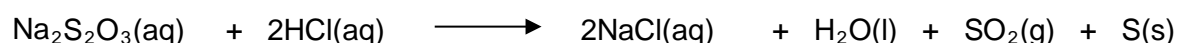
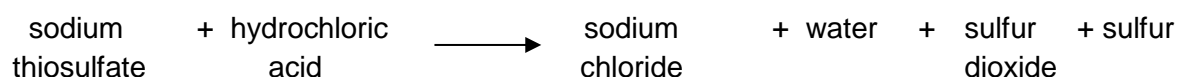


## Investigation of the factors affecting the rate of reaction between dilute hydrochloric acid and sodium thiosulfate

### Introduction

Sodium thiosulfate reacts with hydrochloric acid to form a solid precipitate of sulfur. The formation of this precipitate makes the solution become cloudy, and so the rate at which this cloudiness appears can be used as a way to measure the rate of the reaction. The equation for this reaction is as follows:



The rate at which this precipitate forms can be changed by changing the conditions under which the reaction is carried out.

In this experiment you will study the effect of changing the temperature of the sodium thiosulfate solution.

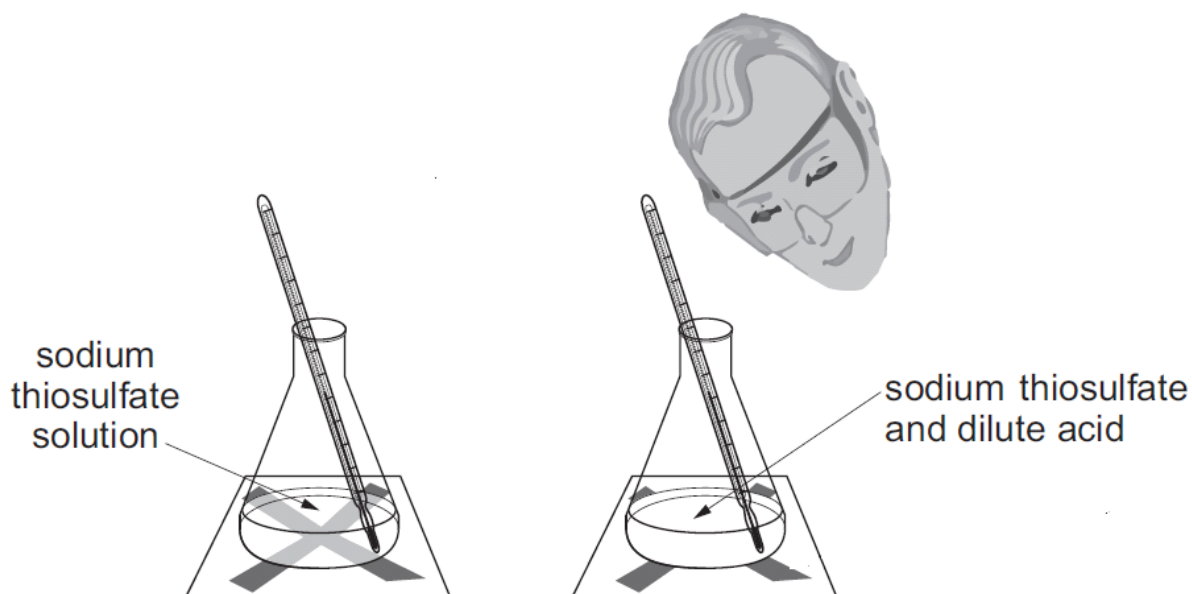
### Apparatus

10cm<sup>3</sup> measuring cylinder  
25cm<sup>3</sup> measuring cylinder  
250cm<sup>3</sup> conical flask  
white paper with cross marked on it  
stopwatch  
1 mol/dm<sup>3</sup> hydrochloric acid  
thermometer

#### Access to:

40 g/dm<sup>3</sup> sodium thiosulfate solution at 5°C  
40 g/dm<sup>3</sup> sodium thiosulfate solution in a waterbath at 60°C

## Diagram of Apparatus



## Method

1. Draw a cross on a square of white paper.
2. Measure  $25 \text{ cm}^3$  of hot sodium thiosulfate using the  $25 \text{ cm}^3$  measuring cylinder and pour into the conical flask. Record the temperature of the solution.
3. Using the  $10 \text{ cm}^3$  measuring cylinder, measure out  $5 \text{ cm}^3$  of the hydrochloric acid.
4. Place the conical flask onto the cross and add the hydrochloric acid. Swirl the flask to mix the contents and at the same time start the stopwatch.
5. Look down at the cross from above the mixture.
6. Stop the stopwatch as soon as the cross disappears.
7. Record the time taken for the cross to disappear.
9. Repeat steps 2 to 7 for different temperatures of sodium thiosulfate, made according to the table below.

Volume of sodium thiosulfate solution at $60^\circ\text{C}$ ( $\text{cm}^3$ )	Volume of sodium thiosulfate solution at $5^\circ\text{C}$ ( $\text{cm}^3$ )
25	0
20	5
15	10
10	15
5	20
0	25

## Analysis

1. Plot a graph of the temperature of sodium thiosulfate against the time taken for the cross to disappear.

## Assessment

Hazard	Risk	Control measure
Hydrochloric acid is an irritant.	Damage/irritation to skin. There may be transfer from the hands to the eyes causing irritation.	Wash skin immediately if contact made with hydrochloric acid. Wear safety goggles.
Sodium thiosulfate is an irritant	Damage/irritation to skin. There may be transfer from the hands to the eyes causing irritation.	Wash skin immediately if contact made with sodium thiosulfate. Wear safety goggles
Sulphur dioxide gas produced is an irritant	Inhalation of gas may cause damage/irritation to the lungs	Carry out in a well ventilated space
Hot water can scald/burn	Burns or scalds if the hot sodium thiosulphate is knocked over.	Keep maximum temperature to 60 °C.

## Teacher / Technician notes

The crosses on the paper can be pre-prepared and laminated.

An alternative method can also be followed using the method set out on CLEAPSS card C195. It reduces the volume of reactants used so enabling more sets of equipment to be created.

### Reagents

- Hydrochloric acid – Refer to CLEAPSS hazcard 47A
- Sodium thiosulfate – Refer to CLEAPSS hazcard 95A

No repeats have been included in the method, but reproducibility can be checked by comparing results with other groups. As temperatures will vary across groups, the whole class data could be plotted onto one graph.

More able candidates could calculate and plot the rate of the reaction using  $\frac{1}{\text{time (s)}}$ .

Students should design their own table, but a suggested table format is shown below.

Recorded temperature (°C)	Time taken for cross to disappear (s)

## Working scientifically skills covered

### **1. Experimental skills and strategies**

Carry out experiments appropriately having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations.

### **2. Analysis and Evaluation**

Represent distributions of results and make estimations of uncertainty.

Interpret observations and other data including identifying patterns and trends, making inferences and drawing conclusions.

Evaluate data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.