Chapter 15
Chemical Equilibrium
Learning Objectives

To satisfy the minimum requirements for this course, you should be able to:

1. Describe the properties of chemical equilibrium and be able to
   - write the equilibrium constant expression ($K_c$ or $K_p$ for gaseous reactions) for a balanced chemical equation.
   - given a chemical reaction and its equilibrium constant, determine the new equilibrium constant when the reaction has been reversed, multiplied by a constant, or added to another reaction.
   - interpret the magnitude of $K$ and what this tells you about the composition of the equilibrium mixture, and whether the reaction is reactant-favored or product-favored.

2. Generate an ICE table and:
   - use $K_c$ and $K_p$ to calculate equilibrium concentrations or pressures (i.e., apply ICE tables).
   - calculate $K_c$ and $K_p$ from appropriate initial and equilibrium concentrations or pressures.

3. Understand the relationship between kinetics and equilibrium. (See also textbook sec. 3-3.)

4. Understand the concept of reaction quotient, $Q$, and by comparison of $Q$ with the value of $K$
   - determine whether a reaction is at equilibrium.
   - predict in which direction a reaction will shift to reach equilibrium.

5. Explain, using LeChâtelier’s Principle, how the equilibrium quantities of reactants and products are shifted by
   - changes in temperature.
   - changes in pressure or volume for a gas.
   - changes in concentrations of substances.

6. Explain the effects that temperature or the presence of a catalyst has on the position of a chemical equilibrium.

7. Describe how the Haber-Bosch involves both upon kinetics and equilibrium.

8. NavApp: Submarine Atmosphere
   - give an overview of the submarine atmosphere:
     - (i) closed system; (ii) oxygen must be generated; (iii) gaseous substances such as CO₂, CO, and hydrocarbons are produced during the normal operation of a submarine; (iv) unwanted gases must be removed.
     - describe how carbon dioxide is removed from the submarine atmosphere using the CO₂ scrubber.
     - discuss the impact of changes in the partial pressures of biologically essential and/or sensitive gases such as oxygen, carbon monoxide and carbon dioxide on the suitability of the submarine atmosphere.