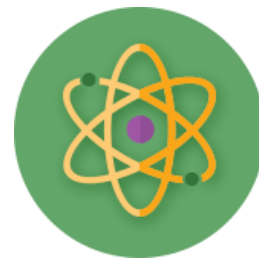


Energy Changes in Chemical Reactions



Glossary

TERM	DEFINITION
chemical reaction	<i>an event in which existing substances are broken down or combined and new substances are formed</i>
chemical energy	
battery	<i>In batteries, the chemical reaction between reactants releases energy and transfers electrons. Chemical energy is transformed into electric energy.</i>
exothermic reaction	
endothermic reaction	
law of conservation of energy	
activation energy	
thermal energy	<i>the total kinetic energy of particles in a specific amount of matter</i>
catalyst	
temperature	<i>the degree of hotness or coldness of a body or environment; the measure of the average kinetic energy of particles</i>
transition state	

Objective

In this lesson, you will

Chemical Reactions and Energy

Energy is something that moves or _____. Energy exists in many different forms, including _____ energy. In some reactions, some chemical energy is _____ into other forms of energy.

→ For example, when substances burn (called combustion). This type of reaction occurs when _____ reacts with a substance and releases a large amount of energy in the form of _____ and _____.



Chemical Reactions Release and Absorb Energy

Exothermic Reactions

★ _____ energy to the surroundings

Examples:

⇒ **Combustion:**

Oxygen reacts with a substance and releases a large amount of energy in the form of heat and light.

⇒ **Respiration:**

Glucose (sugar) reacts with oxygen in the body's cells, and the energy released is used for various activities.

⇒ **Electrochemical reaction:**

Endothermic Reactions

★ _____ energy from the surroundings

Examples:

⇒ **Photosynthesis:**

⇒ *Activating a cold pack starts a reaction that absorbs heat.*

⇒

Describing Energy in Chemical Reactions

In a chemical reaction, one set of substances (_____) is broken down or combined to form another set of substances (_____). But the _____ of energy in a chemical reaction remains the same. So, energy is just transferred from one form to another.



This outcome is based on the law of _____ of _____. This law states that energy is neither _____ nor _____. This law holds true for any form of energy. Chemists have found that:

- The energy released or absorbed is always in the _____ for a given reaction.
- The amount of energy released or absorbed does does not depend on the rate of reaction.
- The change in energy is related _____ to the _____ of the substances in the reaction.

Chemical Energy

Chemical energy is the energy that substances possess because of the way their _____ are _____ together. The _____ of chemical energy is different for different substances and determines whether energy is absorbed or released during a chemical reaction:

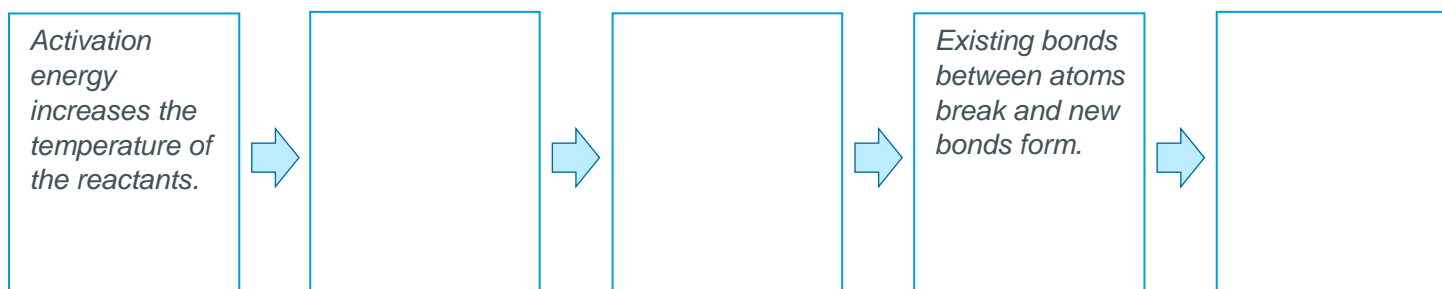
- ❖ If reactants have *more* chemical energy than products, energy is absorbed released.
- ❖ If reactants have *less* chemical energy than products, energy is absorbed released.

Activation Energy

All chemical reactions need a certain amount of energy to begin. This energy is called _____.

- The activation energy is often _____ energy, but it can also be any other form of energy.
- The amount of activation energy needed is always the same for a particular reaction, unless a catalyst is used.
 - A catalyst is a special substance that _____ activation energy.

Why is activation energy needed?



Reaction Energy Diagrams

A reaction energy diagram shows the process of a chemical reaction in terms of energy. The images show these energy values:

- _____
- _____
- _____



Activation energy and the change in chemical energy can be determined from the diagram.

★ *Activation energy* is the difference in energy between the:

reactants transition state products.

★ The *chemical energy released or absorbed* is the difference in energy between the:

reactants transition state products.

<p>Chemical Reactions That _____ Energy</p> <p>→ An exothermic reaction.</p> <p>The products have _____ energy compared with the reactants.</p> <p>Example chemical reaction: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{energy}$</p>	<p>Energy</p> <p>Progress of the Reaction</p>
<p>Chemical Reactions That _____ Energy</p> <p>→ An endothermic reaction.</p> <p>The products have _____ energy compared with the reactants.</p> <p>Example chemical reaction: $2\text{H}_2\text{O} + \text{energy} \rightarrow 2\text{H}_2 + \text{O}_2$</p>	<p>Energy</p> <p>Progress of the Reaction</p>

Science in the News: Hydrogen-Powered Vehicles

Today, combustion of fossil fuels fulfills almost all of our energy needs. However, there are disadvantages when using fossil fuels, including:

- produce _____ during combustion. Excess carbon dioxide has been linked to _____.
- fossil fuels also create _____
- During combustion, fossil fuels produce _____ in the atmosphere, which mix with soil and water and can have harmful effects on organisms.
- Fossil fuels _____ a _____ energy source. Eventually, they'll be used up.

Advantages of Hydrogen Fuel

When hydrogen combines with oxygen, it produces a lot of _____. Water is the only _____ of this reaction. The water produced in this reaction can be broken down to create _____.

The advantages of using hydrogen fuel include:

1. It doesn't produce _____ or any pollutants that form _____, so it has _____ fewer more negative effects on the environment than using fossil fuels.
2. It doesn't have to be _____. Hydrogen can react with oxygen in a special type of battery called a _____, which is _____ less more efficient than combustion.

Hydrogen Fuel Cells

Efficiency is often expressed as a percentage:

$$\text{efficiency (\%)} = \frac{\boxed{\hspace{10em}}}{\boxed{\hspace{10em}}} \times 100$$

<i>Combustion of Fuel</i>	<i>Reaction of Hydrogen in a Fuel Cell</i>
→ is _____ 100 percent efficient	→ an _____ reaction
→ a lot of energy _____ up the surroundings	→ _____ energy is released as heat
	→ most of the energy released is in the form of an _____, which operates a motor

The Challenge of Obtaining Hydrogen

A hydrogen fuel cell can produce electricity to power an electric car and for use in homes too.

- ❖ Fuel cells are quite useful because they're _____, which means they can be easily moved from place to place.
- ❖ The current electricity system isn't as _____ because it requires connection to the _____.

Pure hydrogen is a _____ gas. Its availability is limited. One possible way to get hydrogen is to decompose water (H_2O). Scientists are working to find a _____ that will lower the activation energy needed to decompose water.

Summary

Think of the different types of reactions you have learned about. How can you tell if they absorb energy or release energy, and at the molecular level, how are they different?