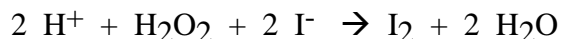


## CHM 115 Lab 14

### Kinetics: Concentration Effects

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



The concentration of  $\text{H}^+$  ion is held constant by using a buffer thus the  $[\text{H}^+]$  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"  $\text{I}_2 + 2 \text{S}_2\text{O}_3^{2-} \rightarrow \text{S}_4\text{O}_6^{2-} + 2 \text{I}^-$

The clock reaction proceeds much faster than the reaction being studied, thus removing the  $\text{I}_2$  as fast as it is produced. The  $\text{S}_2\text{O}_3^{2-}$ , present in a known amount, will react before any free  $\text{I}_2$  is produced. The presence of free  $\text{I}_2$  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- $\text{I}_2$  complex. While there is  $\text{S}_2\text{O}_3^{2-}$  present, the concentration of the  $\text{I}^-$  remains essentially constant. Thus the rate of the reaction will be  $\Delta[\text{H}_2\text{O}_2]/\Delta t$ . Note that 1 mole of  $\text{H}_2\text{O}_2$  reacts with 2 moles of  $\text{I}^-$  to produce 1 mole of  $\text{I}_2$  which reacts with 2 moles of  $\text{S}_2\text{O}_3^{2-}$ . It is necessary to consider this stoichiometry to calculate the amount of  $\text{H}_2\text{O}_2$  that reacts while the  $\text{S}_2\text{O}_3^{2-}$  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  $\text{Rate} = k'[\ ]^n$ , 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  $\ln(\text{Rate})$  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  $\text{I}^-$  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  $\text{Na}_2\text{S}_2\text{O}_3$  into the Erlenmeyer flask, followed by dispensing the appropriate amounts (indicated in the table below) of buffer, KI and starch directly from the auto-pipettors into the labeled Erlenmeyer flasks.

Flask	Deionized H <sub>2</sub> O	Buffer	0.30 M KI	Starch	0.020 M Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>
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<sub>2</sub>O<sub>2</sub> solution in a clean *dry* 150 mL beaker. Record the exact concentration of the H<sub>2</sub>O<sub>2</sub>. 6.0 mL of the H<sub>2</sub>O<sub>2</sub> is to be added to each flask. Use your graduated cylinder to measure 6.0 mL of the H<sub>2</sub>O<sub>2</sub> into each of four small test tubes. The timing of the reaction begins with the addition of the H<sub>2</sub>O<sub>2</sub>. The H<sub>2</sub>O<sub>2</sub> should be added quickly and the contents of the flask mixed well. Measure the time required for the reaction to consume the S<sub>2</sub>O<sub>3</sub><sup>2-</sup>.

2. Now the effect of the concentration of the H<sub>2</sub>O<sub>2</sub> 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<sub>2</sub>S<sub>2</sub>O<sub>3</sub> into the Erlenmeyer flask, followed by dispensing the appropriate amounts (indicated in the table below) of buffer, KI and starch directly from the auto-pipettors into the labeled Erlenmeyer flasks.

Flask	Deionized H <sub>2</sub> O	Buffer	0.30 M KI	Starch	0.020 M Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>
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<sub>2</sub>O<sub>2</sub> varies as follows:

Flask	H <sub>2</sub> O <sub>2</sub>
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<sub>2</sub>O<sub>3</sub><sup>2-</sup>.

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.