CHAPTER 12
CHEMICAL KINETICS

We will spend four lecture days on this chapter.

- ❖ Day 1. Sections 1 – 4: During the first class meeting we will focus on what is kinetics and how do we understand reaction rates, rate laws, rate constants, and similar vocabulary. Keeping the vocabulary straight is critical. We will start to analyze the results using initial concentration and initial rate data.
- ❖ Day 2. Sections 4, 5, 7: We will continue to analyze experimental data. In addition to initial concentration/rates, we will start using time/concentration studies. For both, we will use the following vocabulary: reaction order, first, second and zeroth order reactions, and half-life.
- ❖ Day 3. Sections 8 – 10: After we are comfortable with reaction rate laws and how they are determined, we will then tie these mathematical expressions to step-by-step chemical processes called the reaction mechanism.
- ❖ Day 4. Sections 11 – 15: Finally, we will explore how catalysts work and how temperature affects reaction rates.

Section 12.1
❑ Use a table of concentration versus time data to calculate an average rate of reaction over a period of time.
❑ From the coefficients of a balanced chemical equation, express the relative rates of consumption of reactants and formation of products.
❑ Do Problems 1, 2, 34, 36, 38, and 40.

Section 12.2
❑ Find the reaction order with respect to each reactant and the overall reaction order from a rate law.
❑ Do Problem 3.

Section 12.3
❑ From a table of initial concentrations of reactants and initial rates, determine the order of reaction with respect to each reactant, the overall order of reaction, the rate law, the rate constant, and the initial rate for any other set of initial concentrations.
❑ Do Problems 4 – 6, 24, 42, 44, 46, and 48.

Section 12.4
❑ Use the integrated first-order rate law to find the value of one variable, given values of the other variables.
❑ Use concentration-versus-time, In concentration-versus-time, and 1/concentration-versus-time plots to verify a first-order reaction.
❑ Do Problems 7 and 8.

Section 12.5
❑ From a plot of concentration versus time, estimate the half–life of a first–order reaction.
❑ Use the expression for half-life of a first-order reaction to determine $t_{½}$ from *k*, or vice versa.
❑ Do Problems 9 and 10.

We will cover Section 12.6 when we discuss nuclear chemistry in Chapter 22 in April.

Section 12.7
❑ Use the integrated second-order rate law to find the value of one variable, given values of the other variables.
❑ Use concentration-versus-time, In concentration-versus-time, and 1/concentration-versus-time plots to verify a second-order reaction.
❑ Use the expression for half-life of a second-order reaction to determine $t_{½}$ from *k*, or vice versa.
❑ Do Problem 15.

Section 12.8
❑ Use the integrated zeroth-order rate law to find the value of one variable, given values of the other variables.
❑ Use concentration-versus-time, In concentration-versus-time, and 1/concentration-versus-time plots to verify a zeroth-order reaction.
❑ Do Problem 26, 28, 30, 50, 52, 54, 56, 58, 60, and 62.

Section 12.9
❑ Given a reaction mechanism, write the chemical equation for the overall reaction, identify the reaction intermediates, determine the molecularity of each elementary reaction and the molecularity of the overall reaction.

❏ Do Problem 16.

Section 12.10 ❏ Write rate laws for elementary reactions.
❏ Do Problem 17.

Section 12.11 ❏ Given a an experimental rate law and a reaction mechanism with an initial slow step, determine if the mechanism is consistent with the experimental rate law.
❏ Given an experimental rate law and a reaction mechanism with an initial fast step, write a balanced equation for the overall reaction, determine if the mechanism is consistent with the experimental rate law, and relate the rate constant *k* to the rate constants for the elementary reactions.
❏ Do Problems 18 and 19, 74, 76, 78, 80, 82, and 84.

Section 12.12 ❏ Sketch a potential energy profile, showing the activation energies for the forward and reverse reactions, determine whether the reaction is exothermic or endothermic, and suggest a plausible structure for the transition state.
❏ Do Problem 20 and 32.

Section 12.13 ❏ Prepare an Arrhenius plot, and determine the activation energy from the slope of the line. Solve the Arrhenius equation for any variable, given the others.
❏ Do Problem 21, 86, 88, 90, 92, and 94.

Section 12.14 ❏ Sketch a potential energy profile, showing the activation energies for the forward and reverse reactions and how they are affected by the addition of a catalyst.
Given the mechanism for a reaction, identify the catalyst.
❏ Do Problem 22.

Section 12.15 ❏ Classify catalysts as homogeneous or heterogeneous. Do Problems 96, 98, and 100.