CHM 115 Lab 14

Kinetics: Concentration Effects

The purpose of this experiment is to investigate the kinetics of the reaction

$$2\ H^+ + H_2O_2 + 2\ I^- \rightarrow I_2 + 2\ H_2O$$

The concentration of H^+ ion is held constant by using a buffer thus the $[H^+]$ term will not be included in the rate law, or in determining the rate constant. The rate of this reaction is measured by using the "clock reaction" $I_2 + 2\ S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2\ I^-$

The clock reaction proceeds much faster than the reaction being studied, thus removing the I_2 as fast as it is produced. The $S_2O_3^{2-}$, present in a known amount, will react before any free I_2 is produced. The presence of free I_2 is detected by its reaction with the starch indicator to form a deep blue complex. Thus the rate of the reaction can be measured by timing the appearance of the starch-I_2 complex. While there is $S_2O_3^{2-}$ present, the concentration of the I^- remains essentially constant. Thus the rate of the reaction will be $\Delta[H_2O_2]/\Delta t$. Note that 1 mole of H_2O_2 reacts with 2 moles of I^- to produce 1 mole of I_2 which reacts with 2 moles of $S_2O_3^{2-}$. It is necessary to consider this stoichiometry to calculate the amount of H_2O_2 that reacts while the $S_2O_3^{2-}$ is present.

To determine the order of the reaction for each reactant, a series of reactions are run in which the concentration of only that reactant is varied. Then Rate $= k'[\ \ ]^n$, where k' includes all other reactants, and [ ] is the concentration of the reactant which is being varied. The logarithm of this expression is $\ln(\text{Rate}) = \ln(k') + n\ \ln[\ \ ]$. Thus a graph of ln (Rate) vs ln [ ] is a straight line which has a slope of n.

Procedure

Work with a partner. Each pair should obtain from the stockroom: 5 and 10 mL pipets, bulb and rack.

1. First the effect of the concentration of the I^- will be investigated. Label your four 250 mL Erlenmeyer flasks. Use the graduated cylinder to measure the deionized water indicated in the table below – add the water directly to the 250 mL Erlenmeyer flask. Pipet 5.0 mL of the $Na_2S_2O_3$ into the Erlenmeyer flask, followed by dispensing the appropriate amounts (indicated in the table below) of buffer, KI and starch directly from the auto-pipetters into the labeled Erlenmeyer flasks.

Flask	Deionized H_2O	Buffer	0.30 M KI	Starch	0.020 M $Na_2S_2O_3$	
1	129 mL	6 mL	2.0 mL	2 mL	5.0 mL	
2	127 mL	6 mL	4.0 mL	2 mL	5.0 mL	
3	123 mL	6 mL	8.0 mL	2 mL	5.0 mL	
4	115 mL	6 mL	16 mL	2 mL	5.0 mL	

Obtain about 125 mL (and only 125 mL) of the H_2O_2 solution in a clean *dry* 150 mL beaker. Record the exact concentration of the H_2O_2. 6.0 mL of the H_2O_2 is to be added to each flask. Use your graduated cylinder to measure 6.0 mL of the H_2O_2 into each of four small test tubes. The timing of the reaction begins with the addition of the H_2O_2. The H_2O_2 should be added quickly and the contents of the flask mixed well. Measure the time required for the reaction to consume the $S_2O_3^{2-}$.

2. Now the effect of the concentration of the H_2O_2 will be investigated. Rinse your four 250 mL Erlenmeyer flasks. Use the graduated cylinder to measure the deionized water indicated in the table below – add the water directly to the 250 mL Erlenmeyer flask. Pipet 5.0 mL of the $Na_2S_2O_3$ into the Erlenmeyer flask, followed by dispensing the appropriate amounts (indicated in the table below) of buffer, KI and starch directly from the auto-pipetters into the labeled Erlenmeyer flasks.

Flask	Deionized H_2O	Buffer	0.30 M KI	Starch	0.020 M $Na_2S_2O_3$	
1	128 mL	6 mL	6.0 mL	2 mL	5.0 mL	
2	125 mL	6 mL	6.0 mL	2 mL	5.0 mL	
3	119 mL	6 mL	6.0 mL	2 mL	5.0 mL	
4	107 mL	6 mL	6.0 mL	2 mL	5.0 mL	

This time the amount of H_2O_2 varies as follows:

Flask	H_2O_2
1	3.0 mL
2	6.0 mL
3	12 mL
4	24 mL

Use your graduated cylinder to measure the required amounts of peroxide. As before, measure the time required to consume the $S_2O_3^{2-}$.

3. Perform the necessary calculations and draw the required graphs to determine the order of the reaction with respect to peroxide, order with respect to iodide, and the rate constant for each trial.