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

1.6.2021

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. Given a balanced equation, be able to write an equilibrium constant (*K*) expression.
   - realize that the mass action expression at equilibrium ***is*** the equilibrium constant expression (K_c or K_p for gaseous reactions).
   - realize the mass action expression that is not necessarily at equilibrium ***is*** the reaction quotient (*Q*).

3. 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 reveals about the composition of the equilibrium mixture, and whether the reaction is reactant-favored or product-favored.

4. 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.

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. 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.

7. Understand the relationship between ΔG°_{rxn} and K and be able to
   - calculate ΔG°_{rxn} from K and perform the reverse operation.
   - identify a reaction as product-favored or reactant-favored from the sign or magnitude of ΔG°_{rxn} or K, respectively
   - explain how ΔG_{rxn} differs from ΔG°_{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.

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

9. NavApp: Submarine Atmosphere
   - give an overview of the submarine atmosphere:
   - (i) closed system; (ii) oxygen must be generated; (iii) gaseous substances such as CO_2, 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 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.