



James Burton

Lab report 4 – Kinetics – Rate of Reaction

University of Wales, Trinity St Davids  
Ordnance, Munitions and Explosives(BEng) - Chemistry

Academic Year: 2024 - 2025

Supervisor: Ewa Kazmierski  
Associate Supervisor: Mark Broadhead

## Table of Contents

|                                                                                        |     |
|----------------------------------------------------------------------------------------|-----|
| List of Figures.....                                                                   | iii |
| List of Tables.....                                                                    | iii |
| List of Equations.....                                                                 | iii |
| 1 Introduction.....                                                                    | 1   |
| 2 Results .....                                                                        | 3   |
| 2.1 Effect of Concentration of HCl on Speed of H <sub>2</sub> gas Evolution .....      | 3   |
| 2.2 Effect of Temperature on Speed of H <sub>2</sub> Gas Evolution (Using 1M HCl)..... | 5   |
| 2.3 Effect of the Surface Area of Mg on Speed of H <sub>2</sub> Gas Evolution .....    | 6   |
| 2.4 Moles of the Reactants .....                                                       | 7   |
| 2.5 Calculations .....                                                                 | 7   |
| 2.6 Graphical Representation of Findings.....                                          | 10  |
| 3 Discussion.....                                                                      | 12  |
| 3.1 Significance of Findings .....                                                     | 12  |
| 3.2 Relevance to OME.....                                                              | 12  |
| 3.3 Limitations and Sources of Error in the Experiment.....                            | 13  |
| 4 Conclusion.....                                                                      | 14  |
| 4.1 Summary and Evaluation.....                                                        | 14  |
| 4.2 Direction for Future Research .....                                                | 14  |
| 5 References.....                                                                      | 15  |
| 6 Appendices.....                                                                      | 16  |
| 6.1 Materials and Equipment .....                                                      | 16  |
| 6.2 Experimental Procedure .....                                                       | 16  |
| 6.2.1 Effect of HCl concentration on the speed of H <sub>2</sub> gas evolution .....   | 16  |
| 6.2.2 Effect of temperature on the speed of H <sub>2</sub> gas evolution .....         | 17  |
| 6.2.3 Effect of the surface area of Mg on speed of H <sub>2</sub> gas evolution.....   | 17  |
| 6.3 Screenshots of Data Sheets .....                                                   | 18  |

## List of Figures

|                                                                                                                |    |
|----------------------------------------------------------------------------------------------------------------|----|
| Figure 1 - Graph Showing the Effect of Concentration of HCl on Speed of H <sub>2</sub> Gas Evolution.....      | 10 |
| Figure 2 - Graph Showing the Effect of Temperature of HCl on Speed of H <sub>2</sub> Gas Evolution.....        | 10 |
| Figure 3 - Graph Showing the Effect of Surface Area of Mg on Speed of H <sub>2</sub> Gas Evolution.....        | 11 |
| Figure 4 - The Woods Metal Bath.....                                                                           | 12 |
| Figure 5 - Data Sheet Showing the Effect of Concentration of HCl on Speed of H <sub>2</sub> Gas Evolution..... | 18 |
| Figure 6 - Data Sheet Showing the Effect of Temperature of HCl on Speed of H <sub>2</sub> Gas Evolution .....  | 19 |
| Figure 7 - Data Sheet Showing the Effect of Surface Area of Mg on Speed of H <sub>2</sub> Gas Evolution .....  | 20 |
| Figure 8 - Data Sheet Showing the Moles of Reactants.....                                                      | 21 |

## List of Tables

|                                                                                          |   |
|------------------------------------------------------------------------------------------|---|
| Table 1 - Results on the Effect of Concentration of HCl .....                            | 3 |
| Table 2 - Time to dissolve and Rate of Reaction of Different Concentrations of HCl ..... | 4 |
| Table 3 - Results on the Effect of Temperature .....                                     | 5 |
| Table 4 - Time to dissolve and Rate of Reaction of Different Temperatures .....          | 5 |
| Table 5 - Results on the Effect of Surface Area of Mg .....                              | 6 |
| Table 6 - Moles, Time to dissolve and Rate of Reaction of Surface Area of Mg. 6          |   |
| Table 7 - Moles of the Reactants.....                                                    | 7 |

## List of Equations

|                                                                              |   |
|------------------------------------------------------------------------------|---|
| Equation 1 - Calculating the Rate of Reaction.....                           | 1 |
| Equation 2 - Calculating the Number of Moles Using Mass and Molar Mass ..... | 2 |
| Equation 3 - Calculating the Number of Moles Using Molarity and Volume ..... | 2 |

# 1 Introduction

The purpose of this experiment is to understand how different factors can affect rates of reaction, with the reactants in this experiment being Hydrochloric Acid (HCl) and Magnesium (Mg). This is important as it helps provide an in-depth understanding of the energy released during a reaction in different environments and compound mixtures, identifying how temperature, concentration and surface area can either increase or decrease the rate of reaction.

There are 3 parts to this experiment:

- In Part 1 the variable used will be the concentration of HCl in the reaction
- In part 2 the influence of temperature will be used to understand how the rate of reaction is affected
- In part 3 the surface area will be investigated by using a magnesium powder rather than strip in the reaction

For each of the parts the rate of reaction will be calculated using the following equation:

$$rate = \frac{\Delta V_{H_2}}{\Delta t} \text{ [cm}^3\text{/s]}$$

**Equation 1 - Calculating the Rate of Reaction**

Where:

$\Delta V_{H_2}$  = change in volume of hydrogen

$\Delta t$  = Change in time

*rate* = Rate of reaction in cm<sup>3</sup>/s

This equation describes how the change in the volume of hydrogen gas (a resultant of the reaction) along with the time can be used to calculate the rate in which the base and reactant are reacting.

It is predicted that increasing the 3 variables of molarity, temperature and surface area, will increase the rate of reaction.

Other Equations used in this experiment are as follows:

$$n = \frac{m}{MM}$$

**Equation 2 - Calculating the Number of Moles Using Mass and Molar Mass**

$$n = MV$$

**Equation 3 - Calculating the Number of Moles Using Molarity and Volume**

Where:

$n$  = Number of moles

$m$  = Mass

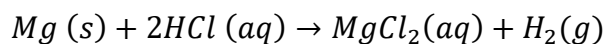
$M$  = Molarity

$MM$  = Molar mass

$V$  = Volume

## 2 Results

The reaction can be described by the following chemical equation:



### 2.1 Effect of Concentration of HCl on Speed of H<sub>2</sub> gas Evolution

| 0.5 M HCl |                       | 0.5 M HCl (cont.) |                       | 1.0 M HCl    |                       | 1.5 M HCl |                       |
|-----------|-----------------------|-------------------|-----------------------|--------------|-----------------------|-----------|-----------------------|
|           |                       |                   |                       | T 1 = 23.8°C |                       |           |                       |
| time, s   | V H <sub>2</sub> , mL | time, s           | V H <sub>2</sub> , mL | time, s      | V H <sub>2</sub> , mL | time, s   | V H <sub>2</sub> , mL |
| 0         | 0                     | 480               | 52.5                  | 0            | 0                     | 0         | 0                     |
| 20        | 3                     | 500               | 54                    | 10           | 10                    | 10        | 25                    |
| 40        | 6                     | 520               | 55                    | 20           | 20                    | 20        | 45                    |
| 60        | 9                     | 540               | 56                    | 30           | 28                    | 30        | 57                    |
| 80        | 12                    | 560               | 57                    | 40           | 35                    | 40        | 63                    |
| 100       | 15                    | 580               | 58                    | 50           | 41                    | 50        | 67                    |
| 120       | 17.5                  | 600               | 59                    | 60           | 43                    | 60        | 70                    |
| 140       | 20                    | 620               | 60                    | 70           | 53                    | 70        | 73                    |
| 160       | 22                    | 640               | 60.5                  | 80           | 60                    | 80        | 74                    |
| 180       | 25                    | 660               | 61.5                  | 90           | 63                    | 90        | 75                    |
| 200       | 27                    | 680               | 62                    | 100          | 66                    | 100       | 75                    |
| 220       | 29.5                  | 700               | 63                    | 110          | 69                    | 110       | 75                    |
| 240       | 31.5                  | 720               | 63.5                  | 120          | 70                    |           |                       |
| 260       | 34                    | 740               | 64                    | 130          | 71                    | 2.0 M HCl |                       |
| 280       | 36                    | 760               | 64.5                  | 140          | 72                    | 0         | 0                     |
| 300       | 38                    | 780               | 65                    | 150          | 72.5                  | 10        | 42                    |
| 320       | 40                    | 800               | 66                    | 160          | 73                    | 20        | 57                    |
| 340       | 42                    | 820               | 66                    | 170          | 74                    | 30        | 65                    |
| 360       | 43.5                  | 840               | 66                    | 180          | 74                    | 40        | 70                    |
| 380       | 45                    | 860               | 66                    | 190          | 75                    | 50        | 74                    |
| 400       | 47                    | 880               | 66                    | 200          | 75                    | 60        | 76                    |
| 420       | 48.5                  | 900               | 66                    | 210          | 75                    | 70        | 76                    |
| 440       | 50                    |                   |                       | 220          | 75                    | 80        | 76                    |
| 460       | 51                    |                   |                       | 227.7        | 75                    |           |                       |

Table 1 - Results on the Effect of Concentration of HCl

| [HCl] | time to dissolve<br>Mg (s) | average rate<br>(cm <sup>3</sup> /s) | instantaneous rate<br>at     |
|-------|----------------------------|--------------------------------------|------------------------------|
|       |                            |                                      | t = 0 s (cm <sup>3</sup> /s) |
| 0.5 M | 900                        | 0.15                                 | 0.15                         |
| 1.0 M | 227                        | 0.75                                 | 1.0                          |
| 1.5 M | 90                         | 0.93                                 | 2.5                          |
| 2.0 M | 80                         | 0.95                                 | 4.2                          |

**Table 2 - Time to dissolve and Rate of Reaction of Different Concentrations of  
HCl**

## 2.2 Effect of Temperature on Speed of H<sub>2</sub> Gas Evolution (Using 1M HCl)

| T 2 = 41.2°C |                          | T 3 = 53.8°C |                          | T 3 = 53.8°C<br>(Cont.) |                          |
|--------------|--------------------------|--------------|--------------------------|-------------------------|--------------------------|
| time,<br>s   | V H <sub>2</sub> ,<br>mL | time,<br>s   | V H <sub>2</sub> ,<br>mL | time,<br>s              | V H <sub>2</sub> ,<br>mL |
| 10           | 18                       | 0            | 0                        | 170                     | 62                       |
| 20           | 31                       | 10           | 17                       | 180                     | 63.5                     |
| 30           | 41                       | 20           | 29                       | 190                     | 65                       |
| 40           | 50                       | 30           | 38                       | 200                     | 66                       |
| 50           | 57                       | 40           | 44                       | 210                     | 67                       |
| 60           | 61                       | 50           | 47                       | 220                     | 68.5                     |
| 70           | 63                       | 60           | 50                       | 230                     | 69.5                     |
| 80           | 64.5                     | 70           | 51                       | 240                     | 70.5                     |
| 90           | 65                       | 80           | 53                       | 250                     | 71.5                     |
| 100          | 66                       | 90           | 54                       | 260                     | 72.5                     |
| 110          | 67                       | 100          | 55                       | 270                     | 73.5                     |
| 120          | 68                       | 110          | 56                       | 280                     | 74                       |
| 130          | 68.5                     | 120          | 57                       | 290                     | 74.5                     |
| 140          | 70                       | 130          | 57.5                     | 300                     | 75                       |
| 150          | 70                       | 140          | 58                       | 310                     | 75                       |
| 160          | 71                       | <b>150*</b>  | <b>59*</b>               | 320                     | 75                       |
| 170          | 71.5                     | 160          | 61                       | 330                     | 75                       |

**Table 3 - Results on the Effect of Temperature**

\* Magnesium had not fully submerged until this point – this dramatically effected results

| temperature | time to dissolve<br>Mg (s) | average rate<br>(cm <sup>3</sup> /s) | instantaneous<br>rate at     |
|-------------|----------------------------|--------------------------------------|------------------------------|
|             |                            |                                      | t = 0 s (cm <sup>3</sup> /s) |
| T 1         | 227                        | 0.75                                 | 1.0                          |
| T 2         | 170                        | 0.81                                 | 1.8                          |
| T 3         | 371                        | 0.66                                 | 1.7                          |

**Table 4 - Time to dissolve and Rate of Reaction of Different Temperatures**

## 2.3 Effect of the Surface Area of Mg on Speed of H<sub>2</sub> Gas Evolution

| T 1 = 24.6°C |                          |            |                          |
|--------------|--------------------------|------------|--------------------------|
| time,<br>s   | V H <sub>2</sub> ,<br>mL | time,<br>s | V H <sub>2</sub> ,<br>mL |
| 0            | 0                        | 170        | 61.5                     |
| 10*          | 0*                       | 180        | 62.5                     |
| 20           | 8                        | 190        | 64                       |
| 30           | 15                       | 200        | 64.5                     |
| 40           | 22                       | 210        | 65                       |
| 50           | 27                       | 220        | 65.5                     |
| 60           | 31                       | 230        | 66                       |
| 70           | 35                       | 240        | 66                       |
| 80           | 39                       | 250        | 66.5                     |
| 90           | 43                       | 260        | 66.5                     |
| 100          | 46                       |            |                          |
| 110          | 49                       |            |                          |
| 120          | 52.5                     |            |                          |
| 130          | 54.5                     |            |                          |
| 140          | 57                       |            |                          |
| 150          | 58.5                     |            |                          |
| 160          | 60                       |            |                          |

**Table 5 - Results on the Effect of Surface Area of Mg**

\* The syringe had not been reset at the start of the reaction, causing a delay

| Mg turnings |        | time to<br>dissolve<br>Mg (s) | rate                            |                                                 |
|-------------|--------|-------------------------------|---------------------------------|-------------------------------------------------|
| mass (g)    | moles  |                               | Average<br>(cm <sup>3</sup> /s) | instantaneous at t<br>= 0s (cm <sup>3</sup> /s) |
| 0.073       | 0.0030 | 297                           | 0.49                            | 0.8                                             |

**Table 6 - Moles, Time to dissolve and Rate of Reaction of Surface Area of Mg**

## 2.4 Moles of the Reactants

| Mg      |        | 2 M HCl    |       |
|---------|--------|------------|-------|
| Mass(g) | moles  | Volume(mL) | moles |
| 0.0765  | 0.0031 | 5          | 0.010 |
|         |        | 10         | 0.020 |
|         |        | 15         | 0.030 |
|         |        | 20         | 0.040 |

Table 7 - Moles of the Reactants

## 2.5 Calculations

Calculations for instantaneous and average rate for effect of concentration of HCl:

$$rate = \frac{\Delta V_{H_2}}{\Delta t}$$

For 0.5M HCl:

$$rate_{Ins} = \frac{3mL}{20s} = 0.15CM^3/S$$

$$rate_{Avg} = \frac{12mL}{80s} = 0.15CM^3/S$$

For 1.0M HCl:

$$rate_{Ins} = \frac{10mL}{10s} = 1.0CM^3/S$$

$$rate_{Avg} = \frac{60mL}{80s} = 0.75CM^3/S$$

For 1.5M HCl:

$$rate_{Ins} = \frac{25mL}{10s} = 2.5CM^3/S$$

$$rate_{Avg} = \frac{74mL}{80s} = 0.93CM^3/S$$

For 2.0M HCl:

$$rate_{Ins} = \frac{42mL}{10s} = 4.2CM^3/S$$

$$rate_{Avg} = \frac{76mL}{80s} = 0.95CM^3/S$$

Calculations for instantaneous and average rate for effect of temperature:

T1 the results used were taken from the previous experiment for 1M

For T2:

$$rate_{Ins} = \frac{18mL}{10s} = 1.8CM^3/S$$

$$rate_{Avg} = \frac{64.5mL}{80s} = 0.81CM^3/S$$

For T3:

$$rate_{Ins} = \frac{17mL}{10s} = 1.7CM^3/S$$

$$rate_{Avg} = \frac{53mL}{80s} = 0.66CM^3/S$$

Calculations for instantaneous and average rate for effect of the surface area of Mg:

$$rate_{Ins} = \frac{8mL}{10s} = 0.8CM^3/S \quad - \text{ This figure was calculated from } T0 = 10 \text{ and } T1=20$$

$$rate_{Avg} = \frac{66.5mL}{297s} = 0.22CM^3/S$$

Calculations for number of moles in Mg and HCl:

$$n = \frac{m}{MM} \text{ for solids and } n = MV \text{ for fluids}$$

For Mg strips:

$$n = \frac{0.0765g}{24.3g/M} = 0.0031 \text{ moles}$$

For Mg turnings:

$$n = \frac{0.073g}{24.3g/M} = 0.0030 \text{ moles}$$

For 0.5M HCl:

$$n = 2M \times 0.005L = 0.010 \text{ moles}$$

For 1.0M HCl:

$$n = 2M \times 0.01L = 0.020 \text{ moles}$$

For 1.5M HCl:

$$n = 2M \times 0.015L = 0.030 \text{ moles}$$

For 2.0M HCl:

$$n = 2M \times 0.02L = 0.040 \text{ moles}$$

## 2.6 Graphical Representation of Findings

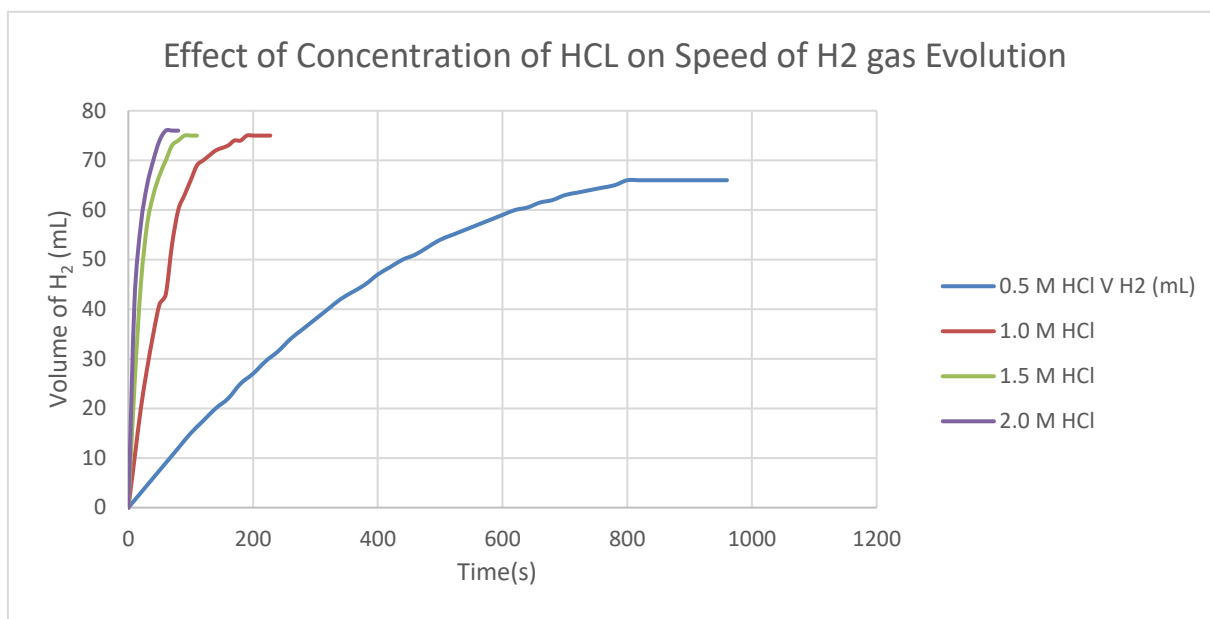


**Figure 1 - Graph Showing the Effect of Concentration of HCl on Speed of H<sub>2</sub> Gas Evolution**

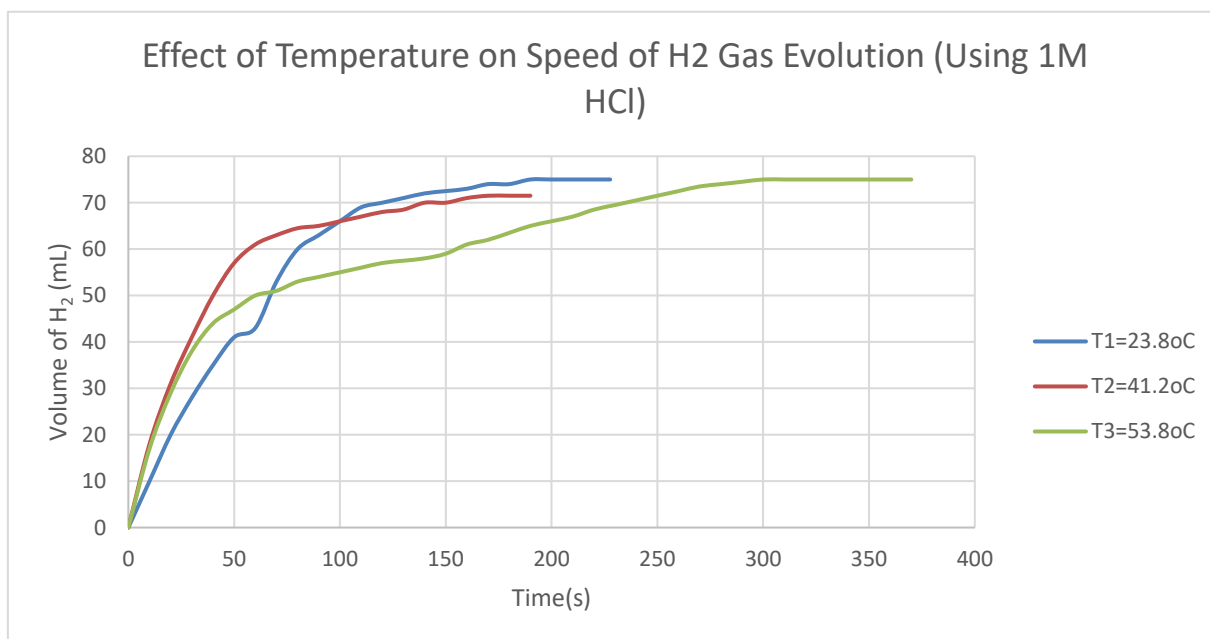


**Figure 2 - Graph Showing the Effect of Temperature of HCl on Speed of H<sub>2</sub> Gas Evolution**

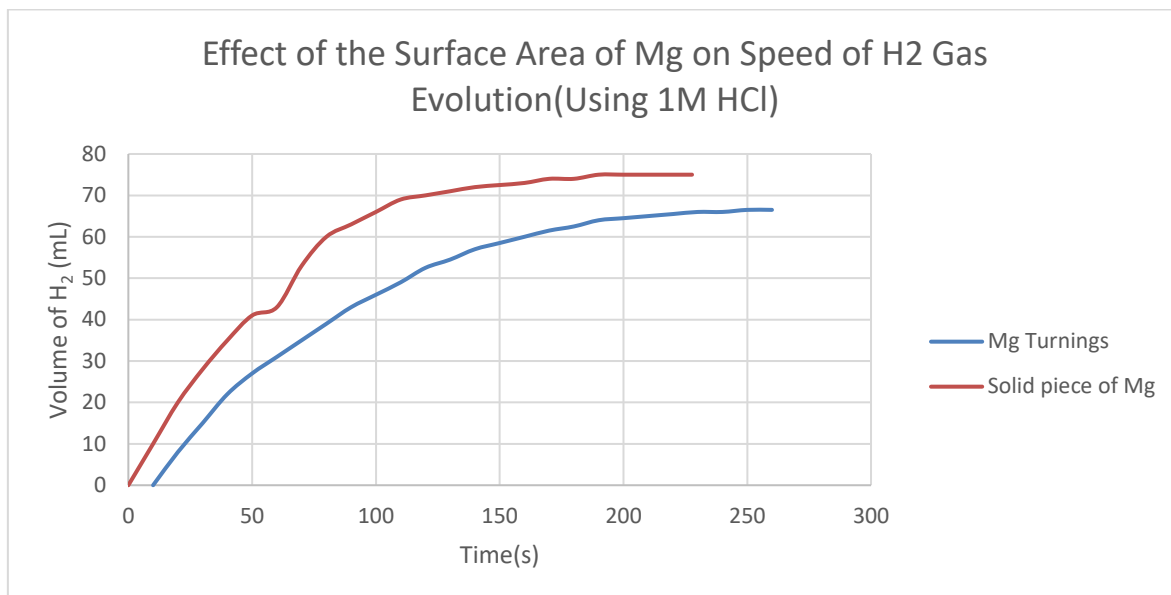


**Figure 3 - Graph Showing the Effect of Surface Area of Mg on Speed of H<sub>2</sub> Gas Evolution**

## 3 Discussion

### 3.1 Significance of Findings

The findings support the hypothesis in the instances that there was not an issue with the experiment, proving that raising the concentration, temperature and/or surface area of the reactant will increase the rate of reaction.

### 3.2 Relevance to OME

Within the mining industry, materials are tested for rate of explosive decomposition through variation of temperature, using a piece of equipment known as the 'Woods Metal Bath', shown below:

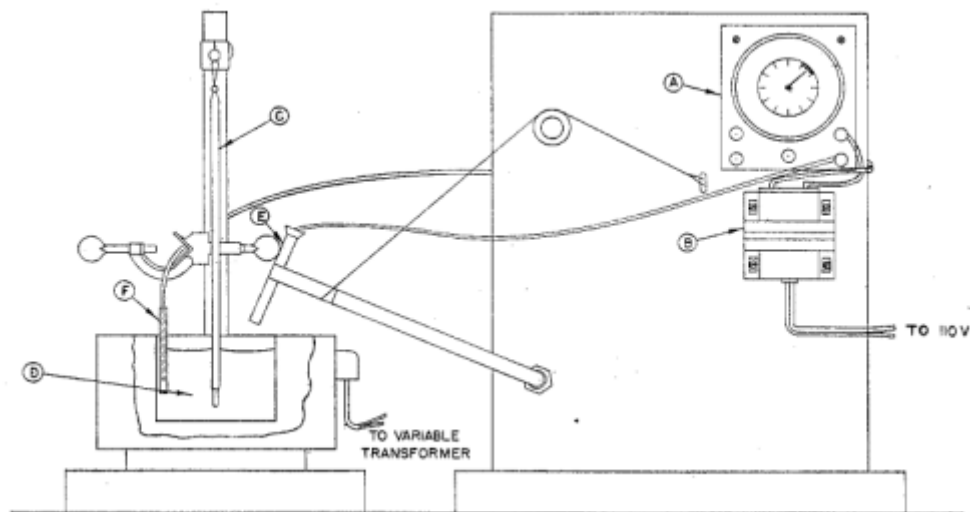


**Figure 4 - The Woods Metal Bath**

This apparatus is comprised of a cylindrical copper tube, Nichrome wire wound in a coil, a gage, a mandrel, a mercury thermometer for measuring temperature and asbestos for insulation against short circuits. A Small amount of explosive material is placed inside the copper tube and heated via electrical methods until an impulse is felt by the wire. Its purpose is to identify temperatures in which materials became explosive and therefore understanding safe operating conditions. It is described as permitting “A more accurate and objective determination of the time lag prior to explosion”. [1]

Also within OME sector surface area has been analysed for safety purposes. This is done by testing “the rate of pressure rise of explosion reactions in dust/air mixtures under atmospheric conditions”, as described by Klaus-Werner Stahmer. The study goes on to talk about the planning of protective measures such as pressure release or suppression systems and uses Equations such as Arrhenius equation to calculate the kinetics of the explosion reactions. [2]

### **3.3 Limitations and Sources of Error in the Experiment**

A number of errors occurred during this experiment, such as the magnesium strip sticking to the side of the test tube and not fully submerging in the solution, therefore creating a reduction in reaction. Another error was forgetting to reset the gas syringe to 0 when beginning the experiment with the Mg turnings, leading to a loss of gas buildup and reaction measurement for the first 10 seconds of this part of the experiment, which is arguably where the highest rate of reaction would be taking place.

## **4 Conclusion**

### **4.1 Summary and Evaluation**

To summarise, the experiment analysed and understood the effects of concentration, temperature and surface area on the rate of reaction between a solution and reactant. It proved the hypothesis even in the event that the experiment was misconducted, as less Mg was submerged there was a smaller surface area of the reactant in the reaction, therefore slowing the rate of reaction. Unfortunately due to time restraints and a breakage of equipment at the beginning of the experiment, parts of the experiment were not able to be reconducted.

### **4.2 Direction for Future Research**

If this experiment were to be conducted again, then any mistakes would be reconducted more accurately and apparatus would be tested prior to use to ensure correct working conditions.

## 5 References

- [1] H.Henkin and R. McGill. "Experimental and Theoretical Kinetic Study as a Function of Temperature", *Rates of Explosive Decomposition of Explosives* –. Volume 44, Issue 6, Page 1391. 19520601.
- [2] K.W.Stahmer. "Effect of Variation in Particle Surface Area upon Explosion reaction", *Study of the Explosion Reactions of Sucrose, Activated Charcoal, Polyethylene and Lignite Part 1*. Volume 46. Pages 177-184. 20170301.

## 6 Appendices

### 6.1 Materials and Equipment

- Long test tube with arm
- Gas syringe
- Rubber bung and delivery tube to fit the test tube
- Two large beakers for the water bath and reaction mixture
- Pipette and pipette filler
- Two clamp stands
- Test tube holder
- Thermometer
- Ring stand, Bunsen burner, clay triangle
- Stopwatch

### 6.2 Experimental Procedure

#### 6.2.1 Effect of HCl concentration on the speed of H<sub>2</sub> gas evolution

1. Four 20.0 mL solutions of HCl were prepared with the following concentrations: 2.0 M (stock), 1.5 M, 1.0 M and 0.5 M. Using the pipette, appropriate volumes of the 2.0 M HCl solution and De-Ionised water were measured.
2. The HCl solution with the lowest concentration was poured into the test tube with arm.
3. When ready, a 4 cm strip of magnesium ribbon was added to the test tube, the bung quickly put back, and the stopwatch started.
4. For the 1 M HCl, the Mg ribbon from the premeasured vial was used. This set of data was used for Part 3.
5. The volume of hydrogen gas given off was recorded at suitable intervals (10-20 seconds). Timing was continued until no more gas was given off.
6. After the reaction was completed, the reaction mixture was discarded into the waste beaker.
7. The temperature of 1.0 M HCl was measured as it was needed for Part 2.
8. The same experiment was repeated for three other concentrations of HCl.

The graph ( $V_{H_2}$  vs  $t$ ) was plotted showing the change in volume of H<sub>2</sub> gas over time for each concentration of HCl.

For each concentration of HCl it was determined the:

1. Average rate of reaction (between  $t = 0$ s and  $t = t_1$ ; using the same  $t_1$  for all concentrations)
2. Instantaneous rate of reaction at  $t = 0$ .

### 6.2.2 Effect of temperature on the speed of H<sub>2</sub> gas evolution

1. A water bath was set up by pouring water into the large beaker and heating it over the Bunsen burner until the temperature of water increased by approximately 10°C when compared to the initial temperature of 1 M HCl measured in the previous part.
2. 20 mL of 1.0 M stock solution was transferred via pipette into two test tubes.
3. The first test tube with 1.0 M HCl was placed in the water bath and left until the temperature of the acid reached the temperature of the water in the water bath.
4. The warm HCl was quickly transferred into the tube with the arm, as well as a piece of the pre-measured magnesium ribbon, the bung put back, and the stopwatch started.
5. Timing continued until no more gas was given off.
6. After the reaction was completed, the reaction mixture was discarded into the waste beaker.
7. The same experiment was repeated another temperatures (roughly 10 degC higher).

A separate graph was plotted showing the change in volume of H<sub>2</sub> gas over time for each temperature (V<sub>H<sub>2</sub></sub> vs t).

For each concentration of HCl it was determined the:

1. Average rate of reaction (between t = 0s and t = t<sub>1</sub>; use the same t<sub>1</sub> for all temperatures)
2. Instantaneous rate of reaction at t = 0.

### 6.2.3 Effect of the surface area of Mg on speed of H<sub>2</sub> gas evolution

1. Using the pipette 20 mL of 1 M HCl was transferred at room temperature into the test tube with arm.
2. The Mg turnings were quickly added into the test tube, putting the bung back after and starting the stopwatch.
3. Timing continued until no more gas was given off.
4. After the reaction was complete, The reaction mixture was discarded into the waste beaker.

The graph showing the change in volume of H<sub>2</sub> gas over time (V<sub>H<sub>2</sub></sub> vs t) was plotted for each temperature. Determining the:

1. Average rate of reaction (between t = 0s and t = t<sub>1</sub>; use the same t<sub>1</sub> for both Mg samples).
2. Instantaneous rate of reaction at t = 0.

## 6.3 Screenshots of Data Sheets

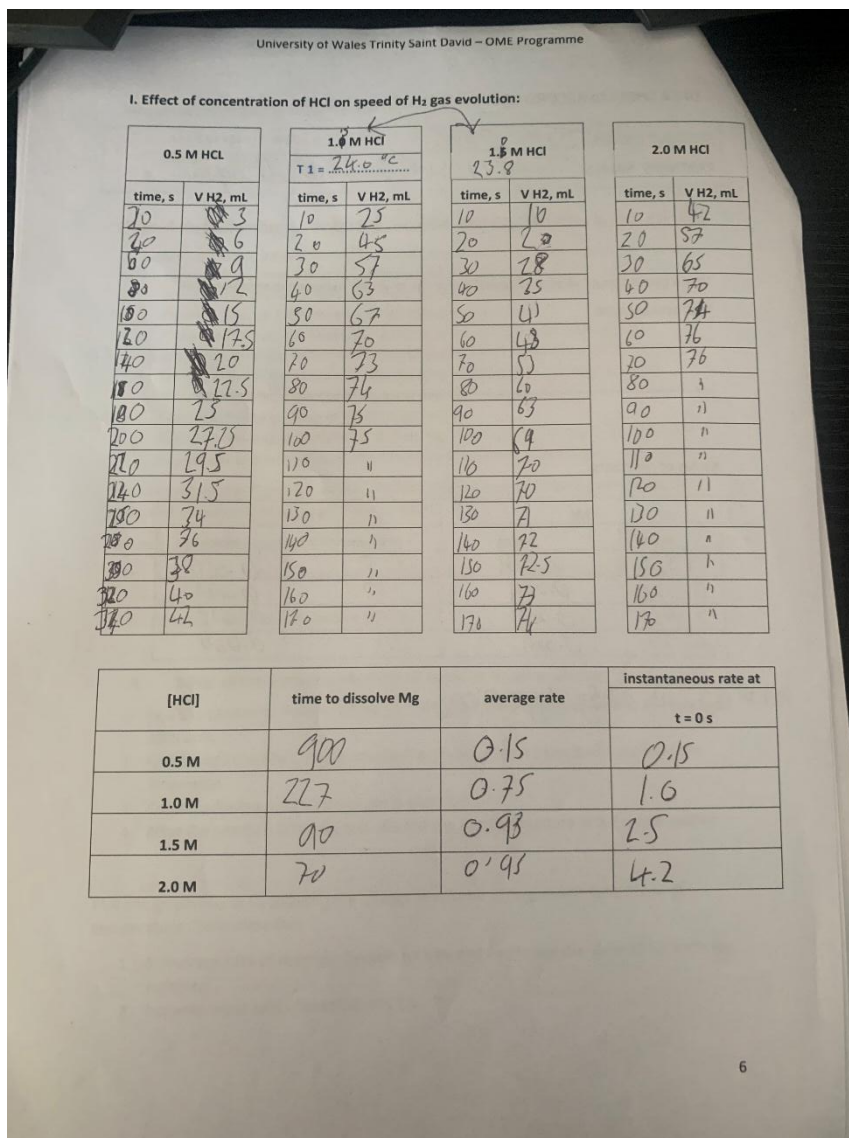


Figure 5 - Data Sheet Showing the Effect of Concentration of HCl on Speed of H<sub>2</sub> Gas Evolution

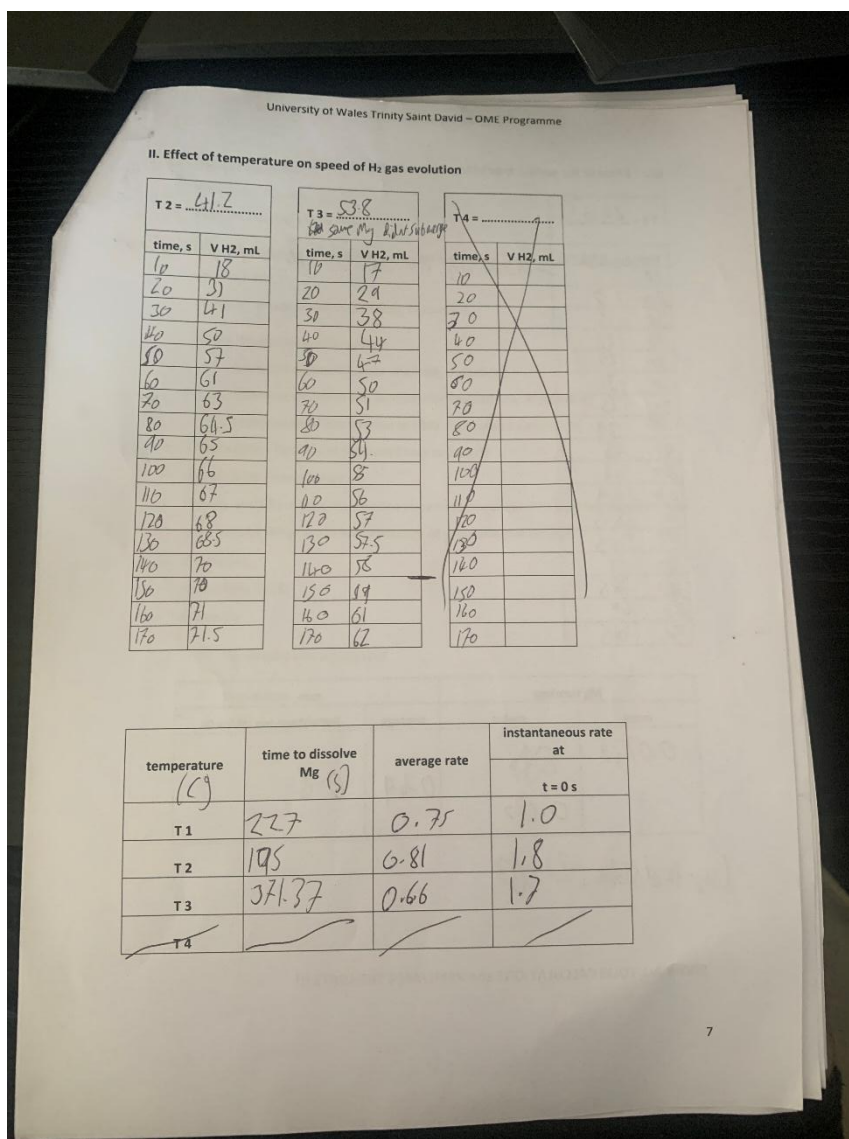


Figure 6 - Data Sheet Showing the Effect of Temperature of HCl on Speed of H<sub>2</sub> Gas Evolution

III. Effect of the surface area of Mg on speed of H<sub>2</sub> gas evolution

T 1 = 24.6 °C

| time, s | V H <sub>2</sub> , mL |
|---------|-----------------------|
| 10      |                       |
| 20      | 8                     |
| 30      | 15                    |
| 40      | 22                    |
| 50      | 27                    |
| 60      | 31                    |
| 70      | 35                    |
| 80      | 39                    |
| 90      | 43                    |
| 100     | 46                    |
| 110     | 49                    |
| 120     | 52.5                  |
| 130     | 54.5                  |
| 140     | 57                    |
| 150     | 58.5                  |
| 160     | 60                    |
| 170     | 61.5                  |

initial 10s not recorded - forgot to reset plunger

| Mg turnings |                             | rate    |                         |
|-------------|-----------------------------|---------|-------------------------|
| mass        | moles                       | average | instantaneous at t = 0s |
| 0.073g      | <del>0.0028</del><br>0.0030 | 0.49    | 0.8                     |

time to dissolve = 297.6s

SHOW ALL YOUR CALCULATIONS and REMEMBER THE UNITS !!!

Figure 7 - Data Sheet Showing the Effect of Surface Area of Mg on Speed of H<sub>2</sub> Gas Evolution

DATA SHEET to RECORD OBSERVATIONS, CALCULATIONS and RESULTS

STUDENT'S NAME: JAMES BURTON

PARTNERS' NAMES: Thomas Cresswell & Joseph Nelham

REPORT IS DUE MAY 09 2025 (DD. MAY 16) @3.00pm submitted via Moodle

Write the balanced chemical equation for the reaction between magnesium and hydrochloric acid:

.....

Moles of reactants:

| Mg       |        | 2 M HCl     |       |
|----------|--------|-------------|-------|
| mass (g) | moles  | volume (ml) | moles |
| 0.0765   | 0.0031 | 5           | 0.010 |
| 0.0765   | 0.0031 | 10          | 0.020 |
| 0.0765   | 0.0031 | 15          | 0.030 |
| 0.0765   | 0.0031 | 20          | 0.040 |

Mass of Mg = 0.0765g Avg  $\pm$  0.005

Figure 8 - Data Sheet Showing the Moles of Reactants