RATE OF THE CLOCK REACTION

Do temperature and concentration changes alter the rate of a chemical reaction? If so, to what extent? In this experiment, you will investigate the role of concentration and temperature by performing some experiments with an interesting reaction called the "clock reaction". You will appreciate the significance of the name after you have completed your first determination.

In order to determine the role of each factor independently, you will vary the concentration of one of the reacting species in Part 1 and vary the temperature in Part 2. In each case, you will keep other possible variables - that is, "conditions that matter" - constant.

The clock reaction is performed by mixing the two solutions described below.
1) Solution A is a dilute solution of potassium iodate, KIO_3. This is the source of the iodate ion, $IO_3^-(aq)$.
2) Solution B contains some starch and the other reacting species, the hydrogen sulfite ion, $HSO_3^-(aq)$

When the two solutions are thoroughly mixed, the ions of the resulting solution proceed through the following reactions:

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

Reaction 2 $5I^-(aq) + 6H^+(aq) + IO_3^-(aq) \rightarrow 3I_2(dissolved) + 3H_2O(l)$

Reaction 3 $I_2(dissolved) + HSO_3^-(aq) + H_2O(l) \rightarrow 2I^-(aq) + SO_4^{-2}(aq) + 3H^+(aq)$

Reaction 4 $I_2(dissolved)$ + starch --> blue solution

The reaction take place in the manner outlined in the flowchart seen below. Only when the $HSO_3^-(aq)$ has been entirely consumed in reactions 1, 2 and 3 will the $I_2(dissolved)$ react with the starch in reaction 4. The appearance of the blue colour indicates that all the $HSO_3^-(aq)$ has been consumed and I_2 remains in solution.

Part 1 - ***The Effect of Concentration Changes***

In order to study the effect on the reaction time of changing the concentration of one of the reactants, you will prepare dilutions of solution A to vary the concentration of the iodate ion. In each case, the concentration of the hydrogen sulfite ion will be kept constant. The temperature of the solutions should be that of the room. Your teacher will assign you certain concentrations. By exchanging results with other members of the class, you will be able to draw some conclusions concerning the effect of iodate ion concentration on reaction rate.

Procedure:

1. Use a clean, graduated cylinder to measure 10.0mL of solution A. Pour it into a clean test tube. Rinse the graduated cylinder and in a similar manner place 10.0mL of solution B into another test tube. If the solutions have been in the laboratory for some time, you may assume that they are at room temperature. Otherwise, you should put the test tubes containing the solutions into a 250mL beaker about two thirds full of water at room temperature and let them stand for several minutes.

2. Using a stop watch with a second hand, record the time to the nearest tenth of a second as you pour solution A into solution B. Pour them back and forth quickly three times to insure uniform mixing. Time should be recorded from the instant both solutions are in contact.

3. Watch the solution in the test tube carefully. Record the time at the first sign of a reaction.

4. Repeat the experiment to check your results.

5. Prepare different concentrations of the KIO3 solution by diluting solution A as shown in the table below. Do as many dilutions as your teacher directs. Note that the total volume is always 10.0mL. Mix each of the diluted solutions well.

6. Repeat the procedure by adding one diluted solution A to 10.0mL of solution B, both at room temperature.

Solution A	Distilled Water
9.0 mL	1.0 mL
8.0 mL	2.0 mL
7.0 mL	3.0 mL
etc.	

Part 2 - ***The Effect of Temperature***

In order to investigate the effect of changes in temperature, you will determine the time required for this reaction at room temperature and at other temperatures within a range of +/-20°C. Your teacher will assign particular temperatures for you and your partner to use. By exchanging results with other members of the class, you will be able to draw some conclusions concerning the effect of temperature on the time of reaction.

Procedure:

1. Put 10.0mL of solution A (labelled for Part 2) into one test tube and 10.0mL of solution B into another. These solutions must be brought to the desired temperature before they are mixed. Put both test tubes into a 250mL beaker about two thirds full of water and adjusted to the temperature you were assigned to investigate. Let them stand for about 10 minutes so the solutions will come to the temperature of the water bath. If the same thermometer is used for measuring the temperatures of the two solutions, be sure to rinse it carefully between uses.

2. Using a watch with a second hand, record the time to the nearest second as you pour solution A into solution B. Immediately mix the solutions by pouring them back and forth quickly three times. Time should be recorded from the instant both solutions are in contact.

3. Place the test tube in the water bath and observe it carefully. Record the time at the first sign of a reaction.

Calculations and Results for Part 1

1. Your teacher will tell you the concentration of solution A. Calculate the concentration of KIO_3 in moles per litre (molar) in each of the solutions after all the components (A + B + water) have been mixed.

2. Why is it important to keep the total volume at 10.0mL during the dilutions of solution A?

3. Plot a graph of the concentration vs time data with time on the vertical axis and the concentration of the KIO_3 on the horizontal axis. Use the data of other members of the class also.

4. Give the equation of the line found in your graph drawn in question 3.

5. How is the time of the reaction related to the rate of the reaction?

Calculations and Results for Part 2

1. Using your data and that of other members of the class, plot a graph of the temperature vs time data with temperature on the horizontal axis and time on the vertical axis.

2. Give the equation of the line.

3. Make a prediction of the time of the reaction at $0^{o}C$ and at $50^{o}C$, assuming that the other variables in the experiment are held constant.