Foundations of Chemistry

Chemical Properties and Changes

Before You Read

What do you think? Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	7. When wood burns, new materials form.	
	8. Temperature can affect the rate at which chemical changes occur.	

Read to Learn

Chemical Properties

Recall that a physical property is a characteristic of matter that you can observe or measure without changing the identity of the matter. However, matter has other properties that you can observe only when the matter changes from one substance to another. *A* **chemical property** *is a characteristic of matter that can be observed as it changes to a different type of matter.* For example, can you tell by just looking at paper that it will burn easily? The only way to know that paper burns is to bring a flame near the paper and watch it burn. When paper burns, it changes into different types of matter. The ability of a substance to burn is a chemical property. The ability to rust is another chemical property.

Comparing Properties

All matter can be described by its physical and chemical properties. For example, a wood log is solid, rounded, heavy, and rough. These are physical properties that you can observe with your senses. The log also has mass, volume, and density, which are physical properties that you can measure. The ability of wood to burn is a chemical property. This property is obvious only when you burn the wood. It also will rot, another chemical property you can observe when the log decomposes, becoming other substances. When you describe matter, you consider its physical and its chemical properties.

Key Concepts

- What is a chemical property?
- What are some signs of chemical change?
- Why are chemical equations useful?
- What are some factors that affect the rate of chemical reactions?

Study Coach

Preview Headings Before you read the lesson, preview all the headings. Make a chart and write a question for each heading beginning with *What* or *How*. As you read, write the answers to your questions.

Key Concept Check

1. Identify What are some chemical properties of matter?

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.

FOLDABLES

Make a four-column chart to explain how the identity of matter changes during a chemical change.

Action/ Matter	Signs of Chemical Change	Explain the Chemical Reaction	What affects the reaction rate?

Key Concept Check

2. Recognize What are signs of a chemical change?

Chemical Changes

Recall that during a physical change, the identity of matter does not change. However, *a* **chemical change** *is a change in matter in which the substances that make up the matter change into other substances with new physical and chemical properties.* When iron undergoes a chemical change with oxygen, rust forms. The substances that undergo a change no longer have the same properties because they no longer have the same identity.

Signs of Chemical Change

How do you know when a chemical change occurs? What signs show you that new types of matter have formed? Signs of chemical changes include the formation of bubbles or a change in odor, color, or energy. For example, the odor of fruit changes when it rots. Leaves change color in autumn. Energy changes when fireworks explode.

These signs do not always mean a chemical change has occurred. When you heat water on a stove, bubbles form as the water boils. In this case, bubbles show that the water is changing state, which is a physical change. Bubbles that form when you add an antacid tablet to water is evidence that a chemical change might have occurred. However, the only proof of chemical change is the formation of a new substance.

Explaining Chemical Reactions

Why do chemical changes create new substances? Recall that particles in matter move constantly. As particles move, they collide with each other. If the particles collide with enough force, the bonded atoms that make up the particles can break apart. These atoms then rearrange and bond with other atoms. When atoms bond together in new combinations, new substances form. This process is called a reaction. Chemical changes often are called chemical reactions.

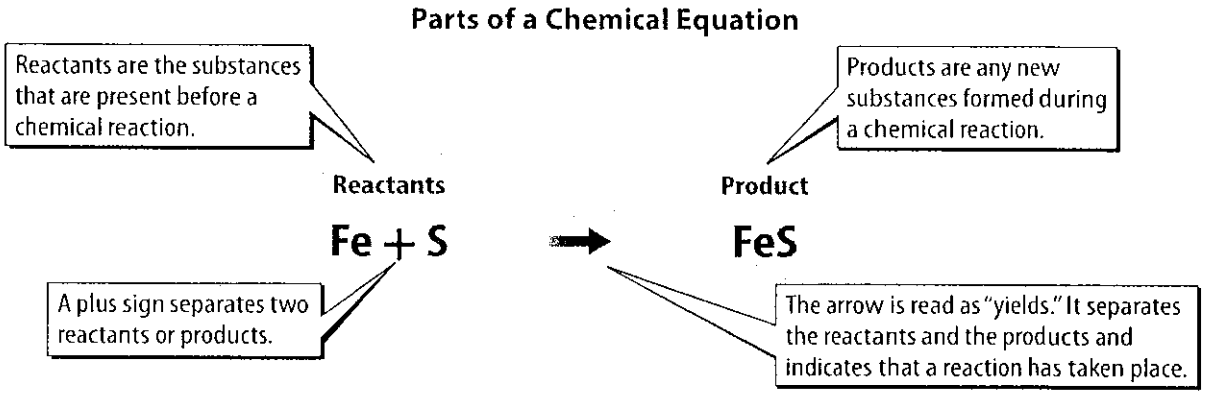
Using Chemical Formulas

A chemical equation is a useful way to express what happens during a chemical reaction. A chemical equation shows the chemical formula of each substance in the reaction. Look at the chemical equation in the figure on the next page. The formulas to the left of the arrow represent the reactants. Reactants are the substances present before the reaction takes place. The formulas to the right of the arrow represent the products. Products are the new substances present after the reaction.

Key Concept Check

3. Explain Why are chemical equations useful?

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.



Balancing Chemical Equations

In the equation in the figure above, notice that one iron (Fe) atom is on the reactants side and one iron atom is on the product side. This is also true for the sulfur (S) atoms. One sulfur atom is on each side of the arrow. The arrow indicates that a reaction has taken place. In a chemical equation, the arrow is read as "yields." A reaction between the reactants to the left of the arrow yields, or produces, the new products on the right side of the arrow.

Recall that during physical and chemical changes, mass is conserved. This means that the total mass before and after a change must be equal. Therefore, in a chemical equation, the number of atoms of each element before a reaction must equal the number of atoms of each element after the reaction. This is called a balanced chemical equation, and it illustrates the conservation of mass.

When balancing an equation, you cannot change the chemical formula of any reactants or products. Changing a formula changes the identity of the substance. Instead, you can place coefficients, or multipliers, in front of formulas. Coefficients change the amount of the reactants and products present.

For example, an H_2O molecule has two H atoms and one O atom. Placing the coefficient *2* before H_2O ($\mathbf{2}H_2O$) means that you double the number of H atoms and O atoms present:

$$\mathbf{2} \times 2 \text{ H atoms} = 4 \text{ H atoms}$$
$$\mathbf{2} \times 1 \text{ O atom} = 2 \text{ O atoms}$$

Note that $2H_2O$ is still water. However, it describes two water particles instead of one.

Visual Check

4. Interpret In the chemical equation above, which two substances undergo chemical changes during the reaction?

_____

_____

Think it Over

5. Apply Suppose you place the coefficient *4* before H_2O. How many atoms of hydrogen and how many atoms of oxygen will the formula have?

_____

_____

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.

Balancing Chemical Equations

Example

When methane (CH_4)—a gas burned in furnaces—reacts with oxygen (O_2) in the air, the reaction produces carbon dioxide (CO_2) and water (H_2O). Write and balance a chemical equation for this reaction.

1. Write the equation, and check to see if it is balanced.

a. Write the chemical formulas with the reactants on the left side of the arrow and the products on the right side. **b.** Count the atoms of each element in the reactants and in the products. • Note which elements have a balanced number of atoms on each side of the equation. • If all elements are balanced, the overall equation is balanced. If not, go to step 2.	**a.** $CH_4 + O_2 \rightarrow CO_2 + H_2O$ **not balanced** **b.** reactants → products C=1 C=1 **balanced** H=4 H=2 **not balanced** O=2 O=3 **not balanced**

2. Add coefficients to the chemical formulas to balance the equation.

a. Pick an element in the equation whose atoms are not balanced, such as hydrogen. Write a coefficient in front of a reactant or a product that will balance the atoms of the chosen element in the equation. **b.** Recount the atoms of each element in the reactants and the products, and note which are balanced on each side of the equation. **c.** Repeat steps 2a and 2b until all atoms of each element in the reactants equal those in the products.	**a.** $CH_4 + O_2 \rightarrow CO_2 + 2H_2O$ **not balanced** **b.** C=1 C=1 **balanced** H=4 H=4 **balanced** O=2 O=4 **not balanced** **c.** $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ **balanced** C=1 C=1 **balanced** H=4 H=4 **balanced** O=4 O=4 **balanced**

3. Write the balanced equation that includes the coefficients: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Interpreting Tables

6. Recognize In the table, highlight the numbers of atoms that show the equation is not balanced.

The table above explains how to write and balance a chemical equation. Equations must balance because mass does not change during a chemical reaction.

The Rate of Chemical Reactions

Recall that the particles that make up matter are constantly moving and colliding with one another. Different factors can make these particles move faster and collide harder and more frequently. These factors increase the rate of a chemical reaction.

Temperature A higher temperature usually increases the rate of reaction. For example, chemical reactions that occur during cooking happen at a faster rate when temperature increases. As temperature rises, the particles move faster. Therefore, the particles collide with greater force and more frequently.

Reading Check

7. Explain Why does the rate of reaction increase when temperature increases?

_____

_____

_____

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.

After You Read

Mini Glossary

chemical change: a change in matter in which the substances that make up the matter change into other substances with new physical and chemical properties

chemical property: a characteristic of matter that can be observed as it changes to a different type of matter

concentration: the amount of substance in a certain volume

1. Review the terms and their definitions in the Mini Glossary. Write two sentences that explain the difference between a chemical change and a physical change.

_____

_____

_____

2. Count the number of atoms of each element on both sides of the chemical equation below. Then determine whether the equation is balanced or not balanced.

$C_2H_4O_2 + 2O_2 \longrightarrow 2CO_2 + 2H_2O$

C = _____	C = _____
H = _____	H = _____
O = _____	O = _____

balanced or not balanced? _____

3. When a banana spoils, how can you tell that a chemical change has occurred?

_____

_____

_____

What do you think NOW?

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?

Connect ED

Log on to ConnectED.mcgraw-hill.com and access your textbook to find this lesson's resources.

END OF LESSON

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.