Chemical Reaction Overview

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Printed: November 10, 2015

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CHAPTER 1

Chemical Reaction Overview

- Define chemical reaction.
- Describe what happens during chemical reactions.
- Identify types of chemical reactions.
- State the role of energy in chemical reactions.

Does the term *chemical reaction* bring to mind an image like this one? In the picture, a chemist is mixing chemicals in a lab. Many chemical reactions take place in labs. However, most chemical reactions do not. Where do they occur? They happen in the world all around you. They even happen inside your own body. In fact, you are alive only because of the many chemical reactions that constantly take place inside your cells.

What Is a Chemical Reaction?

A **chemical reaction** is a process in which some substances change into different substances. Substances that start a chemical reaction are called reactants. Substances that are produced in the reaction are called products. Reactants and products can be elements or compounds. Chemical reactions are represented by chemical equations, like the one below, in which reactants (on the left) are connected by an arrow to products (on the right).

Reactants $\rightarrow$ Products

Chemical reactions may occur quickly or slowly. Look at the two pictures in the **Figure** 1.1. Both represent chemical reactions. In the picture on the left, a reaction inside a fire extinguisher causes foam to shoot out of the extinguisher. This reaction occurs almost instantly. In the picture on the right, a reaction causes the iron tool to turn to rust. This reaction occurs very slowly. In fact, it might take many years for all of the iron in the tool to turn to rust.

Q: What happens during a chemical reaction? Where do the reactants go, and where do the products come from?

A: During a chemical reaction, chemical changes take place. Some chemical bonds break and new chemical bonds form.

FIGURE 1.1

Same Atoms, New Bonds

The reactants and products in a chemical reaction contain the same atoms, but they are rearranged during the reaction. As a result, the atoms are in different combinations in the products than they were in the reactants. This happens because chemical bonds break in the reactants and new chemical bonds form in the products.

Consider the chemical reaction in which water forms from oxygen and hydrogen gases. The **Figure** 1.2 represents this reaction. Bonds break in molecules of hydrogen and oxygen, and then new bonds form in molecules of water. In both reactants and products there are four hydrogen atoms and two oxygen atoms, but the atoms are combined differently in water. You can see another example at this URL: http://www.avogadro.co.uk/h_and_s/bondenthalpy/bondenthalpy.htm .

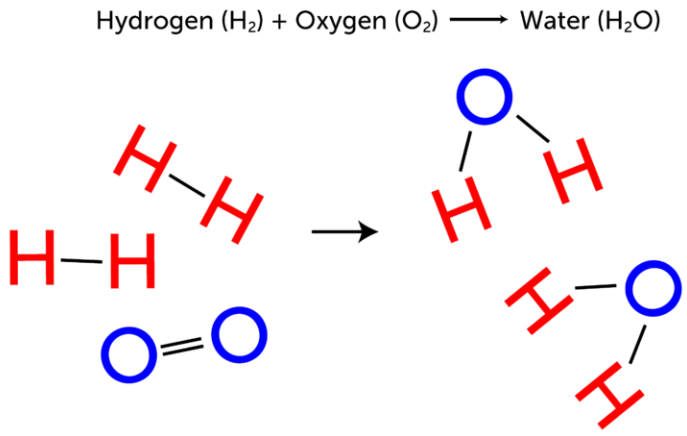


FIGURE 1.2

Types of Chemical Reactions

The chemical reaction in the **Figure** 1.2, in which water forms from hydrogen and oxygen, is an example of a synthesis reaction. In this type of reaction, two or more reactants combine to synthesize a single product. There are several other types of chemical reactions, including decomposition, replacement, and combustion reactions. The **Table** 1.1 compares these four types of chemical reactions. You can see demonstrations of each type at this URL: http://www.youtube.com/watch?v=nVysOW0Lb8U .

TABLE 1.1: Types of Chemical Reactions

Type of Reaction	General Equation	Example

TABLE 1.1: (continued)

Type of Reaction	General Equation	Example
Synthesis	A+B → C	$2Na + Cl_2 \rightarrow 2NaCl$
Decomposition	AB → A + B	$2H_2O \rightarrow 2H_2 + O_2$
Single Replacement	A+BC → B+ AC	$2K + 2H_2O \rightarrow 2KOH + H_2$
Double Replacement	AB+ CD → AD + CB	NaCl+ AgF → NaF + AgCl
Combustion	fuel + oxygen → carbon dioxide + water	$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Q: The burning of wood is a chemical reaction. Which type of reaction is it?

A: The burning of wood—or of anything else—is a combustion reaction. In the combustion example in the table, the fuel is methane gas (CH_4).

Energy In and Energy Out

All chemical reactions involve energy. Energy is used to break bonds in reactants, and energy is released when new bonds form in products. In terms of energy, there are two types of chemical reactions: endothermic reactions and exothermic reactions.

- In exothermic reactions, more energy is released when bonds form in products than is used to break bonds in reactants. These reactions release energy to the environment, often in the form of heat or light.
- In endothermic reactions, more energy is used to break bonds in reactants than is released when bonds form in products. These reactions absorb energy from the environment.

Q: When it comes to energy, which type of reaction is the burning of wood? Is it an endothermic reaction or an exothermic reaction? How can you tell?

A: The burning of wood is an exothermic reaction. You can tell by the heat and light energy given off by a wood fire.

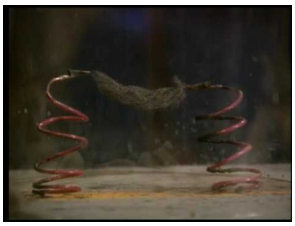
Summary

- A chemical reaction is a process in which some substances, called reactants, change into different substances, called products. During the reaction, chemical bonds break in the reactants and new chemical bonds form in the products.
- Types of chemical reactions include synthesis, decomposition, replacement, and combustion reactions.
- All chemical reactions involve energy. Exothermic reactions release more energy than they use. Endothermic reactions use more energy than they release.

Explore More

At the following URL, watch Bill Nye the Science Guy demonstrate chemical reactions. Then answer the questions below.

http://www.youtube.com/watch?v=66kuhJkQCVM



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URL: http://www.ck12.org/flx/render/embeddedobject/201

1. What did you observe when Bill Nye ran electrons through steel wool? What happened chemically in this reaction? Is the reaction endothermic or exothermic?
2. Describe the reaction in which Bill Nye ran electrons through hydrogen and oxygen gases. How can you tell that the reaction released energy?

Review

1. What is a chemical reaction?
2. Write a general chemical equation that shows the relationship of products to reactants in a chemical reaction.
3. Contrast exothermic and endothermic chemical reactions.

References

1. Fire extinguisher: Official U.S. Navy Page; Screw: Paulnasca. Chemical reactions can be fast or slow, like a f ire extinguisher or rusting . CC BY 2.0
2. Joy Sheng. Reaction of hydrogen and oxygen to form water . CC BY-NC 3.0