GCSE

Rewarding Learning

CCEA GCSE TEACHER GUIDANCE

Double Award Science Practical Manual

Unit 7: Practical Skills

C4: Investigate how changing a variable changes the rate of reaction

For first teaching from September 2017

Investigate how changing a variable changes the rate of reaction

The rate of a chemical reaction can be thought of as:-

How quickly reactants are used up, or how quickly products form.

In this experiment we will be looking at how quickly magnesium reacts with dilute hydrochloric acid.

Write a balanced symbol equation for the reaction of magnesium with hydrochloric acid, include state symbols.

The reaction is complete when the magnesium disappears completely. The rate of the reaction will be affected by how concentrated the hydrochloric acid is, why is this?

We will be changing the concentration of the hydrochloric acid and investigating how this change affects how quickly the magnesium reacts. What do you think will happen?

To carry out this investigation we need to consider several factors:-

1) What will we change?

   This is known as the Independent Variable – in this case you will change the concentration of the hydrochloric acid by diluting it with deionised water.

2) What will we measure?

   This is known as the Dependent Variable – it will depend on the changes we make. We will measure the time it takes for the magnesium to react fully with the acid.

3) What will we keep the same?

   These are known as Controlled Variables – these are factors which would affect the rate of the reaction if they were not kept the same. In this case we need to:

   Use the same volume of solution

   Use the same mass of magnesium

   Use the same temperature of reaction

   Use the same particle size of magnesium

Safety considerations

Follow safety advice as given by your teacher.

Apparatus and Chemicals

200 cm^3 of 2 mol/dm^3 hydrochloric acid and deionised water

10 x 3 cm strips of magnesium

100 cm^3 beaker, 250 cm^3 beaker, watch glass, measuring cylinder (25 cm^3)

Stop clock

Method

1. Carefully collect 200 cm^3 of hydrochloric acid using the 250cm^3 beaker, and 10 strips of magnesium using a watch glass.

2. Using the measuring cylinder, measure out 25 cm^3 of hydrochloric acid and add to the small beaker. Remember to use the measuring cylinder accurately.

3. Drop the piece of magnesium ribbon into the beaker and start the stop watch, swirl once to ensure the magnesium is fully coated in the acid. Stop the watch when all the magnesium disappears.

4. Repeat the experiment to ensure reliability of results.

5. Repeat steps 2-4 except using a total of five different volumes of acid and water to ensure different concentrations of acid. The proportions you need to use are given in the results table:

Volume of hydrochloric acid (cm^3)	Volume of deionised water (cm^3)	Time taken for magnesium to disappear (s)		
		1	2	Average
25	0			
20	5			
15	10			
10	15			
5	20			

Analysis of results

In this experiment we can use the times to calculate an approximate value for the rate of each reaction by using the formula:-

$$\text{Rate} = \frac{1}{\text{time}}$$

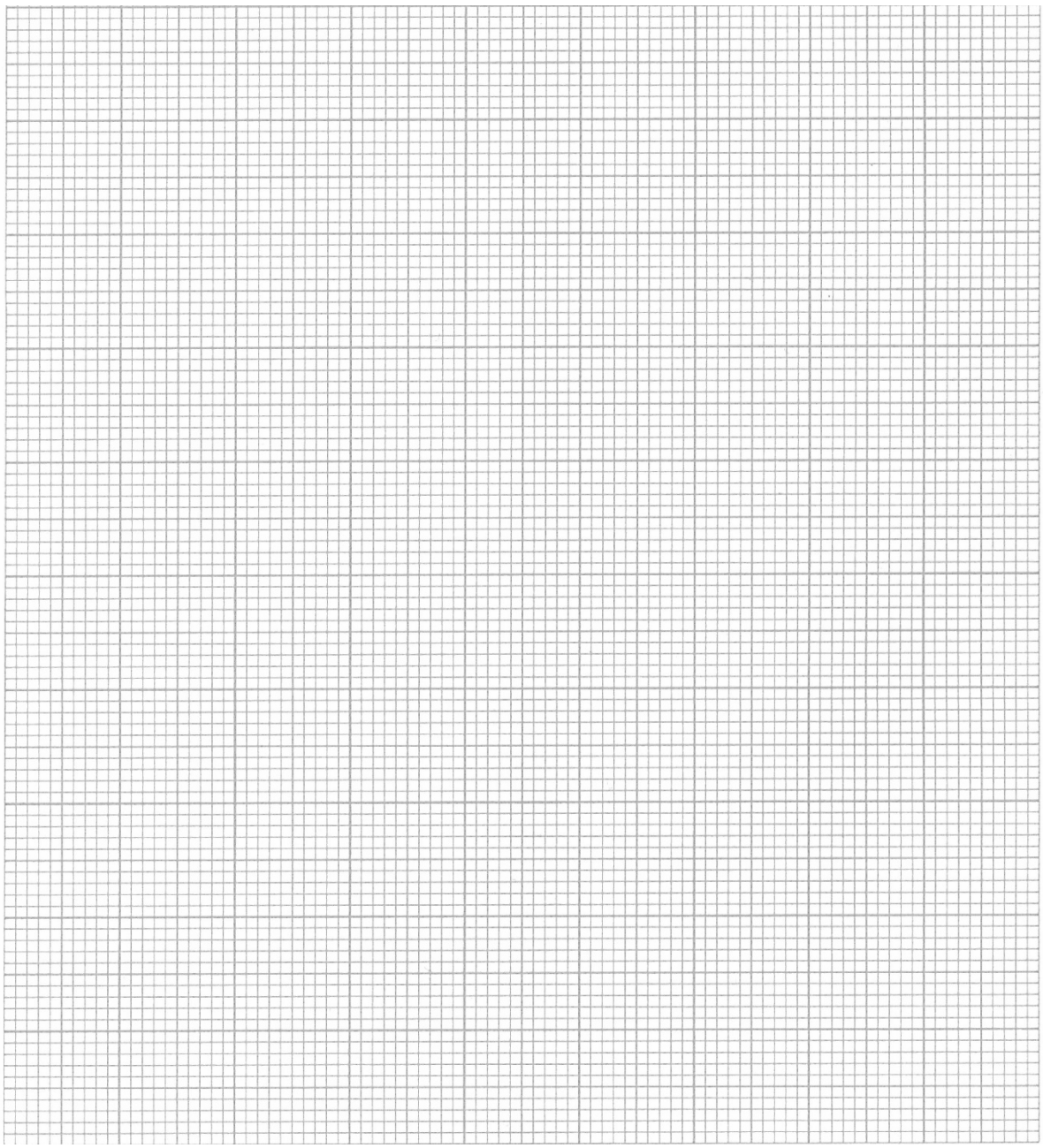
Using your average times calculate the rate of reaction for each experiment:-

Average time (s)	Rate (s^{-1})

We can also calculate the percentage of acid used, or, since we know the original concentration of the acid is 2 mol/dm^3, we can calculate the concentration for each experiment:-

Volume of Acid (cm^3)	Percentage Acid	Concentration (mol/dm^3)
25	100	2.0
20	80	1.6
15	60	1.2
10	40	0.8
5	20	0.4

Finally, we can plot a graph of our Independent Variable (x-axis) against our Dependent Variable (y-axis). Your Independent Variable will be either % Acid, or Concentration. Your Dependent Variable will either be time or rate. Your teacher will instruct you on which to use.



Conclusions

How did your Independent Variable affect the Dependent Variable?

Compare your graph with other groups in your class, are there any similarities? Are there any differences?

Did you have any anomalous results? How did you know?

How could you have made your measurements more accurate in this experiment?