Physical Science

Corbin

Weeks 5, 6

Apr 27 – May 8

chapter 19

Chemical Reactions

section 2 Classifying Chemical Reactions

What You'll Learn

- what the five kinds of chemical reactions are
- what oxidation and reduction are
- what a redox reaction is
- which metals replace others in compounds

Before You Read

Why do you think there are different sections in your school library to organize, or classify, the books?

_____

_____

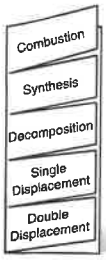
Read to Learn

Mark the Text

Find Main Ideas As you read this section, highlight the headings that are questions in one color. Then highlight the answers to those questions in another color.

FOLDABLES

B Build Vocabulary
Make the following Foldable to help you organize information about chemical reactions. Label the tabs as shown.



Types of Reactions

Millions of chemical reactions occur every day. Scientists organize, or group, reactions into five types—combustion, synthesis, decomposition, single displacement, and double displacement. Organizing reactions in this way helps scientists use the knowledge they gain, just as classifying books in the library helps you use the books.

What are combustion reactions?

When you see something burning, you are seeing a combustion reaction. A **combustion reaction** occurs when a substance reacts with oxygen to produce heat and light. Combustion reactions produce one or more products that contain the elements of the reactants. For example, carbon reacts with oxygen to produce carbon dioxide. This reaction describes what happens when coal burns. Many combustion reactions also fit into other types of reactions. For example, the reaction between carbon and oxygen is a combustion reaction and a synthesis reaction.

What are synthesis reactions?

In a **synthesis reaction**, two or more substances combine to form another substance. The general formula for a synthesis reaction is $A + B \rightarrow AB$. Substance A reacts with substance B to form substance AB.

An example of a synthesis reaction is hydrogen burning in oxygen to form water.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

This reaction is used to power some rockets, including the main engines of a space shuttle. Have you ever seen a rusty car or bike? The reaction that causes rust is a synthesis reaction. When iron reacts with oxygen in the presence of water, hydrated iron(II) oxide, or rust, is formed.

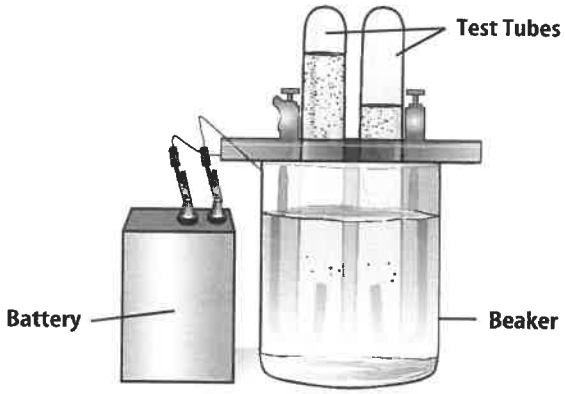
Reading Check

1. **Explain** What type of reaction is the formation of rust?

What are decomposition reactions?

A decomposition reaction is the reverse of a synthesis reaction. A **decomposition reaction** occurs when one substance breaks down, or decomposes, into two or more substances. The general formula for a decomposition reaction is $AB \rightarrow A + B$. Most decomposition reactions use heat, light, or electricity. For example, an electric current passed through water produces hydrogen and oxygen. The chemical equation and figure below show this.

$$2H_2O(l) \xrightarrow{\text{elec.}} 2H_2(g) + O_2(g)$$



Picture This

2. **Interpret Illustrations** Look at the coefficients of the products in the equation. Which test tube has hydrogen in it, the left one or the right one? How do you know this?

What are single-displacement reactions?

A **single-displacement reaction** happens when one element replaces another element in a compound. The general formula for a single-displacement reaction is $A + BC \rightarrow AC + B$. Atom A displaces, or takes the place of, atom B. A new molecule, AC, forms. A single-displacement reaction occurs when a copper wire is put into a solution of silver nitrate. Copper is a more active metal than silver, so it replaces the silver. A blue copper(II) nitrate solution forms. The silver, which is not soluble, forms on the wire.

$$Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$$

What is the activity series? You can predict which metal will replace another metal in displacement reactions. The diagram lists metals by how reactive they are. The most-active metals are at the top of the list. The least-active metals are at the bottom. A metal will replace any less-active metal. Notice that copper, silver, and gold are the least-active metals on the list. That is why these elements often occur in relatively pure deposits.

Picture This

3. **Order** Write these elements in order from least active to most active: lead, aluminum, copper, silver, zinc.

_____

_____

_____

_____

_____

What are double-displacement reactions?

In a **double-displacement reaction**, the positive ion of one compound replaces the positive ion of the other compound to form two new compounds. The general formula for a double-displacement reaction is AB + CD → AD + CB. A double-displacement reaction takes place if a precipitate, water, or gas forms when two ionic compounds in solution are combined. A **precipitate** is an insoluble compound (one that cannot be dissolved) that comes out of solution during a double-displacement reaction.

Reading Check

4. **Identify** Which type of reaction causes a precipitate to form?

_____

_____

Look at the following example of a double-replacement reaction.

$$Ba(NO_3)_2(aq) + K_2SO_4(aq) \rightarrow BaSO_4(s) + 2KNO_3(aq)$$

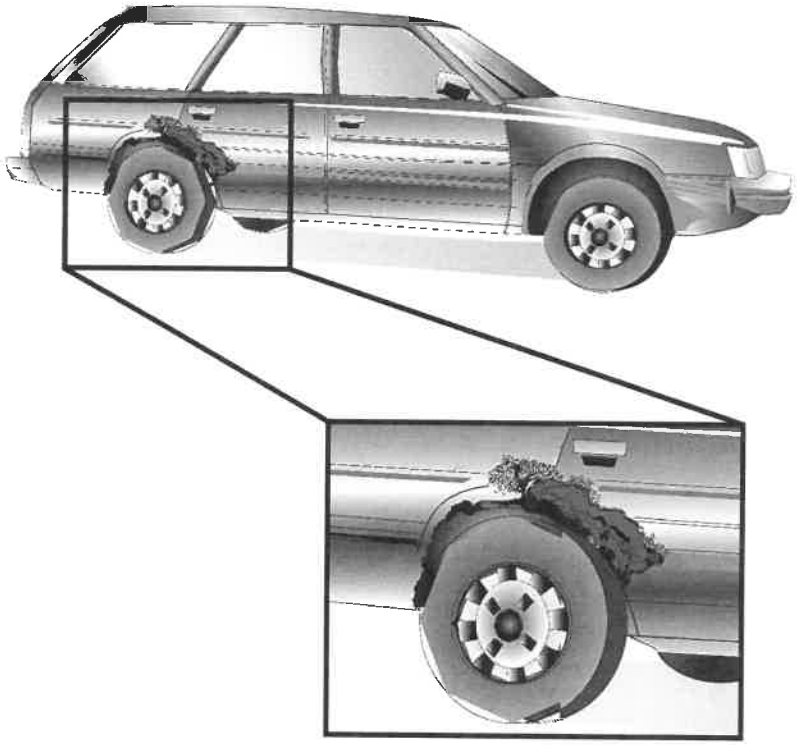
The reactants are barium nitrate and potassium sulfate. Both compounds are in solutions. The products are solid barium sulfate, which is the precipitate, and potassium nitrate, which is in solution.

The chemical reactions you learned about in this section are only a few examples. Thousands of reactions of each type happen all around you.

What are oxidation-reduction reactions?

In many chemical reactions, substances gain or lose electrons. Chemists use two terms to describe gaining or losing electrons. **Oxidation** is a loss of electrons during a chemical reaction. **Reduction** is a gain of electrons during a chemical reaction. Chemical reactions involving electron transfer of this sort often involve oxygen. Oxygen is very reactive. It often pulls electrons from metals. Oxidation-reduction reactions cause metals to corrode, or rust, as you can see in the figure.

During an oxidation-reduction reaction, one substance gains electrons while another loses electrons. The substance that gains electrons becomes more negative, so we say it is reduced. Another substance loses electrons and becomes more positive. We say it is oxidized. Reduction and oxidation always occur together. That is why these reactions are often called redox reactions. Redox stands for *red*uction and *ox*idation.



Think it Over

5. **Draw Conclusions** Chlorine has seven electrons in its outer energy level. In reactions, chlorine usually gains an electron. In a redox reaction, would chlorine be oxidized or reduced? Explain.

Picture This

6. **Explain** What has happened to the electrons in the metal of the car in the figure?

After You Read

Mini Glossary

combustion reaction: a reaction in which a substance reacts with oxygen to produce heat and light

decomposition reaction: a reaction in which one substance breaks down, or decomposes, into two or more substances

double-displacement reaction: a reaction in which the positive ion of one compound replaces the positive ion of the other compound to form two new compounds

oxidation: a loss of electrons during a chemical reaction

precipitate: an insoluble compound that comes out of solution during a double-displacement reaction

reduction: a gain of electrons during a chemical reaction

single-displacement reaction: a reaction in which one element replaces another element in a compound

synthesis reaction: a reaction in which two or more substances combine to form another substance

1. Review the terms and their definitions in the Mini Glossary. Choose two terms that are related and write a sentence using both of them.

_____

_____

2. Write the letter of the description in Column 2 that matches the reaction in Column 1.

Column 1	Column 2
_____ 1. decomposition reaction	a. $A + B \rightarrow AB$
_____ 2. single-displacement reaction	b. $AB + CD \rightarrow AD + CB$
_____ 3. synthesis reaction	c. burning
_____ 4. combustion reaction	d. $A + BC \rightarrow AC + B$
_____ 5. double-displacement reaction	e. $AB \rightarrow A + B$

3. Mark the Text How did highlighting the questions and answers in different colors help you learn the material in this section?

_____

_____

End of Section

Name _____ Date _____

Chemical Reactions

Section 2 Classifying Chemical Reactions

Skim *Section 2. Write two statements about what you plan to learn from the reading.*

1. _____

_____

2. _____

Review Vocabulary

Define states of matter.

states of matter _____

_____

New Vocabulary

Read the definitions below. Then write the key term for each one in the left column.

_____	a reaction in which a substance reacts with oxygen to produce heat and light
_____	a reaction in which two or more substances combine to form another substance
_____	a reaction in which one substance breaks down, or decomposes, into two or more substances
_____	a reaction in which one element replaces another element in a compound
_____	a reaction in which the positive ion of one compound replaces the positive ion of the other compound to form two new compounds
_____	an insoluble compound that comes out of a solution during a double-displacement reaction
_____	a loss of electrons during a chemical reaction
_____	a gain of electrons during a chemical reaction

Name _____ Date _____

Section 2 Classifying Chemical Reactions (continued)

Main Idea

Types of Reactions

I found this information on page _____.

Details

Describe *each type of chemical reaction in words. Give the general form if it exists and an example for each.*

I. Combustion Reaction

Description: _____

Example: _____

II. Synthesis Reaction

Description: _____

_____

General form: _____

Example: _____

III. Decomposition Reaction

Description: _____

General form: _____

Example: _____

IV. Single-Displacement Reaction

Description: _____

General form: _____

Example: _____

V. Double-Displacement Reaction

Description: _____

_____

General form: _____

Example: _____

VI. Oxidation-Reduction Reaction

Description: _____

_____

_____

Name _____ Date _____

Section 2 Classifying Chemical Reactions (continued)

Main Idea — **Details**

Type of Reactions

I found this information on page _____.

I found this information on page _____.

Analyze *the activity series chart in your book to decide which metal will replace the other in a displacement reaction.*

1. calcium	2. tin	3. copper
lead	**zinc**	**aluminum**
_____	_____	_____

Classify *each chemical reaction by writing the reaction type in the blank to the left.*

- decomposition
- double displacement
- single displacement
- synthesis

_____ $2LiBr + Pb(NO_3)_2 \rightarrow PbBr_2 + 2LiNO_3$

_____ $Fe + 2HCl \rightarrow FeCl_2 + H_2$

_____ $CaO + H_2O \rightarrow Ca(OH)_2$

_____ $NiCl_2 \rightarrow Ni + Cl_2$

Model *a synthesis reaction and a decomposition reaction using the following elements. Balance the equations.*

Calcium Hydrogen Oxygen

Synthesis _____

Decomposition _____

[energy will be required to cause the decomposition reaction]

CONNECT IT Select an example of a chemical reaction that you have observed. Describe the reaction and try to write an equation for it.

_____

_____

CHAPTER 19 LESSON 2 QUIZ

NAME: _____ PERIOD: _____ TEACHER: _____

- **1.** In a _____ reaction, two or more substances combine to form another substance.
  - A. synthesis
  - B. decomposition
  - C. single replacement
  - D. double replacement

- **2.** The formula $AB \rightarrow A + B$ represents what type of chemical reaction?
  - A. synthesis
  - B. decomposition
  - C. single displacement
  - D. double displacement

- **3.** Which of the following general formulas represents a single-displacement reaction?
  - A. $AB \rightarrow A + B$
  - B. $A + B \rightarrow AB$
  - C. $A + BC \rightarrow AC + B$
  - D. $AB + CD \rightarrow AD + CB$

- **4.** An insoluble compound that comes out of solution during a double displacement reaction is called a _____.
  - A. solvent
  - B. reactant
  - C. precipitate
  - D. catalyst

- **5.** What type of reaction is represented by the following equation: $2H_2 + O_2 \rightarrow 2H_2O$?
  - A. synthesis
  - B. single displacement
  - C. double displacement
  - D. decomposition

chapter 19

Chemical Reactions

section 3 Chemical Reactions and Energy

Before You Read

You have probably seen video of a building being demolished by an explosion. Describe what happened on the lines below.

_____

_____

What You'll Learn

- energy change sources in chemical reactions
- the difference between exergonic and endergonic reactions
- how catalysts and inhibitors are used

Read to Learn

Chemical Reactions—Energy Exchanges

When they are no longer useful, buildings are sometimes demolished with dynamite. A dynamite explosion is an example of a rapid chemical reaction.

Most chemical reactions happen more slowly than a dynamite explosion, but all chemical reactions release or absorb energy. The energy released in a chemical reaction can be in the form of heat, light, sound, or electricity. Wood burns and releases heat and light. A glow stick releases only light.

Chemical bonds are the source of this energy. Most chemical reactions break some chemical bonds in the reactants. It takes energy to break the chemical bonds. That is why many substances need heat to make them react. For products to be produced, new bonds must form. When bonds form, energy is released. The amount of energy required to break the chemical bonds in dynamite is much less than the amount of energy released when new bonds form. The result is a release of energy and sometimes a loud explosion.

More Energy Out

An **exergonic** (ek sur GAH nihk) **reaction** releases energy. In an exergonic reaction, less energy is needed to break the bonds in the reactants than is released when new bonds in the products form. Exergonic reactions give off energy, such as light or heat. An exergonic reaction produces visible light in a glow stick.

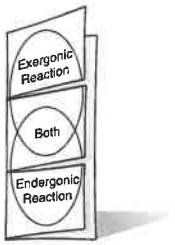
Mark the Text

Underline As you read this section, underline the information you think is important. When you finish reading, look back at what you underlined.

FOLDABLES

Make a Venn Diagram

Make the following Foldable to compare and contrast exergonic and endergonic reactions.

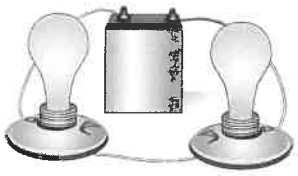


What are exothermic reactions?

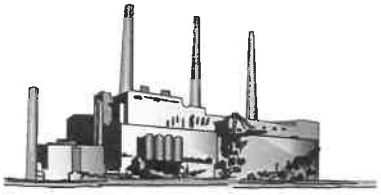
In some reactions, the energy is given off as thermal energy. Have you ever used a heat pack? Heat packs release thermal energy. An **exothermic** (ek soh THUR mihk) **reaction** releases thermal energy. Burning wood and exploding dynamite are examples of exothermic reactions. Iron rusting is also exothermic. The chemical reaction that produces rust occurs so slowly that you can't detect the thermal energy.

How are exothermic reactions used?

Have you turned on a light or used a blow-dryer today? The energy you used probably came from exothermic reactions. The power plant the electricity came from probably uses fossil fuels. The carbon in the fossil fuels combines with oxygen to form carbon dioxide gas and energy. This reaction is exothermic.



Other substances in fossil fuels also react. Often, the products of these other reactions are pollutants. Sulfur in fossil fuels reacts with oxygen to form sulfur dioxide, which combines with water in the atmosphere to form acid rain.



Picture This

1. **Identify** What type of reactions provides the energy for the items in the figures?

_____

More Energy In

An **endergonic** (en dur GAH nihk) **reaction** absorbs energy. In an endergonic reaction, it takes more energy to break the bonds in the reactants than is released when new bonds in the products form. Endergonic reactions absorb energy such as heat, light, or electricity.

Reading Check

2. **Determine** What happens to energy in an endergonic reaction?

_____

_____

Electricity is often used to supply energy to endergonic reactions. Electricity supplies energy to a reaction that puts a coat of metal onto a surface. This reaction is called electroplating. Electricity also is used to supply energy to separate aluminum metal from its ore.

In the following endergonic reaction, energy from electricity keeps the reaction going.

$$2Al_2O_3(l) \xrightarrow{\text{elec.}} 4Al(l) + 3O_2(g)$$

What is an endothermic reaction?

An **endothermic** (en duh THUR mihk) **reaction** absorbs energy, usually as heat. When an endothermic reaction takes place in a beaker, it can make the beaker feel cold. Physical changes also can be described as endothermic. For example, a salt dissolving in water is an endothermic physical change.

An endothermic reaction is used to make homemade ice cream. In an ice-cream maker, salt is added to a bucket of ice and water. The salt dissolves and absorbs heat. This makes the mixture of salt and water colder. Without salt, the ice would not make the ice cream mixture cold enough to freeze.

Some reactions are extremely endothermic. When barium hydroxide ($BaOH_2$) reacts with ammonium chloride (NH_4Cl) in a beaker of water, it is so endothermic that it causes a drop of water on the outside of the beaker to freeze. Cold packs contain ammonium nitrate crystals and water. They are another example of an endothermic reaction.

How is energy conserved in chemical reactions?

You read in an earlier chapter that energy can change from one form to another, but the total amount of energy never changes. This principle is usually called the law of conservation of energy. Does this mean that the total amount of energy remains constant in chemical reactions, too? Yes. Consider the burning of methane (CH_4) in air. Methane is the major component of natural gas, and is described by the following equation. Note that energy is included as a product and recall that oxygen is in the air.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g) + \text{energy}$$

During this process, some of the chemical energy of the reactants is released as thermal energy and light. However, the sum of the energy released and the chemical energy of the products is exactly equal to the chemical energy of the reactants in an exergonic chemical reaction. In other words, the chemical energy released plus the chemical energy of the products is equal to the chemical energy of the reactants. So the total amount of energy before and after the reaction remains the same. Similarly, the total amount of energy remains the same in endergonic chemical reactions. Summarizing, the law of conservation of energy applies to chemical reactions, as well as to other types of energy transformations.

Think it Over

3. Compare and Contrast What is the difference between an endergonic reaction and an endothermic reaction?

After You Read

Mini Glossary

endergonic reaction: a reaction that absorbs energy

endothermic reaction: a reaction that absorbs energy, usually as heat

exergonic reaction: a reaction that releases energy

exothermic reaction: a reaction that releases energy, usually as heat

1. Review the terms and their definitions in the Mini Glossary. Write a sentence giving an example of the type of reaction that can cause its container to get cold or freeze water.

2. Complete the table. The first row gives examples of different kinds of reactions. Name the type of reaction for each example. Then describe the reaction.

Example of Reaction				
	Glow Stick	**Dynamite Exploding**	**Electroplating Metals**	**Cold Pack**
Type of Reaction	exergonic reaction		endergonic reaction	
Description of the Reaction		release energy in the form of heat		

3. Mark the Text What idea was the hardest for you to understand in this section? How would you explain that idea to a friend?

End of Section

Name _____ Date _____

Chemical Reactions

Section 3 Chemical Reactions and Energy

Preview *Section 3 of this chapter. Read the headings and the illustration captions. Write three questions that come to mind.*

1. _____
2. _____
3. _____

_____

Review Vocabulary

Define chemical bond.

chemical bond _____

New Vocabulary

Use your book to define the following key terms.

exergonic reaction _____

exothermic reaction _____

endergonic reaction _____

endothermic reaction _____

Academic Vocabulary

Use a dictionary to define release.

release _____

Name _____ Date _____

Section 3 Chemical Reactions and Energy (continued)

Main Idea | **Details**

Chemical Reactions—Energy Exchanges

I found this information on page _____.

Identify *three pieces of information about chemical reations and energy.*

1. _____

2. _____

3. _____

More Energy Out, More Energy In

I found this information on page _____.

Complete *the following sentences about energy reactions.*

All exothermic reactions are _____, but not all exergonic reactions are _____. _____ give off thermal energy, and _____ give off any type of energy.

All _____ reactions are endergonic, but not all _____ reactions are endothermic. _____ reactions absorb thermal energy, and _____ reactions absorb any type of energy.

Classify *each reaction as endergonic or exergonic.*

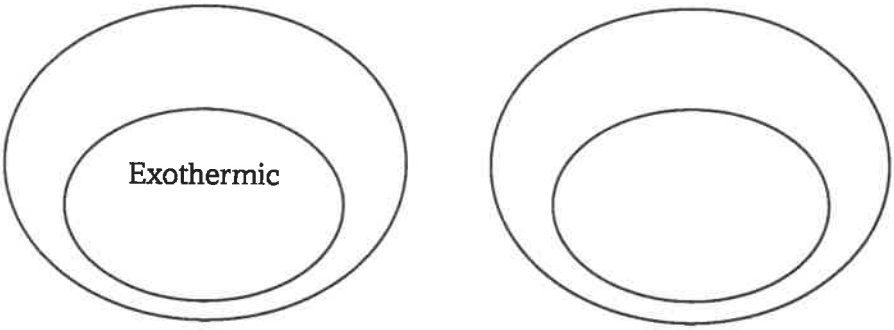
- combustion of fossil fuels
- dissolving salt in water
- dynamite explosions
- electroplating
- fireflies' light
- glow sticks
- photosynthesis
- rusting iron
- separating aluminum metal from its ore

Exergonic	Endergonic

Name _____ Date _____

Section 3 Chemical Reactions and Energy (continued)

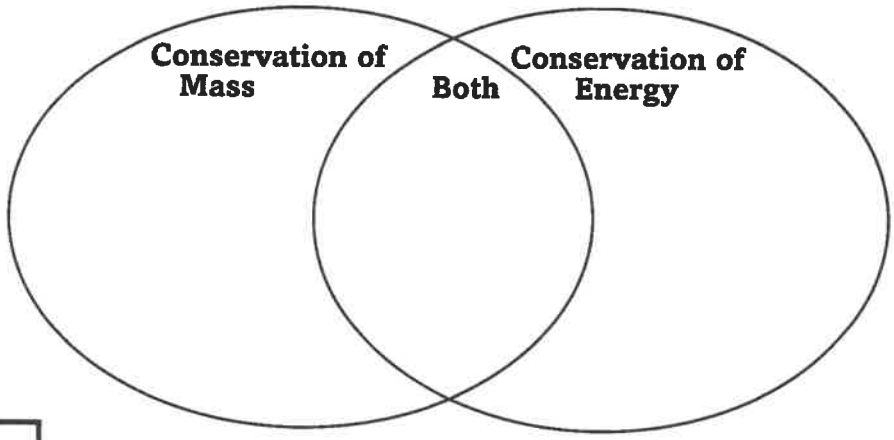
Main Idea	Details
More Energy Out, More Energy In *I found this information on page _____.*	**Model** ***the exergonic/exothermic and endothermic/endergonic relationships by completing the Venn Diagram below. The first step has been done for you.***



Conservation of Energy in Chemical Reactions *I found this information on page _____.*	**Compare and contrast** ***the conservation of mass and the conservation of energy in the equation below. Fill the Venn diagram using phrases from the bank below the equation.***

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g) + \text{energy}$

- Balanced equation
- Chemical energy is released as thermal energy.
- New compounds are created.
- Matter is not created or destroyed.
- Light is a product.



CONNECT IT Use what you have learned in this section to explain why a match will not light if you do not strike it hard enough.

_____

_____

CHAPTER 19 LESSON 3 QUIZ

NAME: _____ PERIOD: _____ TEACHER: _____

- **1.**Which form of energy is produced by an exothermic reaction?
  - A. ○ thermal energy
  - B. ○ light
  - C. ○ electricity
  - D. ○ sound

- **2.**What is the name of the energy that is required to start a chemical reaction?
  - A. ○ starting energy
  - B. ○ activation energy
  - C. ○ chemical energy
  - D. ○ reaction energy

- **3.**Which type of reaction requires the addition of thermal energy to continue?
  - A. ○ exergonic reaction
  - B. ○ endergonic reactions
  - C. ○ exothermic reaction
  - D. ○ endothermic reactions

- **4.**Classify the following chemical reaction: energy + reactants → products.
  - A. ○ exergonic
  - B. ○ endergonic
  - C. ○ exothermic
  - D. ○ endothermic

- **5.**When bonds form in a chemical reaction, energy is _____.
  - A. ○ conserved
  - B. ○ required
  - C. ○ released
  - D. ○ not involved