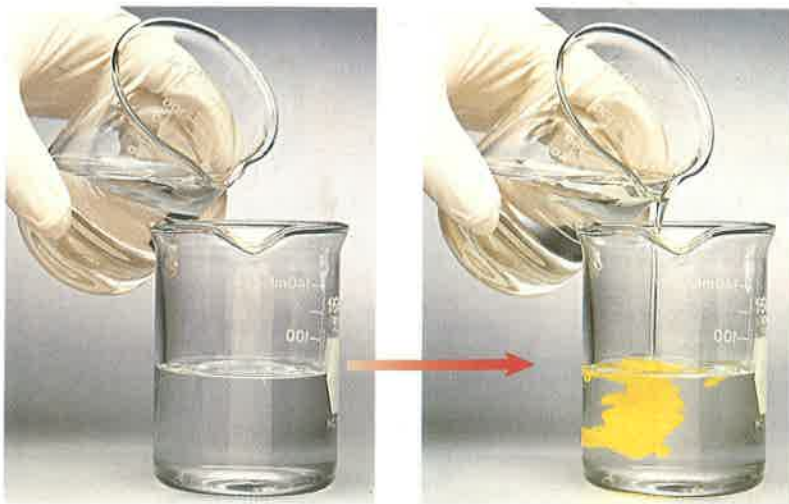


Figure 15

A The bubbles of gas formed when this antacid tablet is dropped into water indicate a chemical change. **B** The solid forming from two liquids is another sign that a chemical change has taken place.



Figure 16

As wood burns, it turns into a pile of ashes and gases that rise into the air. Can you turn ashes back into wood?

Not Easily Reversed How do physical and chemical changes differ from one another? Think about ice for a moment. After solid ice melts into liquid water, it can refreeze into solid ice if the temperature drops enough. Freezing and melting are physical changes. The substances produced during a chemical change cannot be changed back into the original substances by physical means. For example, the wood in **Figure 16** changes into ashes and gases that are released into the air. After wood is burned, it cannot be restored to its original form as a log.

Think about a few of the chemical changes you just read about to see if this holds true. An antacid tablet cannot be restored to its original form after being dropped in water. Rotten eggs cannot be made fresh again, and pancakes cannot be turned back into batter. The substances that existed before the chemical change no longer exist.



Reading Check

What signs indicate a chemical change?

Math Skills Activity

Converting Temperatures

Fahrenheit is a non-SI temperature scale. Because it is used so often, it is useful to be able to convert from Fahrenheit to Celsius. The equation that relates Celsius degrees to Fahrenheit degrees is:

$$(^{\circ}\text{C} \times 1.8) + 32 = ^{\circ}\text{F}$$

Using this information, what is 15°F on the Celsius scale?

Solution

- | | |
|--|---|
| 1 This is what you know: | temperature = 15°F |
| 2 This is what you want to find: | temperature in degrees Celsius |
| 3 This is the equation you need to use: | $(^{\circ}\text{C} \times 1.8) + 32 = ^{\circ}\text{F}$ |
| 4 Rearrange the equation to solve for $^{\circ}\text{C}$. | $(^{\circ}\text{C} \times 1.8) + 32 = ^{\circ}\text{F}$
$^{\circ}\text{C} = (^{\circ}\text{F} - 32)/1.8$ |

Then substitute the known value for $^{\circ}\text{F}$. $^{\circ}\text{C} = (15 - 32)/1.8 = -9.4^{\circ}\text{C}$

Check your answer by substituting the Celsius temperature into the original equation. Did you calculate the Fahrenheit temperature that was given in the question?

Practice Problem

Water is being heated on the stove at 156°F . What is this temperature on the Celsius scale?

For help refer to the **Math Skill Handbook**.

Chemical Versus Physical Change

Now you have learned about many different physical and chemical changes. You have read about several characteristics that you can use to distinguish between physical and chemical changes. The most important point for you to remember is that in a physical change, the composition of a substance does not change and in a chemical change, the composition of a substance does change. When a substance undergoes a physical change, only its form changes. In a chemical change, both form and composition change.

When the wood and copper in **Figure 17** undergo physical changes, the original wood and copper still remain after the change. When a substance undergoes a chemical change, however, the original substance is no longer present after the change. Instead, different substances are produced during the chemical change. When the wood and copper in **Figure 17** undergo chemical changes, wood and copper have changed into new substances with new physical and chemical properties.

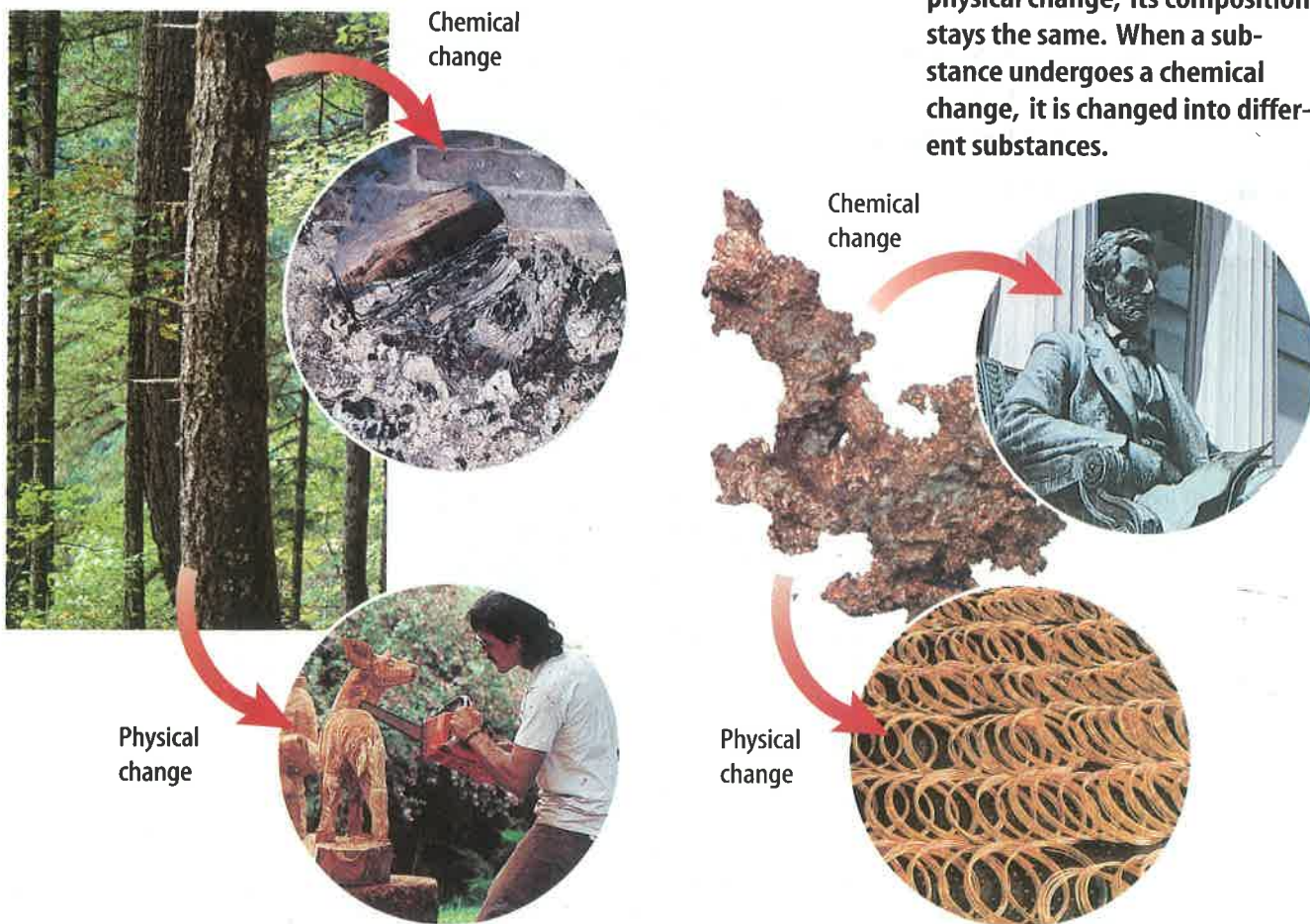
Physical and chemical changes are used to recycle or reuse certain materials. **Figure 18** discusses the importance of some of these changes in recycling.



Some physical and chemical changes are good for the environment. To find out more, read through the **Recyclable Plastics Field Guide** at the back of the book.

Figure 17

When a substance undergoes a physical change, its composition stays the same. When a substance undergoes a chemical change, it is changed into different substances.



Conservation of Mass

During a chemical change, the form or the composition of the matter changes. The particles within the matter rearrange to form new substances, but they are not destroyed and new particles are not created. The number and type of particles remains the same. As a result, the total mass of the matter is the same before and after a physical or chemical change. This is known as the **law of conservation of mass**.

This law can sometimes be difficult to believe, especially when the materials remaining after a chemical change might look different from those before it. In many chemical changes in which mass seems to be gained or lost, the difference is often due to a gas being given off or taken in. The difference, for example, before and after the candle in **Figure 19** is burned is in the gases released into the air. If the gases could be contained in a chamber around the candle, you would see that the mass does not change.

The scientist who first performed the careful experiments necessary to prove that mass is conserved was Antoine Lavoisier (AN twan • luh VWAH see ay) in the eighteenth century. It was Lavoisier who recognized that the mass of gases that are given off or taken from the air during chemical changes account for any differences in mass.



Figure 19

The candle looks as if it lost mass when it was burned. However, if you could trap and measure the gases given up during burning you would find that the mass of the candle and the gases is equal to the mass of the original candle.

Section

2

Assessment

1. What happens during a physical change?
2. List five physical changes you can observe in your home. Explain how you decided that each change is physical.
3. What kind of change occurs on the surface of bread when it is toasted—physical or chemical? Explain.
4. What does it mean to say that mass is conserved during a chemical change?
5. **Think Critically** A log is reduced to a small pile of ash when it burns. The law of conservation of mass states that the total mass of matter is the same before and after a chemical change. Explain the difference in mass between the log and the ash.

Skill Builder Activities

6. **Classifying** Classify the following changes as physical or chemical: baking a cake, folding towels, burning gasoline, melting snow, grinding beef into a hamburger, pouring milk into a glass, making cookies, and cutting a sheet of paper into paper dolls. For more help, refer to the **Science Skill Handbook**.
7. **Solving One-Step Equations** Magnesium and oxygen undergo a chemical change to form magnesium oxide. How many grams of magnesium oxide will be produced when 0.486 g of oxygen completely react with 0.738 g of magnesium? For more help, refer to the **Math Skill Handbook**.