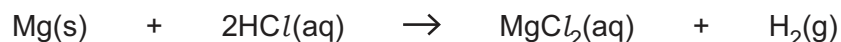


- 1 Magnesium reacts with dilute hydrochloric acid to form magnesium chloride and hydrogen.

The equation for this reaction is shown.



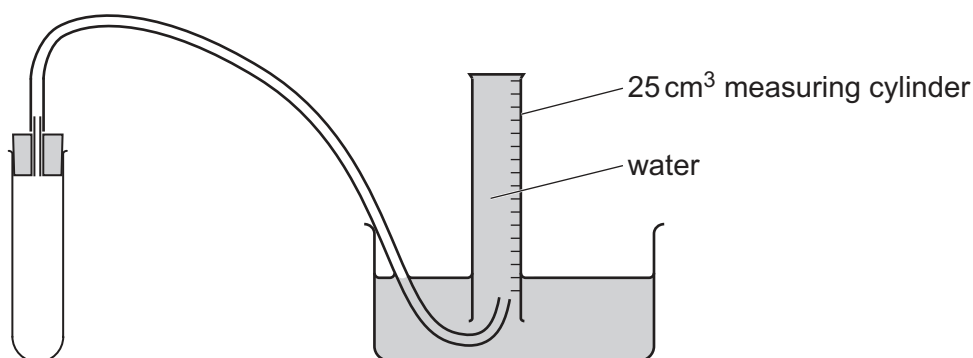
You are going to investigate the effect of the concentration of hydrochloric acid on the rate of the reaction.

P is 2.0 mol/dm^3 hydrochloric acid.

Q is magnesium ribbon.

- (a) Use the apparatus shown with the boiling tube in a rack and the measuring cylinder supported with a stand and clamp.

Fill the trough and measuring cylinder with water.



Remove the bung from the boiling tube.

Place one strip of **Q** into the boiling tube.

In experiment 1 add 4.0 cm^3 of water and then 6.0 cm^3 of **P** to the boiling tube. Quickly insert the bung back into the boiling tube.

Immediately start timing.

Stop timing when 18 cm^3 of hydrogen has been collected. Record the time taken to the nearest second in the table.

Repeat the experiment four more times using the volumes of **P** and water shown in the table.

experiment	1	2	3	4	5
volume of water/ cm^3	4.0	3.0	2.0	1.0	0.0
volume of P / cm^3	6.0	7.0	8.0	9.0	10.0
time to produce 18 cm^3 gas/s					
concentration of P in mol/dm^3					2.0

[7]

- (b) P is 2.0 mol/dm^3 hydrochloric acid.

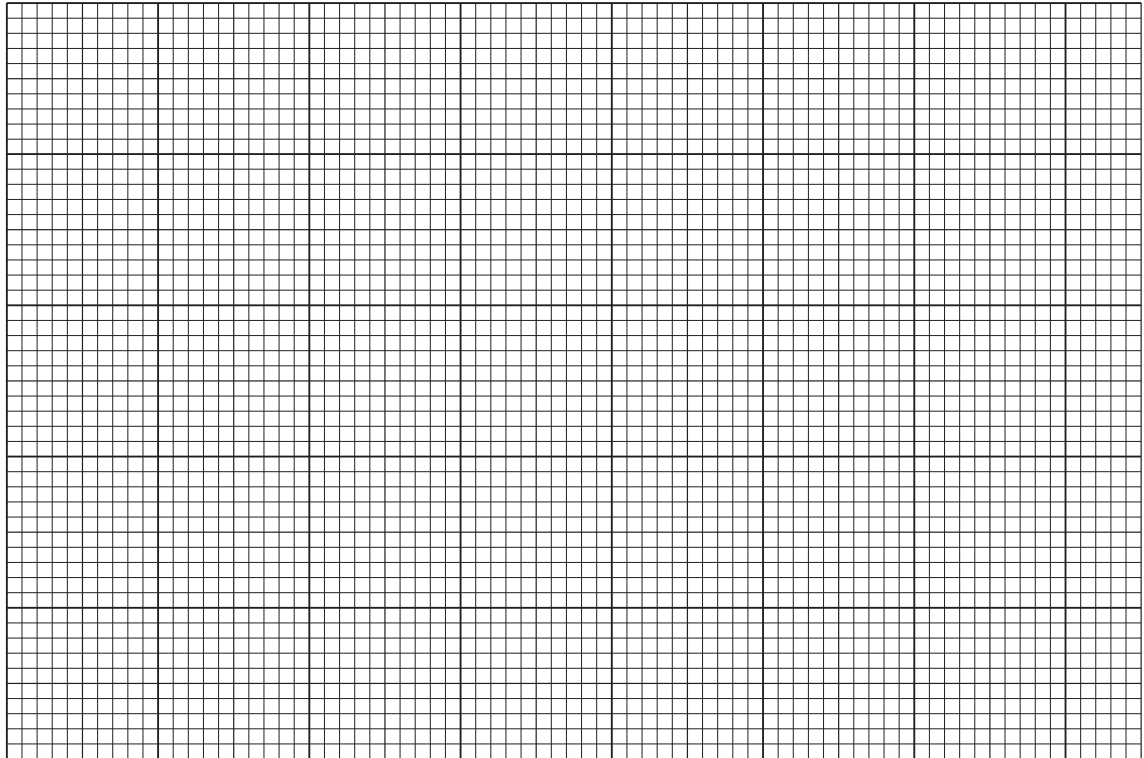
Calculate the concentration of hydrochloric acid in each experiment.

Write your answers in the table.

[1]

- (c) Use data from the table to plot a graph of the concentration of hydrochloric acid (x-axis) against the time taken to collect 18 cm^3 of hydrogen (y-axis).

Draw a curve of best fit.



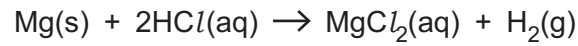
[5]

- (d) Calculate the number of moles of hydrogen, H_2 , in 18 cm^3 of hydrogen at room temperature and pressure (r.t.p.).

[The volume of one mole of hydrogen is $24\,000 \text{ cm}^3$ at r.t.p.]

number of moles of hydrogen [1]

- (e) Use your answer from (d) to calculate the number of moles of HCl that react to form 18 cm³ of H₂ at r.t.p.



number of moles of HCl [1]

- (f) Use data from the table and your answer from (e) to calculate the mean rate of reaction, in mol/s, of P in experiment 5.

Give your answer to **two** significant figures.

mean rate of reaction in experiment 5 mol/s [2]

[Total: 17]

2 You are provided with solution **R** and solution **S**.

(a) (i) Do the tests shown in the table on **R**.

Record your observations in the table.

You should test and name any gases evolved.

test no.	test	observations
1	To 1 cm depth of R in a boiling tube, add aqueous sodium hydroxide drop by drop until a change is seen. Add excess aqueous sodium hydroxide. Keep the solution for use in test 2.	
2	Gently warm the mixture from test 1.	
3	To 1 cm depth of R in a test-tube, add aqueous ammonia drop by drop until a change is seen. Add excess aqueous ammonia.	
4	To 1 cm depth of R in a test-tube, add a few drops of dilute nitric acid. Add a 1 cm depth of aqueous barium nitrate.	

[9]

Conclusions

(ii) **R** contains two cations.

Identify the **two** cations in **R**.

..... and

[2]

(iii) **R** contains one anion.

Identify the anion in **R**.

.....

[1]

(b) (i) Do the tests shown in the table on **S**.

Record your observations in the table.

You should test and name any gases evolved.

test no.	test	observations
1	To 1 cm depth of S in a boiling tube, add a 1 cm depth of aqueous sodium carbonate. Add dilute nitric acid until there is no further change.	
2	To 1 cm depth of S in a test-tube, add aqueous sodium hydroxide drop by drop until a change is seen. Add excess aqueous sodium hydroxide.	
3	To 1 cm depth of S in a test-tube, add a few drops of dilute nitric acid. Add a 1 cm depth of aqueous silver nitrate.	

[9]

Conclusions

(ii) **S** contains one cation.

Identify the cation in **S**.

.....

[1]

(iii) **S** contains one anion.

Identify the anion in **S**.

.....

[1]

[Total: 23]

QUALITATIVE ANALYSIS NOTES

Tests for anions

<i>anion</i>	<i>test</i>	<i>test result</i>
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then add aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt., insoluble in excess dilute nitric acid

Tests for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
aluminium (Al^{3+})	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt.
chromium(III) (Cr^{3+})	green ppt., soluble in excess, giving a green solution	green ppt., insoluble in excess
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint

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