Chapter 14
Chemical Equilibrium: Equal but Opposite Reaction Rates
Learning Objectives

1-6-2023

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

1. Explain why chemical equilibrium is a dynamic process and how it depends on reaction rates.

2. Describe the properties of chemical equilibrium and be able to
   - write the equilibrium constant (*K*) expression (K_c or K_p for gaseous reactions) for a balanced chemical equation.
   - given equilibrium concentrations (or pressures), calculate the value of K_c (or K_p).
   - 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.

3. Understand the concept of the reaction quotient, *Q*, and by comparison of *Q* with the value of *K*
   - determine whether a reaction is at equilibrium.
   - predict the direction a reaction must shift in order to reach equilibrium.

4. Explain, using LeChâtelier's Principle, how the equilibrium quantities of reactants and products are affected by
   - changes in temperature.
   - changes in pressure or volume for a gas.
   - changes in concentrations or pressures of substances.
   - addition of a catalyst.

5. Perform calculations based on *K* by generating and solving a RICE table, including:
   - using K_c and K_p to calculate equilibrium concentrations or pressures
   - calculating K_c and K_p from appropriate initial and equilibrium concentrations or pressures.

6. Understand the relationship between $\Delta G°_{rxn}$ and K and be able to
   - calculate $\Delta G°_{rxn}$ from K and perform the reverse operation.
   - identify a reaction as product-favored or reactant-favored from the sign or magnitude of $\Delta G°_{rxn}$ or K, respectively
   - explain how ΔG_{rxn} differs from $\Delta G°_{rxn}$ and discuss how ΔG_{rxn} changes during the course of a reaction.
   - calculate the free-energy change, ΔG_{rxn}, for a given set of reaction concentrations.

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

8. NavApp: Submarine Atmosphere
   - give an overview of the submarine atmosphere:
     (i) the submarine is a closed system; (ii) oxygen must be generated for crew respiration; (iii) gaseous substances including CO_2, CO, and hydrocarbons are released into the submarine atmosphere during normal operation; (iv) unwanted gases must be removed.
   - describe the chemical process by which carbon dioxide is removed from the submarine atmosphere using the CO_2 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.