

Changes of Matter

KEY IDEAS

As you read this section, keep these questions in mind:

- What is a physical change?
- What is a chemical change?
- How can the parts of a mixture and a compound be separated?

What Is a Physical Change?

Suppose you break a piece of chalk in half. You have changed some of its physical properties. The two pieces of chalk have a different size and shape than the original piece. However, you have not changed the chemical properties of the chalk. For example, each piece of chalk would produce bubbles if you placed it in vinegar.

Breaking chalk is an example of a physical change. A **physical change** affects one or more physical properties of a substance without changing the identity of the substance. No matter how small the pieces of chalk are, each piece still has the same chemical properties. ✓

Examples of physical changes include boiling water, sanding a piece of wood, and mixing sand and water. The figure below shows other examples of physical changes.



Cutting changes the size of an object or substance.



Crushing changes the shape of an object or substance.

DISSOLVING SUBSTANCES

People often add sugar to tea. As you stir the tea, the sugar seems to disappear. However, just one taste will tell you that the sugar is still there. What happened to it?

The sugar *dissolved* in the tea. When sugar dissolves, the sugar molecules spread out among the water molecules in the tea.

READING TOOLBOX

Organize After you read this section, prepare two-column notes. Place the three Key Ideas in the left column. Add details and examples in the right column for each Key Idea. Then reread the section to see if you can add more details and examples.

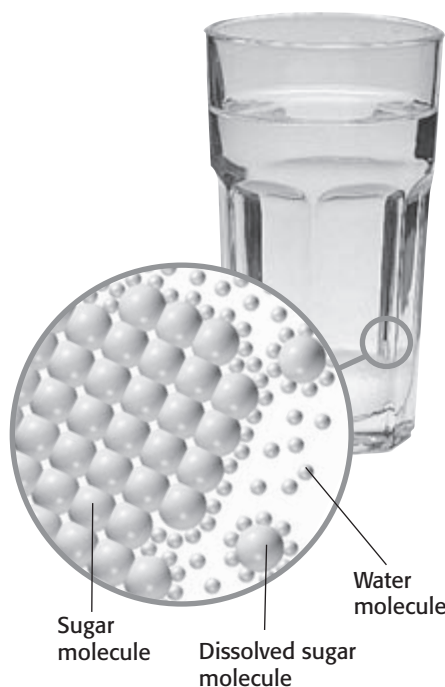
**READING CHECK**

1. Explain How does a physical change affect the identity of a substance?

LOOKING CLOSER

2. Identify Give two properties of an object that can be affected by a physical change.

SECTION 3 Changes of Matter *continued*



Water molecules attract the sugar molecules and pull them apart. As a result, the sugar molecules spread out, or dissolve, in the water.

LOOKING CLOSER

3. Analyze Do the molecules of water and sugar change as sugar dissolves?

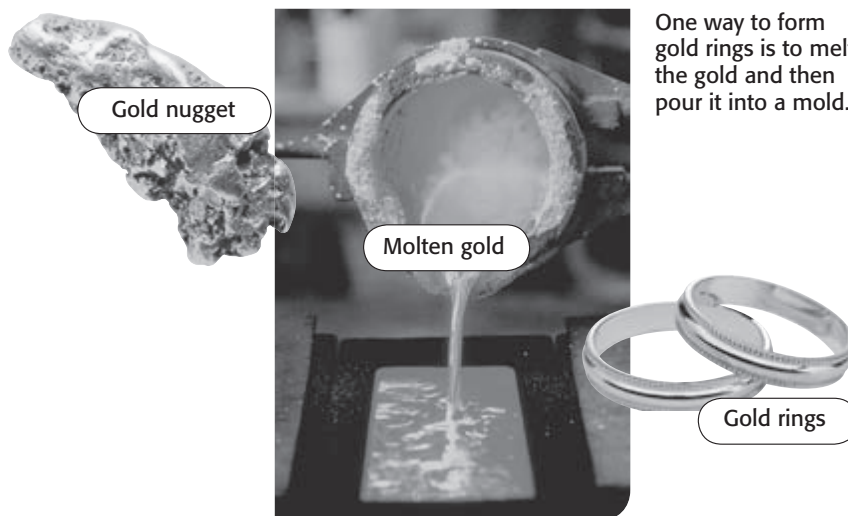
When sugar dissolves in water or tea, the molecules do not change. In other words, the components of the mixture keep their identities. Because no atoms recombine when one substance dissolves in another, dissolving is a physical change.

MELTING AND FREEZING

Melting and freezing are also examples of physical changes. Consider what happens when a gold nugget is melted to form a gold ring. The gold changes from solid to liquid and then back to solid again. The shape of the gold also changes, but the atoms of gold do not change.

Critical Thinking

4. Infer Why is melting a physical change and not a chemical change?



One way to form gold rings is to melt the gold and then pour it into a mold.

SECTION 3 Changes of Matter *continued***What Is a Chemical Change?**

Some materials are useful because they can change and combine to form new substances. For example, gasoline is flammable. When it burns, it produces CO_2 and H_2O and releases a great deal of energy. Because of this property, people use gasoline to power machines. Burning compounds is an example of a chemical change. A **chemical change** happens when one or more substances change into new substances that have different properties. ✓

Chemical changes take place constantly both around you and inside you. For example, chemical changes occur when fruits ripen and when leaves change color. The oxygen we breathe undergoes several chemical changes inside your body. These chemical changes supply the energy your body needs.

REARRANGEMENT OF ATOMS

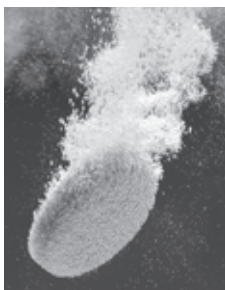
Recall that atoms are not rearranged during a physical change. During a chemical change, however, atoms re-arrange to form new substances. For example, when you bake bread, you combine water, flour, and yeast. Each ingredient has its own properties. The heat of the oven and interactions among the ingredients cause chemical changes. These changes produce a new substance—bread.

EVIDENCE OF CHEMICAL CHANGE

Certain clues can tell you that a chemical change has happened. These may include:

- Production of gas bubbles
- Change in color or odor
- Release of light, sound, or heat

When you add effervescent tablets to water, a chemical reaction takes place. The citric acid and baking soda in the tablets react to form carbon dioxide. This causes bubbles to form.



The Statue of Liberty is made of copper. Copper is a shiny, orange-brown metal. However, when copper reacts with water and compounds in the air, green compounds form.

READING CHECK

5. Describe What happens during a chemical change?

Critical Thinking

6. Compare How does a chemical change differ from a physical change?

LOOKING CLOSER

7. Identify What two clues that a chemical change has happened are shown in this figure?

SECTION 3 Changes of Matter *continued***REVERSING CHEMICAL CHANGES**

Most chemical changes that you observe in your daily life cannot be reversed. For example, bread baking, milk turning sour, and iron rusting are examples of chemical changes that cannot be reversed. However, under the right conditions, some chemical changes can be reversed by another chemical change. To reverse a chemical change, the atoms in the new substance must recombine again. ✓

READING CHECK

8. Explain How can a chemical change be reversed?

How Can a Mixture Be Separated?

Recall that a mixture is a combination of substances that are not chemically combined. Each component of a mixture has the same chemical identity that it had before the mixture was made. Therefore, separating a mixture does not involve recombining atoms. In other words, the components of a mixture can be separated by physical changes.

Some mixtures can be separated easily. For example, pizza is a mixture that has components you can see. If you don't like one of the toppings on a pizza, you can take it off. Removing a component of a mixture is a physical change. ✓

READING CHECK

9. Identify What kind of change is used to separate components of a mixture?

Other mixtures are more difficult to separate. For example, you cannot pick salt out of saltwater. However, you can separate the components of saltwater by heating the mixture. When the water evaporates, the salt remains.



Sea water is a mixture. Its components can be separated by physical changes. In a saltwater pond such as this one, sea water evaporates and salt is left behind.

Talk About It

Find Examples With a partner, think of some types of mixtures that could be separated with each of these methods: evaporation, distillation, filtration, by centrifuge. Discuss whether each method would be better for separating mixtures of solids, mixtures of liquids, or mixtures of both.

Some other methods of separating mixtures are described below:

- During *distillation*, a mixture is heated and each component boils and evaporates at a different time.
- In *filtration*, a liquid component passes through a filter and solid components stay in or on the filter.
- Spinning some mixtures in a *centrifuge* causes components to separate.

SECTION 3 Changes of Matter *continued*

A centrifuge is used to separate substances that have different densities. The centrifuge spins rapidly and denser substances collect at the bottom of the tube.

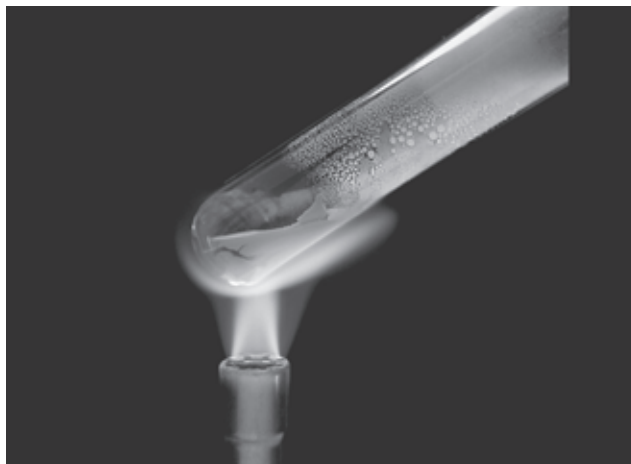
**LOOKING CLOSER**

10. Identify What property of a substance is important for separating a mixture with a centrifuge?

How Can a Compound Be Separated?

Recall that a compound is made up of atoms that are chemically combined. As a result, a compound can be broken apart only by rearranging atoms. In other words, the elements that make up a compound can be separated only by chemical changes. For example, when the compound mercury (II) oxide is heated, it breaks down into the elements mercury and oxygen. ✓

A compound, such as mercury (II) oxide, can be separated into elements only by chemical changes.

**READING CHECK**

11. Identify What kind of change is needed to separate a compound—physical or chemical?

Some compounds can be separated with electrical currents. For example, scientists can pass current through table salt when the compound is in a liquid state. This causes the compound to separate into its elements—sodium and chlorine.

Some compounds undergo chemical changes to form simpler compounds. Gasoline in a car engine reacts with oxygen to produce carbon dioxide and water. Additional changes can break down carbon dioxide and water into the elements carbon, oxygen, and hydrogen.

Section 3 Review

SECTION VOCABULARY

chemical change a change that occurs when one or more substances change into entirely new substances with different properties	physical change a change of matter from one form to another without a change in chemical properties
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1. Classify For each example, place a mark in the correct column to indicate whether it is a physical change or a chemical change.

Example	Chemical change	Physical change
Ice cream melting		
Fruit rotting		
Paint peeling		
An egg frying		
Plants changing carbon dioxide and water into sugar and oxygen		
Salt dissolving in water		

2. Infer Can a physical change reverse a chemical change? Explain your answer.

3. Compare How do the general methods for separating mixtures and compounds differ?

4. Apply Concepts Suppose your teacher asks you to separate a mixture of sand and water. Which of the following methods would you use: distillation, filtration, or evaporation? Explain your answer.

5. Compare Does a physical change affect the identity of a substance? Does a chemical change affect the identity of a substance?
