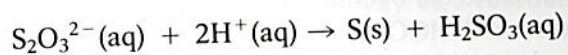


## The Sulfur Clock

It is known that the thiosulfate ion,  $\text{S}_2\text{O}_3^{2-}(\text{aq})$ , decomposes in the presence of the hydrogen ion,  $\text{H}^+(\text{aq})$ , in the following manner.



When sulfur is produced, it makes the solution opaque. When the solution becomes opaque, it is no longer possible to see through it. You will use this fact to determine reaction time, which is defined in this experiment to be the time when you no longer see a mark on a piece of paper under the flask. If you start timing the reaction as soon as the hydrogen ion is added, very good *rate* data can be obtained.

### Objectives

**Compare** the time that it takes for opacity to occur when thiosulfate ion at different concentrations are added to a constant concentration of hydrogen ion.

**Measure** the time in seconds for opacity to occur and **plot** it against the concentration of thiosulfate ion.

**Determine** what relationship, if any, exists between the rate and the concentration of the thiosulfate ion.

### Materials

#### Apparatus

- graph paper
- 4 125-mL flasks
- 50-mL graduated cylinder
- 10-mL graduated cylinder
- 5-mL graduated cylinder or pipet
- marking pencil


#### Reagents

- 150 mL of 0.161M  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$  (called hypo) solution
- 50 mL of 1.00M HCl(aq) solution
- distilled or deionized water

### Procedure



1. Put on your laboratory apron and safety goggles.

 **CAUTION:** 1M hydrochloric acid is corrosive to skin and eyes. Wash off spills or splashes with plenty of water. Use



the eyewash fountain if 1M HCl gets in your eyes. Call your teacher.

Label your four flasks A, B, C, and D with a marking pencil.

Take a piece of white paper and place on it whatever mark you wish to utilize during the experimental procedure. It is very important that you use the same mark for all four runs.

Into flask A, put 10 mL of the thiosulfate solution and 30 mL of distilled water. Set flask A aside for now.

Into flask B, put 20 mL of the thiosulfate solution and 20 mL of distilled water. Set flask B aside for now.

Into flask C, put 30 mL of the thiosulfate solution and 10 mL of distilled water. Set flask C aside for now.

Into flask D, put 40 mL of the thiosulfate solution and *no* distilled water. Place flask D aside for now.

Return to flask A and swirl the contents to make certain the contents are thoroughly mixed to a uniform concentration. Place the flask over the mark. Measure, very carefully, 10.0 mL of 1.0M HCl(aq). Get ready to start timing. When ready, quickly pour the acid into flask A. Start timing. Swirl the flask and peer through the solution until the mark is no longer visible. Stop the timing. Record this time in seconds in your data table.

Swirl flask B and give the contents a chance to be thoroughly mixed. Place the flask over the same mark. Once again, measure carefully 10.0 mL of 1.0M HCl(aq). Get ready to start your timer. Pour the 10.0 mL of acid into the flask and start timing immediately. Record in your data table the time at which you can no longer see the mark.

- Continue with the same process you used for flasks A and B, using the remaining solutions in flasks C and D. Record these times in your data table.
- The products of these reactions can be rinsed down the drain and the flasks cleaned with detergent. Make certain that you clean up your laboratory station. Put your laboratory equipment away before you do the calculations or analysis of data.

### Data Analysis

### Data Table

Time in Seconds	
Flask A	_____
Flask B	_____
Flask C	_____
Flask D	_____

- Obtain a piece of graph paper from your instructor. Label the *x*-axis (abscissa) *time in seconds*. Be certain to use the whole *x*-axis and use all of the spaces available to you. Do not clutter your labels; that is, label only every fifth unit or so. Label the *y*-axis (ordinate) *volume of thiosulfate* in mL. Expand your graph to utilize the entire page of graph paper.

### Conclusions

- What kind of graph results when you plot mL of thiosulfate against time in seconds?
- What does this tell you about the rate of the reaction?
- What do you think would have happened to the reaction time if you had reduced the hydrochloric acid by half? Why?