CHEM 361A - Lecture 15 Activity

Rate Laws

In Class

1. The rate of formation of D in the reaction

$$3\,\mathrm{A} + 2\,\mathrm{B} \longrightarrow \mathrm{C} + 5\,\mathrm{D}$$

   is 1.5 mol L^{-1} s^{-1}. State the rates of formation and consumption of A, B, and C.

2. The decomposition of a molecule, A, to product P was found to follow the third order reaction

$$\mathrm{A} \longrightarrow \mathrm{P}$$

   (a) What is the rate law expression for A?

   (b) Determine the integrated rate law expression for this reaction.

   (c) Determine an expression which can calculate the half-life for this reaction from a given $[A]_0$.

   (d) How long is the half-life of A when $[A]_0 = 2.2$ mol L^{-1} and $k_f = 5.2$ L^2 mol^{-2} s^{-1}

3. Consider the following parallel reaction:

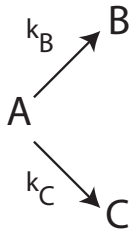

Figure 1: Schematic for a parallel reaction.

   (a) The reaction starts with [A]=$[A]_0$, [B]=0, and [C]=0. If the two parallel reactions only go in the forward direction and the order of every reagent is 1, write a rate law expression for $\frac{d[A]}{dt}$, $\frac{d[B]}{dt}$, and $\frac{d[C]}{dt}$

   (b) Find the integrated rate law expression for $[A](t)$.

   (c) Find the integrated rate law expressions for $[B](t)$ and $[C](t)$.

   (d) What is the ratio of $[B](t)/[C](t)$?

(e) The yield of a parallel decay process, Φ, is given by

$$\Phi_i = \frac{k_i}{\sum_n k_n}$$

This expression says that the probability of a certain decay product to be formed relative to all other products is dependent on its rate constant relative to all others. For the parallel reaction illustrated in Figure 1, if $k_C = 2k_B$, what is the yield of B (Φ_B)?

Homework

4. The decomposition of a molecule, A, to product P was found to follow the 7th order reaction

$$\text{A} \longrightarrow \text{P}$$

   (a) What is the rate law expression for A? ($\frac{d[A]}{dt} = -k[A]^7$)

   (b) Determine the integrated rate law expression for this reaction. ($\frac{1}{[A]^6} = 6kt + \frac{1}{[A]_0^6}$)

   (c) Determine an expression which can calculate the half-life for this reaction from a given $[A]_0$. ($t_{1/2} = \frac{21}{2k[A]_0^6}$)

   (d) How long is the half-life of A when $[A]_0 = 1.5$ mol L^{-1} and $k_f = 7.3$ L^6 mol^{-6} s^{-1} (0.126 s)

5. In acidic conditions, benzyl penecillin (BP) undergoes the the parallel reaction illustrated in Figure 2. Imagine swallowing BP with the pH of your stomach equal to 3. At this pH, the rate constants for the three processes at 22°C are $k_1 = 7.0 \times 10^{-4}$ s^{-1}, $k_2 = 4.1 \times 10^{-3}$ s^{-1}, and $k_3 = 5.7 \times 10^{-3}$ s^{-1}. What is the yield of P1? (0.067)

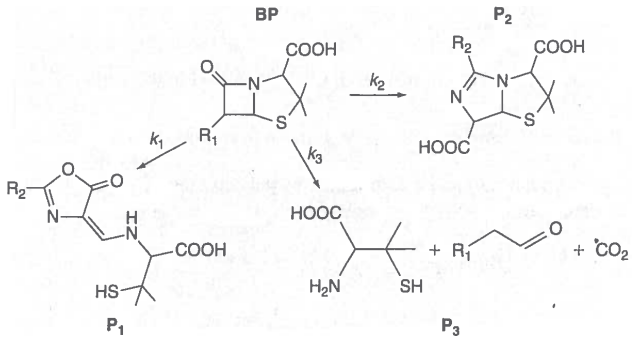

Figure 2: The decay reaction for benzyl penecillin.