The Effect of Reactant Concentration on the Rate of a Chemical Reaction

By Shazan Pestonji, Chun Kit Lam & Jonathan Ng

Objective: To investigate how changes in the concentration of a reactand affects the rate of a particular chemical reaction.

Hypothesis: The greater the concentration of the reactants the faster the rate of chemical reaction will occur, where as solutions which are diluted with other substances will require a longer reaction time.

Equipment & materials:

- Beaker
- Stop Watch
- 500 ml measuring cylinder
- Cross on a piece of paper
- Conical Flask
- 30 mL of Hydrochloric acid (2M HCL)
- 135 mL of Sodium Thiosulfate (NA_2S_2O)
- 100 mL of Water

Method:

1. Collect Equipment and Materials stated above.
2. Collect the total amount of Sodium Thiosulfate (135mL) and water (100ml) required for all the experiments. Each sample will need to have 50 mL of mixture in the conical flask at any time. Thus the amount of water and Na_2S_2O will be varied to make up this amount.
3. Then pour the amount of Sodium Thiosulfate using a measuring cylinder to the conical flask, the amount will vary depending on the sample.
4. Rinse the measuring cylinder in water under the tap to clean it of excess sodium thiosulfate.
5. Pour the water from the measuring cylinder into the conical flask (already containing the Sodium Thiosulfate), the amount of water will vary depending on the sample.
6. Draw a cross on a blank piece of paper.
7. Place the conical flash containing the water and Sodium Thiosulfate mixture directly on top of the cross on the paper.
8. Collect 5 ml of Hydrochloric Acid using the clean measuring cylinder.
9. Keep the stop watch ready to time the reaction time once the Hydrochloric Acid is added to the conical flask.
10. Transfer all of the 5 mL of Hydrochloric Acid into the conical flask and swirl the conical flask to start the reaction and begin timing.
11. Stop timing and record the time taken, when you can no longer see the cross drawn on the paper.
12. Repeat steps 2-11 for each sample while changing the some of the variants.

Variables:

- Independent Variable:
  The variable that changes in the investigation is the amount of Sodium Thiosulfate in the solution.

- Dependent Variable
  For this experiment the measured variable is the time taken for the reaction to conclude. This was measured in seconds.

- Controlled Variables:
  - The amount of water in solution – this was added to ensure that 50 mL of mixture was contained within the flask for each sample case.
  - Temperature
  - Amount of Hydrochloric acid 5 mL each time.

Results:

We observed that when the HCL was added into the conical flask that a murky perception formed in the solution thus the clear solution turned unclear. This can be explained by the following chemical reaction taking place;

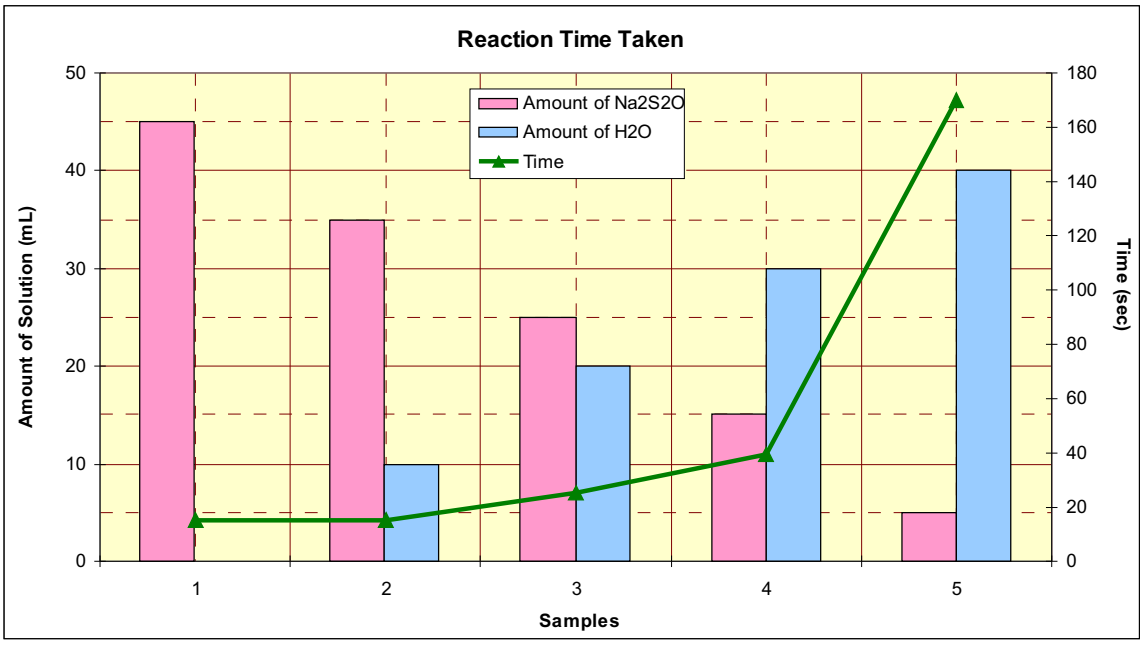
$$2HCL_{(aq)} + Na_2S_2O_{(aq)} \rightarrow S_{(s)} + SO_{2\,(g)} + H_2O$$

The table below captures the results we obtained;

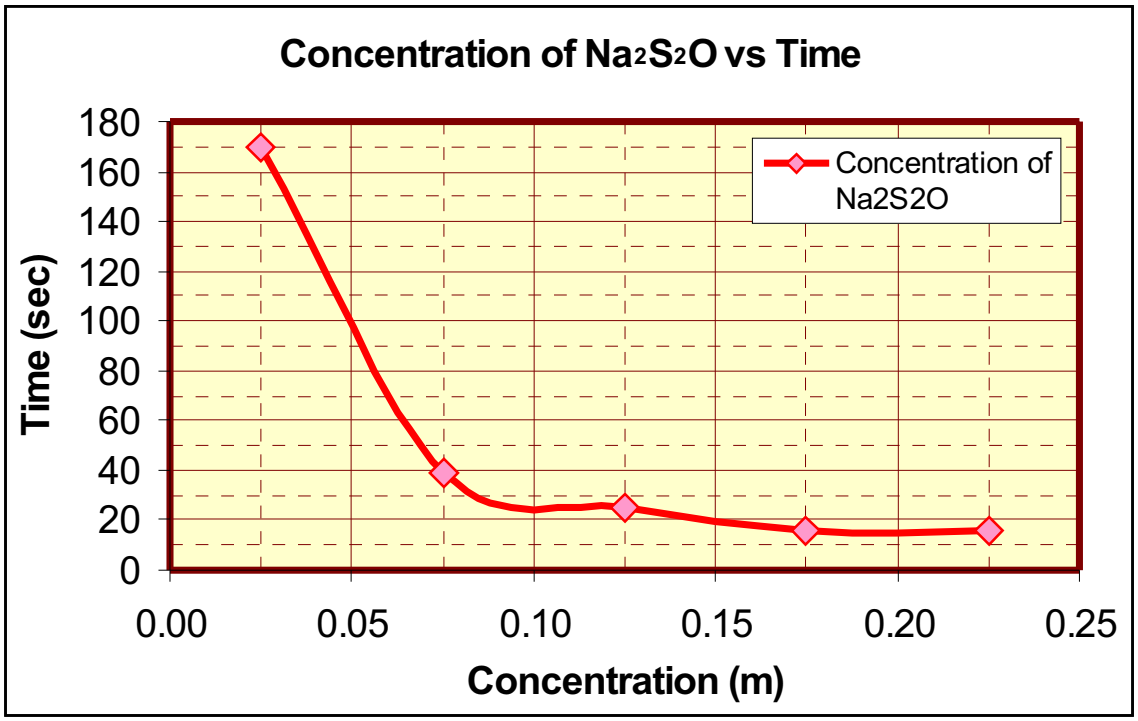
Table 1

Sample	2M HCL	Amount of Na2S2O	Amount of H2O	Concentration of Na2S2O	Time
	mL	mL	mL	M	Sec
1	5	45	0	0.225	15.37
2	5	35	10	0.175	15.40
3	5	25	20	0.125	25.06
4	5	15	30	0.075	39.25
5	5	5	40	0.025	169.86

Graph 1



Graph 2



Discussion:

By collecting the results from the investigation we were able to come to a conclusion on the affects of varying the amount of Na_2S_2O and water has on the reaction of a solution.

Graph 1 and Table 1 above shows the amount of Na_2S_2O and the amount of water in each sample. This graph also shows the time taken for the reaction to finish, this being the time when we could no longer see the cross on the paper below the conical flask due to the solution becoming too murky in colour.

It can be observed by looking at Graph 1 that, the lower the amount of Na_2S_2O that is present in the solution, the longer the time taken for the reaction to finish. This occurs because there is a reduced amount of Na_2S_2O concentration present in the mixture which can react with the HCL. This can also be seen in Graph 2 which shows the relationship between the amounts of Na_2S_2O concentration to the time required for the reaction to finish. Graph 1 also shows that the greater the amount of water present in the solution the longer it takes for the reaction to finish as the concentration of Na_2S_2O to HCL is further diluted.

Thus it can be concluded that our results support the hypothesis; that more concentrated solutions react faster than diluted solutions do. The affect on the reaction rate when varying the amount of water and Na_2S_2O is that; more concentrated the Na_2S_2O and HCL mixture is, the faster the reaction occurs, i.e. the less water that is present to dilute the mixture the faster the reaction occurs.

Evaluation:

Overall the investigation was completed successfully and we achieved our aim of investigating how a change in the concentration of a reactant affects that rate of a chemical reaction.

There are a number of factors that can be changed and controlled so that to improve the accuracy of the results. The following things done in the future will help to ensure that more reliable data is obtained;

- Using a rubber stopper in the conical flask: when the HCL was transferred into the conical flask, gas escaped form the top of the flask. If in future tests, this gas was trapped inside the flask with the use of a stopper the reaction may have completed faster.

- Reducing human error: Starting the timer at the same time in all the reactions would have helped to increase the accuracy of the results. The timer should have been started either once the full amount of HCL was transferred in the conical flask or should have started when the pouring started.

- Another variable which could have been controlled was the number of times the conical flask was swirled after the HCL was added. This would have further

helped with the accuracy of the data if all the samples were swirled at the same speed and the same number of times.

- Using distilled water: this would ensure that the water is pure

- There might have also been errors with reading the scales on the measuring cylinder as we were reading these to the best of our ability. To be certain that the exact amount of solution was added an electronic weighing scale could have been used.