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Chapter 7 Chemical Reactions

Summary

7.1 Describing Reactions

- In a chemical reaction, the substances that undergo change are called **reactants.**
- The new substances formed as a result of that change are called **products.**
- A **chemical equation** is a representation of a chemical reaction in which the reactants and products are expressed as formulas.

The law of conservation of mass states that mass is neither created nor destroyed in a chemical reaction.

- During a chemical reaction, the mass of the products is always equal to the mass of the reactants.

In order to show that mass is conserved during a reaction, a chemical equation must be balanced.

- In a balanced chemical equation, the number of atoms on the left side of the equation equals the number of atoms on the right.
- You can balance a chemical equation by changing the coefficients.
- **Coefficients** are the numbers that appear before the formulas.

Because chemical reactions often involve large numbers of small particles, chemists use a counting unit called the mole to measure amounts of a substance.

- A **mole** (mol) is an amount of a substance that contains approximately 6.02×10^{23} particles of that substance. This number is known as Avogadro's number.
- The mass of one mole of a substance is called a **molar mass.** For an element, the molar mass is the same as its atomic mass expressed in grams.

In chemical reactions, the mass of a reactant or product can be calculated by using a balanced chemical equation and molar masses of the reactants and products.

7.2 Types of Reactions

Some general types of chemical reactions are synthesis reactions, decomposition reactions, single-replacement reactions, double-replacement reactions, and combustion reactions.

- A **synthesis reaction** is a reaction in which two or more substances react to form a single substance. The general equation for a synthesis reaction is $A + B \longrightarrow AB$.

- A **decomposition reaction** is a reaction in which a compound breaks down into two or more simpler substances. The general equation for a decomposition reaction is $AB \longrightarrow A + B$.
- A **single-replacement reaction** is a reaction in which one element takes the place of another element in a compound. The general equation for a single-replacement reaction is $A + BC \longrightarrow B + AC$.
- A **double-replacement reaction** is one in which two different compounds exchange positive ions and form two new compounds. The general equation for a double-replacement reaction is $AB + CD \longrightarrow AD + CB$.
- A **combustion reaction** is one in which a substance reacts rapidly with oxygen, often producing heat and light.

The discovery of subatomic particles enabled scientists to classify certain chemical reactions as transfers of electrons between atoms.

- A reaction in which electrons are transferred from one reactant to another is called an **oxidation-reduction reaction,** or redox reaction.
- Any process in which an element loses electrons during a chemical reaction is called oxidation.
- Any process in which an element gains electrons during a chemical reaction is called reduction.

7.3 Energy Changes in Reactions

Chemical reactions involve the breaking of chemical bonds in the reactants and the formation of chemical bonds in the products.

During a chemical reaction, energy is either released or absorbed.

- **Chemical energy** is the energy stored in the chemical bonds of a substance.
- A chemical reaction that releases energy to its surroundings is called an **exothermic reaction.**
- A chemical reaction that absorbs energy from its surroundings is called an **endothermic reaction.**
- In both exothermic reactions and endothermic reactions, the total amount of energy before and after the reaction is the same. This principle is known as the law of conservation of energy.

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7.4 Reaction Rates

Reaction rates tell you how fast a reaction is going.

- A **reaction rate** is the rate at which reactants change into products over time.
- Chemical reactions involve collisions between particles of reactants. If collisions occur more frequently, the reaction rate increases.

Factors that affect reaction rates include temperature, surface area, concentration, stirring, and catalysts.

- An increase in temperature will usually increase the reaction rate. A decrease in temperature will usually decrease the rate.
- An increase in surface area increases the exposure of reactants to one another. As a result, the reaction rate tends to increase with surface area.
- Stirring also increases the exposure of reactants to each other. As a result, the reaction rate tends to increase with stirring.
- *Concentration* refers to the number of particles in a given volume. More particles in the same volume means more frequent collisions. As a result, the reaction rate increases as concentration increases.
- A **catalyst** is a substance that affects the reaction rate without being used up in the reaction. Catalysts speed up reactions by lowering the energy barrier to the reaction.

7.5 Equilibrium

When a physical change does not go to completion, a physical equilibrium is established between the forward and reverse changes.

When a chemical reaction does not go to completion, a chemical equilibrium is established between the forward and reverse reactions.

- **Equilibrium** is a state in which the forward and reverse paths of a change take place at the same rate.
- A **reversible reaction** is a reaction in which the conversion of reactants into products and the conversion of products into reactants can happen simultaneously.

When a change is introduced to a system in equilibrium, the equilibrium shifts in the direction that relieves the change.