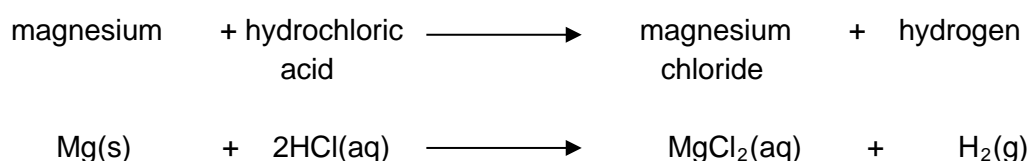


## Investigation of the factors that affect the rate of reaction using a gas collection method

### Introduction

Magnesium reacts with dilute hydrochloric acid to produce hydrogen. The equation for the reaction is as follows:



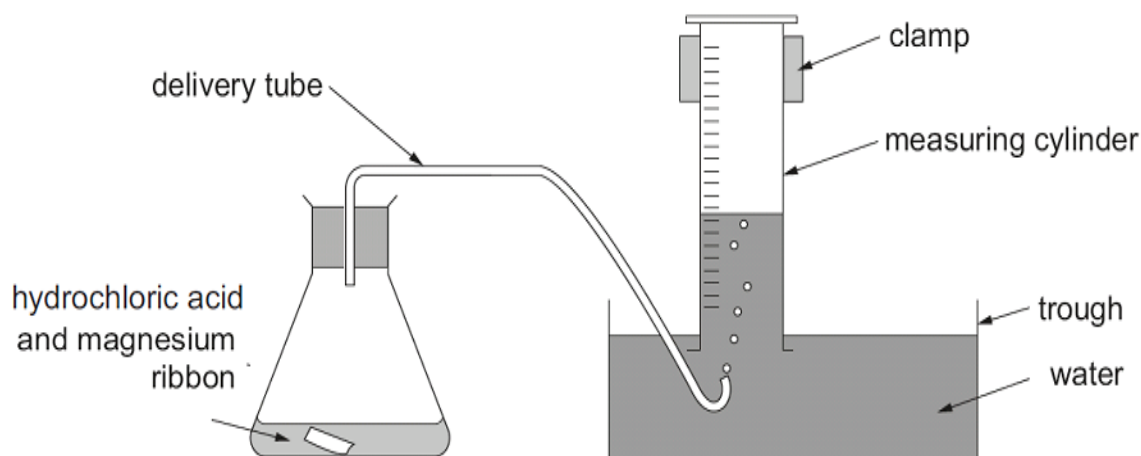
The rate at which the hydrogen gas is produced can be used to determine the rate of the reaction.

In this experiment you will study the effect of changing the concentration of the hydrochloric acid on the rate of the reaction.

### Apparatus

250 cm<sup>3</sup> conical flask  
 single-holed rubber bung  
 delivery tube to fit conical flask  
 trough or plastic washing-up bowl  
 100 cm<sup>3</sup> measuring cylinder  
 250 cm<sup>3</sup> measuring cylinder  
 clamp stand, boss and clamp  
 stopwatch  
 magnesium ribbon in 3 cm lengths  
 1 mol/dm<sup>3</sup> hydrochloric acid

## Diagram of Apparatus



## Method

1. Set up the apparatus as shown in the diagram.
2. Measure  $20\text{ cm}^3$  of  $1\text{ mol/dm}^3$  hydrochloric acid using the  $25\text{ cm}^3$  measuring cylinder. Pour the acid into the  $250\text{ cm}^3$  conical flask.
3. Fill the other measuring cylinder with water, make sure that it stays filled with water when you turn it upside down and clamp above the trough.
4. Add a 3cm strip of magnesium ribbon to the flask, put the bung into the flask and start the stopwatch.
5. Record the volume of hydrogen gas given off every ten seconds. Continue timing until no more gas appears to be given off.
6. Repeat steps 2-5 using  $10\text{ cm}^3$  of the hydrochloric acid and  $10\text{ cm}^3$  of water to make the total volume used  $20\text{ cm}^3$ .

## Analysis

1. Plot a graph of volume of hydrogen gas ( $y$ -axis) against time ( $x$ -axis), for both concentrations of hydrochloric acid and label the lines appropriately.

## Risk Assessment

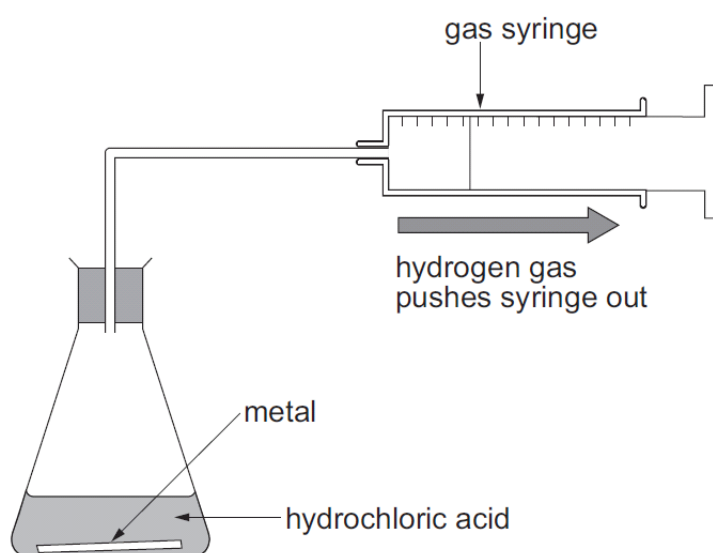
Hazard	Risk	Control measure
Hydrochloric acid is an irritant	Hydrochloric acid could get onto the skin when adding to measuring cylinder	Wash hands immediately if any hydrochloric acid gets onto them / wear laboratory gloves
	Hydrochloric acid could get transferred from the hands to the eyes	Wear eye protection

## Teacher / Technician notes

The magnesium ribbon should be clean and free from obvious corrosion or oxidation. Clean if necessary by rubbing lengths of the ribbon with an emery cloth to remove the layer of oxide. To ensure that most of the magnesium surface is under the surface of the acid, it should be folded into a zigzag shape.

The bungs in the flasks need to be rubber. Corks are too porous and will leak. The tube through the bung should be a short section of glass, and then a flexible rubber tube can be connected. These can be pre-prepared before the reaction so all the student has to do is push the bung into the flask.

Gas syringes can be used instead of troughs of water and measuring cylinders. Syringes should not be allowed to become wet, or the plungers will stick inside the barrels. The apparatus set up for this procedure is shown in the diagram below:



Reagents:

- Hydrochloric acid – Refer to CLEAPSS hazard card 47A
- Magnesium ribbon – Refer to CLEAPSS hazard card 59A

A 3cm length of magnesium ribbon has a mass of 0.04 g and should yield 40cm<sup>3</sup> of hydrogen gas when reacted with this excess of acid.

If a graph of volume (y-axis) against time (x-axis) is drawn, the slope of the graph is steepest at the beginning. This shows that the reaction is fastest at the start. As the magnesium is used up, the rate falls. This can be seen on the graph, as the slope becomes less steep and then levels out when the reaction has stopped (when no more gas is produced).

No repeats have been included in the method, but students can compare results with other groups to make judgements on reproducibility.

### Working scientifically skills covered

#### 2. 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.

Make and record observations and measurements using a range of apparatus and methods.

#### 3. Analysis and Evaluation

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

#### 4. Scientific vocabulary, quantities, units, symbols and nomenclature

Use scientific vocabulary, terminology and definitions.