Rates of Reaction

Pre-lab Discussion:

The rate of a chemical reaction is the time required for a given quantity of reactants to be changed to products. This rate is affected by the nature of the reactants, concentration of the reactants, temperature, pressure and the presence of catalysts. In this experiment, you will study the effects of temperature and concentration.

A chemical reaction is the result of effective collisions, collisions with the correct amount of energy and the correct orientation between reactant particles. Inorder to increase the rate of a reaction the effective collisions must be increased. Increasing the temperature of a system raises the average kinetic energy. This results in more effective collisions. Increasing the concentration of the reactants increases the number of particles present which leads to more effective collisions.

The following reaction, which takes place in two steps, will be studied:

$$IO_3^{1-}(aq) + 3\,HSO_3^{1-}(aq) \longrightarrow I^{1-}(aq) + 3\,SO_4^{2-}(aq) + 3\,H^{1+}(aq)$$

$$5\,I^{1-}(aq) + 6\,H^{1+}(aq) + IO_3^{1-}(aq) \longrightarrow 3\,I_2(aq) + 3\,H_2O(l)$$

The rate for the entire reaction can be determined by timing the interval between the time the two solutions are mixed and the appearance of the blue color change.

Purpose:

To study the rates of reaction when concentration and temperature of some reactants are changed.

Materials:

250 mL beaker	2 - 100 mL beakers	10 mL graduated cylinder
2 test tubes	thermometer	timer
safety glasses	Solution A [$IO_3^{1-}(aq)$]	distilled water
ice	Solution B [$HSO_3^{1-}(aq)$ & soluble starch]	

Procedure:

1. Obtain the following amounts of the following chemicals for the 6 trials:

Trial	100 mL beaker 1 {Solution B(mL)}	100 mL beaker 2 {Solution A(mL) & distilled H_2O(mL)}	
1	10	10	0
2	10	9	1
3	10	8	2
4	10	7	3
5	10	6	4
6	10	5	5

2. Prepare to time the reaction. While one partner pours Solution A into Solution B, the second partner should immediately start timing the reaction. Pour the solutions back and forth several times from one beaker to the other to ensure thorough mixing. At the instant a color change occurs, stop the timer and record the time. Rinse and dry the beakers and graduated cylinder and repeat until all 6 trials have been concluded.

3. For the second part of this experiment you will use 10 mL of Solution A in test tube 1 and 10 mL of Solution B in test tube 2 for all 5 trials.

4. Obtain the following temperatures for the solutions for the 5 trials by making water baths in a 250 mL beaker (you may use ice or hot water to obtain the correct temperatures) making sure to record the actual temperature of the solutions (they don't have to be exactly the same as the baths but they should be close):

Trial	Temperature of Bath(°C)
1	5
2	15
3	25
4	35
5	45

5. When the solutions have reached the correct temperature prepare to start the timer.

6. One partner pours Solution A into Solution B, the second partner should immediately start timing the reaction. Pour the solutions back and forth several times from one test tube to the other to ensure thorough mixing. At the instant a color change occurs, stop the timer, measure the temperature, and elapsed time and record it. Rinse and dry the test tubes and graduated cylinder and repeat until all 5 trials have been concluded.

7. Wash all glassware with soap and water.

8. Draw a separate line graph for each set of data.
   a. Time vs. mL of Solution A
   b. Time vs. Temperature

Discussion Questions:

1. Based on the data you collected develop a hypothesis about the effect of concentration of reactants on reaction rate and a second hypothesis about the effect of temperature on reaction rate.

2. What other factors affect the rate of reaction ?

3. How does the "collision theory" relate to the rate of a chemical reaction ?

4. Increasing the temperature increases the rate of a reaction by
   a) increasing the frequency of effective collisions between reacting molecules
   b) lowering the frequency of effective collisions between reacting molecules
   c) lowering the activation energy
   d) increasing the activation energy

5. Which event must always occur for a chemical reaction to take place?
   a. Formation of a precipitate
   b. Formation of a gas
   c) addition of a catalyst to the reaction system
   d) effective collisions between reacting particles

6. Given the reaction at 25°C: $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

The rate of this reaction can be increased by using 5.0 grams of powered zinc instead of a 5.0 gram strip of zinc because the powered zinc has
   a) more zinc atoms b) lower concentration c) more surface area d) lower kinetic energy

Chemistry Lab 17 Rates of Reaction Name _____
Period ____
Date _____

Purpose _____

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Data Procedure 1 Procedure 4

Trial	ml of solution A	time (s)		Trial	Temperature	time (s)
1	10			1	5	
2	9			2	15	
3	8			3	25	
4	7			4	35	
5	6			5	45	
6	5					

Discussion Questions:

1. _____

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2. _____

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3. _____

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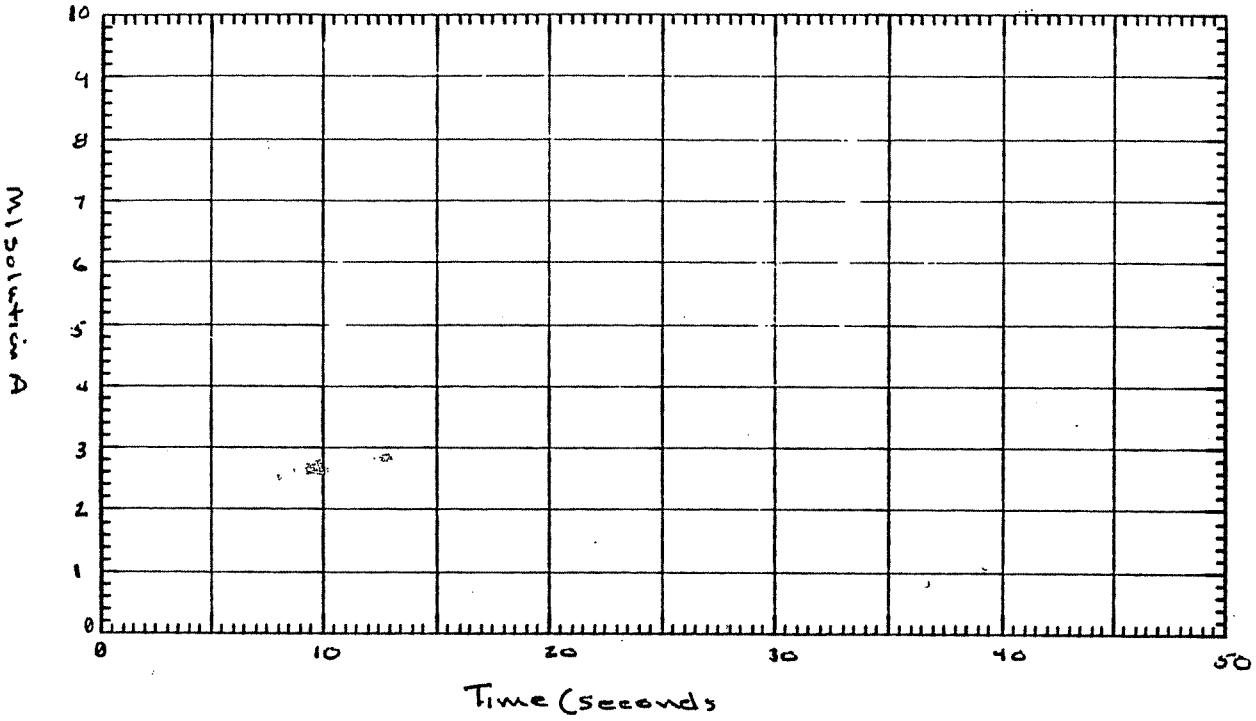
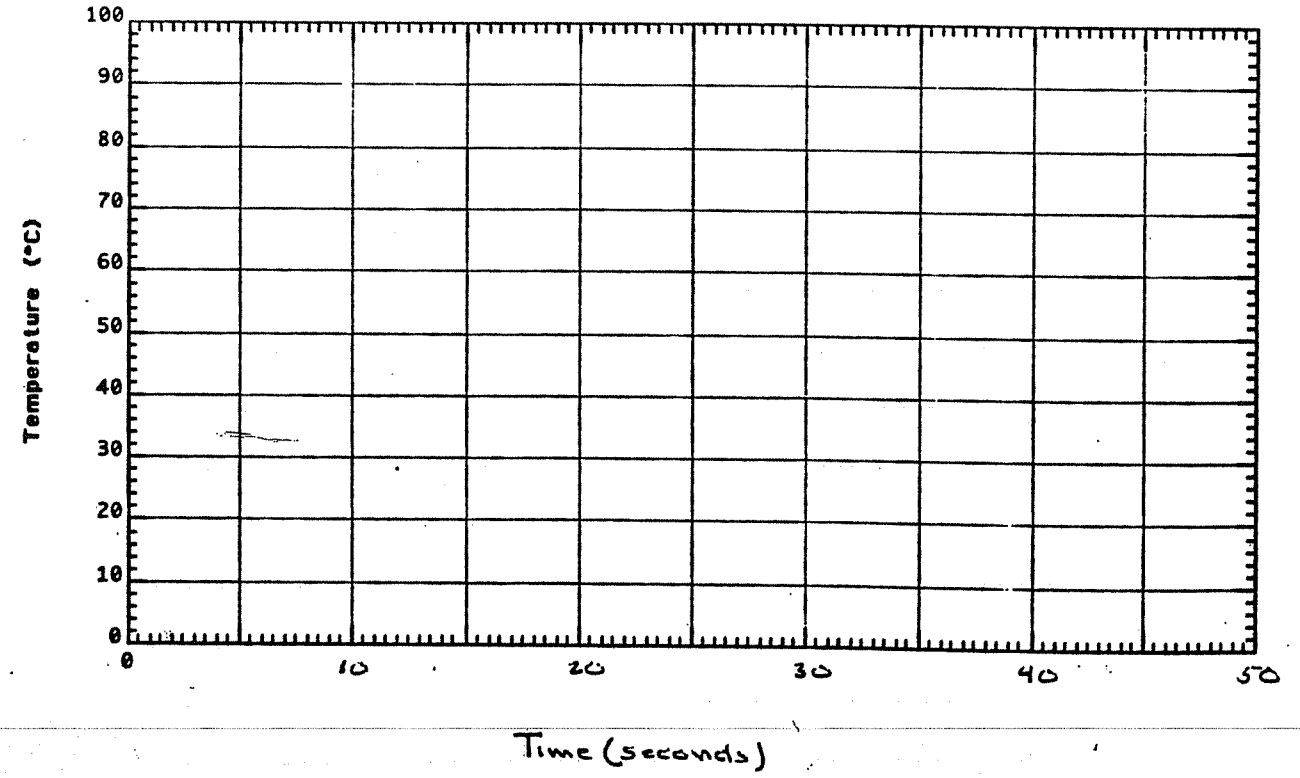

0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
Time (seconds
M Solution A


Temperature (°C)
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
Time (seconds)