1. True or false? If a statement is false, explain why.
   a. Diffusion arises from pressure differences.
   b. Diffusion does not occur in solids.
   c. At 1 atm, diffusion coefficients are much greater in gases than in liquids.
   d. The root mean square displacement (in 2a below, you are asked to derive this) of diffusing molecules is proportional to the diffusion time. (You probably need to do #2a before you can answer this.)

2. a. Derive the expression for the root mean square displacement of a particle in a liquid.
   b. For Sb diffusing into Ag at 293 K, how many years will it take for the root mean square displacement to reach 1 cm? For Sb in Ag, \( D = 10^{-21} \text{ cm s}^{-1} \).
   c. Repeat the calculation from (b) for Al diffusing in Cu. For Al in Cu, \( D = 10^{-30} \text{ cm s}^{-1} \).

3. If the reaction \( \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \) has \( \frac{d\text{N}_2}{dt} = -0.006 \text{ M s}^{-1} \) at a certain instant, what is \( \frac{d\text{N}_2}{dt} \) at that instant?

4. The reaction \( 2\text{A} \rightarrow 2\text{B} + \text{C} \) is first order in A. Experimentally it was found that the reaction was 35% complete after 325 s.
   a. Find the rate constant, \( k \).
   b. How long will it take for the reaction to be 70% complete?
   c. How long will it take for the reaction to be 90% complete?

5. Consider the reaction \( a\text{A} \rightarrow \text{P} \). If the reaction is third order, derive the integrated rate expression.

6. The reaction \( a\text{A} + b\text{B} \rightarrow \text{P} \) is second order in A and first order in B (so that it is third order overall). Derive the integrated rate expression. You may need to consult a table of integrals.

7. The decomposition of dinitrogen pentoxide, \( 2\text{N}_2\text{O}_5 \rightarrow 4\text{NO}_2 + \text{O}_2 \) obeys the following rate law:
   \[ r = k_{\text{obs}} c_{\text{N}_2\text{O}_5} \]
   and the reaction rate is given by
   \[ r = \frac{1}{2} \frac{dc_{\text{N}_2\text{O}_5}}{dt} \]
   This reaction has been studied in detail and found to follow the following multistep mechanism:
   I. \( \text{N}_2\text{O}_5 \rightarrow k_1 \text{NO}_2 + \text{NO}_3 \)
   II. \( \text{NO}_2 + \text{NO}_3 \rightarrow k_2 \text{NO} + \text{O}_2 + \text{NO}_2 \)
   III. \( \text{NO} + \text{NO}_3 \rightarrow k_3 \text{2NO}_2 \)
   Treating both NO and NO\(_3\) as intermediates that reach a steady state concentration, show that
   \[ k_{\text{obs}} = \frac{k_1 k_2}{k_3 + 2k_2} \]
   Each of the reactions (I to III) in the multistep mechanism above are known as elementary reactions. We have not talked about this, but the orders for each participant in an elementary reaction are equal to their stoichiometric coefficients. (Hint: Start by writing the rate law for the first step, then use the steady state approximation for NO and NO\(_3\) to get the desired result.)