

## Pre-Lab Questions

Read the *Background* section of this lab, then answer the following questions using the information given. Show all work.

Hypothetical Reaction:  $2A + B \rightarrow C + D$

General Rate Law:  $\text{Rate} = k [A]^n [B]^m$

Experiment #	[A]	[B]	Reaction Time (sec)	Reaction Rate ( $\text{sec}^{-1}$ )
1	0.10 M	0.05 M	150	
2	0.20 M	0.05 M	70	
3	0.30 M	0.05 M	50	
4	0.20 M	0.10 M	18	
5	0.20 M	0.15 M	8	

1. Calculate the reaction rate in  $\text{sec}^{-1}$  for each experiment.
2. Determine the order with respect to A.
3. Determine the order with respect to B.
4. Calculate the overall order of the reaction.
5. Determine the rate law.
6. Calculate the units on the rate constant,  $k$ .

Name: \_\_\_\_\_

## Reaction Orders and Rate Laws

## Data Sheet

Data Table 1 — Varying the Concentration of HCl

Well #	mL of 1.0 M HCl	mL of water	mL of 0.30 M Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	[HCl] initial conc.	[Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> ] initial conc.	[HCl] final conc.	[Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> ] final conc.	Reaction time (sec)			Reaction Rate (sec <sup>-1</sup> )
								Trial #1	Trial #2	Average	
1	3	0	2								
2	1.5	1.5	2								
3	1	2	2								

Data Table 2 — Varying the Concentration of Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>

Well #	mL of 1.0 M HCl	mL of water	mL of 0.30 M Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	[HCl] initial conc.	[Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> ] initial conc.	[HCl] final conc.	[Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> ] final conc.	Reaction time (sec)			Reaction Rate (sec <sup>-1</sup> )
								Trial #1	Trial #2	Average	
1	2	0	3								
2	2	1.5	1.5								
3	2	2	1								

## Post-Lab Questions

1. Calculate the concentrations of the HCl solutions before mixing them with the  $\text{Na}_2\text{S}_2\text{O}_3$  solution in Part A. Remember to calculate the concentration of the HCl solutions that were diluted by mixing water and HCl in the syringe using the equation  $M_1V_1 = M_2V_2$  where  $M$  is molarity and  $V$  is volume. Record concentrations in the column labeled “[HCl] initial concentration” in Data Table 1. Show at least one sample calculation below. Record the concentration of the  $\text{Na}_2\text{S}_2\text{O}_3$  solution used in Part A in the column labeled “[ $\text{Na}_2\text{S}_2\text{O}_3$ ] initial concentration” in Data Table 1. Repeat for Part B and Data Table 2.
2. Calculate the concentrations of the HCl solutions and  $\text{Na}_2\text{S}_2\text{O}_3$  solutions after mixing them together for each well. Record these concentrations in the columns labeled “final concentration” in both Data Tables. Show at least one sample calculation below. To calculate these concentrations, remember that mixing the solutions dilutes each of them. Use the formula  $M_1V_1 = M_2V_2$  to calculate the final concentrations after dilution.
3. Calculate and record the reaction rate in  $\text{sec}^{-1}$  for each well in the Data Tables.
4. Based on your data in Data Table 1, does the reaction rate depend on the HCl concentration? If so, how? What is the reaction order for HCl?
5. Based on your data in Data Table 2, does the reaction rate depend on the  $\text{Na}_2\text{S}_2\text{O}_3$  concentration? If so, how? What is the reaction order for  $\text{Na}_2\text{S}_2\text{O}_3$ ?
6. Plot a graph showing the reaction rate vs. [HCl] using the data from Data Table 1. What is the shape of the resulting plot?
7. On the same graph, plot the reaction rate vs. [ $\text{Na}_2\text{S}_2\text{O}_3$ ] using the data from Data Table 2. What is the shape of the resulting plot?
8. What is the overall order of the reaction?
9. Write the rate law for this reaction.
10. Based on the rate law you determined, what are the units on the rate constant,  $k$ ?