

Lab Record: Rate of Reaction: Effect of Concentration on Rate ($\text{Na}_2\text{S}_2\text{O}_3 + \text{HCl}$)

Aim

The aim of this experiment is to investigate the effect of varying the concentration of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) on the rate of its reaction with hydrochloric acid (HCl). We will determine how changes in concentration affect the time taken for the reaction to reach a specific endpoint.

Theory

The reaction between sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) and hydrochloric acid (HCl) produces a cloudy precipitate of sulfur. The rate of this reaction is influenced by several factors, including the concentration of the reactants. Collision theory states that for a reaction to occur, reactant particles must collide with sufficient energy (activation energy) and proper orientation. Increasing the concentration of a reactant increases the number of reactant particles in a given volume. This leads to a higher frequency of collisions between reactant particles, thus increasing the likelihood of successful collisions that result in product formation. Consequently, a higher concentration of reactants generally leads to a faster reaction rate. In this experiment, we are observing the time it takes for a fixed amount of sulfur to precipitate out of the solution, making the solution opaque. By varying the concentration of sodium thiosulfate and measuring the time taken for the solution to become opaque, we can determine the relationship between concentration and reaction rate. The rate of reaction is inversely proportional to the time taken for the reaction to occur.

Procedure

1. Prepare solutions of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) with varying concentrations (0.1 M to 1.0 M).
2. Measure a fixed volume (e.g., 50 mL) of each $\text{Na}_2\text{S}_2\text{O}_3$ solution into separate beakers.
3. Place each beaker on a piece of paper marked with a cross.
4. Add a fixed volume (e.g., 5 mL) of hydrochloric acid (HCl) of a known concentration to each beaker simultaneously.
5. Immediately start a timer.
6. Observe the cross through the solution and stop the timer when the cross is no longer visible due to the formation of sulfur precipitate.
7. Record the time taken for the cross to disappear for each concentration of $\text{Na}_2\text{S}_2\text{O}_3$.
8. Repeat the experiment for each concentration at least three times and calculate the average time.

Result

The experiment demonstrates an inverse relationship between the concentration of sodium thiosulfate and the time taken for the reaction to reach completion. As the concentration of $\text{Na}_2\text{S}_2\text{O}_3$ increases, the reaction time decreases, indicating a faster reaction rate. The data collected supports the hypothesis that increasing reactant concentration increases the rate of reaction.

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