Chapter 17: Equilibrium

I. Equilibrium
- a. How Chemical Reactions Occur
  - i. Collision Model
    1. Idea that reactions occur during molecular collisions
    2. Explains many characteristics of chemical reactions
- b. Conditions That Affect Reaction Rates
  - i. Activation Energy (E_a)
    1. Minimum energy needed for a reaction to occur
  - ii. Reactions occur faster as the temperature is increased
    1. Higher temperatures → higher speeds → more high-energy collisions → more collisions that break bonds → Faster reaction
  - iii. Catalyst
    1. A substance that speeds up reactions without being consumed
- c. Heterogeneous Reactions
  - i. Homogeneous Reactions
    1. Reactions involving only one phase
  - ii. Heterogeneous Reactions
    1. Reactions involving two phases
  - iii. Factors That Affect Reaction Rates
    1. Nature of Reactants
       - a. Substances vary greatly in their tendency to react depending on their bond strengths and structures
    2. Concentration (Pressure)
       - a. The rate of a homogenous reaction depends on the number of collisions that occur between reactants. Reaction rates typically increase as concentration (solution reactions) or pressure (gaseous reactions) increase
    3. Temperature
       - a. Because increased temperature accelerates reactant speeds and thus increases the number of high-energy collisions, reaction rates increase in temperature
    4. Surface Area
       - a. For heterogeneous reactions, reaction rates increase with increased surface area.
- d. The Equilibrium Condition
  - i. Equilibrium

1. The exact balancing of two processes, one of which is the opposite of the other

ii. Chemical equilibrium
1. A dynamic state where the concentrations of all reactants and products remain constant

e. The Equilibrium Constant: An Introduction
i. Law of Chemical Equilibrium
1. A general description of the equilibrium condition; it defines the equilibrium expression

ii. Equilibrium Expression
1. The expression (from the law of mass action) equal to the product of the product concentrations divided by the product of the reactant concentrations, each concentration having first been raised to a coefficient in the balanced equation

iii. Equilibrium Constant
1. The value obtained when equilibrium concentrations of the chemical species are substituted into the equilibrium expression

iv. Equilibrium Position
1. A particular set of equilibrium concentrations

f. Heterogeneous Equilibria
i. Homogeneous Equilibria
1. An equilibrium system in which all reactants and products are in the same state

ii. Heterogeneous Equilibria
1. An equilibrium involving reactants and/or products in more than one state

iii. $K= [CO_2][CaO]/[CaCO_3]$

iv. $H_2 + O_2 \Leftrightarrow 2H_2O$
1. $K= [H_2]^2[O_2]/[H_2O]^2$

g. Le Châtelier's Principle
i. Le Châtelier's Principle
1. When a change is imposed on a system at equilibrium, the position of the equilibrium shifts in a direction that tends to reduce the effect of that change.

h. Solubility Equilibria
i. Solubility Product Constant
1. Expressed as K_{sp}
2. The constant for the equilibrium expression representing the dissolving of an ionic solid in water
3. Also called the Solubility Product
4. Ex: $PbCl_2 \Leftrightarrow Pb^{2+} + Cl^{2-}$
a. $K_{sp}=[Pb^{2+}][Cl^-]^2$