EXPERIMENT 2

Aim

To study the effect of change in temperature on the rate of reaction between Sodium Thiosulphate and Hydrochloric Acid.

Theory

The rate of reaction between sodium thiosulphate and hydrochloric acid also increases with increase in temperature. Increase in temperature increases kinetic energy of the molecules. Therefore, the fraction of molecules having energy greater than its threshold energy increases which results in the increase in number of effective collisions per second. It has been observed that in most of the cases for every 10°C rise in temperature, the rate of the reaction becomes almost double.

Material Required

Conical flask (100 ml), burette, stop-watch, thermometer, tripod stand, wire-gauze, burner, 0.1 M, sodium thiosulphate solution ($Na_2S_2O_3$), 1 M, hydrochloric acid (HCl), distilled water and conc. HNO_3.

Procedure

1. Take 50 ml of 0.1 M sodium thiosulphate solution ($Na_2S_2O_3$) in a 100 ml conical flask and note its temperature with the help of a thermometer. Let the temperature be T°C.
2. Place the beaker on a cross mark put on a white paper or tile.
3. Add 5 ml of 1M HCl to it and start the stopwatch immediately when half of the hydrochloric acid solution has been added.
4. Observe the cross-mark from the top and note the time taken for the mark to become just invisible.
5. Empty the flask and clean it thoroughly with conc. HNO_3 and then with water.
6. Take again 50 ml of 0.1 M, $Na_2S_2O_3$ in conical flask and heat it so that the temperature of the solution becomes (T + 5) °C.
7. Remove the flask from the tripod-stand and add 10 ml of 1 M, HCl to it and start the stopwatch.
8. Shake the contents gently and place it on the tile having a cross-mark.
9. Note the time taken for the mark to become just invisible.
10. Repeat the experiment at the difference for 5°C each as;
    (T + 10) °C, (T + 15) °C and (T + 20) °C temperatures
11. Record the observations as given below.

Observations

Volume of 0.1 M, $Na_2S_2O_3$ solution taken each time = 50 ml

Volume of 1 M, HCl added each time = 5 ml

Table.2.

S. No.	Temperature	Time taken for cross to become just invisible/second
1.	T	-
2.	T+5	-
3.	T+10	-
4.	T+15 So on...	-

Plotting of graph

Plot a graph by taking time along the ordinate (vertical axis) and temperature along the abscissa (horizontal axis).

Result

Rate of reaction between sodium thiosulphate and hydrochloric acid increases with the increase in temperature.

Precautions

1. The apparatus must be thoroughly clean. If the same conical flask is to be used again and again, it should be thoroughly washed with a conc. HNO_3 and then with water.
2. Measure the volumes of sodium thiosulphate solution, hydrochloric acid and distilled water very accurately.
3. Use the same tile with the same cross-mark for all observation,
4. Complete the experiment at one time only so that there is not much temperature variation.
5. Start the stopwatch immediately when half of the hydrochloric acid solution has been added to sodium thiosulphate solution.
6. View the cross-mark through the reaction mixture from top to bottom from same height for all observations.

VIVA VOCE

Q 1. How does increasing the temperature affect the rate of reaction between sodium thiosulfate and hydrochloric acid?

Ans. Increasing the temperature generally increases the rate of reaction between sodium thiosulfate and hydrochloric acid due to the higher kinetic energy of the reactant molecules, leading to more frequent and energetic collisions.

Q 2. What experimental setup can be used to investigate the effect of temperature on the rate of reaction between sodium thiosulfate and hydrochloric acid?

Ans. An experimental setup involving a water bath or a thermostatically controlled environment to maintain specific temperatures, along with precise temperature measurement devices, can be employed to investigate temperature-dependent changes in reaction rates.

Q 3. How do changes in temperature influence the activation energy of the reaction between sodium thiosulfate and hydrochloric acid?

Ans. Increasing the temperature decreases the activation energy required for the reaction, making it easier for reactant molecules to overcome the energy barrier and react, resulting in a higher reaction rate.

Q 4. What is the purpose of studying the effect of temperature on the rate of this reaction?

Ans. The purpose is to investigate how changes in temperature affect the rate of reaction, which can provide insights into the kinetics and mechanism of the reaction.

Q 5. How can you measure the rate of reaction in this experiment?

Ans. The rate of reaction can be measured by monitoring the time taken for a precipitate of sulfur to form, obscuring a cross marked beneath the reaction vessel.

Q 6. What factors can influence the rate of a chemical reaction?

Ans. Factors such as concentration, temperature, surface area, and presence of a catalyst can influence the rate of a chemical reaction.

Q 7. How does an increase in temperature affect the rate of reaction in general?

Ans. An increase in temperature generally increases the rate of reaction because it provides more kinetic energy to the reacting particles, leading to more frequent and energetic collisions.

Q 8. Can you explain the collision theory in the context of this experiment?

Ans. The collision theory states that for a reaction to occur, reactant particles must collide with sufficient energy and proper orientation. Increasing the temperature increases the kinetic energy of the particles, thereby increasing the frequency and effectiveness of collisions.

Q 9. How would you control the temperature during the experiment?

Ans. The temperature can be controlled by using a water bath or a thermostatically controlled heating mantle. Thermometers can be used to monitor and adjust the temperature as needed.

Q 10. What precautions should be taken to ensure accurate results in this experiment?

Ans. Precautions include ensuring that all glassware is clean and dry, accurately measuring the reactants, maintaining a consistent temperature throughout the experiment, and performing multiple trials to ensure reproducibility of results.

Q 11. Can you explain the concept of activation energy?

Ans. Activation energy is the minimum amount of energy required for a chemical reaction to occur. It represents the energy barrier that must be overcome for reactant molecules to transform into products.

Q 12. How would you analyze the data obtained from this experiment to draw conclusions about the effect of temperature on the rate of reaction?

Ans. The data can be plotted on a graph, with reaction rate (measured as 1/time taken for the cross to be obscured) on the y-axis and temperature on the x-axis. By analyzing the trend in the graph, conclusions can be drawn about how temperature affects the rate of reaction.