Name Period Date

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SECTION 2.4 | CHEMICAL REACTIONS
Study Guide

KEY CONCEPT

Life depends on chemical reactions.

VOCABULARY		
chemical reaction	bond energy	exothermic
reactant	equilibrium	endothermic
product	activation energy	

MAIN IDEA: Bonds break and form during chemical reactions.

1. Label the reactants and products in the chemical reaction shown below. Write brief definitions for these terms next to their labels.

reactants- substances changed during a chemical reaction.

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

products- substances made by a chemical reaction.

2. What causes chemical bonds to break during a reaction?

addition of energy to the reactants

3. What is bond energy?

the amount of energy that will break a bond between two atoms

4. In a chemical equation, what symbol is used to show that a chemical reaction goes in both directions?

$\rightleftharpoons$

5. When does a chemical reaction reach equilibrium?

when a reaction takes place at equal rates in both directions

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MAIN IDEA: Chemical reactions release or absorb energy.

6. The bond energy of the reactants and products determines whether energy will be released or absorbed during a chemical reaction.

7. Before a chemical reaction can start, energy must be absorbed by the reactants. The amount that must be absorbed to start the reaction is called the activation energy.

8. In an exothermic reaction, the products have a lower bond energy than the reactants. Overall, energy is released.

9. In an endothermic reaction, the products have a higher bond energy than the reactants. Overall, energy is absorbed.

Vocabulary Check

10. Write one sentence that uses the words *chemical reaction, reactant,* and *product.*

A chemical reaction changes reactants into products

11. Write your own analogy to remember the meaning of *activation energy.*

the energy it takes to get out of bed in the morning before you can start your day

12. The term *equilibrium* is based on two Latin roots that mean "equal" and "balance." How do these meanings tell you the meaning of *equilibrium* in a chemical reaction?

the reactants and products are formed equally; the reaction is in a balanced state

13. The prefix *exo-* means "out," and the prefix *endo-* means "in." What do these prefixes tell you about *exothermic* and *endothermic* reactions?

energy goes out of an exothermic reaction and goes into an endothermic reaction

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SECTION 2.4 | CHEMICAL REACTIONS

Reinforcement

KEY CONCEPT Life depends on chemical reactions.

At the most fundamental level, every process that takes place in an organism depends on chemical reactions. In a **chemical reaction,** substances are changed into different substances by the breaking and forming of chemical bonds. The substances that are present at the start of a chemical reaction, and are changed by the reaction, are called **reactants.** The substances that are formed by a chemical reaction are the **products.**

Chemical bonds must be broken in the reactants and new ones must be formed in the products. Energy must be added to break chemical bonds. In contrast, energy is always released when new bonds form. The amount of energy needed to break a bond, or the amount of energy released when a bond forms, is called **bond energy.**

All chemical reactions require the input of at least a small amount of energy in order for bonds to break in the reactants and for the reaction to start. The energy needed to start a chemical reaction is the **activation energy.** In general, there are two types of energy changes that can occur during a chemical reaction.

- Exothermic reaction: An **exothermic chemical reaction releases more energy than it absorbs.** The bonds that are broken in the reactants of an exothermic reaction have a higher bond energy than the new bonds that form in the products. Energy is usually released as heat or light.
- Endothermic reaction: An **endothermic chemical reaction absorbs more energy than it releases.** The bonds that are broken in the reactants of an endothermic reaction have a lower bond energy than the new bonds that form in the products. The energy that is absorbed makes up for the difference.

1. What are the two parts of a chemical reaction?

the products and the reactants

2. What is activation energy?

the energy needed to start a chemical reaction.

3. How are exothermic reactions different from endothermic reactions?

exothermic releases more energy than it releases endothermic reaction absorbs more energy than it releases

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SECTION 2.5 | ENZYMES
Study Guide

KEY CONCEPT

Enzymes are catalysts for chemical reactions in living things.

VOCABULARY	
catalyst	substrate
enzyme	

MAIN IDEA: A catalyst lowers activation energy.

1. What is activation energy?

the amount of energy required to start a chemical reaction

2. Take notes about catalysts in the chart below. In the first two boxes, write detail notes about the main functions of catalysts. In the third box, write a detail about another characteristic.

A catalyst lowers activation energy.

- catalysts decrease activation energy for a chemical reaction
- Catalysts increase the rate of a chemical reaction
- catalysts are neither reactants nor products because they are not changed or used up

3. When a catalyst is present, more / less activation energy is needed to start a chemical reaction.

less

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MAIN IDEA: Enzymes allow chemical reactions to occur under tightly controlled conditions.

4. Take notes about enzymes by filling in the Main Idea Web below.

Enzymes

Why enzymes are necessary: because reactions in organisms have to occur at a low body temperature, with low concentrations of reactants, and at a high rate.

How structure affects function: if structure changes, substrates will not be able to bind to an enzyme's active sites

Important factors in enzyme structure: order of amino acids and hydrogen bonding between the amino acids

Lock-and-key model: only certain substrates bind to an enzyme's active sites; when bound to the enzyme the chemical reaction can occur

5. How do enzymes weaken the bonds in substrates?

The enzyme's shape changes slightly, which strains the bonds inside the substrate. The strain on the bonds weakens them.

Vocabulary Check

6. The word *catalyst* comes from the Greek word meaning "to dissolve." How does this definition relate to the meaning of *catalyst*? A catalyst "dissolves" or "gets rid of" some of the activation energy needed to start a reaction

7. How are substrates like keys and enzymes like locks? Specific substrates fit exactly into active sites for specific enzymes, in a similar way that only a certain key will open an given lock.

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SECTION 2.5 | ENZYMES
Reinforcement

KEY CONCEPT Enzymes are catalysts for chemical reactions in living things.

Chemical reactions require the addition of energy, called activation energy, to take place. Even if a chemical reaction starts, it may not happen very quickly. However, both the activation energy and the rate of a chemical reaction can be changed by a chemical catalyst. A **catalyst** is a substance that decreases the activation energy for a reaction and increases the rate of the reaction.

In living things, **enzymes** are catalysts for chemical reactions. Almost all enzymes are proteins, and almost every process in living things needs enzymes. The function of each enzyme depends on its structure. A change in biological conditions within an organism can affect the shape of an enzyme, which can decrease or prevent an enzyme from working properly. For example, enzymes function best in a small range around an organism's normal temperature and pH.

The shape of an enzyme is important because it allows only certain molecules to bind to the enzyme. The specific molecules that an enzyme acts on are called **substrates.** One way to think of enzyme function is called the lock-and-key model. Substrates bind to an enzyme like the way in which a key fits into a lock. If an enzyme's structure changes, the substrates cannot bind to the enzyme.

- Substrates bind to an enzyme. The enzyme brings molecules close together so that they can react with one another.
- The bonds inside the substrates are stretched slightly out of position, which weakens the bonds. Less energy is needed to break weaker bonds.
- The reaction takes place and the product is released from the enzyme. The enzyme can then bind to more of the substrate molecules.

CHAPTER 2 Chemistry of Life

1. What is a catalyst?

a substance that decreases the activation energy for a reaction and increases the rate of a reaction

2. Where are enzymes found?

in living things

3. How does an enzyme work?

the substrate binds to an enzyme, the enzyme brings molecules close together, the bonds are slightly stretched, less energy is needed to break weaker bonds, the reaction takes place and the product is released from the enzyme

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