Exothermic and Endothermic Reactions

Jean Brainard, Ph.D.

AUTHOR
Jean Brainard, Ph.D.

To access a customizable version of this book, as well as other interactive content, visit www.ck12.org

CK-12 Foundation is a non-profit organization with a mission to reduce the cost of textbook materials for the K-12 market both in the U.S. and worldwide. Using an open-source, collaborative, and web-based compilation model, CK-12 pioneers and promotes the creation and distribution of high-quality, adaptive online textbooks that can be mixed, modified and printed (i.e., the FlexBook® textbooks).

Printed: October 20, 2017

flexbook
next generation textbooks

CHAPTER 1

Exothermic and Endothermic Reactions

Learning Objectives

- Define endothermic reaction.
- Describe the role of energy in endothermic reactions.
- Give examples of endothermic reactions.

Did you ever use an instant ice pack like this one? You don't have to pre-cool it in the freezer. All you need to do is squeeze the pack and it starts to get cold. How does this happen? The answer is an endothermic chemical reaction.

What Is An Endothermic Reaction?

All chemical reactions involve energy. Energy is used to break bonds in reactants, and energy is released when new bonds form in products. In an **endothermic reaction**, it takes more energy to break bonds in the reactants than is released when new bonds form in the products.

Energy Change in Endothermic Reactions

The word *endothermic* literally means "taking in heat." A constant input of energy, often in the form of heat, is needed to keep an endothermic reaction going. This is illustrated in the equation below. Energy must be absorbed

because the process needs more energy to break more bonds in the reactants. The general equation for an endothermic reaction is:

$$\text{Reactants} + \text{Energy} \rightarrow \text{Products}$$

If the energy in a reaction is absorbed and used by the reactants, the temperature of the products decreases. In an endothermic reaction, the products usually feel colder than the reactants.

Q: Now can you guess how an instant cold pack works?

A: Squeezing the cold pack breaks an inner bag of water, and the water mixes with a chemical inside the pack. The chemical and water combine in an endothermic reaction. The energy needed for the reaction to take place comes from the water, which gets colder as the reaction proceeds.

Photosynthesis

One of the most important series of endothermic reactions is photosynthesis. In photosynthesis, plants make the simple sugar glucose ($C_6H_{12}O_6$) from carbon dioxide (CO_2) and water (H_2O). They also release oxygen (O_2) in the process. The reactions of photosynthesis are summed up by this chemical equation:

$$6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2$$

The energy for photosynthesis comes from light. Without light energy, photosynthesis cannot occur. As you can see in the **Figure** below, plants can get the energy they need for photosynthesis from either sunlight or artificial light.

FIGURE 1.1

Summary

- An endothermic reaction is a chemical reaction in which more energy is needed to break bonds in the reactants than is released when new bonds form in the products.
- A constant input of energy, often in the form of heat, is needed to keep an endothermic reaction going.
- The products of an endothermic reaction usually feel cold.

Exothermic Reactions

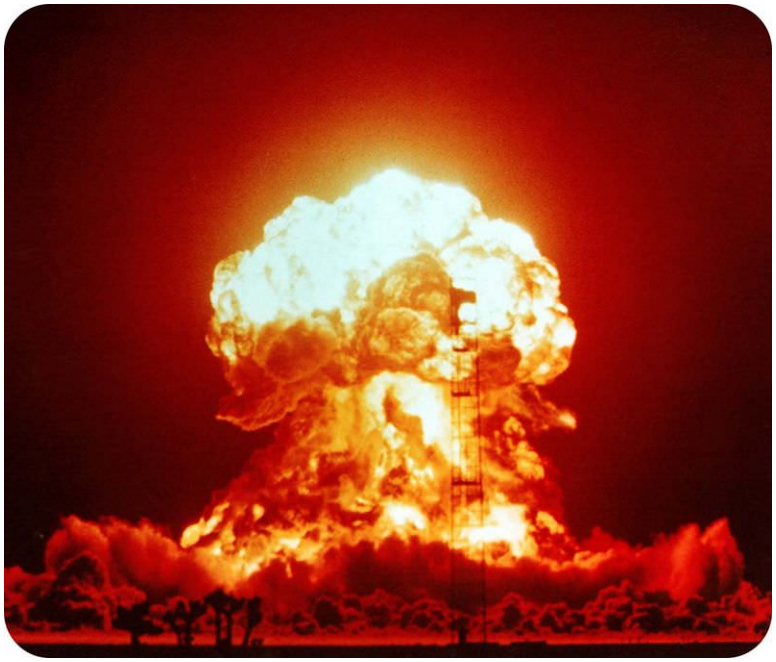


FIGURE 1.2

This mushroom cloud was produced in a 1953 nuclear bomb test in Nevada. There's no doubt that the explosion gave off a huge amount of energy . Although not as impressive as nuclear reactions , many chemical reactions also give off energy. These reactions are called exothermic reactions.

What Is An Exothermic Reaction?

All chemical reactions involve energy . Energy is used to break bonds in reactants, and energy is released when new bonds form in products. In some chemical reactions, called endothermic reactions, less energy is released when new bonds form in the products than is needed to break bonds in the reactants. The opposite is true of exothermic reactions. In an **exothermic reaction**, it takes less energy to break bonds in the reactants than is released when new bonds form in the products.

Energy Change in Exothermic Reactions

The word *exothermic* means "releasing heat ." Energy, often in the form of heat, is released as an exothermic reaction proceeds. This is illustrated in the **Figure** below . The general equation for an exothermic reaction is:

Reactants $\rightarrow$ Products + Energy

If the energy produced in an exothermic reaction is released as heat , it results in a rise in temperature . As a

Combustion as an Exothermic Reaction

All combustion reactions are exothermic reactions. During a combustion reaction , a substance burns as it combines with oxygen. When substances burn, they usually give off energy as heat and light. Look at the big bonfire in

the **Figure** below. The combustion of wood is an exothermic reaction that releases a lot of energy as heat and light. You can see the light energy the fire is giving off. If you were standing near the fire, you would also feel its heat.

FIGURE 1.3

Wood burning in a bonfire is an exothermic reaction

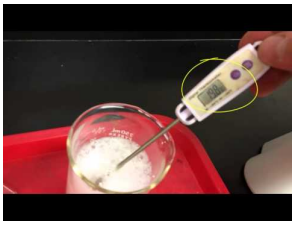
Summary

- An exothermic reaction is a chemical reaction in which less energy is needed to break bonds in the reactants than is released when new bonds form in the products.
- During an exothermic reaction, energy is constantly given off, often in the form of heat.
- All combustion reactions are exothermic reactions. During combustion, a substance burns as it combines with oxygen, releasing energy in the form of heat and light.

MEDIA

Click image to the left or use the URL below.

URL: http://www.ck12.org/flx/render/embeddedobject/204329



MEDIA

Click image to the left or use the URL below.

URL: http://www.ck12.org/flx/render/embeddedobject/212351

Review (Answer on a sheet of lined paper, titled "Exo and Endothermic Reactions")

1. What is an endothermic reaction?
2. Why is the temperature of products likely to be lower than the temperature of reactants in an endothermic reaction?
3. What is an exothermic reaction?
4. Why is the temperature of products likely to be higher than the temperature of reactants in an exothermic reaction?

References

1. Left: Greg O'Beirne (User:Gobeirne/Wikimedia Commons); Right: Josh Kelahan. Plants photosynthesize using sunlight or artificial light . Left: CC BY 2.5; Right: CC BY 2.0
2. . Wood burning in a bonfire is an exothermic reaction.
3. . Wood burning in a bonfire is an exothermic reaction.