AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.2.1

Reactions of acids with metals

Past-paper questions

Tier	**Foundation**
Question groups	**37**
Available paper years	**2007–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.4.2.1 Reactions of acids with metals

Question 01

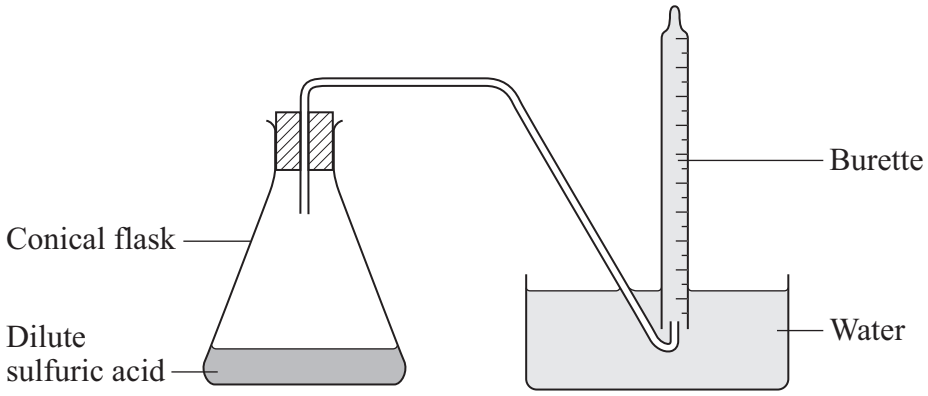
March 2007 | CHY1A | Original Q7 | Legacy

QUESTION SEVEN

Metals can react with acids to produce hydrogen gas.

Iron reacts with sulfuric acid to produce hydrogen gas.

Five students, **A**, **B**, **C**, **D** and **E**, reacted iron with dilute sulfuric acid in the apparatus shown below.



- In the first experiment, each student weighed out 0.04 grams of iron.
- The students then dropped the iron into the acid in the conical flask.
- The students replaced the bung in the flask as quickly as possible.
- They recorded the volume of hydrogen collected when all the iron had reacted.
- They repeated the experiment using 0.08, 0.12, 0.16 and 0.20 grams of iron.

Results

Mass of iron in grams	**Volume of hydrogen in cm^3**					
	Student **A**	Student **B**	Student **C**	Student **D**	Student **E**	Mean
0.04	14	10	11	12	13	12
0.08	32	23	30	33	29	31
0.12	53	49	49	48	46	49

4.4.2.1 Reactions of acids with metals

Question 01 · continued March 2007 | CHY1A | Original Q7 | Legacy

7A The expected volume of hydrogen produced from 0.04 grams of iron and this volume of sulfuric acid is 17 cm^3.
All five students collected less hydrogen than this.

The most likely reason for this similar error is that . . .

1 the conical flask was too big.

2 the burette was not accurate enough.

3 some of the hydrogen gas escaped.

4 the acid was too dilute.

7B Student **B**'s result was not used to calculate the mean for 0.08 grams of iron.
This was because it was . . .

1 a systematic error.

2 an anomalous result.

3 a categoric error.

4 a negative result.

7C 86 cm^3 is the true value for the volume of hydrogen produced from 0.20 grams of iron.
All the students carried out the tests with greater accuracy by the time they reached the last of the five experiments.
Their results, using 0.20 grams of iron, are more accurate because they . . .

1 are much higher than their first results.

2 are close to 100 cm^3.

3 are about five times higher than their first results.

4 are all close to the true value.

7D Each student's results would be best shown as . . .

1 a pie chart.

2 a line graph.

3 a bar chart.

4 a scattergram.

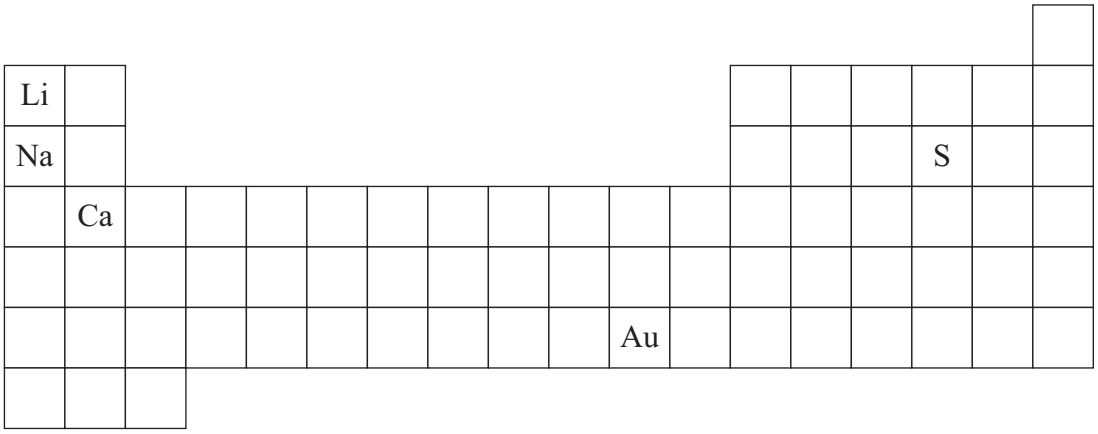
4.4.2.1 Reactions of acids with metals

Question 02

June 2007 | CHY1A | Original Q2 | Legacy

QUESTION TWO

The diagram shows the position of some elements in the periodic table.



Match elements, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A gold (Au)

B lithium (Li)

C calcium (Ca)

D sulfur (S)

	What we can say about the element
1	It is combined with the element oxygen in quicklime.
2	It is in a compound that produces acid rain.
3	It is an unreactive transition metal.
4	It has similar chemical properties to sodium.

4.4.2.1 Reactions of acids with metals

Question 03

January 2008 | CHY2F | Original Q3 | Legacy

3 Distress flares are used to attract attention in an emergency.



Flares often contain magnesium. Magnesium burns to form magnesium oxide.

(a) The distress flare burns with a bright flame because the reaction is very *exothermic*.

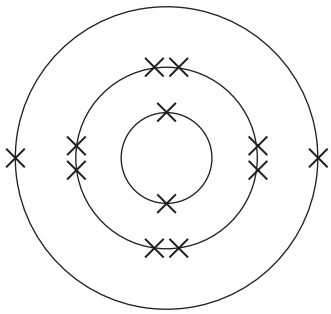
Complete the following sentence using the correct words from the box.

gives out heat	**stores heat**	**takes in heat**

An *exothermic* reaction is one which ..... .

(1 mark)

(b) The diagram shows the electronic structure of a magnesium atom.
The atomic (proton) number of magnesium is 12.



Magnesium atom

Question 03 · continued

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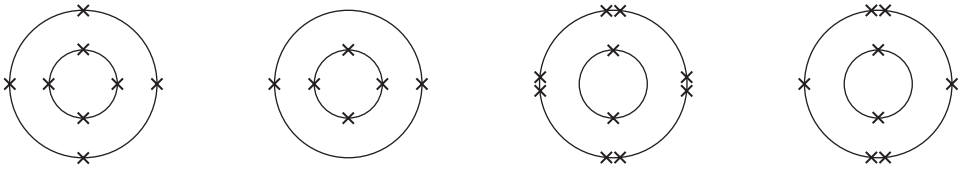
The atomic (proton) number of oxygen is 8.

Which diagram, **A**, **B**, **C** or **D**, shows the electronic structure of an oxygen atom?

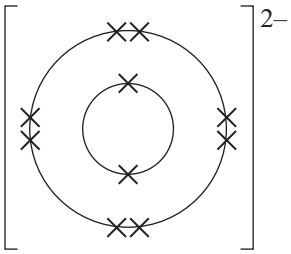


A **B** **C** **D**

Diagram .....

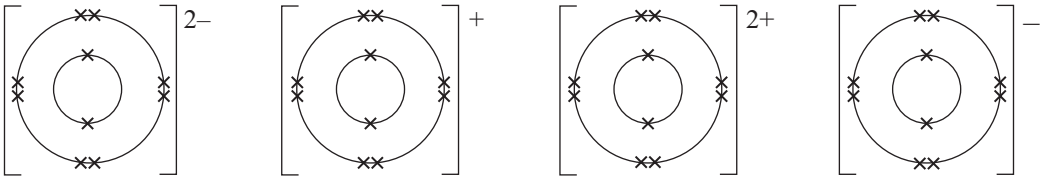
(1 mark)

(c) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen. The diagram shows the electronic structure of an oxide ion.



Oxide ion

Which diagram, **J**, **K**, **L** or **M**, shows the electronic structure of a magnesium ion?



J **K** **L** **M**

Diagram .....

(1 mark)

(d) Indigestion tablets can be made from magnesium oxide. The magnesium oxide neutralises some of the hydrochloric acid in the stomach.

Draw a ring around the name of the salt formed when magnesium oxide reacts with hydrochloric acid.

magnesium chloride **magnesium hydroxide** **magnesium sulfate**

(1 mark)

4

4.4.2.1 Reactions of acids with metals

Question 04

June 2008 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about environmental problems caused by burning fuels.

Match combustion products, **A**, **B**, **C**, and **D**, with the numbers **1–4** in the table.

A carbon dioxide

B smoke particles

C sulfur dioxide

D water vapour

	Environmental problem
1	acid rain
2	global dimming
3	global warming
4	no problems

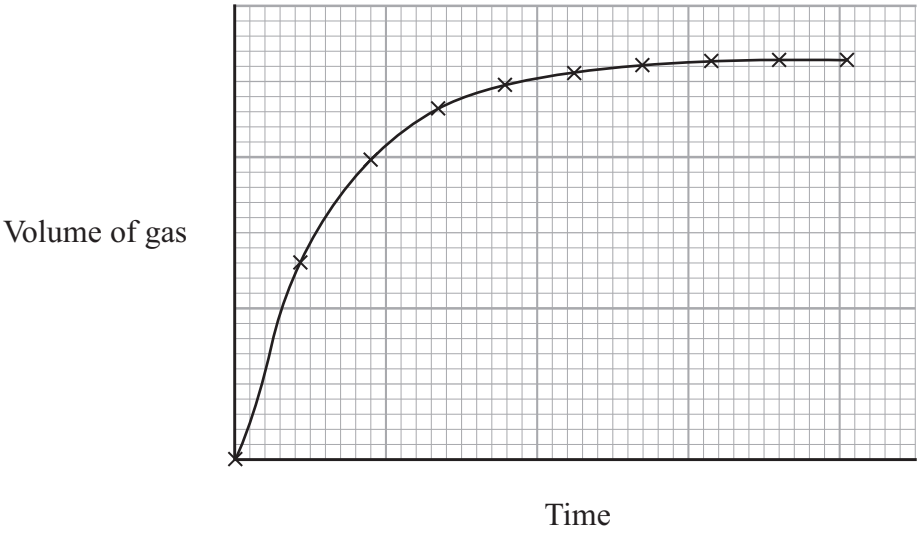
4.4.2.1 Reactions of acids with metals

Question 05

June 2008 | CHY2F | Original Q2 | Legacy

2 Pieces of zinc react with dilute acid to form hydrogen gas.

The graph shows how the volume of hydrogen gas produced changes with time.



2 (a) Describe, as fully as you can, how the volume of gas produced changes with time.

.....

.....

.....

.....

(2 marks)

2 (b) A student wants to make the reaction take place faster.
Some suggestions are given in the table.

Put ticks (✓) next to the **two** suggestions that would make the reaction take place faster.

Suggestions	(✓)
Use bigger pieces of zinc.	
Use a more concentrated acid.	
Use zinc powder.	
Decrease the temperature of the acid.	

(2 marks)

4

4.4.2.1 Reactions of acids with metals

Question 06

January 2019 | CHY1F | Original Q3 | Legacy

3 In 1980 Mount St Helens suddenly exploded. This volcanic eruption was so violent that it blew off the top of the mountain. Ash particles and volcanic gases spread throughout the Earth's atmosphere.



3 (a) Mount St Helens is on a boundary between two of the Earth's tectonic plates.

Draw a ring around the correct word to complete the sentences.

3 (a) (i) The Earth's tectonic plates are made up of the upper part of the mantle

and the

atmosphere.
core.
crust.

(1 mark)

3 (a) (ii) The movement of the Earth's tectonic plates is caused by convection currents within the mantle. These convection currents are driven by heat released by

natural

combustion
radioactive
shrinking

processes.

(1 mark)

4.4.2.1 Reactions of acids with metals

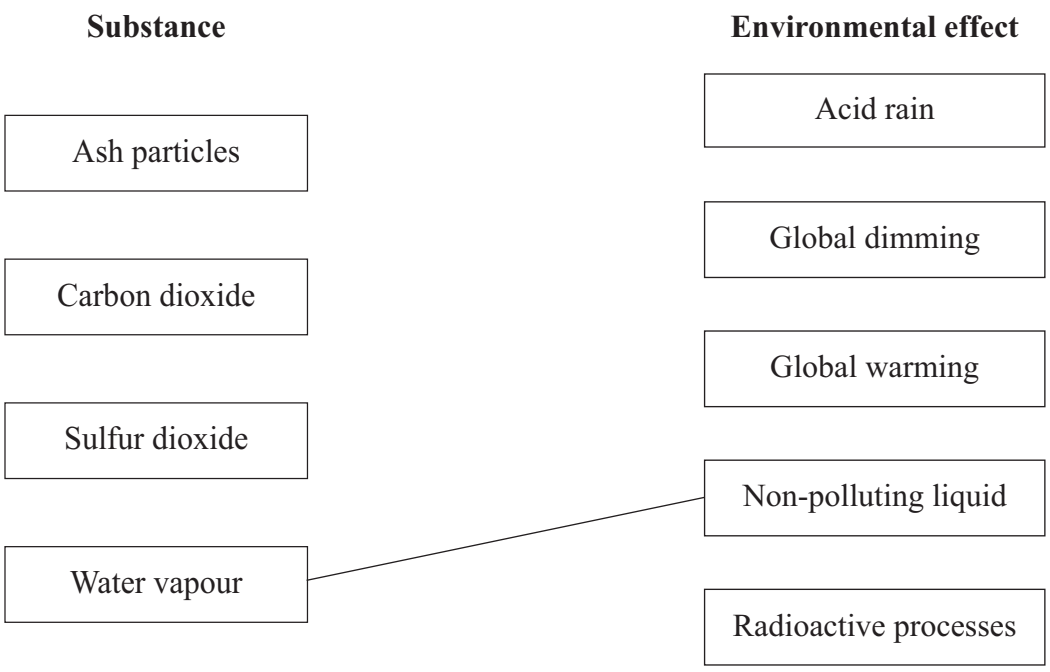
Question 06 · continued

for mark

3 (b) The volcano released large amounts of ash particles, carbon dioxide, sulfur dioxide and water vapour.

Draw **one** straight line from each substance to an environmental effect that it causes.

One has been done for you.



(3 marks)

3 (c) Why do volcanic eruptions and earthquakes happen?

.....

.....

(1 mark)

6

4.4.2.1 Reactions of acids with metals

Question 07

March 2010 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

New substances are formed when fuels are burned. Some of these substances affect the environment.

Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A carbon dioxide

B particles

C sulfur dioxide

D water vapour

	Environmental effect
1	acid rain
2	global dimming
3	global warming
4	non-polluting

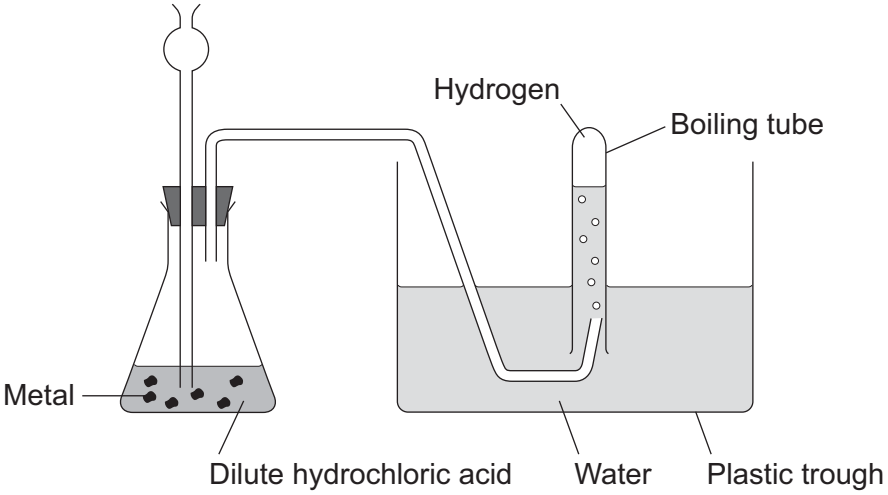
4.4.2.1 Reactions of acids with metals

Question 08

June 2010 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

Some students were trying to decide which one of the metals, **K**, **L**, **M** or **N**, was the most reactive. They set up the apparatus shown in the diagram.



Dilute hydrochloric acid was added to the metal **K**. Hydrogen was given off. The students recorded how long it took to fill the boiling tube with the hydrogen. They did the experiment twice more under exactly the same conditions.

They repeated the experiment, using equal-sized pieces of metals **L**, **M** and **N**.

The results are shown in the table.

	Time taken to fill the boiling tube with hydrogen in seconds		
Metal	**Experiment 1**	**Experiment 2**	**Experiment 3**
K	600	479	649
L	189	220	178
M	81	82	78
N	125	132	143

4.4.2.1 Reactions of acids with metals

Question 08 · continued June 2010 | CHY1AP | Original Q6 | Legacy

6A To make it a fair test, the students made sure that the boiling tube was always completely filled with hydrogen before they recorded the time.

What else should they do to make it a fair test?

1 use a different acid for each metal

2 use the same volume of the acid for each test

3 replace the water in the plastic trough for each test

4 use different temperatures for each metal

6B Which metal was the most reactive?

1 metal **K**

2 metal **L**

3 metal **M**

4 metal **N**

6C Why did the students take more than one reading for each metal?

1 to make an error less likely

2 so that they could plot a graph

3 to make it easier to see the relationship between the two variables

4 to make it a fair test

6D Some of their results were anomalous.

Which of the following experiments should the students repeat?

1 metal **K**, experiment 2

2 metal **L**, experiment 3

3 metal **M**, experiment 3

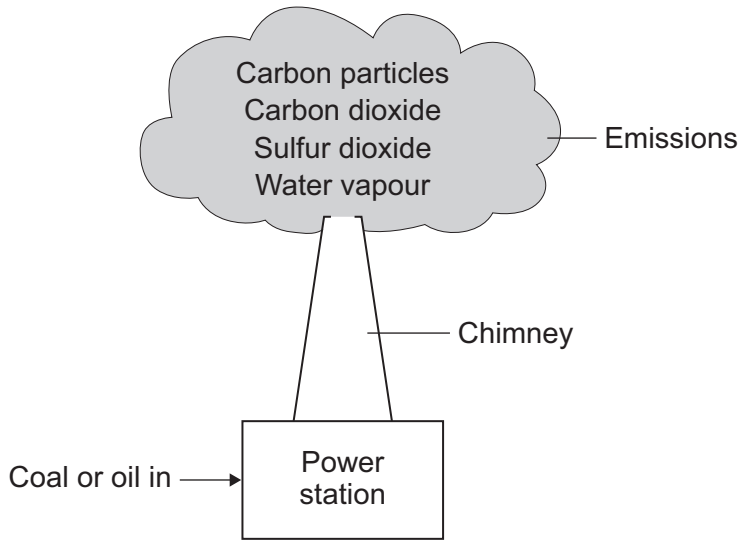
4 metal **N**, experiment 1

4.4.2.1 Reactions of acids with metals

Question 09

June 2019 | CHY1F | Original Q3 | Legacy

3 In the future more coal-fired and fewer oil-fired power stations will be used to generate electricity.
When coal and oil are burned they produce the same types of emissions which can cause environmental problems.



3 (a) Emissions from the chimney can cause acid rain, global dimming and global warming.
Draw **one** straight line from each possible environmental problem to the emission that causes it.

Possible environmental problem	Emission that causes it
acid rain	carbon particles
global warming	carbon dioxide
global dimming	sulfur dioxide
	water vapour

(3 marks)

3 (b) Draw a ring around the correct word in the box to complete each sentence.

3 (b) (i) Incomplete combustion of coal or oil is caused by too little

carbon dioxide.
nitrogen.
oxygen.

(1 mark)

4.4.2.1 Reactions of acids with metals

Question 09 · continued June 2019 | CHY1F | Original Q3 | Legacy

3 (b) (ii) A gas formed by the incomplete combustion of coal or oil is

carbon monoxide.
hydrogen.
oxygen.

(1 mark)

3 (c) The table shows the world production for both coal and oil in 2000.
The world production figures after 2000 are predicted.

Year	World production of coal (billions of tonnes per year)	World production of oil (billions of barrels per year)
2000	3.5	12.5
2050	4.5	5.6
2100	5.0	1.7
2150	5.5	0.5
2200	6.0	0.0

3 (c) (i) How is the world production of oil predicted to change from 2000 to 2200?

.....

.....

(1 mark)

3 (c) (ii) Suggest **two** reasons why the world production of coal is predicted to increase.

1 .....

.....

2 .....

.....

(2 marks)

8

4.4.2.1 Reactions of acids with metals

Question 10

November 2010 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

This question is about how we obtain some metals.

Match statements, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A uses another metal

B does **not** use a chemical reaction

C could be done in a blast furnace

D is called electrolysis

1	Aluminium is made when an electric current passes through a molten aluminium compound.
2	Gold can be found at the bottom of some streams.
3	Titanium is made by reacting titanium chloride with magnesium.
4	Zinc is made when a mixture of zinc oxide and carbon is heated.

4.4.2.1 Reactions of acids with metals

Question 11

January 2011 | CHY2F | Original Q3 | Legacy

3 (a) A magnesium atom contains 12 protons (●),12 neutrons (o) and 12 electrons (×).

Which diagram, **A**, **B** or **C**, represents this magnesium atom?

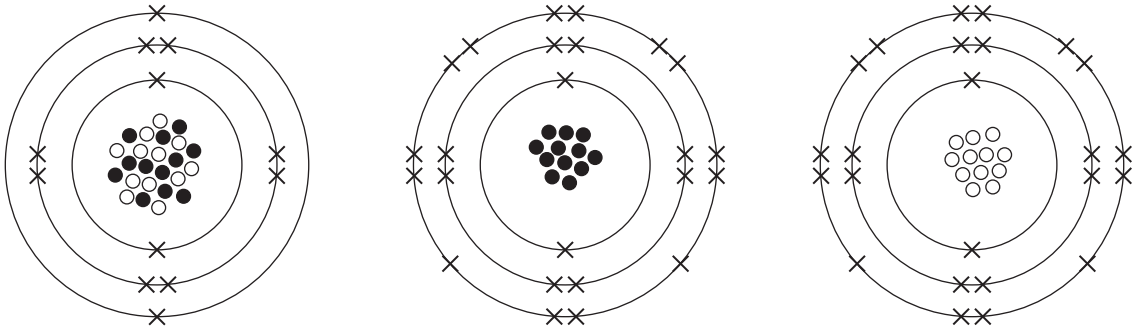
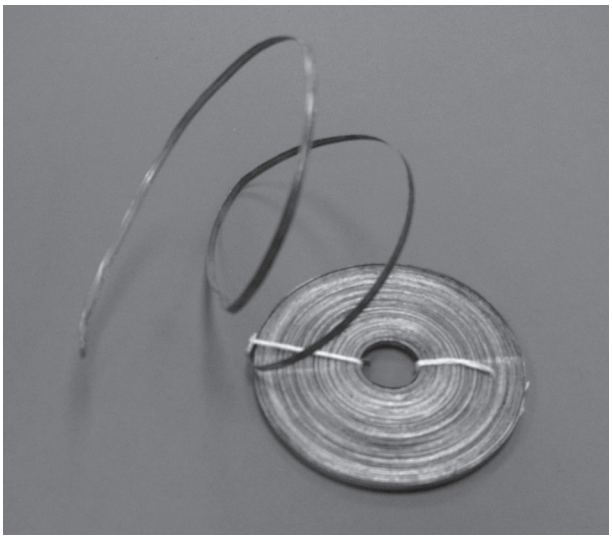


Diagram A **Diagram B** **Diagram C**

This magnesium atom is **Diagram** ☐ .

(1 mark)

3 (b) Magnesium metal is shaped to make magnesium ribbon.



Tick (✓) **two** reasons which explain why metals can be shaped.

Reason why	Tick (✓)
The atoms are all joined by covalent bonds.	
The atoms can slide over each other.	
The atoms are large.	
The atoms are in layers.	

(2 marks)

4.4.2.1 Reactions of acids with metals

Question 11 · continued

3 (c) Magnesium sulfate is a salt of magnesium.

It can be prepared by the reaction of magnesium metal with an acid. The equation for the reaction of magnesium with this acid is:

Mg(s)	+	H_2SO_4(aq)	→	$MgSO_4$(aq)	+	H_2(g)
magnesium		acid		magnesium sulfate solution		hydrogen

3 (c) (i) Draw a ring around the name of the acid used in this reaction.

hydrochloric **nitric** **sulfuric**

(1 mark)

3 (c) (ii) Use the equation to help you to answer this question.

Tick (✓) **two** things that happen when this reaction takes place.

	Tick (✓)
Bubbles are produced.	
The magnesium disappears.	
A solid is formed.	
Water is formed.	

(2 marks)

3 (c) (iii) Draw a ring around a method to get solid magnesium sulfate from magnesium sulfate solution.

crystallisation **electrolysis** **oxidation**

(1 mark)

7

4.4.2.1 Reactions of acids with metals

Question 12

January 2011 | CHY3F | Original Q3 | Legacy

3 This label was on a bottle of vinegar.



Vinegar contains ethanoic acid, which is a *weak* acid.

3 (a) Draw a ring around the correct answer to complete the sentences.

3 (a) (i) Ethanoic acid is an acid because it contains [hydrogen / hydroxide / oxide] ions.

(1 mark)

3 (a) (ii) Ethanoic acid is a *weak* acid because it is [completely / not / partially] ionised in water.

(1 mark)

3 (b) Magnesium ribbon can be used in a test to show that ethanoic acid is a weaker acid than hydrochloric acid.

3 (b) (i) State **one** way of making this test fair.

.....

.....

(1 mark)

3 (b) (ii) Give the results of this test.

.....

.....

.....

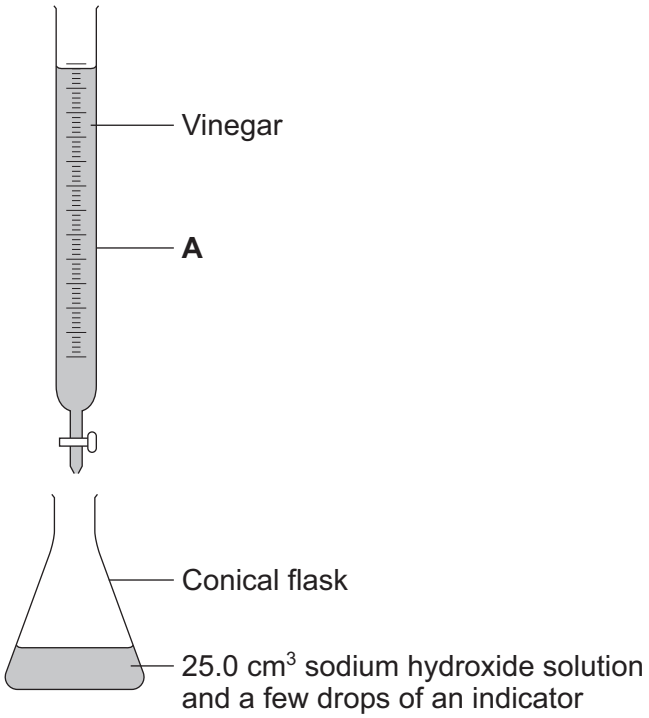
.....

(2 marks)

4.4.2.1 Reactions of acids with metals

Question 12 · continued

3 (c) The diagram shows the apparatus a student used to find the volume of vinegar that reacts with 25.0 cm^3 of sodium hydroxide solution.



3 (c) (i) Choose the correct word from the box to complete the sentence.

filtration	**polymerisation**	**titration**

The name of this method is ..... .

(1 mark)

3 (c) (ii) Which **one** of the following is the correct name for apparatus **A**?

Draw a ring around **one** answer.

burette **measuring cylinder** **pipette**

(1 mark)

3 (c) (iii) State how the student knew when enough vinegar had been added.

.....

.....

(1 mark)

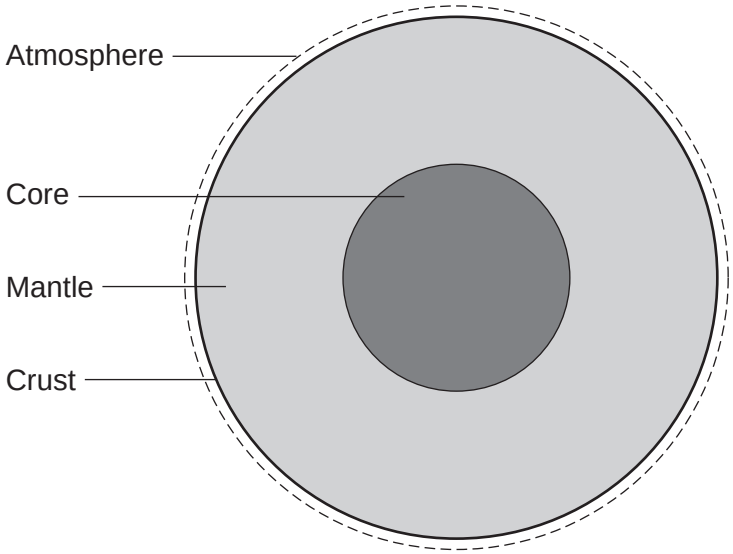
8

4.4.2.1 Reactions of acids with metals

Question 13

January 2013 | CH1FP | Original Q2 | Legacy

2 The diagram shows the layers in and around the Earth.



2 (a) Use the diagram above to help you to answer this question.

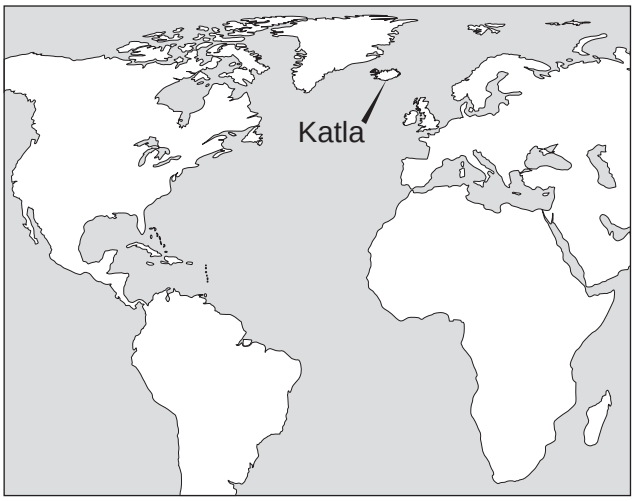
Draw **one** line from each statement to its correct layer.

Statement	Layer
There are mountain ranges.	atmosphere
There are convection currents that cause earthquakes.	core
There is a mixture of gases.	crust
	mantle

(3 marks)

Question 13 · continued

2 (b) Iceland has many volcanoes.
Scientists are monitoring a volcano in Iceland, called Katla.



There has been an increase in the number of small earthquakes (tremors) around Katla.

2 (b) (i) Draw a ring around the correct answer to complete the sentence.

Iceland has volcanoes because it

- has low temperatures.
- is an island.
- is on a tectonic plate boundary.

(1 mark)

2 (b) (ii) People do not know when Katla will next erupt.

Tick (✓) the correct reason why.

Reason	Tick (✓)
Small earthquakes (tremors) near the volcano are happening more often.	
The last two eruptions happened a long time ago in October 1918 and in May 1860.	
Scientists cannot accurately predict when volcanic eruptions will occur.	

(1 mark)

Question 2 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 13 · continued

2 (c) Previous eruptions of Katla produced large amounts of solid ash particles and sulfur dioxide.

Use the correct answer to complete each sentence.

acid rain	**earthquakes**	**global dimming**	**global warming**

An environmental impact caused by solid ash particles is ..... .

An environmental impact caused by sulfur dioxide is ..... .

(2 marks)

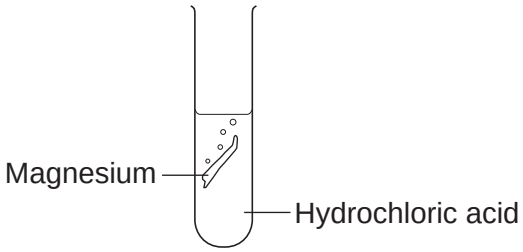
7

4.4.2.1 Reactions of acids with metals

Question 14

June 2013 | CH2FP | Original Q6 | Legacy

6 A student investigated the reaction between magnesium and hydrochloric acid.



The equation for the reaction is:

Mg(s)	+	2 HCl(aq)	⟶	$MgCl_2$(aq)	+	H_2(g)
magnesium		hydrochloric acid		magnesium chloride		hydrogen

6 (a) Give **two** observations the student could make during the reaction.

1 .....

.....

2 .....

.....

(2 marks)

6 (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The student investigated how the rate of this reaction changed when the concentration of hydrochloric acid was changed.

Write a plan the student could use.

In your plan you should:

- describe how you would carry out the investigation and make it a fair test
- describe the measurements you would make.

.....

.....

.....

.....

.....

.....

4.4.2.1 Reactions of acids with metals

Question 15

2 This question is about salts.

2 (a) Salt (sodium chloride) is added to many types of food.

Sodium chloride is produced by reacting sodium with chlorine.

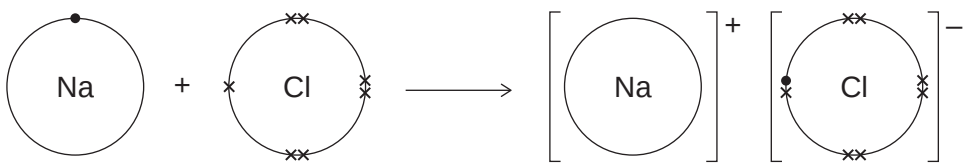
sodium + chlorine ⟶ sodium chloride

Figure 2 shows what happens to atoms of sodium and chlorine in this reaction.

The dots (•) and crosses (×) represent electrons.

Only the outer electrons are shown.

Figure 2



Describe, in terms of electrons, what happens when a sodium atom reacts with a chlorine atom to produce sodium chloride.

[3 marks]

.....

.....

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.....

Question 2 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 15 · continued

2 (b) Lack of iodine can affect the learning ability of children.

One idea is that salt (sodium chloride) should have iodine added.

2 (b) (i) Iodine consists of simple molecules.

What is a property of substances that have simple molecules?

[1 mark]

Tick (✓) **one** box.

Have no overall electric charge ☐

Have high boiling points ☐

Have giant covalent structures ☐

2 (b) (ii) Which one of the following questions cannot be answered by science alone?

[2 marks]

Tick (✓) **one** box.

How much sodium chloride is in food? ☐

What harm does a lack of iodine do? ☐

Should iodine be added to salt in food? ☐

Give **one** reason why this question cannot be answered by science alone.

.....

.....

2 (c) A student produced the salt ammonium nitrate by adding an acid to ammonia solution.

2 (c) (i) Name the acid used.

[1 mark]

.....

4.4.2.1 Reactions of acids with metals

Question 15 · continued

2 (c) (ii) Use the correct answer from the box to complete the sentence.

[1 mark]

an acid	an alkali	a salt

Ammonia solution (ammonium hydroxide) is ..... .

2 (c) (iii) The student added a few drops of a solution which changed colour when the reaction was complete.

Complete the sentence.

[1 mark]

The solution added is an ..... .

2 (d) Farmers buy solid ammonium nitrate in poly(ethene) sacks.

2 (d) (i) How is solid ammonium nitrate made from a solution of ammonium nitrate?

[1 mark]

Tick (✓) **one** box.

Crystallisation ☐

Decomposition ☐

Electrolysis ☐

2 (d) (ii) Why do farmers use ammonium nitrate on their fields?

[1 mark]

.....

.....

2 (d) (iii) The properties of poly(ethene) depend on the reaction conditions when it is made.

State **one** reaction condition that can be changed when making poly(ethene).

[1 mark]

.....

.....

12

4.4.2.1 Reactions of acids with metals

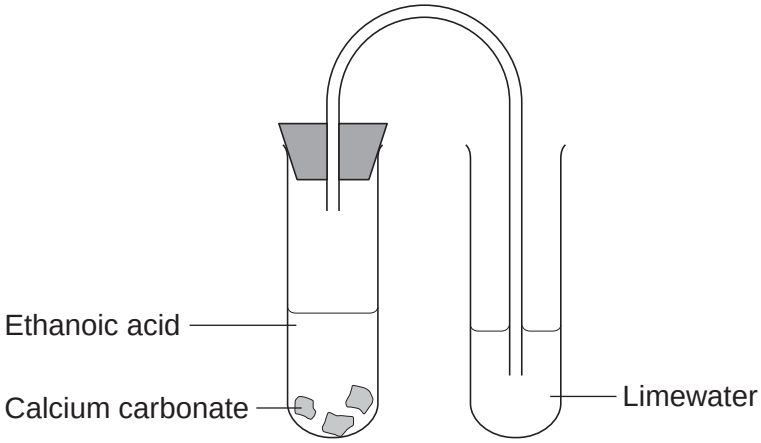
Question 16

June 2016 | CH3FP | Original Q5 | Legacy

5 This question is about reactions of ethanoic acid and the analysis of salts.

5 (a) **Figure 7** shows the apparatus used to investigate the reaction of ethanoic acid with calcium carbonate.

Figure 7



5 (a) (i) Describe a change that would be seen in each test tube.

Give a reason for each change.

[4 marks]

Test tube 1 _____

_____

_____

_____

Test tube 2 _____

_____

_____

_____

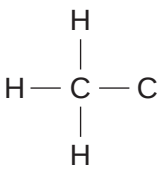
Question 5 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 16 · continued

5 (a) (ii) Complete the displayed structure of ethanoic acid.

[1 mark]



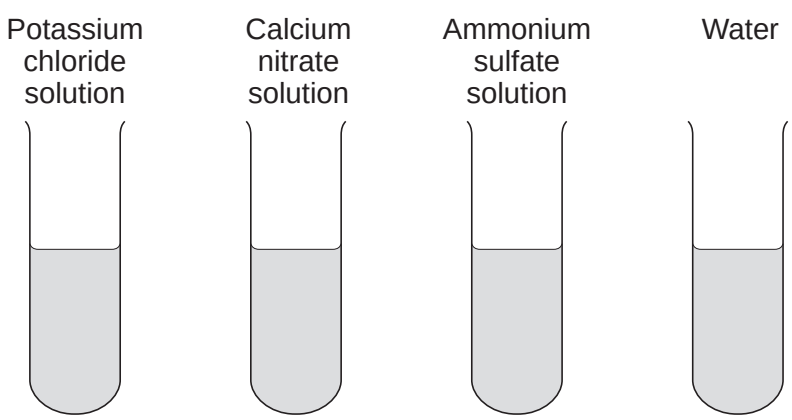
5 (a) (iii) Ethanoic acid is a carboxylic acid.
Complete the sentence.

[2 marks]

Carboxylic acids react with alcohols in the presence of an _____ catalyst to produce pleasant-smelling compounds called _____ .

5 (b) **Figure 8** shows four test tubes containing three different salt solutions and water.

Figure 8



Each solution and the water was tested with:

- silver nitrate in the presence of dilute nitric acid
- barium chloride in the presence of dilute hydrochloric acid.

4.4.2.1 Reactions of acids with metals

Question 16 · continued

Complete the table of results.

[2 marks]

	Potassium chloride solution	Calcium nitrate solution	Ammonium sulfate solution	Water
Test with silver nitrate in the presence of dilute nitric acid			no change	no change
Test with barium chloride in the presence of dilute hydrochloric acid		no change	white precipitate	

5 (c) Flame tests can be used to identify metal ions.

5 (c) (i) Complete the following sentences.

[2 marks]

The flame colour for potassium ions is _____ .

The flame colour for calcium ions is _____ .

5 (c) (ii) Give **one** reason why a flame test would **not** show the presence of both potassium ions and calcium ions in a mixture.

[1 mark]

_____

_____

_____

12

4.4.2.1 Reactions of acids with metals

Question 17

June 2017 | CH1FP | Original Q3 | Legacy

3 This question is about metals.

3 (a) Complete the word equation for the reaction of magnesium with oxygen.

[1 mark]

magnesium + oxygen ⟶ _____

3 (b) Iron oxide is reduced to iron in a blast furnace.

The chemical equation for the reaction is:

$$2\ Fe_2O_3 + 3\ C \longrightarrow 4\ Fe + 3\ CO_2$$

3 (b) (i) Give the name of the element used for the reduction of iron oxide.

[1 mark]

_____

3 (b) (ii) How can you tell that iron oxide is reduced?

[1 mark]

_____

_____

3 (b) (iii) Complete the sentences.

[3 marks]

For many uses, iron from the blast furnace is too _____ .

For many uses, pure iron is too _____ .

Mixtures of iron with carbon are called _____ .

6

4.4.2.1 Reactions of acids with metals

Question 18

June 2018 | 8462/1F | Original Q8

0 8 Soluble salts are formed by reacting metal oxides with acids.

0 8 . 1 Give **one** other type of substance that can react with an acid to form a soluble salt.

[1 mark]

0 8 . 2 Calcium nitrate contains the ions Ca^{2+} and NO_3^-

Give the formula of calcium nitrate.

[1 mark]

0 8 . 3 Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

[6 marks]

4.4.2.1 Reactions of acids with metals

Question 19

June 2018 | 8462/2F | Original Q7

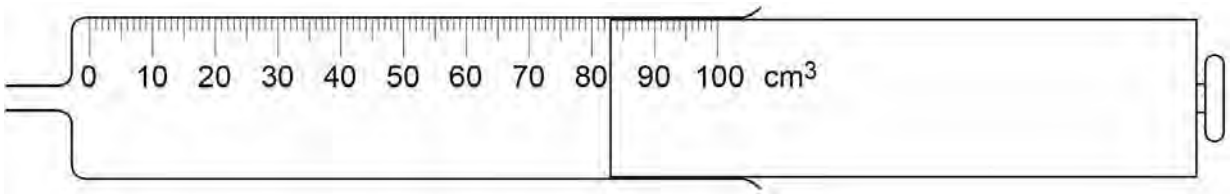
0 7 A student investigated how concentration affects the rate of reaction between magnesium and hydrochloric acid.

This is the method used.

1. Place hydrochloric acid in a conical flask.
2. Add magnesium powder.
3. Collect the gas produced in a gas syringe.
4. Measure the volume of gas every 40 seconds for 160 seconds.
5. Repeat steps 1–4 three more times.
6. Repeat steps 1–5 with hydrochloric acid of a higher concentration.

0 7 . 1 **Figure 5** shows a gas syringe.

Figure 5



What is the volume of gas in the syringe?

[1 mark]

Volume = _____ cm^3

0 7 . 2 Which **two** variables should the student keep the same to make the investigation a fair test?

[2 marks]

Tick **two** boxes.

- Concentration of hydrochloric acid ☐
- Mass of magnesium powder ☐
- Temperature of hydrochloric acid ☐
- Time for reaction to end ☐
- Volume of gas collected ☐

4.4.2.1 Reactions of acids with metals

Question 19 · continued

Table 5 shows the student's results for the experiment with hydrochloric acid of a lower concentration.

Table 5

Time in seconds	Volume of gas collected in cm^3				
	Test 1	Test 2	Test 3	Test 4	Mean
0	0	0	0	0	0
40	46	30	47	49	**X**
80	78	83	83	82	82
120	98	94	96	95	96
160	100	100	100	100	100

0 7 . 3 Calculate mean value **X** in **Table 5**.

Do **not** include the anomalous result in your calculation.

Give your answer to 2 significant figures.

[2 marks]

X = _____ cm^3

4.4.2.1 Reactions of acids with metals

Question 19 · continued

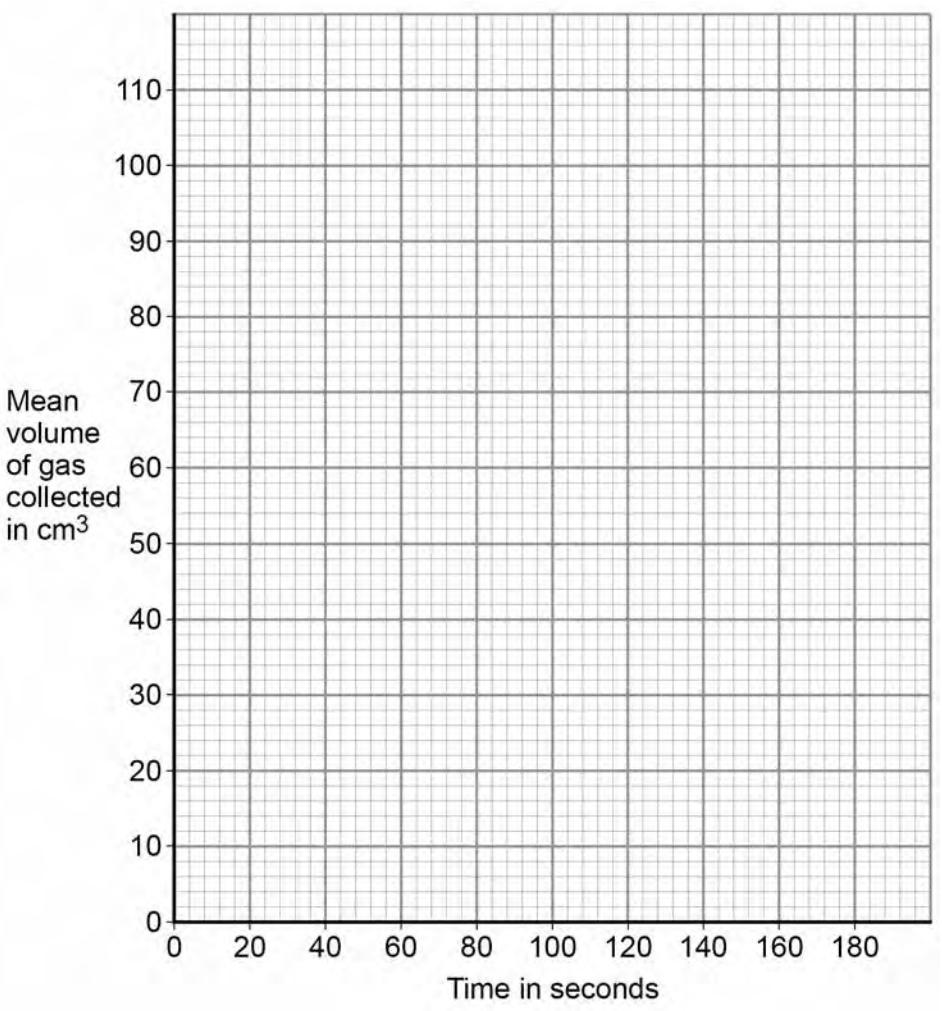
0 7 . 4 Plot the data from **Table 5** on **Figure 6**.

You should include your answer to Question **07.3**.

You do **not** need to draw a line of best fit.

[2 marks]

Figure 6



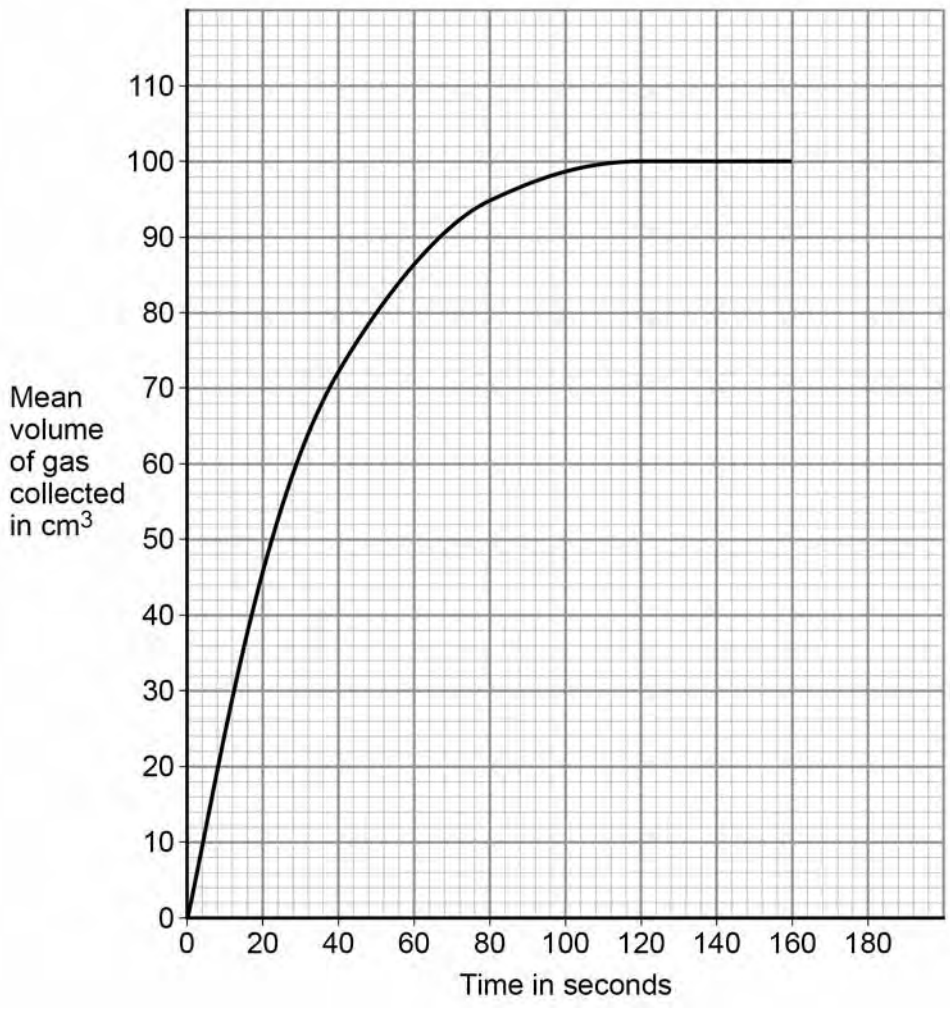
Question 7 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 19 · continued

Figure 7 shows results of the experiment with the hydrochloric acid of a higher concentration.

Figure 7



0 7 . 5 Calculate the mean rate of reaction between 0 and 50 seconds.

Use **Figure 7** and the equation:

$$\text{mean rate of reaction} = \frac{\text{mean volume of gas collected}}{\text{time taken}}$$

[2 marks]

Mean rate of reaction = _____ cm^3/s

4.4.2.1 Reactions of acids with metals

Question 19 · continued

0 7 . 6 Describe how the **rate of reaction** changes between 0 and 160 seconds.

Use **Figure 7**.

[3 marks]

0 7 . 7 The student concludes that the rate of reaction is greater when the concentration of hydrochloric acid is higher.

Why is the rate of reaction greater when the concentration of hydrochloric acid is higher?

[2 marks]

Tick **two** boxes.

- The particles are moving faster ☐
- The particles have more energy ☐
- The surface area of magnesium is smaller ☐
- There are more particle collisions each second ☐
- There are more particles in the same volume ☐

Question 7 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 19 · continued

0 7 . 8 The student tests the gas produced by bubbling it through limewater.

No change is seen in the limewater.

Give **one** conclusion the student can make about the gas.

[1 mark]

0 7 . 9 The student tests the gas produced using a burning splint.

Name the gas the student is testing for.

Give the result of a positive test for this gas.

[2 marks]

Name of gas _____

Result _____

4.4.2.1 Reactions of acids with metals

Question 19 · continued

June 2018 | 8462/2F | Original Q7

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

4.4.2.1 Reactions of acids with metals

Question 20

June 2019 | 8462/2F | Original Q9

0 9 This question is about lithium carbonate.

Lithium carbonate is used in medicines.

Figure 7 shows a tablet containing lithium carbonate.

Figure 7



0 9 . 1 Lithium carbonate contains lithium ions and carbonate ions.

A student tested the tablet for lithium ions and for carbonate ions.

The student used:

- a metal wire
- dilute hydrochloric acid
- limewater.

Plan an investigation to show the presence of lithium ions **and** of carbonate ions in the tablet.

You should include the results of the tests for the ions.

[6 marks]

4.4.2.1 Reactions of acids with metals

Question 20 · continued

0 9 . 2 The tablet also contains other substances.

The substances in tablets are present in fixed amounts.

What name is given to mixtures like tablets?

[1 mark]

0 9 . 3 The tablet has a mass of 1.20 g and contains 700 mg of lithium carbonate.

Calculate the percentage by mass of lithium carbonate in this tablet.

[3 marks]

Percentage by mass of lithium carbonate = _____ %

10

4.4.2.1 Reactions of acids with metals

Question 21

June 2019 | 8462/2F | Original Q10

1 0 This question is about rate of reaction.

A student investigated the rate of the reaction between magnesium and dilute hydrochloric acid.

The equation for the reaction is:

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

1 0 . 1 Which state symbol in the equation for the reaction does **not** represent one of the three states of matter?

[1 mark]

The student determined the rate of production of hydrogen gas.

1 0 . 2 What **two** pieces of measuring apparatus could the student use to find the rate of production of hydrogen gas?

[2 marks]

1 _____

2 _____

Question 10 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 21 · continued

Table 6 shows the results of the investigation.

Table 6

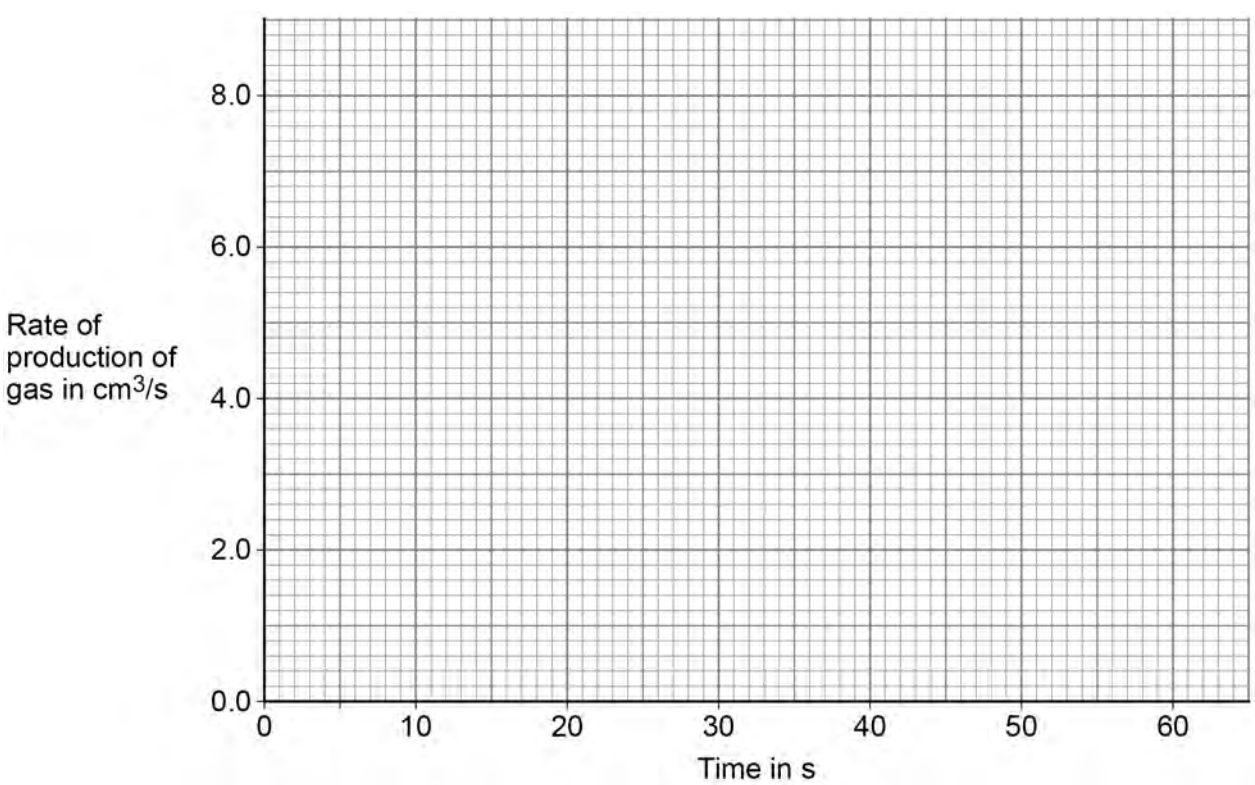
Time in s	Rate of production of gas in cm^3/s
10	6.9
20	3.9
30	2.0
40	0.9
50	0.3
60	0.0

1 0 . 3 Plot the data from **Table 6** on **Figure 8**.

You should draw a line of best fit.

[3 marks]

Figure 8



4.4.2.1 Reactions of acids with metals

Question 21 · continued

1 0 . 4 Give **three** conclusions that can be drawn about the rate of reaction between magnesium and dilute hydrochloric acid in this investigation.

Use data from **Figure 8** and **Table 6**.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

1 0 . 5 The student repeated the investigation using dilute hydrochloric acid at a higher temperature.

All the other variables were kept the same.

Which **two** statements are correct?

[2 marks]

Tick (✓) **two** boxes.

- More bubbles were produced in the first 10 seconds. ☐
- The activation energy for the reaction was higher. ☐
- The magnesium was used up more quickly. ☐
- The reaction finished at the same time. ☐
- The total volume of gas collected was greater. ☐

11

4.4.2.1 Reactions of acids with metals

Question 22

November 2020 | 8462/1F | Original Q7

0 7 This question is about acids, bases and salts.

Zinc nitrate is a salt.

A student produces zinc nitrate using an acid and a base.

0 7 . 1 Which acid should the student use to produce zinc nitrate?

[1 mark]

Tick (✓) **one** box.

- Hydrochloric acid ☐
- Nitric acid ☐
- Sulfuric acid ☐

0 7 . 2 Which is a base the student could use to produce zinc nitrate?

[1 mark]

Tick (✓) **one** box.

- Zinc chloride ☐
- Zinc oxide ☐
- Zinc sulfate ☐

0 7 . 3 Name the salt with the formula $MgBr_2$

[1 mark]

_____

4.4.2.1 Reactions of acids with metals

Question 22 · continued

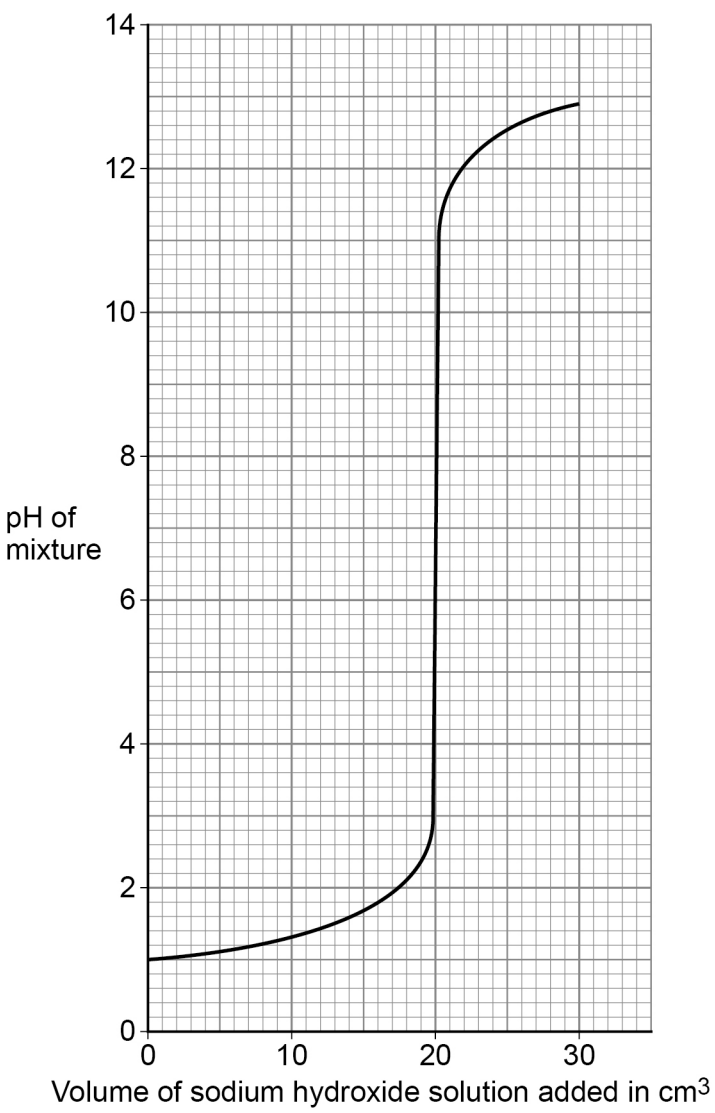
A student investigated how pH changes during a titration.

This is the method used.

1. Pour 25.0 cm^3 of hydrochloric acid into a beaker.
2. Measure the pH of the hydrochloric acid with a pH probe.
3. Add 1.0 cm^3 of sodium hydroxide solution from a burette.
4. Swirl the mixture.
5. Measure the pH of the mixture.
6. Repeat steps 3 to 5 until a total of 30.0 cm^3 of sodium hydroxide solution has been added.

Figure 10 shows the student's results.

Figure 10



4.4.2.1 Reactions of acids with metals

Question 22 · continued

0 7 . 4 Describe how the pH of the mixture changes as sodium hydroxide solution is added to hydrochloric acid.

Use data from **Figure 10** in your answer.

[3 marks]

0 7 . 5 What volume of sodium hydroxide solution is needed to neutralise 25.0 cm^3 of hydrochloric acid?

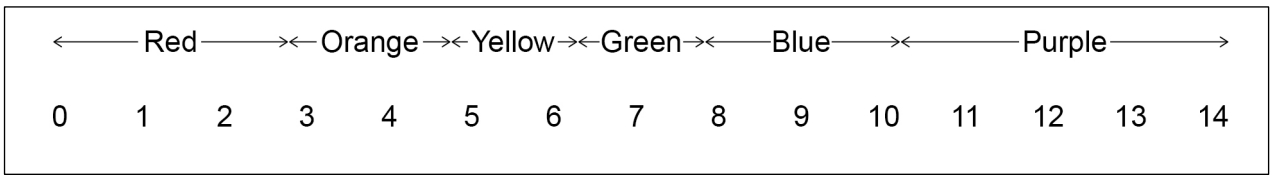
Use **Figure 10**.

[1 mark]

Volume = _____ cm^3

0 7 . 6 **Figure 11** shows the colour of universal indicator at different pH values.

Figure 11



The student could have used universal indicator instead of a pH probe.

Determine the colour of universal indicator when 10.0 cm^3 of sodium hydroxide solution has been added to 25.0 cm^3 of hydrochloric acid.

Use **Figure 10** and **Figure 11**.

[1 mark]

Colour = _____

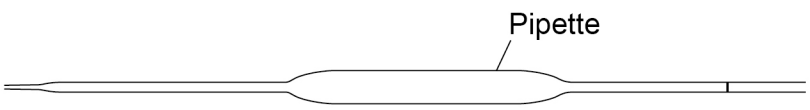
4.4.2.1 Reactions of acids with metals

Question 22 · continued

0 7 . 7 The student used a pipette to measure 25.0 cm^3 of hydrochloric acid.

Figure 12 shows a pipette.

Figure 12



The pipette is labelled 25.0 ± 0.06 cm^3

Calculate the percentage uncertainty in the volume measured using this pipette.

Use the equation:

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{volume measured}} \times 100$$

[2 marks]

Percentage uncertainty = _____ %

0 7 . 8 Give **one** advantage of using a pipette rather than using a measuring cylinder to measure the volume of hydrochloric acid.

[1 mark]

11

4.4.2.1 Reactions of acids with metals

Question 23

November 2020 | 8462/1F | Original Q9

0 9 This question is about metals and the reactivity series.

0 9 . 1 Which **two** statements are properties of most transition metals?

[2 marks]

Tick (✓) **two** boxes.

- They are soft metals. ☐
- They form colourless compounds. ☐
- They form ions with different charges. ☐
- They have high melting points. ☐
- They have low densities. ☐

0 9 . 2 A student added copper metal to colourless silver nitrate solution.

The student observed:

- pale grey crystals forming
- the solution turning blue.

Explain how these observations show that silver is less reactive than copper.

[3 marks]

4.4.2.1 Reactions of acids with metals

Question 23 · continued

0 9 . 3 A student is given three metals, **X**, **Y** and **Z** to identify.

The metals are magnesium, iron and copper.

Plan an investigation to identify the three metals by comparing their reactions with dilute hydrochloric acid.

Your plan should give valid results.

[4 marks]

Question 9 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 23 · continued

0 9 . 4 Metal **M** has two isotopes.

Table 6 shows the mass numbers and percentage abundances of the isotopes.

Table 6

Mass number	Percentage abundance (%)
203	30
205	70

Calculate the relative atomic mass (A_r) of metal **M**.

Give your answer to 1 decimal place.

[2 marks]

Relative atomic mass (1 decimal place) = _____

11

4.4.2.1 Reactions of acids with metals

Question 24

November 2021 | 8462/1F | Original Q4

0 4 A student investigated the reactivity of metals with hydrochloric acid.

This is the method used.

1. Measure 50 cm^3 of hydrochloric acid into a polystyrene cup.
2. Measure the temperature of the hydrochloric acid.
3. Add one spatula of metal powder to the hydrochloric acid and stir.
4. Measure the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1 to 5 three more times.
7. Repeat steps 1 to 6 with different metals.

Table 4 shows the student's results.

Table 4

Metal	Temperature increase in °C				Mean temperature increase in °C
	Trial 1	Trial 2	Trial 3	Trial 4	
Cobalt	6	7	5	9	7
Magnesium	54	50	37	55	**X**
Zinc	18	16	18	20	18

0 4 . 1 Calculate the mean temperature increase **X** for magnesium in **Table 4**.

Do **not** include the anomalous result in your calculation.

[2 marks]

X = _____ °C

4.4.2.1 Reactions of acids with metals

Question 24 · continued

0 4 . 2 Determine the order of reactivity for the metals cobalt, magnesium and zinc.

Use **Table 4**.

[1 mark]

Most reactive _____

_____

Least reactive _____

0 4 . 3 The range of measurements either side of the mean shows the uncertainty in the mean temperature increase.

Complete the sentence.

Use **Table 4**.

[1 mark]

The mean temperature increase for zinc is 18 ± _____ °C

0 4 . 4 What type of variable is the volume of hydrochloric acid in this investigation?

[1 mark]

Tick (✓) **one** box.

Control ☐

Dependent ☐

Independent ☐

0 4 . 5 Suggest **one** way of improving **step 3** in the method to give results which are more repeatable.

[1 mark]

_____

_____

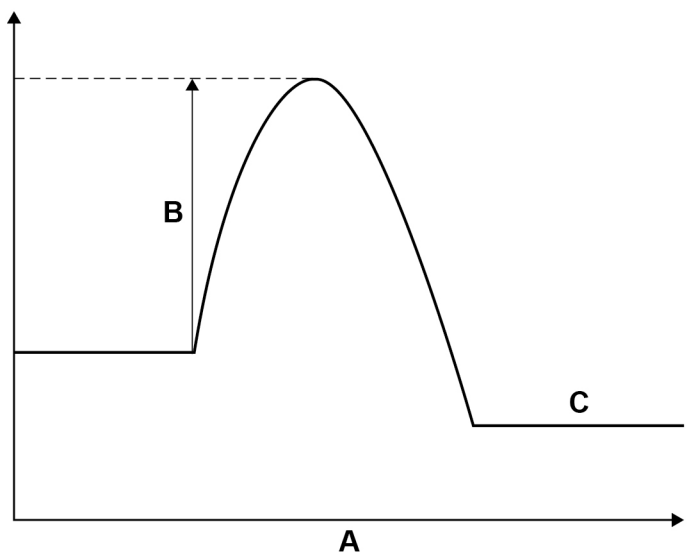
_____

4.4.2.1 Reactions of acids with metals

Question 24 · continued

0 4 . 6 **Figure 6** shows a reaction profile for the reaction of magnesium with hydrochloric acid.

Figure 6



What do labels **A**, **B** and **C** represent on **Figure 6**?

Choose answers from the box.

[3 marks]

activation energy	**energy**	**overall energy change**
products	**progress of reaction**	**reactants**

A _____

B _____

C _____

9

4.4.2.1 Reactions of acids with metals

Question 25

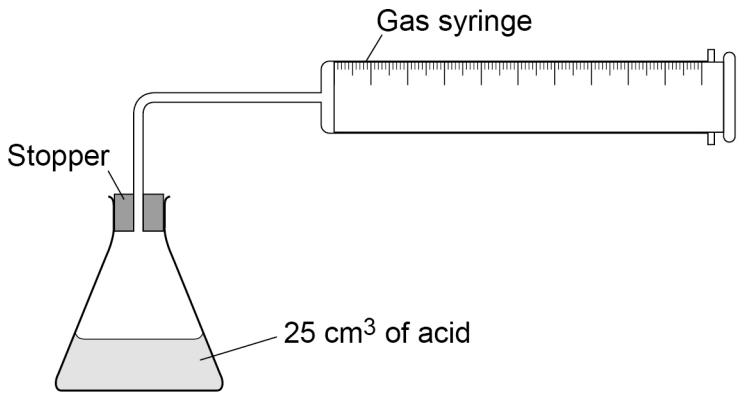
November 2021 | 8462/1F | Original Q6

0 6 This question is about metal carbonates.

A student investigated the reaction of copper carbonate with an acid.

Figure 8 shows the apparatus.

Figure 8

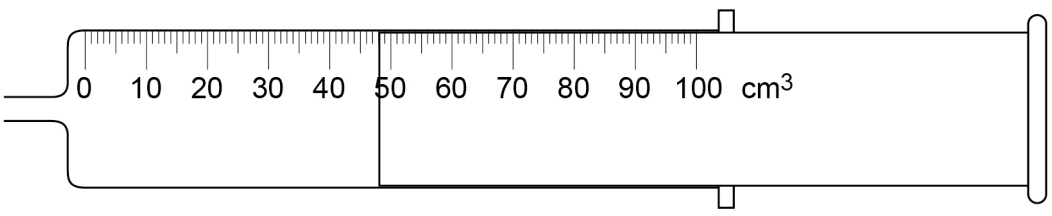


This is the method used.

1. Pour 25 cm^3 of the acid into a conical flask.
2. Weigh 0.10 g of copper carbonate.
3. Remove the stopper and add the copper carbonate to the flask.
4. Quickly replace the stopper.
5. Record the maximum volume of gas collected in the gas syringe.
6. Repeat steps 1 to 5 with different masses of copper carbonate.

0 6 . 1 **Figure 9** shows the gas syringe during the experiment.

Figure 9



What is the reading on the gas syringe?

[1 mark]

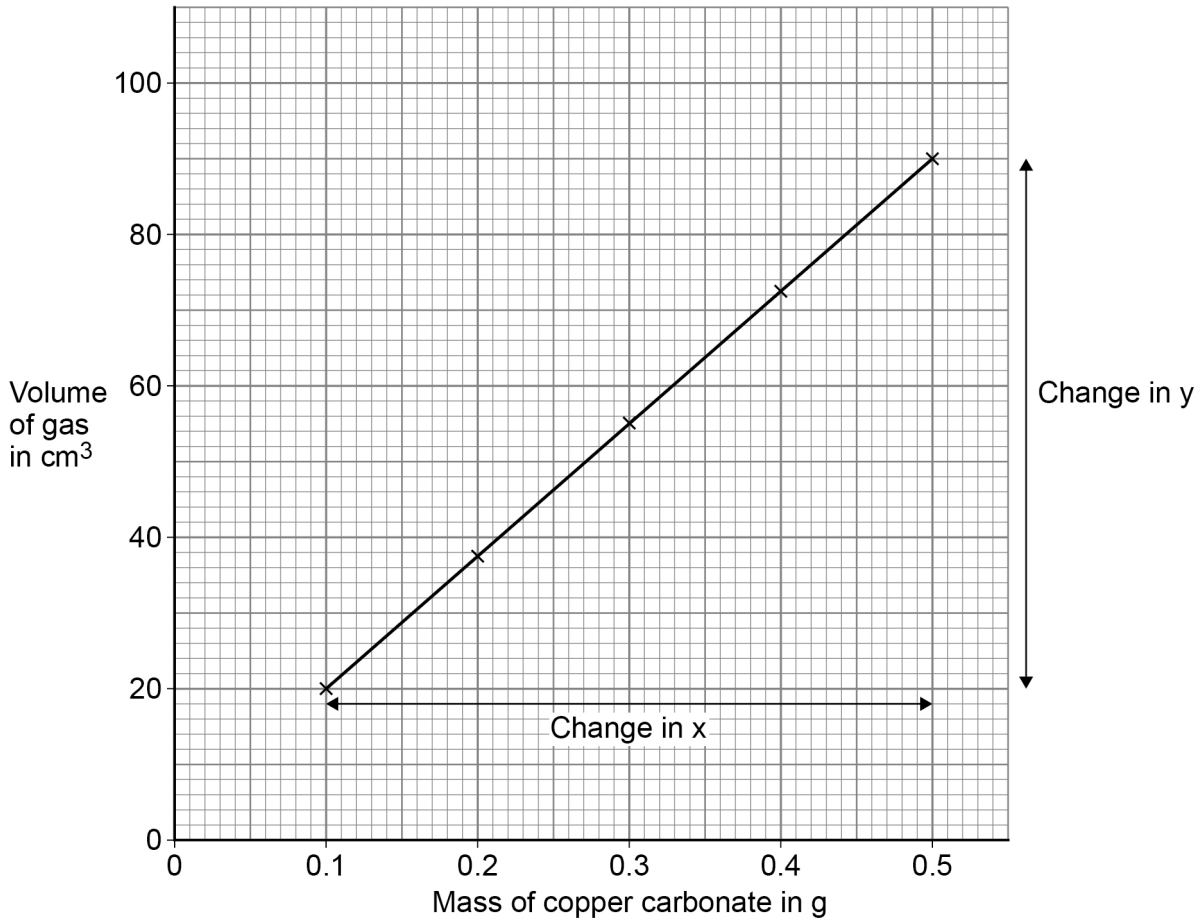
_____ cm^3

Question 25 · continued

0 6 . 2 The student plotted the results on a graph.

Figure 10 shows the student's graph.

Figure 10



Determine the gradient of the line of best fit.

You should:

- calculate the values of the change in y and the change in x
- calculate the gradient of the line of best fit.

[4 marks]

Change in y = _____ cm^3

Change in x = _____ g

Gradient _____

_____

Gradient = _____ cm^3/g

4.4.2.1 Reactions of acids with metals

Question 25 · continued

0 6 . 3 Copper chloride was produced in the reaction.

Which acid reacts with copper carbonate to produce copper chloride?

[1 mark]

Tick (✓) **one** box.

- Hydrochloric acid ☐
- Nitric acid ☐
- Sulfuric acid ☐

0 6 . 4 The reaction between copper carbonate and the acid produced a gas.

What was the gas?

[1 mark]

Tick (✓) **one** box.

- Carbon dioxide ☐
- Chlorine ☐
- Hydrogen ☐
- Oxygen ☐

4.4.2.1 Reactions of acids with metals

Question 25 · continued

A different student produced a pure, dry sample of copper chloride using the same reaction.

This is the method used.

1. Add excess copper carbonate to the acid.
2. Filter the mixture.
3. Heat the solution gently until crystals start to form.
4. Leave for 24 hours.
5. Remove the crystals.
6. Rinse with water and dry the crystals.

0 6 . 5 Why was the solution heated gently in **step 3**?

[1 mark]

Tick (✓) **one** box.

- To evaporate acid ☐
- To evaporate copper carbonate ☐
- To evaporate water ☐

0 6 . 6 How should the solution be heated gently in **step 3**?

[1 mark]

_____

_____

9

4.4.2.1 Reactions of acids with metals

Question 26

November 2021 | 8462/2F | Original Q5

0 5 A student investigated the rate of the reaction between zinc and sulfuric acid.

This is the method used.

1. Pour 40 cm^3 of sulfuric acid into a conical flask.

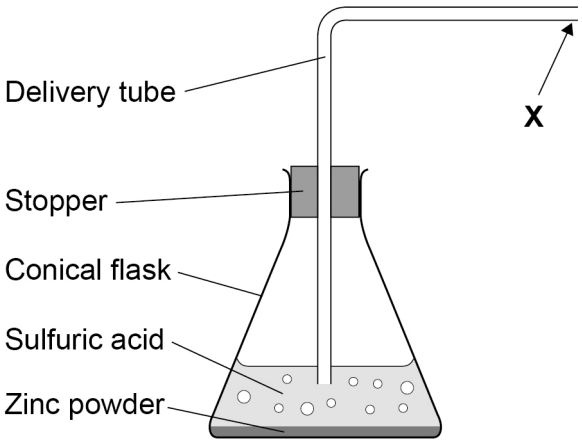
2. Add 2.0 g of zinc powder to the conical flask.

3. Put the stopper in the conical flask.

4. Measure the volume of hydrogen gas collected every 30 seconds for 5 minutes.

Figure 4 shows part of the apparatus used.

Figure 4



4.4.2.1 Reactions of acids with metals

Question 26 · continued

0 5 . 1 **X** shows where a piece of equipment is connected to measure the volume of hydrogen gas collected.

Complete **Figure 4** to show the equipment used.

[1 mark]

0 5 . 2 The student made an error setting up the delivery tube shown in **Figure 4**.

Describe the error **and** the problem this error would cause.

[2 marks]

Error made _____

_____

Problem caused _____

_____

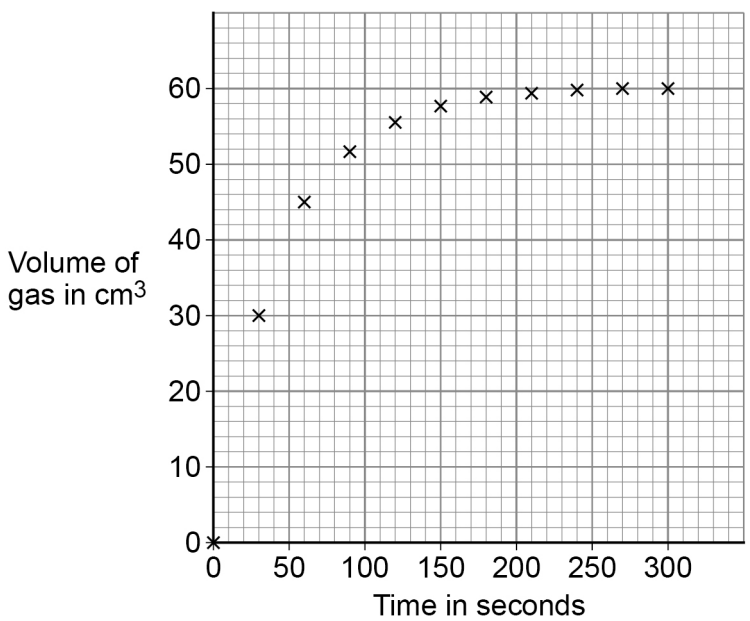
Question 5 continues on the next page

Question 26 · continued

The student then set up the apparatus correctly.

Figure 5 shows the student's results.

Figure 5



0 5 . 3 Complete **Figure 5** by drawing a line of best fit.

[1 mark]

4.4.2.1 Reactions of acids with metals

Question 26 · continued

0 5 . 4 Determine the mean rate of reaction between 0 seconds and 60 seconds.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas formed}}{\text{time taken}}$$

Use data from **Figure 5**.

Give the unit.

Choose the answer from the box.

[4 marks]

cm^3/s	**g/s**	**s/cm^3**	**s/g**

Mean rate of reaction = _____ Unit _____

0 5 . 5 The student repeated the investigation using sulfuric acid of a higher concentration.

The student plotted the results and drew a line of best fit.

How would the line of best fit for higher concentration compare with the line of best fit for lower concentration?

[1 mark]

Tick (✓) **one** box.

The line of best fit for higher concentration would have a less steep slope. ☐

The line of best fit for higher concentration would have a steeper slope. ☐

The lines of best fit would have slopes with the same steepness. ☐

9

4.4.2.1 Reactions of acids with metals

Question 27

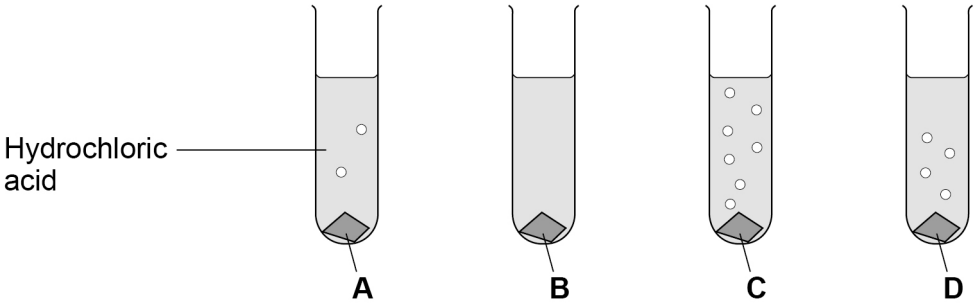
June 2022 | 8462/1F | Original Q3

0 3 This question is about acids.

A student added four metals, **A**, **B**, **C** and **D** to hydrochloric acid.

Figure 4 shows the rate of bubbling in each tube.

Figure 4



Use **Figure 4** to answer questions **03.1** and **03.2**.

0 3 . 1 Which metal is copper?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 3 . 2 Which metal is the most reactive?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 3 . 3 A metal oxide reacts with an acid to produce zinc sulfate and water.

Name the metal oxide and the acid used in this reaction.

[2 marks]

Name of metal oxide _____

Name of acid _____

4.4.2.1 Reactions of acids with metals

Question 27 · continued

0 3 . 4 Universal indicator is used to measure the pH of a solution.

Draw **one** line from each pH to the colour of universal indicator in a solution with that pH.

[2 marks]

pH	Colour of universal indicator
	Blue
1	Green
	Purple
7	Red
	Yellow

Question 3 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 27 · continued

A student reacts an acid with an alkali in a titration.

0 3 . 5 What is the type of reaction when an acid reacts with an alkali?

[1 mark]

Tick (✓) **one** box.

Combustion ☐

Decomposition ☐

Neutralisation ☐

0 3 . 6 **Figure 5** shows a piece of equipment used to measure the volume of the acid in the titration.

Figure 5



What is the name of this piece of equipment?

[1 mark]

Tick (✓) **one** box.

Burette ☐

Pipette ☐

Syringe ☐

Tube ☐

8

4.4.2.1 Reactions of acids with metals

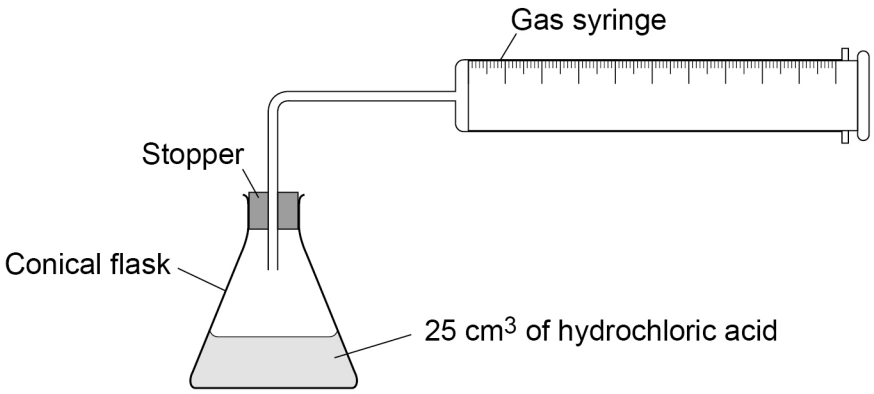
Question 28

June 2022 | 8462/1F | Original Q5

0 5 A student investigated the reaction of magnesium with hydrochloric acid.

Figure 7 shows the apparatus used.

Figure 7



This is the method used.

1. Set up the apparatus as shown in **Figure 7**.
2. Cut 10 mm of magnesium ribbon.
3. Remove the stopper.
4. Add the magnesium ribbon to the conical flask.
5. Replace the stopper as quickly as possible.
6. Record the final reading on the gas syringe when the reaction has stopped.
7. Repeat steps 1 to 6 three more times.
8. Repeat steps 1 to 7 with different lengths of magnesium ribbon.

4.4.2.1 Reactions of acids with metals

Question 28 · continued

0 5 . 1 Which gas is produced when magnesium reacts with hydrochloric acid?

[1 mark]

Tick (✓) **one** box.

- Carbon dioxide ☐
- Chlorine ☐
- Hydrogen ☐
- Oxygen ☐

0 5 . 2 What was the independent variable in the investigation?

[1 mark]

_____

0 5 . 3 Give **one** control variable in the investigation.

[1 mark]

_____

Question 5 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 28 · continued

Table 5 shows the results for one length of magnesium ribbon.

Table 5

	Trial 1	Trial 2	Trial 3	Trial 4
Volume of gas produced in cm^3	19	36	37	32

One of the results was anomalous.

0 5 . 4 Which trial in **Table 5** gave an anomalous result?

[1 mark]

Trial _____

0 5 . 5 Suggest **one** reason for the anomalous result in **Table 5**.

[1 mark]

_____

_____

Question 28 · continued

0 5 . 6 **Table 6** shows the mean volume of gas produced for each length of magnesium ribbon.

Table 6

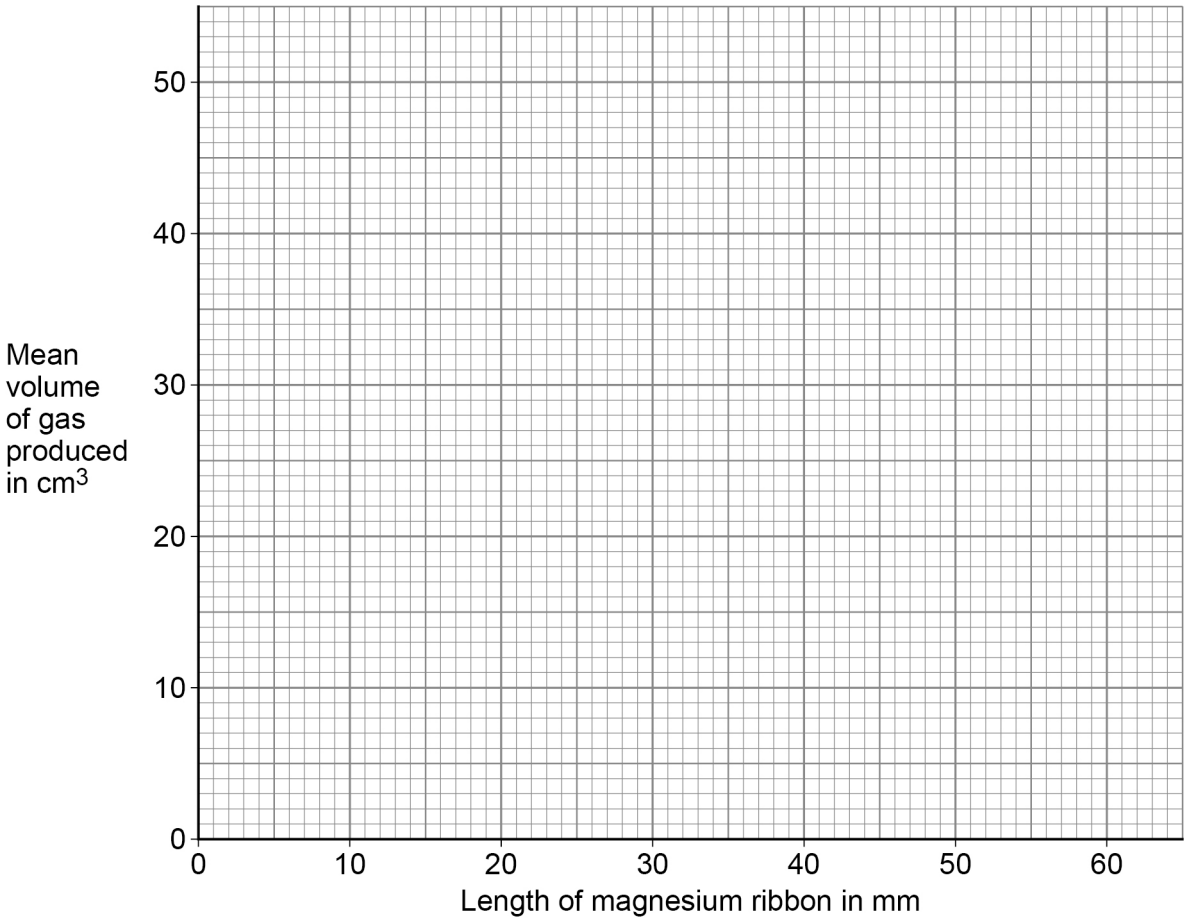
Length of magnesium ribbon in mm	10	20	30	40	50	60
Mean volume of gas produced in cm^3	7	14	21	28	35	42

Plot the data from **Table 6** on **Figure 8**.

Draw a line of best fit.

[3 marks]

Figure 8



0 5 . 7 Complete the sentence.

[1 mark]

As the length of the magnesium ribbon increases, the mean volume of gas produced

_____.

9

4.4.2.1 Reactions of acids with metals

Question 29

June 2023 | 8462/1F | Original Q8

0 8 This question is about displacement reactions.

Iron is extracted from iron oxide by a displacement reaction with carbon.

0 8 . 1 Balance the equation for the reaction.

[2 marks]

$$Fe_2O_3 + 3\,C \rightarrow ____Fe + ____CO$$

0 8 . 2 Iron oxide is reduced in this reaction.

How does the equation show that iron oxide is reduced?

[1 mark]

0 8 . 3 Calculate the relative formula mass (M_r) of Fe_2O_3

Relative atomic masses (A_r): O = 16 Fe = 56

[2 marks]

M_r = _____

Question 8 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 29 · continued

0 8 . 4 Copper oxide reacts with hydrogen to produce copper.

The equation for the reaction is:

$$CuO + H_2 \rightarrow Cu + H_2O$$

Calculate the percentage atom economy for obtaining copper from this reaction.

Use the equation:

$$\text{Percentage atom economy} = \frac{A_r \text{ of Cu}}{M_r \text{ of } H_2 + M_r \text{ of CuO}} \times 100$$

Relative atomic mass (A_r): Cu = 63.5
Relative formula masses (M_r): H_2 = 2 CuO = 79.5

[2 marks]

Percentage atom economy = _____ %

A student investigated the reactivity of four different metals, **A**, **B**, **C** and **D**.

The student:

- added each metal to aqueous solutions of each of the metal sulfates
- observed whether a reaction took place.

0 8 . 5 Give **one** observation that would show a reaction took place.

[1 mark]

4.4.2.1 Reactions of acids with metals

Question 29 · continued

0 8 . 6 **Table 4** shows the results.

Table 4

	Metal sulfate solution			
Metal	**A sulfate**	**B sulfate**	**C sulfate**	**D sulfate**
A	×	×	✓	×
B	✓	×	✓	×
C	×	×	×	×
D	✓	✓	✓	×

✓ shows that a displacement reaction took place.
× shows that a displacement reaction did not take place.

Write metals **A**, **B**, **C** and **D** in order of reactivity.

Give a reason for your order of reactivity.

[2 marks]

Most reactive _____

_____

_____

Least reactive _____

Reason _____

_____

10

4.4.2.1 Reactions of acids with metals

Question 30

June 2023 | 8462/1F | Original Q11

1 1 This question is about making a soluble salt.

1 1 . 1 Plan a method to make pure, dry crystals of zinc chloride from zinc carbonate and a dilute acid.

[6 marks]

1 1 . 2 Name **two** other substances that can each be reacted with a dilute acid to make zinc chloride.

Do **not** refer to zinc carbonate in your answer.

[2 marks]

1 _____

2 _____

8

4.4.2.1 Reactions of acids with metals

Question 31

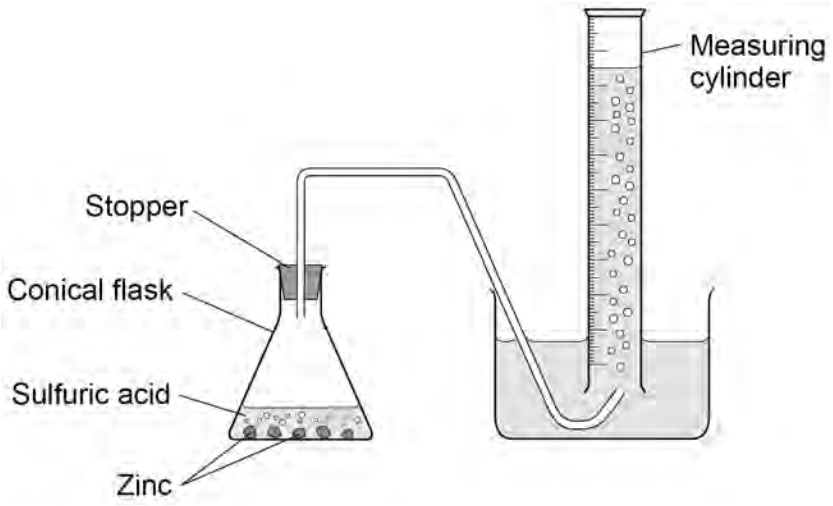
June 2023 | 8462/2F | Original Q8

0 8 A student investigated the rate of the reaction between zinc and sulfuric acid.

Hydrogen gas is produced during this reaction.

Figure 7 shows the apparatus.

Figure 7



This is the method used.

1. Add 50 cm^3 of sulfuric acid to a conical flask.

2. Add 2.0 g of zinc to the conical flask.

3. Quickly put a stopper in the conical flask and start a timer.

4. Measure the time taken to collect 20 cm^3 of gas.

5. Repeat steps 1 to 4 three more times.

0 8 . 1 Suggest why the stopper must be put in the conical flask as quickly as possible in **step 3**.

[1 mark]

0 8 . 2 The student calculated the rate of the reaction for each trial.

Table 7 shows the results of the calculations.

Table 7

	Trial 1	Trial 2	Trial 3	Trial 4
Rate of reaction in cm^3/s	0.78	0.81	0.68	0.81

Determine the mean time taken to collect 20 cm^3 of gas.

Do **not** include any anomalous results.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas collected}}{\text{mean time taken}}$$

[5 marks]

Mean time taken = _____ s

Question 8 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 31 · continued

0 8 . 3 The student changed the investigation so that the mean time taken to collect 20 cm^3 of gas was greater.

Which **two** changes would increase the mean time taken to collect 20 cm^3 of gas?

[2 marks]

Tick (✓) **two** boxes.

- Use a catalyst ☐
- Use a larger conical flask ☐
- Use a lower temperature ☐
- Use smaller pieces of zinc ☐
- Use sulfuric acid of a lower concentration ☐

0 8 . 4 Hydrogen gas is produced during this reaction.

Describe the test for hydrogen gas.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

10

4.4.2.1 Reactions of acids with metals

Question 32

June 2023 | 8462/2F | Original Q10

1 0 This question is about chemical analysis.

Potassium bromide is used in medicine.

A scientist tested a sample of medicine to show the presence of potassium ions and of bromide ions.

The sample is soluble in water.

1 0 . 1 Plan a method the scientist could use to show that the sample of medicine contains potassium ions **and** bromide ions.

The scientist has:

- a Bunsen burner
- a metal wire
- test tubes
- a dropping pipette
- distilled water
- dilute nitric acid
- silver nitrate solution.

You should give the results of the tests.

[6 marks]

4.4.2.1 Reactions of acids with metals

Question 32 · continued June 2023 | 8462/2F | Original Q10

The scientist could also use an instrumental method to show the presence of potassium ions in the medicine.

10.2 Which instrumental method could be used to show the presence of potassium ions in the medicine?

[1 mark]

10.3 Give **one** advantage of using this instrumental method instead of a chemical test.

[1 mark]

8

4.4.2.1 Reactions of acids with metals

Question 33

June 2024 | 8462/1F | Original Q8

0 8 A student produced a salt by reacting copper carbonate with sulfuric acid.

This is the method used.

1. Measure 50 cm^3 of sulfuric acid into a beaker.
2. Add copper carbonate powder.
3. Stir the mixture.
4. Repeat steps 2 and 3 until copper carbonate is in excess.
5. Filter the mixture.
6. Warm the filtrate gently until crystals start to appear.
7. Leave the solution to cool and crystallise.

0 8 . 1 Complete the word equation for the reaction.

[2 marks]

copper carbonate + sulfuric acid → _____ + _____ + carbon dioxide

0 8 . 2 Give **one** observation the student could make during **Step 4** which shows that the copper carbonate is in excess.

[1 mark]

_____

_____

0 8 . 3 Give **one** reason for filtering the mixture in **Step 5**.

[1 mark]

_____

_____

4.4.2.1 Reactions of acids with metals

Question 33 · continued

0 8 . 4 Name the equipment that can be used to warm the filtrate **gently** in **Step 6**.

[1 mark]

0 8 . 5 The maximum theoretical mass of the salt that could be produced using 50 cm^3 of the sulfuric acid is 12.5 g.

The percentage yield of the salt is 92.8%.

Calculate the mass of salt actually produced.

Use the equation:

$$\% \text{ yield} = \frac{\text{mass of salt actually produced}}{\text{maximum theoretical mass of salt that could be produced}} \times 100$$

[3 marks]

Mass of salt actually produced = _____ g

Question 8 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 33 · continued

0 8 . 6 Some salts can be produced by reacting sulfuric acid with a metal.

Neither copper nor sodium is used to produce a salt with sulfuric acid.

Give **one** reason why each metal is **not** used.

[2 marks]

Copper _____

_____

Sodium _____

_____

10

4.4.2.1 Reactions of acids with metals

Question 34

June 2024 | 8462/2F | Original Q2

0 2 This question is about burning coal.

A power station has four coal-burning furnaces.

Each furnace burns 3000 kg of coal per minute.

Table 1 shows some information about this coal burning power station

Table 1

Number of furnaces in use	Mass of coal burned per minute in kilograms	Mass of sulfur dioxide produced per minute in kilograms	Mass of carbon dioxide produced per minute in kilograms
0	0	0	0
1	3000	100	7000
2	6000	200	14 000
3	9000	300	21 000
4	12 000	400	28 000

0 2 . 1 Carbon dioxide is a greenhouse gas.

What is the effect on the rate of global climate change of using more furnaces in this power station?

Complete the sentence.

Choose the answer from the box.

[1 mark]

decreases	**stays the same**	**increases**

Use **Table 1**.

The rate of global climate change _____.

4.4.2.1 Reactions of acids with metals

Question 34 · continued

0 2 . 2 7000 kg of carbon dioxide are produced when 3000 kg of coal are burned.

Calculate the mass of carbon dioxide produced when 1 kilogram of coal is burned.

[2 marks]

Mass of carbon dioxide = _____ kg

0 2 . 3 Complete the sentence.

[1 mark]

Sulfur dioxide causes an environmental effect called acid _____ .

Question 2 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 34 · continued

Table 1 is repeated below.

Table 1

Number of furnaces in use	Mass of coal burned per minute in kilograms	Mass of sulfur dioxide produced per minute in kilograms	Mass of carbon dioxide produced per minute in kilograms
0	0	0	0
1	3000	100	7000
2	6000	200	14 000
3	9000	300	21 000
4	12 000	400	28 000

0 2 . 4 **Figure 3** shows how the mass of sulfur dioxide produced per minute varies with the mass of coal burned per minute.

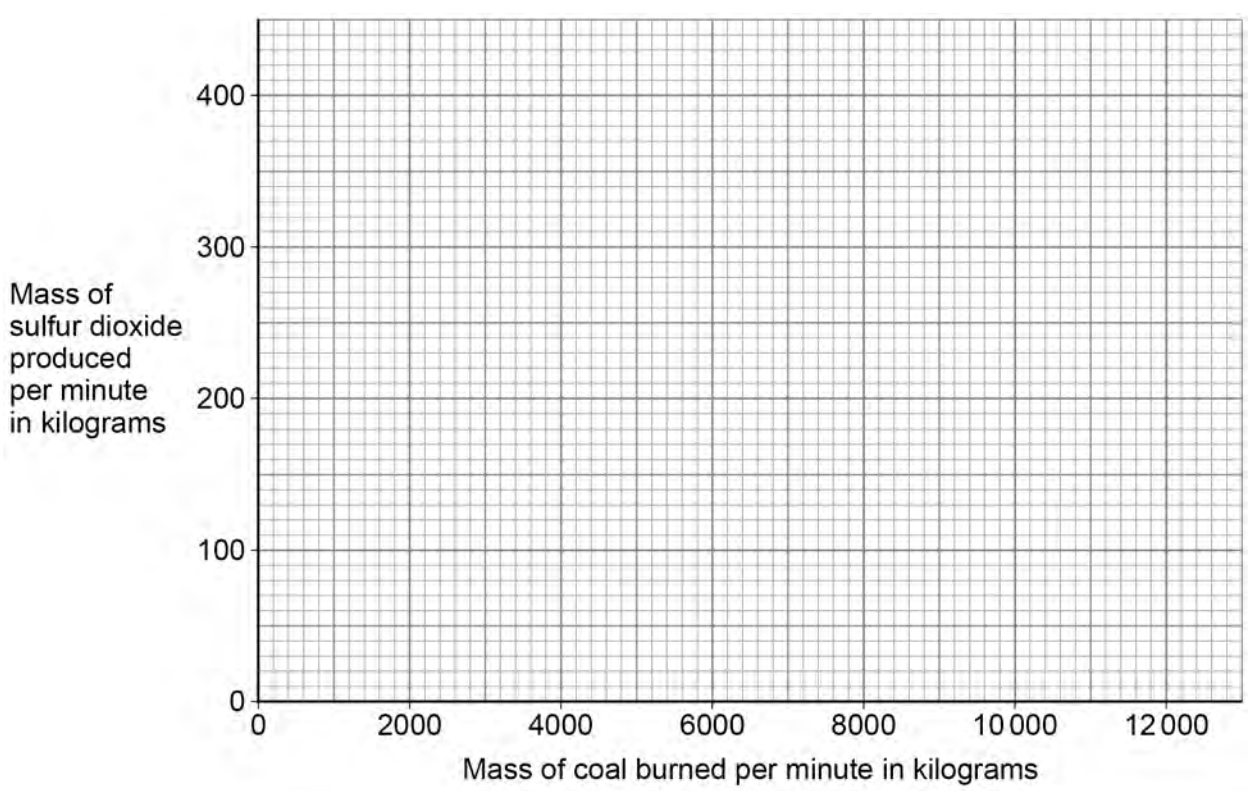
Complete **Figure 3**.

You should:

- plot data from **Table 1** on **Figure 3**
- draw a line of best fit.

[3 marks]

Figure 3



4.4.2.1 Reactions of acids with metals

Question 34 · continued

0 2 . 5 Complete the sentence.

Use **Table 1** and **Figure 3**.

[1 mark]

As the mass of coal burned per minute increases, the mass of sulfur dioxide produced per minute _____ .

0 2 . 6 This power station also releases particulates into the air.

Complete the sentence.

[1 mark]

The release of particulates into the air causes global _____ .

9

Turn over for the next question

4.4.2.1 Reactions of acids with metals

Question 35

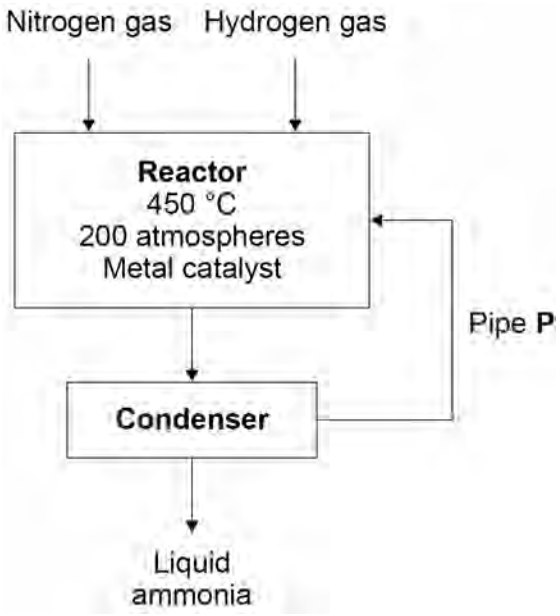
June 2024 | 8462/2F | Original Q9

0 9 This question is about ammonia and nitric acid.

In the Haber process ammonia is produced from nitrogen and hydrogen.

Figure 10 represents the Haber process.

Figure 10



0 9 . 1 Pipe **P** links the condenser to the reactor.

Why is the condenser linked to the reactor?

Use **Figure 10**.

[1 mark]

0 9 . 2 Which metal is used as a catalyst in this reaction?

[1 mark]

4.4.2.1 Reactions of acids with metals

Question 35 · continued

Nitric acid is produced by reacting ammonia with oxygen.

The word equation for the production of nitric acid is:

ammonia + oxygen → water + nitric acid

Platinum is a catalyst in this reaction.

0 9 . 3 Describe the test for oxygen gas.

Give the result if oxygen gas is present.

[2 marks]

Test _____

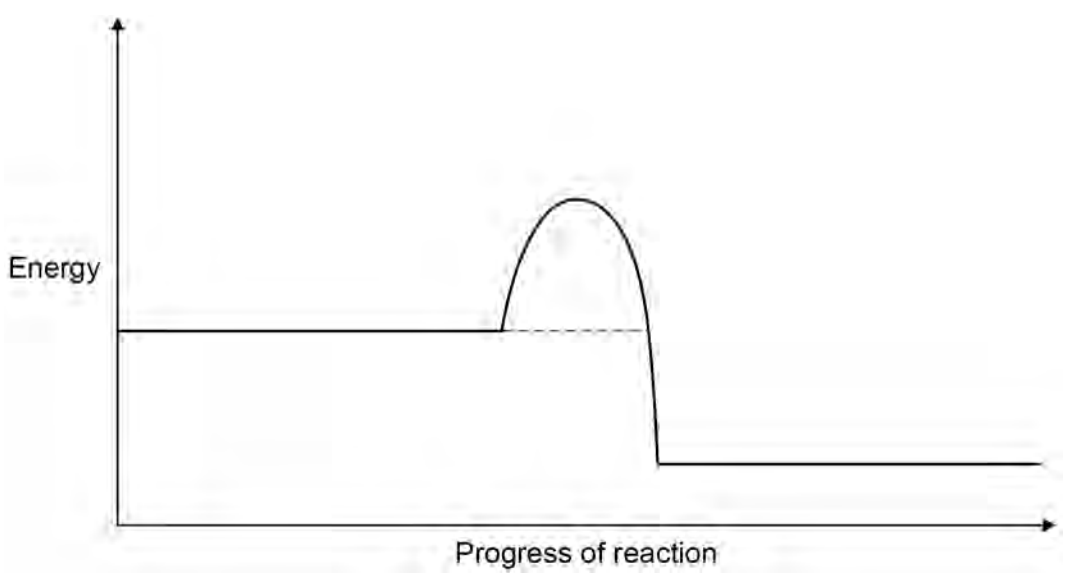
_____

Result _____

_____

Figure 11 represents the reaction profile of the catalysed reaction between ammonia and oxygen.

Figure 11



4.4.2.1 Reactions of acids with metals

Question 35 · continued

0 9 . 4 Complete the reaction profile for the catalysed reaction in **Figure 11**.

You should:

- label the activation energy
- label the reactants and products, using the names of the reactants and products.

[2 marks]

0 9 . 5 How would **Figure 11** be different if **no** catalyst was used?

[1 mark]

Tick (✓) **one** box.

The final energy level would be higher. ☐

The final energy level would be lower. ☐

The line would reach a higher peak. ☐

The line would reach a lower peak. ☐

0 9 . 6 Ammonia and nitric acid react to produce the salt, ammonium nitrate.

Ammonium ions and nitrate ions both contain nitrogen.

Suggest **one** use of ammonium nitrate.

[1 mark]

_____

_____

8

4.4.2.1 Reactions of acids with metals

Question 36

June 2025 | 8462/1F | Original Q2

0 2 Metals react with acids to produce a salt and a gas.

0 2 . 1 Which salt is produced when magnesium reacts with hydrochloric acid?

[1 mark]

Tick (✓) **one** box.

- Magnesium chloride ☐
- Magnesium nitrate ☐
- Magnesium sulfate ☐

0 2 . 2 Which gas is produced when magnesium reacts with hydrochloric acid?

[1 mark]

Tick (✓) **one** box.

- Carbon dioxide ☐
- Chlorine ☐
- Hydrogen ☐
- Oxygen ☐

Question 2 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 36 · continued

A student investigated the temperature change in the reaction between metals and hydrochloric acid.

This is the method used.

1. Measure 25 cm^3 of hydrochloric acid at 20 °C into a container.

2. Add 1 g of a metal.

3. Record the temperature change.

4. Repeat steps 1 to 3 using a different metal.

0 2 . 3 Draw **one** line from the type of variable to the name of the variable in the investigation.

[2 marks]

Type of variable	Name of variable
	Mass of metal
Dependent variable	Temperature change
Independent variable	Type of metal
	Volume of hydrochloric acid

4.4.2.1 Reactions of acids with metals

Question 36 · continued

0 2 . 4 Which container would be the most suitable to reduce energy transfer with the surroundings?

[1 mark]

Tick (✓) **one** box.

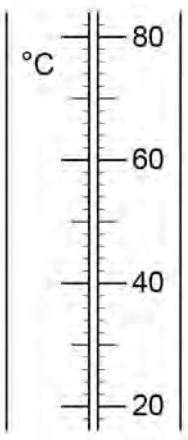
A copper can ☐

A glass beaker ☐

A polystyrene cup ☐

0 2 . 5 **Figure 1** shows part of the scale of the thermometer used in the investigation.

Figure 1



What is the resolution of the thermometer?

[1 mark]

Tick (✓) **one** box.

1 °C ☐ 2 °C ☐ 10 °C ☐ 20 °C ☐

4.4.2.1 Reactions of acids with metals

Question 36 · continued

0 2 . 6 The reaction between a metal and an acid is exothermic.

What happens to the temperature of the mixture during the reaction?

[1 mark]

Tick (✓) **one** box.

Decreases ☐

Stays the same ☐

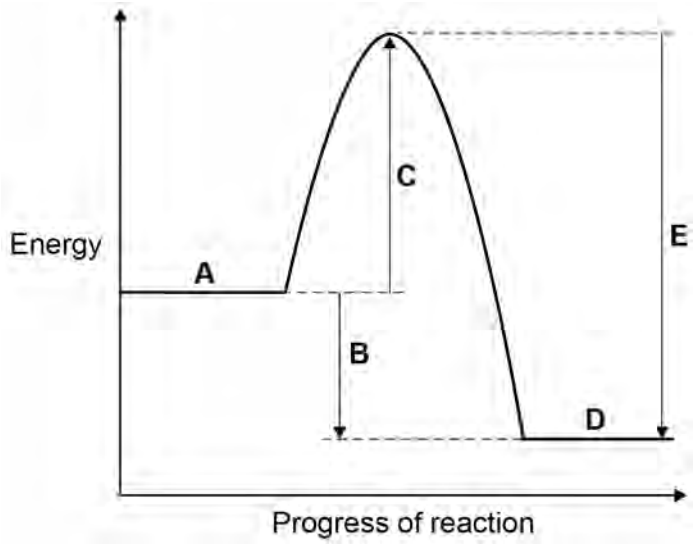
Increases ☐

4.4.2.1 Reactions of acids with metals

Question 36 · continued

Figure 2 shows the reaction profile for the reaction between a metal and an acid.

Figure 2



0 2 . 7 Which letter in **Figure 2** represents the reactants?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

0 2 . 8 Which letter in **Figure 2** represents the activation energy?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

0 2 . 9 Which letter in **Figure 2** represents the overall energy change?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

10

4.4.2.1 Reactions of acids with metals

Question 37

June 2025 | 8462/2F | Original Q1

0 1 This question is about chemical analysis.

Some metal ions can be identified using a flame test.

0 1 . 1 Describe how to do a flame test using a metal wire and a Bunsen burner.

[2 marks]

0 1 . 2 Draw **one** line from each metal ion to the flame colour produced by the metal ion.

[2 marks]

Metal ion	Flame colour
Lithium	Crimson
Potassium	Green
	Lilac
	Orange-red
	Yellow

4.4.2.1 Reactions of acids with metals

Question 37 · continued

0 1 . 3 Which gas is produced when carbonates are reacted with dilute acids?

[1 mark]

Tick (✓) **one** box.

- Carbon dioxide ☐
- Hydrogen ☐
- Oxygen ☐

0 1 . 4 Which solution is used to test for sulfate ions?

[1 mark]

Tick (✓) **one** box.

- Barium chloride solution ☐
- Magnesium chloride solution ☐
- Sodium chloride solution ☐

Precipitates are used to identify some ions.

0 1 . 5 Complete the sentence.

Choose the answer from the box.

[1 mark]

gas	**liquid**	**solid**

A precipitate is a _____.

4.4.2.1 Reactions of acids with metals

Question 37 · continued

0 1 . 6 Some metal ions in solution can be identified by adding sodium hydroxide solution.

Draw **one** line from each metal ion to the colour of the precipitate produced by the metal ion.

[2 marks]

Metal ion	Colour of precipitate
Copper(II)	Blue
	Brown
Magnesium	Green
	White
	Yellow

0 1 . 7 Dilute nitric acid and silver nitrate solution were added to a solution containing iodide ions.

Complete the sentence.

Choose the answer from the box.

[1 mark]

brown	**green**	**yellow**

The colour of the precipitate produced is _____.

10