

Forming New Substances

BEFORE YOU READ

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

- What is a chemical reaction?
- What are exothermic reactions?
- What are endothermic reactions?



California Science Standards

8.3.b, 8.5.a, 8.5.c

What Is a Chemical Reaction?

Chemical reactions happen around you all the time. Wood burns and turns to ash. Rust forms on iron. Bread dough rises. These are all chemical reactions.

A **chemical reaction** happens when substances break apart or combine to form one or more new substances. New substances form when bonds break and new bonds form. The chemical properties of the new substances are different from those of the original substances. ✓

What Are the Signs of a Chemical Reaction?

There are several ways to tell that a chemical reaction has happened. Sometimes, you can see the new substance that forms during the reaction. For example, during some chemical reactions, a precipitate forms. A **precipitate** is a solid substance that forms in a solution. The figure below shows some of the signs that a chemical reaction is happening.

Some chemical reactions produce gas. For example, nitrogen dioxide gas is produced when copper reacts with nitric acid.



Some chemical reactions produce a precipitate. For example, solid silver chromate forms when potassium chromate solution is added to silver nitrate solution.



Some chemical reactions give off energy. For example, burning wood gives off light and heat energy. Other chemical reactions take in energy.



During some chemical reactions, a color change happens. For example, the chemical reaction between the blue dye in jeans and bleach will cause the jeans to change color.

STUDY TIP


Compare and Contrast As you read this section, make a chart comparing and contrasting endothermic and exothermic reactions.

**READING CHECK**

1. Define Write a definition for chemical reaction in your own words.

TAKE A LOOK

2. Identify Give three signs that a chemical reaction is happening.

 CALIFORNIA STANDARDS CHECK
<p>8.3.b Students know that compounds are formed by combining two or more different elements and that compounds have properties that are different from their <u>constituent</u> elements.</p> <p>Word Help: <u>constituent</u> necessary part of a whole</p> <p>3. Explain What happens to the chemical properties of substances during a chemical reaction?</p> <hr/> <hr/> <hr/> <hr/> <hr/>

CHANGING CHEMICAL PROPERTIES

Even if you see some of the signs of a chemical reaction, it does not always mean that a reaction is happening. For example, a gas (water vapor) is given off when water boils. However, remember that boiling is a physical change. It is not a chemical reaction.

How can you be sure that a chemical reaction is happening? The best way is to look at the chemical properties of the substance that forms. The new substances that form during chemical reactions always have different chemical properties than the original substances. The figure below shows an example of how chemical properties can change during a chemical reaction.

This sulfuric acid is a clear liquid.



This sugar is a white solid.



When sulfuric acid reacts with sugar, new substances with different properties form. Carbon is a black solid. Water vapor is a colorless gas.

How Do New Substances Form?

Chemical reactions happen when chemical bonds are broken and formed. A *chemical bond* is a force that holds two atoms together in a molecule. During a chemical reaction, some of the bonds in the original molecule break. New bonds form to produce a new substance. ✓

Remember that molecules are always moving. If the molecules in a substance bump into each other with enough energy, some of the bonds in the molecules can break. The atoms can form new bonds with different atoms. A new substance forms. The figure on the next page shows an example of how new substances can form.

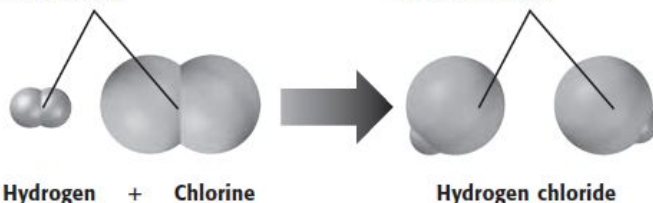
READING CHECK

4. Describe What happens to chemical bonds during a chemical reaction?

SECTION 1 Forming New Substances *continued*

Hydrogen and chlorine are diatomic molecules. Diatomic molecules are made of two atoms bonded together. In order for hydrogen to react with chlorine, the bonds between the atoms must break.

New bonds can form between hydrogen atoms and chlorine atoms. A new substance, hydrogen chloride, forms. Hydrogen chloride is also a diatomic molecule.



TAKE A LOOK

5. Identify Hydrogen and chlorine react to produce hydrogen chloride. What bonds are broken and what bonds are formed during this reaction?

What Happens to Energy During a Reaction?


Remember that all chemical reactions involve breaking and forming bonds. It takes energy to break a chemical bond. Energy is given off when a chemical bond forms. During some reactions, a lot of energy is released when new bonds form. More energy is given off than is used to break the bonds in the original substances. These chemical reactions give off energy.

During other reactions, very little energy is released when new bonds form. The energy that is given off is less than the amount needed to break the bonds in the original substances. These chemical reactions take in energy.

EXOTHERMIC REACTIONS

A reaction that gives off energy is an **exothermic reaction**. *Exo* means “go out” or “exit.” *Thermic* means “heat” or “energy.” During an exothermic reaction, energy is released into the surroundings.

Exothermic reactions can give off energy in several forms. Some exothermic reactions give off electricity. For example, the exothermic reaction in a battery produces electricity that can make a flashlight work. Some exothermic reactions give off heat. Some give off light. Many give off energy in several forms. For example, wood burning is an exothermic reaction. It gives off both heat and light.

	CALIFORNIA STANDARDS CHECK
8.5.c Students know chemical reactions usually <u>liberate</u> heat or absorb heat.	
Word Help: <u>liberate</u> to release; to set free	
6. Explain What can happen to energy during a chemical reaction?	
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Say It

Discuss In a small group, talk about different chemical reactions that affect your life. Are these reactions exothermic or endothermic? How do you know?

Critical Thinking

7. Apply Concepts What probably happened to the temperature of the air, the flask, and the wood during the reaction? Explain your answer.

ENDOTHERMIC REACTIONS

A reaction that takes in energy is an **endothermic reaction**. *Endo* means “go in.” During an endothermic reaction, energy is taken in from the surroundings.

Like exothermic reactions, the energy in endothermic reactions can be in several forms. Some reactions take in light energy. For example, plants use light energy to make food during the process of *photosynthesis*. Photosynthesis is an endothermic reaction.

Some endothermic reactions take in heat energy. For example, in the figure below, the reaction in the flask is endothermic. There were a few drops of water between the wood and the flask. The reaction in the flask absorbed energy from the water, causing it to freeze. The reaction also absorbed energy from the air, the flask, and the wood.

The chemical reaction happening in the flask is endothermic. It absorbs energy from the flask, the wood, and the air.



There were a few drops of water between the wood and the flask. The reaction in the flask absorbed energy from the water and caused it to freeze.

Where Does the Energy Go?

The **law of conservation of energy** states that energy cannot be created or destroyed. However, energy can change forms. Energy can move from one object to another. For example, the chemical reaction between gasoline and oxygen in a car engine makes parts of the engine move. The energy changes from chemical energy to *kinetic energy*, the energy of motion.

The energy given off in an exothermic reaction was once contained in the chemical bonds in the original substances. The energy taken in during an endothermic reaction is stored in the bonds in the new substances.


READING CHECK

8. Define Write your own definition for the law of conservation of energy.

Section 1 Review

8.3.b, 8.5.a, 8.5.c



SECTION VOCABULARY

chemical reaction the process by which one or more substances change to produce one or more different substances

endothermic reaction a chemical reaction that requires heat

exothermic reaction a chemical reaction in which heat is released to the surroundings

law of conservation of energy the law that states that energy cannot be created or destroyed but can be changed from one form to another

precipitate a solid that is produced as a result of a chemical reaction in solution

1. Compare How are exothermic reactions different from endothermic reactions?

2. Explain What happens to energy when a chemical bond forms? What happens to energy when a chemical bond is broken?

3. List Give one example of an exothermic reaction and one example of an endothermic reaction.

4. Apply Concepts Explain why water boiling is not a chemical reaction, even though it releases a gas. Use the words *chemical bond* in your answer.

5. Infer A scientist mixes substance A and substance B in a beaker. Neither substance A nor substance B can conduct electricity. The material in the beaker changes color, and the beaker becomes very hot. The material left in the beaker conducts electricity. Has a chemical reaction occurred? Explain your answer.
