

Lesson 1: Types of Chemical Reactions

Introduction

How does a once shiny paint job on a pick-up truck turn to rust? How does industry turn iron ore rocks into useful steel beams?

The answer to both questions: chemical reactions.

Chemical reactions are happening all around us, all the time. Some occur naturally, others are managed by humans.

In this lesson you will be given an overview of the many types of chemical reactions.

Objectives

After completing this lesson, students will be familiar with the following terms and processes:

- Changes of State
- Combination (Synthesis) Reactions
- Decomposition Reactions
- Displacement Reactions
- Combustion Reactions
- Oxidation and Reduction Reactions

List of Sections

This lesson includes the following sections:

- An Overview of Chemical Reactions
- Kitchen Laboratory: Making Chemiluminescence
- Major Types of Reactions
- Changes of State
- Synthesis (Combination) Reactions
- Decomposition Reactions
- Displacement Reactions
- Combustion Reactions
- Oxidation and Reduction Reactions (Redox)

Lesson 2: Balancing Chemical Reaction Equations and Calculating Production Yields

Introduction

The world around us is full of a huge variety of chemical reactions.

A blowtorch is reacting acetylene (ethyne) gas with oxygen to produce incredible heat that can cut through steel! Methane burns in air on a kitchen stove for cooking.

How would you describe a chemical reaction then to someone else? How could you obtain quantitative information about what went on in the reaction? Chemists use chemical equations to answer these questions.

Objectives

After completing this lesson, students will be able to:

- Prepare balanced chemical equations to describe chemical reactions
- Calculate the product yield theoretically
- Calculate the product yield in reality

List of Sections

This lesson includes the following sections:

- Balancing Chemical Equations
- Balancing Equations: Practice
- Calculating Yields (products) from Chemical Reactions
- Stoichiometry
- Stoichiometry Examples
- Percentage Yield
- Excess Reactants and Limiting Reactants

Lesson 3: Equilibrium Constants and Calculations

Introduction

In the previous lesson we learned that some reactions do not go to completion because the products can decompose and return back to the reactants again.

Such reactions are called reversible reactions and are more common than most people think. In these reactions instead of putting an arrow in one direction to show which way the reaction proceeds like $\rightarrow$, instead we use a double arrow to show that the reaction can go in both directions $\rightleftharpoons$.

Objectives

After completing this lesson, students will be able to:

- Define Excess Reactants and Limiting Reactants
- Give examples of reversible reactions
- Predict in which direction a reversible reaction will occur
- Identify equilibrium constants K_c and K_p
- Use the rules for calculating equilibria constants

List of Sections

This lesson includes the following sections:

- Examples of Reversible Reactions
- What is Equilibrium?
- Reversible Reactions in Open Systems
- Reversible Reactions in Closed Systems
- Simulating Dynamic Equilibrium
- Reaction Rates
- Types of Equilibria
- Equilibrium Constants – Homogenous Equilibria
- Equilibrium Constants – Heterogenous Equilibria
- Understanding the Equilibrium Constant
- Calculations

Lesson 4: Le Chatelier's Principle

Introduction

In the previous lesson, you learned about equilibrium in reversible reactions. In this lesson we will investigate what happens if you create some sort of change to a reversible reaction in equilibrium. What would happen if you added a whole lot more of a reactant? What would happen if you raised the temperature or increased the pressure?

Objectives

After completing this lesson, students will be able to:

- Explain how equilibrium changes when conditions change
- Explain Le Chatelier's Principle
- Explain the effects of concentration, temperature, pressure and catalysts on equilibrium
- Explain forward and backward reaction rates
- Work with the balance beam model

List of Sections

This lesson includes the following sections:

- History
- Le Chatelier's Principle
- Stress 1: Changing Concentrations
- Stress 2: Changing Pressure
- Stress 3: Changing Temperature
- Summary of Effects of Stresses
- Equilibrium Constants and Le Chatelier's Principle
- Catalysts
- Applications in Industry

Lesson 5: Buffers

Introduction

Most people are familiar with aspirin. It is commonly used to relieve headaches and aching muscles and joints. It also reduces fever. Aspirin is often recommended by physicians as a blood thinner for people who are at risk for heart attacks or strokes caused by blood clots.

Aspirin is derived from a substance that occurs naturally in willow trees, which was used as a painkiller even in ancient times. In 1829 scientists determined that the compound salicin from salicylic acid in willow was responsible for the pain-killing qualities. However, this ingredient caused stomach upsets and even caused internal bleeding in the stomach. Chemists began trying to find ways to prevent this from happening.

The same company Bayer, who in 1900 began marketing its trademarked aspirin, later on to deal with sensitive stomachs, began to add magnesium hydroxide $\text{Mg}(\text{OH})_2$ and/or magnesium carbonate MgCO_3 to the product. The addition of these solved the problems of stomach upsets and bleeding.

Why did adding these ingredients help?

Objectives

After completing this lesson, students will be able to:

- Explain why buffers are added to medicines
- Explain how buffer solutions resist pH changes
- Differentiate between alkali and acid buffers
- Calculate buffer pH values

List of Sections

This lesson includes the following sections:

- The Need for pH Maintenance
- Definitions
- How Do Buffer Solutions Work?
- Alkaline Buffer Solutions
- Acid-Base Buffer Lab
- Calculations with Buffers
- Calculations with Acid Buffers
- Calculations with Alkali Buffers
- The Henderson-Hasselbalch Equation
- Common Buffer