



Chapter 4

CHEMICAL REACTIONS AND EQUATIONS

Lesson 1 Vocabulary

- ▶ chemical bond - attraction between atoms when electrons are shared, transferred, or pooled
- ▶ chemical equation - description of a reaction using element symbols and chemical formulas

Lesson 1 Vocabulary

- ▶ chemical reaction - process in which atoms of one or more substances rearrange to form one or more new substances
- ▶ coefficient - number placed in front of an element symbol or chemical formula in an equation

Lesson 1 Vocabulary

- ▶ chemical formula - in an equation law of conservation of mass states that the total mass of the reactants before a chemical reaction is the same as the total mass of the products after the chemical reaction

Lesson 1 Vocabulary

- ▶ product - new substance produced by a chemical reaction
- ▶ reactant - starting substance in a chemical reaction

Lesson 2 Vocabulary

- ▶ combustion - chemical reaction in which a substance combines with oxygen and releases energy
- ▶ decomposition - chemical reaction in which one compound breaks down and forms two or more substances

Lesson 2 Vocabulary

- ▶ double replacement - describes a reaction in which the negative ions in two compounds switch places, forming two new compounds
- ▶ single replacement - describes a reaction in which one element replaces another element in a compound

Lesson 2 Vocabulary

- ▶ synthesis - chemical reaction in which two or more substances combine and form one compound

Lesson 3 Vocabulary

- ▶ activation energy - minimum amount of energy needed to start a chemical reaction
- ▶ catalyst - substance that increases the reaction rate by lowering the activation energy of a reaction

Lesson 3 Vocabulary

- ▶ endothermic - chemical reactions that absorb thermal energy
- ▶ enzyme - catalyst that speeds up chemical reactions in living cells

Lesson 3 Vocabulary

- ▶ exothermic - chemical reactions that release thermal energy
- ▶ inhibitor - substance that slows down, or even stops, a chemical reaction



Lesson 1

UNDERSTANDING CHEMICAL REACTIONS

Standards

- ▶ 7.PS1.4:

- ▶ Analyze and interpret chemical reactions to determine if the total number of atoms in the reactants and products support the Law of Conservation of Mass.

I can...

- ▶ Analyze a chemical reaction.

Essential Questions

- ▶ What are some signs that a chemical reaction might have occurred?
- ▶ What happens to atoms during a chemical reaction?
- ▶ What happens to the total mass in a chemical reaction?

Changes in Matter

- ▶ A physical change does not produce new substances. (A1)
- ▶ During a chemical change, new substances form. (A2)
 - ▶ The starting substances and the substances produced have different physical and chemical properties. (A2A)
 - ▶ A chemical reaction is a process in which atoms of one or more substances rearrange to form one or more new substances. (A2B)

Signs of a Chemical Reaction

- ▶ Sometimes, changes in physical properties, such as color or odor, indicate a chemical reaction. (B1)
- ▶ Formation of bubbles of a substance can also be a sign of a chemical reaction. (B1A)
- ▶ A solid formed when two liquids are mixed is called a precipitate. (B1B)

Signs of a Chemical Reaction



- ▶ A change in energy is another sign that a chemical reaction has occurred. (B2)
- ▶ Thermal energy is absorbed or released during a chemical reaction and is evidenced by warming or cooling. (B2A)
- ▶ Light energy might also be released during a chemical reaction. (B2B)
- ▶ The only way to be certain a chemical reaction has taken place is to compare the chemical properties of the substances before and after the change. (B3)

What happens in a chemical reaction?

- ▶ During a chemical reaction, atoms of elements or compounds rearrange and form new elements or compounds. (C1)
- ▶ Atoms rearrange when chemical bonds between atoms break. (C2)

Chemical Equations

- ▶ A chemical equation is a description of a reaction using element symbols and chemical formulas. (D1)
- ▶ Element symbols represent elements. (D2)
 - ▶ Symbols of elements are shown on the periodic table. (D2A)
 - ▶ When an element exists as a diatomic molecule, the element symbol is followed by the subscript 2. (D2B)

Chemical Equations

- ▶ Chemical formulas represent compounds. (D3)
 - ▶ A chemical formula contains elements' symbols and subscripts to describe the makeup of a compound. (D3A)
 - ▶ When chemical formulas differ, they represent different substances. (D3B)

Chemical Equations

- ▶ A chemical equation includes the substances that react and the substances that are formed. (D4)
 - ▶ Reactants are the starting substances in a chemical reaction. (D4a)
 - ▶ Products are the substances produced by a chemical reaction. (D4b)
 - ▶ In a chemical equation, the reactants are written to the left of an arrow, and the products are written to the right of the arrow. (D4c)
 - ▶ Two or more reactants are separated by plus signs, as are any two or more products. (D4d)

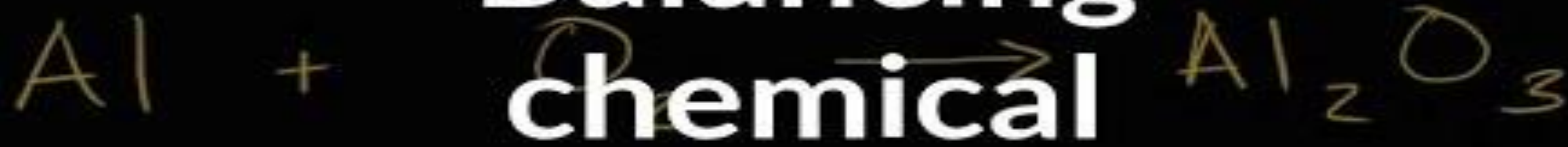
Conservation of Mass

- ▶ The law of conservation of mass states that the total mass of the reactants before a chemical reaction is the same as the total mass of the products after the chemical reaction. (E1)
- ▶ Mass is conserved in a chemical reaction because atoms are conserved. (E2)

Conservation of Mass

- ▶ To show that mass is conserved, a chemical equation must show that the number of each type of element must be balanced, or the same on both sides of the equation. (E3)
 - ▶ Chemical equations are balanced by adding coefficients. (E3a)
 - ▶ A coefficient is a number placed in front of an element symbol or a chemical formula in an equation. (E3b)

Balancing chemical equations



Khan Academy



Lesson 2:

TYPES OF CHEMICAL REACTIONS

Standards

- ▶ 7.PS1.4:

- ▶ Analyze and interpret chemical reactions to determine if the total number of atoms in the reactants and products support the Law of Conservation of Mass.

I can...

- ▶ Analyze a chemical reaction.

Essential Questions

- ▶ How can you recognize the type of chemical reaction by the number or type of reactants and products?
- ▶ What are the different types of chemical reactions?

Patterns in Reactions

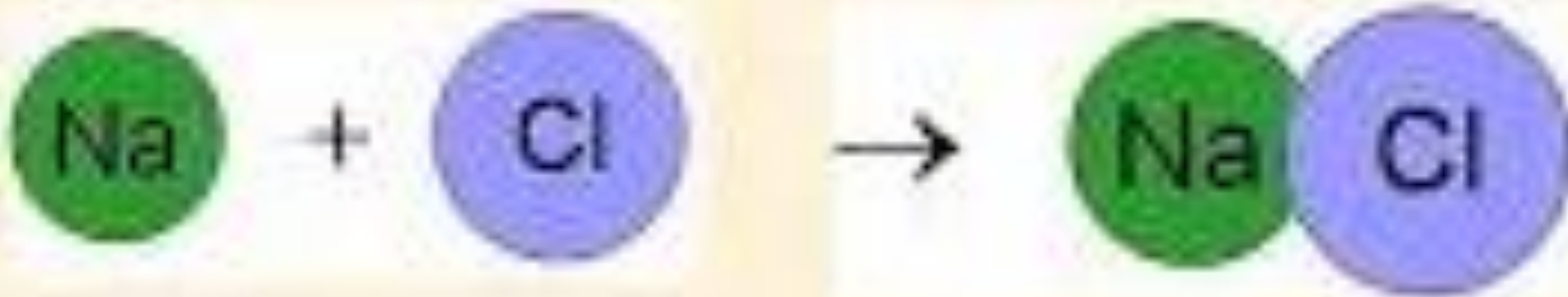
- ▶ There are four major types of chemical reactions (synthesis, decomposition, replacement, and combustion).
- ▶ Each type of chemical reaction follows a unique pattern in the way atoms in reactants rearrange to form products.

Types of Chemical Reactions

- ▶ Knowing the types of chemical reactions helps predict how substances will react and what products will form.
- ▶ In a(n) synthesis reaction, two or more substances combine.
 - ▶ The product in a synthesis reaction is a(n) compound.
 - ▶ A synthesis reaction has two or more reactant(s) and one product(s).

Synthesis Reaction

Example: $\text{NaCl} \rightarrow \text{Na} + \text{Cl}$



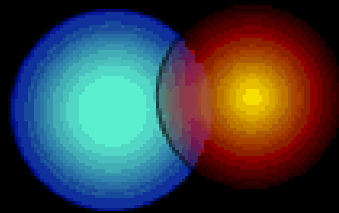
General: $A + B \rightarrow AB$

Types of Chemical Reactions

- ▶ In a(n) decomposition reaction, a substance breaks down and forms two or more substances.
 - ▶ The reactant in a decomposition reaction is a(n) compound.
 - ▶ The products in a decomposition reaction can be elements or compounds.
 - ▶ A decomposition reaction has one reactant(s) and two or more product(s).

Decomposition Reaction

Decomposition



Types of Chemical Reactions

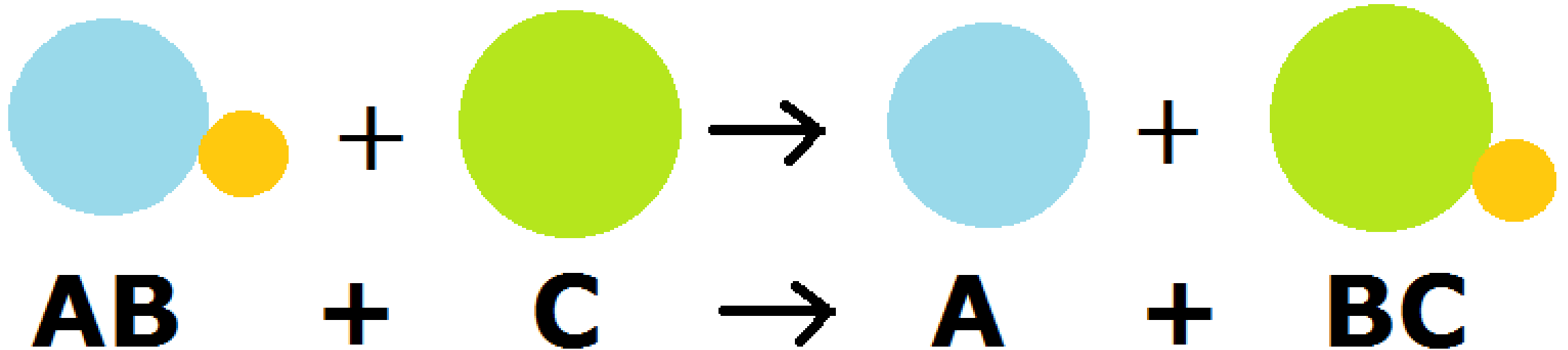


- ▶ In a(n) replacement reaction, an atom or group of atoms replaces part of a(n) compound.

Types of Chemical Reactions

- ▶ One type of replacement reaction is single replacement.
 - ▶ In a(n) single-replacement reaction, one element replaces another element in a compound.
 - ▶ The reactants in this type of reaction are a(n) element and a(n) compound.
 - ▶ The products in this type of reaction are a different element and a different compound.

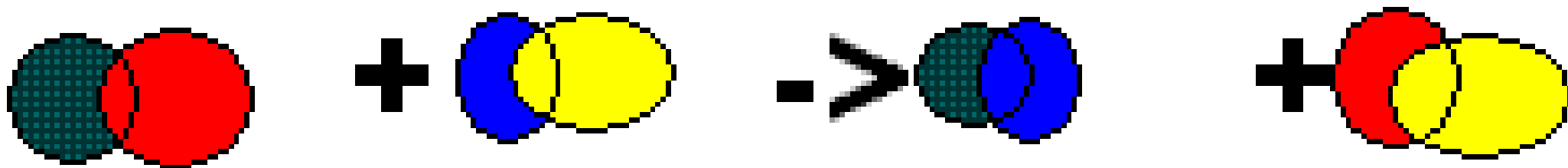
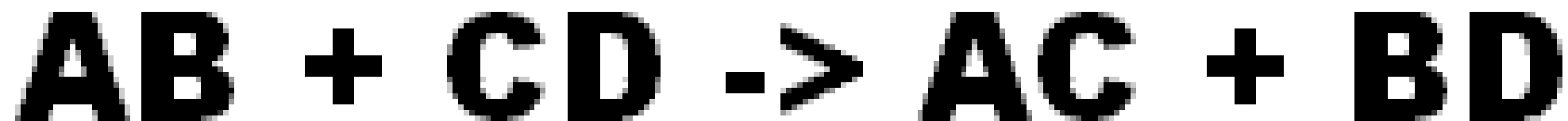
Single Replacement Reaction



Types of Chemical Reactions

- ▶ The other type of replacement reaction is double replacement.
 - ▶ In a(n) double-replacement reaction, the negative ions in two compounds switch places, forming two new compounds.
 - ▶ The reactants in this type of reaction are two compounds.
 - ▶ The products in this type of reaction are two new compounds.

Double Replacement Reaction

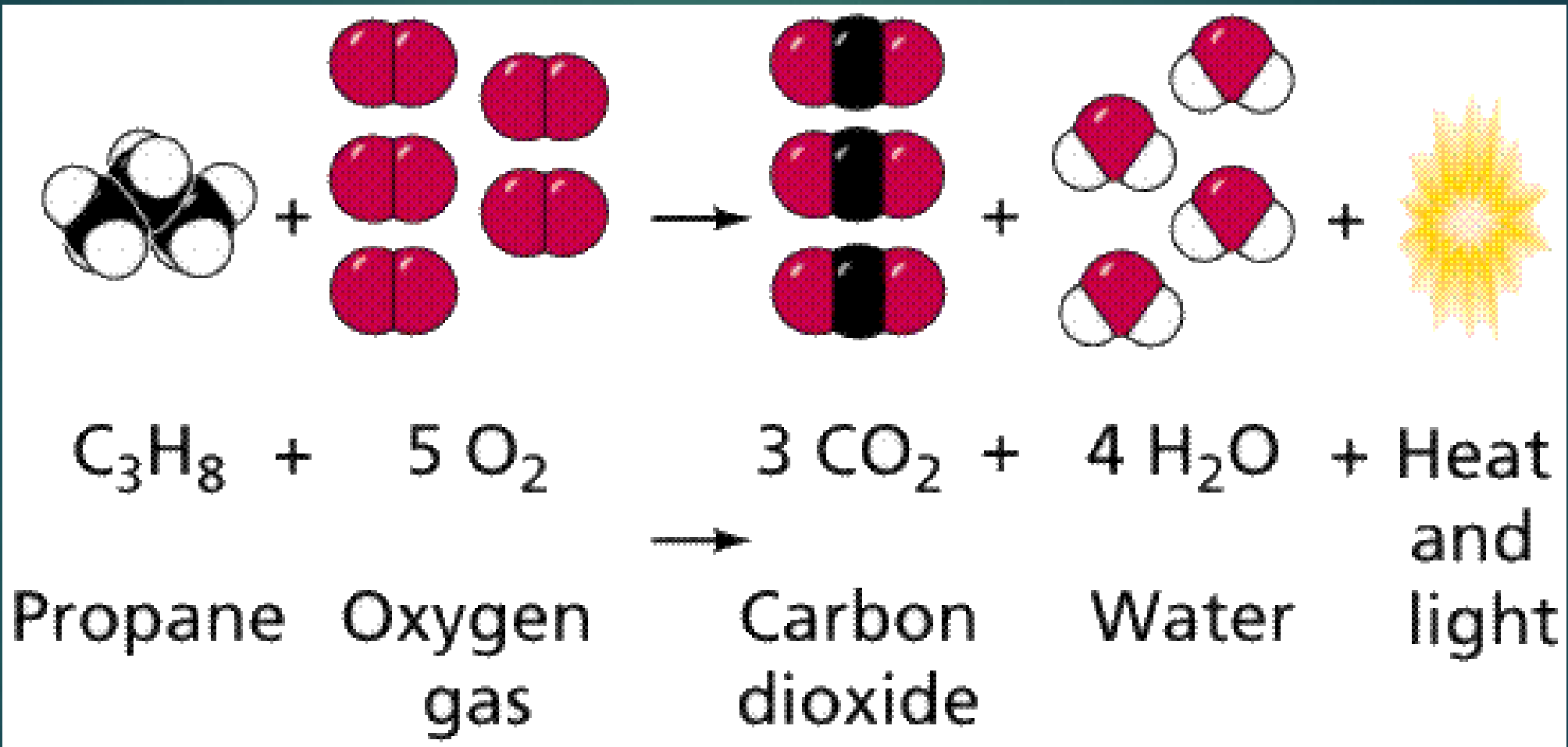


Types of Chemical Reactions



- ▶ In a(n) combustion reaction, a substance combines with oxygen and releases energy, usually in the form of thermal energy and light energy.

Combustion Reaction





BILL N

the Science



Lesson 3:

ENERGY CHANGES AND CHEMICAL
REACTIONS

Standards

- ▶ 7.PS1.4:

- ▶ Analyze and interpret chemical reactions to determine if the total number of atoms in the reactants and products support the Law of Conservation of Mass.

I can...

- ▶ Analyze a chemical reaction.

Essential Questions

- ▶ Why do chemical reactions always involve a change in energy?
- ▶ What is the difference between an endothermic reaction and an exothermic reaction?
- ▶ What factors can affect the rate of a chemical reaction?

Energy Changes

- ▶ Energy released in a chemical reaction comes from chemical energy that is contained in chemical bonds.
 - ▶ Breaking a chemical bond absorbs energy from the surroundings.
 - ▶ Forming a chemical bond releases energy to the surroundings.
 - ▶ The energy in chemical bonds and the energy absorbed or released is always conserved.

Energy Changes

- ▶ Some chemical reactions absorb more energy than they release.
 - ▶ Endothermic reactions are chemical reactions that absorb thermal energy.
 - ▶ In these reactions, more energy is required to break the bonds of the reactants than is released when products form.

Energy Changes

- ▶ Most chemical reactions release more energy than they absorb.
 - ▶ Exothermic reactions are chemical reactions that release thermal energy.
 - ▶ In these reactions, less energy is required to break the bonds of the reactants than is released when products form.

Energy Changes

- ▶ Some chemical reactions do not start by themselves.
 - ▶ All reactions require energy to start the breaking of bonds.
 - ▶ Activation energy is the minimum amount of energy that is needed to start a chemical reaction.

Energy Changes

- ▶ The activation energy of some reactions is so low that enough energy to start the reaction comes from the surroundings.
- ▶ The activation of some reactions is so high that more energy is needed to start the reaction.

Reaction Rates

- ▶ The rate of a reaction is the speed at which it occurs.
- ▶ Chemical reactions occur faster if the particles collide more often or if the particles move faster when they collide.

Reaction Rates

- ▶ Surface area can affect the rate of a reaction.
 - ▶ Surface area is the amount of exposed outer area of a solid.
 - ▶ Increased surface area increases the rate of reaction because more particles on the surface of a solid come in contact with the particles of another substance.

Reaction Rates

- ▶ Temperature can affect the rate of reaction because at higher temperature particles move faster.
- ▶ At higher temperatures, particles collide more often.
- ▶ They also collide with more energy.

Reaction Rates

- ▶ An increase in concentration also increases reaction rate because there are more particles to collide with each other.
- ▶ For gases, increased pressure pushes particles closer together, and more collisions occur.

Reaction Rates

- ▶ A(n) catalyst increases reaction rate by lowering the activation energy of a reaction.
 - ▶ A catalyst is not itself permanently changed during a chemical reaction.
 - ▶ Catalysts also do not change the reactants or the products of the reaction.
 - ▶ A(n) enzyme is a catalyst that speeds up chemical reactions in living cells.

Reaction Rates

- ▶ Substances called inhibitors slow down or stop a chemical reaction.