

**Chapter 15**  
**Acids and Bases**  
*Advanced Chemistry*

**15.1 Acids and Bases**

Learning Objective	
Compare the definitions of acids and bases, including Arrhenius, Bronsted-Lowry, and Lewis acids and bases.	<ul style="list-style-type: none"><li>• Arrhenius definition of acids and bases:<ul style="list-style-type: none"><li>○ Acids contain an excess <math>H^+</math> ion in aqueous solution.</li><li>○ Bases contain excess <math>OH^-</math> ions in aqueous solution.</li></ul></li><li>• Bronsted-Lowry definition of acids and bases:<ul style="list-style-type: none"><li>○ Acids are proton donators.</li><li>○ Bases are proton acceptors.</li></ul></li><li>• Lewis definition of acids and bases:<ul style="list-style-type: none"><li>○ Acids are electron pairs acceptors.</li><li>○ Bases are electron pair donors.</li></ul></li></ul>
Key Term	
Hydronium ion	The result of a proton combining with a polar water molecule to form a hydrated hydroxide ion, $H_3O^+$ .

**15.2 Reactions of Acids and Bases**

Learning Objective	
Describe the general reactions of acids and bases.	<ul style="list-style-type: none"><li>• Acids react:<ul style="list-style-type: none"><li>○ With metals above hydrogen in the activity series to form hydrogen gas and a salt.</li><li>○ With bases to form water and a salt (neutralization reaction).</li><li>○ With metal oxides to form water and salt.</li><li>○ With carbonates to form water, a salt, and carbon dioxide.</li></ul></li><li>• Bases react with acids to form water and a salt (neutralization reaction).</li><li>• Some amphoteric metals react with NaOH or KOH to form hydrogen and a salt.</li></ul>
Key Term	
Amphoteric	A solid without shape or form.

**15.3 Salts**

Learning Objective	
Explain how a salt is formed and predict the formula of a salt given an acid and a base precursor.	<ul style="list-style-type: none"><li>• Salts can be considered to be derived from the reaction of an acid and a base.</li></ul>

## 15.4 Electrolytes and nonelectrolytes

Learning Objective	
Describe properties, ionization, dissociation, and strength of electrolytes and compare them to nonelectrolytes.	<ul style="list-style-type: none"> <li>• Properties:               <ul style="list-style-type: none"> <li>○ A substance whose aqueous solution conducts electricity is called an electrolyte. The aqueous solutions contain ions.</li> <li>○ A substance whose aqueous solution does not conduct electricity is called a nonelectrolyte. The aqueous solution contains molecules, not ions.</li> </ul> </li> <li>• Ionization:               <ul style="list-style-type: none"> <li>○ The formation of ions that occurs as a result of a chemical reaction with water.</li> </ul> </li> <li>• Dissociation:               <ul style="list-style-type: none"> <li>○ The process by which the ions of a salt separate as the salt dissolves.</li> </ul> </li> <li>• Strength:               <ul style="list-style-type: none"> <li>○ Strong electrolytes are 100% ionized in solution (e.g., strong acids and strong bases).</li> <li>○ Weak electrolytes are much less ionized in solution (e.g., weak acids and weak bases).</li> </ul> </li> </ul>
Key Terms	
Electrolyte	A substance whose aqueous solution conducts electricity.
Nonelectrolyte	A substance whose aqueous solutions do not conduct electricity.
Dissociation	The process by which a salt separates into individual ions when dissolved in water.
Ionization	The formation of ions, which occurs as the results of a chemical reaction of certain substances with water.
Strong electrolyte	An electrolyte that is essentially 100% ionized in aqueous solution.
Weak electrolyte	A substance that is ionized to a small extent in aqueous solution.

## 15.5 Introduction to pH

Learning Objective	
Calculate the pH of a solution from the hydrogen ion concentration	<ul style="list-style-type: none"> <li>• Concentrations of ions in water at 25°C:               <ul style="list-style-type: none"> <li>○ <math>[H^+] = 1.0 \times 10^{-7}</math></li> <li>○ <math>[OH^-] = 1.0 \times 10^{-7}</math></li> </ul> </li> <li>• <math>pH = -\log[H^+]</math></li> <li>• <math>pH &lt; 7</math> for acidic solution</li> <li>• <math>pH = 7</math> in neutral solution</li> <li>• <math>pH &gt; 7</math> for basic solution</li> </ul>
Key Terms	
pH	A method of expressing the $H^+$ concentration (acidity) of a solution; $pH = -\log[H^+]$ , $pH = 7$ is a neutral solution, $pH > 7$ is acidic, and $pH < 7$ is basic.
Logarithm (log)	The power to which 10 must be raised to give a certain number. The log of 100 is 2.0

## 15.6 Neutralization

Learning Objective	
Describe a neutralization reaction and do calculations involving titrations.	<ul style="list-style-type: none"><li>The reaction of an acid and a base to form water and a salt is called neutralization. The general equation for a neutralization reaction is: <math>H^+(aq) + OH^-(aq) \rightarrow H_2O(l)</math></li><li>The qualitative study of a neutralization reaction is called a titration.</li></ul>
Key Terms	
Neutralization	The reaction of an acid and a base to form a salt plus water.
Spectator ion	An ion in solution that does not undergo chemical change during a chemical reaction.
Titration	The process of measuring the volume of one reagent required to react with a measured mass or volume of another reagent.

## 15.7 Writing Net Ionic Equations

Learning Objective	
Write net ionic equations using the stated rules.	<ul style="list-style-type: none"><li>Rules for Writing Net Ionic Equations<ol style="list-style-type: none"><li>Strong electrolytes in solution are written in their ionic form.</li><li>Weak electrolytes are written in their molecular form.</li><li>Nonelectrolytes are written in their molecular form.</li><li>Insoluble substances, precipitates, and gases are written in their molecular forms.</li><li>The net ionic equation should include only substances that have undergone a chemical change. Spectator ions are omitted from the net ionic equation.</li><li>Equations must be balanced, both in atoms and in electric charge.</li></ol></li></ul>
Key Terms	
Formula equation	A chemical equation in which all the reactants and products are written in their molecular, or normal, formula expression; as called a molecular equation.
Total ionic equation	An equation that shows compounds in the form in which they actually exist. Strong electrolytes are written as ions in solution, where nonelectrolytes, weak electrolytes, precipitates, and gases are written in the unionized form.
Net ionic equation	A chemical equation that includes only those molecules and ions that have changed in the chemical reaction.

## 15.8 Acid Rain

Learning Objective	
Describe how acid rain forms and its effects on society.	<ul style="list-style-type: none"><li>Acid rain in any atmospheric precipitation that is more acid than usual.</li><li>Acid rain causes significant damage and destruction to our environment.</li></ul>