Chapter 4: Aqueous Reactions and Solution Stoichiometry

- **aqueous solutions** – solutions in which water is the dissolving medium

4.1 Solution Composition

- **solution** – homogeneous mixture of two or more substances
- **solvent** – component that is present in greatest quantity
- **solutes** – substances dissolved in the solvent

4.1.1 Molarity

- **concentration** – the amount of solute dissolved in a given quantity of solvent or solution
- **molarity** – number of moles of solute in a liter of solution

$$Molarity = \frac{\text{moles solute}}{\text{volume of solution in liters}}$$

4.1.2 Dilution

- **dilution** - obtaining a lower concentration of a solution by adding water
- moles solute before dilution = moles solute after dilution

$$M_{initial}V_{initial} = M_{final}V_{final}$$

4.2 Properties of Solutes in Aqueous Solutions

- **electrolyte** – substance whose aqueous solution contains ions
- nonelectrolyte – substance that does not form ions in solution

4.2.1 Ionic Compounds in Water

- **dissociate** – when ions separate from a solid being dissolved

4.2.2 Molecular Comounds in Water

- the molecular structure is maintained

4.2.3 Strong and Weak Electrolytes

- strong electrolytes – ionic compounds that exists entirely of ions in solution
- weak electryolytes – molecular compounds that produce a small amound of ions
- chemical equilibrium – equilibrium of forming ions and recrystalizing ions

4.3 Acids, Bases, and Salts

4.3.1 Acids

- substances that ionize to form hydrogen ions
- proton donors

4.3.2 Bases

- substances that ionize to form hydroxide ions

4.3.3 Strong and Weak Acids and Bases

- **strong acid, strong base** – strong electrolyte
- **weak acid, weak base** – weak electrolyte

4.3.4 Neutralization Reactions and Salts

- **neutralization reaction** – when an acid and base are mixed
- produces water and a salt

4.4 Ionic Equations

- **molecular formula** – and equation written to show the complete chemical formulas of reactants and products
- **spectator ions** – ions that do not play a role in a reaction
- **net ionic equation** – equation where the spectator ions are removed
- only soluble strong electrolytes are written in ionic form

4.5 Metathesis Reactions

- $AX + BY \rightarrow AY + BX$
  - for methathesis to occur:
  - 1) the formation of an insoluble product
  - 2) the formation of either a weak electrolyte or a nonelectrolyte
  - 3) the formation of a gas that escapes from solution

4.5.1 Precipitation Reactions

- **precipitate** – insoluble solid formed by a reaction in solution
- **solubility** – amount of substance that can be dissolved in a given quantity

4.5.2 Solubility Guidelines for Ionic Compounds

- all common ionic compounds of the alkali metal ions and of the ammonium ion are soluble in water

4.5.3 Reactions in Which a Weak Electrolyte or Nonelectrolyte Forms

- hydrogen and hydroxide react to form water
- insoluble metal oxides react with acids

4.6 Introduction to Oxidation-Reduction Reactions

4.6.1 Reactions in Which a Gas Forms

- carbonates and bicarbonates

4.6.2 Oxidation and Reduction

- **oxidation** – loss of electrons
- **reduction** – gain of electrons

4.6.3 Oxidation of Metals by Acids and Salts

- whenever one substance is oxidized, some other substance must be reduced
- metals react with acids to form salts and hydrogen gas

4.6.4 The Activity Series

- **activity series** – list of metals arranged in order of decreasing ease of oxidation
- **active metals** – alkali metals and alkaline earth metals
- any metla on the list can be oxidized by ions of elements below it

4.7 Solution Stoichiometry and Chemical Analysis

4.7.1 Titrations

- **statndard solution** – solution of known concentration
- **titration** – a known solution that undergoes a specific chemical reaction of known stoichiometry with the solution of unknown concentration
- **equivalence point** – stoichiometrically equivalent quantities of reactants are brought together
- **indicator** – used to show the endpoint of the titration