

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

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 $\Delta G^\circ_{\text{rxn}}$ and K and be able to
 - calculate $\Delta G^\circ_{\text{rxn}}$ from K and perform the reverse operation.
 - identify a reaction as product-favored or reactant-favored from the sign or magnitude of $\Delta G^\circ_{\text{rxn}}$ or K , respectively
 - explain how ΔG_{rxn} differs from $\Delta G^\circ_{\text{rxn}}$ 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) 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.