1. Butadiene (C\textsubscript{4}H\textsubscript{6}) reacts with itself to form a dimer with the formula C\textsubscript{8}H\textsubscript{12}. The reaction is second order in C\textsubscript{4}H\textsubscript{6}. If the rate constant at a particular temperature is $4.0 \times 10^{-2}$ M\textsuperscript{-1} s\textsuperscript{-1} and the initial concentration of C\textsubscript{4}H\textsubscript{6} is 0.0200 M.

(a) What is its molarity after a reaction time of 1.00 hour?

(b) What is the time (in hours) when the C\textsubscript{4}H\textsubscript{6} concentration reaches a value of 0.0020 M?

(c) What is the half-life (in minutes) of the reaction when the initial C\textsubscript{4}H\textsubscript{6} concentration is 0.0200 M? How many minutes does it take for the concentration of C\textsubscript{4}H\textsubscript{6} to drop from 0.0100 M to 0.0050 M?

2. At 25°C, the half-life of a certain first-order reaction is 248 s. What is the value of the rate constant at this temperature?

3. A reaction of the type A $\rightarrow$ B + C has a rate constant $k = 3.6 \times 10^{-5}$ M/s.

(a) What is the order of the reaction?

(b) What is the molarity of A after a reaction time of 30.0 min if the initial concentration of A is 0.096 M?

(c) What is the half-life (in minutes) of the reaction in part (b)?

4. The half-life for the first-order decomposition of N\textsubscript{2}O\textsubscript{4} is $1.3 \times 10^{-5}$ s.

   \[ \text{N}_2\text{O}_4(g) \rightarrow 2 \text{NO}_2(g) \]

If N\textsubscript{2}O\textsubscript{4} is introduced into an evacuated flask at a pressure of 17.0 mm Hg, how many seconds are required for the pressure of NO\textsubscript{2} to reach 1.3 mm Hg?

5. The rate constant for the decomposition of gaseous NO\textsubscript{2} to NO and O\textsubscript{2} is $4.7/(\text{M} \cdot \text{s})$ at 383°C. Consider the decomposition of a sample of pure NO\textsubscript{2} having an initial pressure of 746 mm Hg in a 5.00 L reaction vessel at 383°C.

(a) What is the order of the reaction?

(b) What is the initial rate of formation of O\textsubscript{2} in g/(L \cdot s)?

(c) What is the mass of O\textsubscript{2} in the vessel after a reaction time of 1.00 min?