AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.2.1

Reactions of acids with metals

Past-paper questions

Tier	**Higher**
Question groups	**34**
Available paper years	**2008–2025**

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

January 2008 | CHY2H | Original Q5 | Legacy

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



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

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

State the meaning of *exothermic*.

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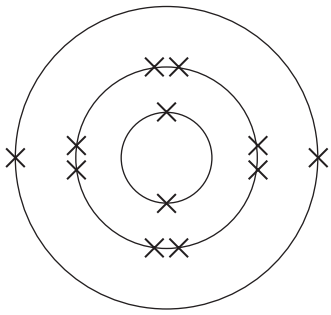
(1 mark)

(b) Write a balanced symbol equation for the reaction between magnesium (Mg) and oxygen (O_2) to form magnesium oxide (MgO).

.....

(1 mark)

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



Magnesium atom

Draw a similar diagram to show the electronic structure of an oxygen atom.
The atomic (proton) number of oxygen is 8.

(1 mark)

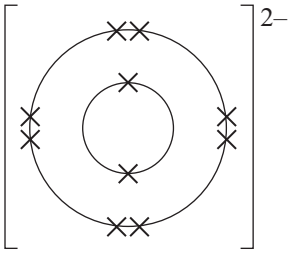
4.4.2.1 Reactions of acids with metals

Question 01 · continued

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(d) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen.

The diagram shows the electronic structure of an oxide ion.



Oxide ion

Draw a similar diagram to show the electronic structure of a magnesium ion.

(1 mark)

(e) Magnesium oxide is a white solid with a high melting point.

Explain how the ions are held together in solid magnesium oxide.

.....

.....

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(2 marks)

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

Complete the word equation for the reaction between magnesium oxide and hydrochloric acid.

hydrochloric acid + magnesium oxide → ..... + water.

(1 mark)

7

4.4.2.1 Reactions of acids with metals

Question 02

March 2009 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about the production of metals.

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

A decomposed

B acidified

C reduced

D extracted

Some metals are produced from their carbonate ores.

The ores are first . . . **1** . . . from the ground.

They are then heated until the metal carbonate is . . . **2** . . . .

When the ore is heated, sulfur impurities may react with air and eventually cause rainwater to be . . . **3** . . . .

Finally, the metal oxide can be reacted with carbon and so be . . . **4** . . . to the metal.

4.4.2.1 Reactions of acids with metals

Question 03

March 2009 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

A scientist investigated the chemistry of four metals, **W**, **X**, **Y** and **Z**.

These are the results.

- The oxides of **W** and **Y** were reduced to the metal when mixed with carbon and heated.
- The oxide of **Z** could not be reduced by heating with carbon.
- The oxide of **X** decomposed to the metal on heating alone.
- **Y** gave off hydrogen gas with dilute acid but **W** and **X** did not.

9A Starting with the most reactive, what is the order of reactivity for the four metals?

1 **X**, **W**, **Y**, **Z**

2 **Z**, **Y**, **W**, **X**

3 **X**, **W**, **Z**, **Y**

4 **Z**, **W**, **Y**, **X**

9B Which metal is most likely to be found in the ground as the pure metal?

1 **W**

2 **X**

3 **Y**

4 **Z**

9C How would metal **Z** be produced?

1 by mixing the oxide of **Z** with carbon and heating

2 by mixing an oxide of **Z** with the metal **W** and heating

3 by electrolysis of a molten oxide of **Z**

4 by heating the oxide of **Z** in a stream of hydrogen gas

4.4.2.1 Reactions of acids with metals

Question 03 · continued March 2009 | CHY1AP | Original Q9 | Legacy

9D The equation for the reduction of the oxide of **W** to the metal **W** can be represented by the following equation:

$$2\mathbf{W}_2O_3 + \boldsymbol{q}C = 3CO_2 + \boldsymbol{r}\mathbf{W}$$

What values of ***q*** and ***r*** are needed to balance the equation?

1 ***q*** = 3 and ***r*** = 4

2 ***q*** = 2 and ***r*** = 2

3 ***q*** = 4 and ***r*** = 2

4 ***q*** = 3 and ***r*** = 2

END OF TEST

4.4.2.1 Reactions of acids with metals

Question 04

June 2009 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

This question is about three metals, copper, lead and zinc.

7A Copper is found in the Earth's crust as the metal itself.

Lead and zinc are also found in the Earth's crust, but only as compounds such as oxides and sulfides.

These facts suggest that . . .

1 copper is a very reactive metal.

2 lead and zinc are transition metals, but copper is not.

3 lead and zinc react rapidly with oxygen and sulfur, but copper does not.

4 lead and zinc are more reactive than copper.

7B A naturally occurring compound of zinc is hydrozincite, $2ZnCO_3.3Zn(OH)_2$

Which row in the table correctly shows the number of elements, and the number of atoms of oxygen in the formula for hydrozincite?

	Number of elements	Number of atoms of oxygen
1	4	12
2	4	8
3	5	5
4	6	4

4.4.2.1 Reactions of acids with metals

Question 04 · continued June 2009 | CHY1AP | Original Q7 | Legacy

7C Zinc is also found as zincite, ZnO.

The metal can be extracted from zincite by mixing it with carbon and heating strongly.

Which row in the table correctly shows the name for this process and the products?

	Name of process	Products
1	electrolysis	zinc and carbon dioxide
2	leaching	zinc and oxygen
3	reduction	zinc and oxygen
4	reduction	zinc and carbon dioxide

Lead and zinc compounds are often found together in the same ore.

The metals can be extracted by mixing the ore with carbon and heating strongly in a furnace. They can then be separated.

The table shows the melting points and boiling points of lead and zinc.

	Lead	Zinc
Melting point in °C	328	420
Boiling point in °C	1740	907

The furnace operates at a temperature of 1200 °C.

7D How will the lead and zinc be separated?

1 Molten lead remains in the furnace and the zinc evaporates.

2 Molten lead and molten zinc form two separate layers in the furnace.

3 Molten zinc remains in the furnace and the lead evaporates.

4 Zinc and lead vapours leave the furnace and are separated in a condenser.

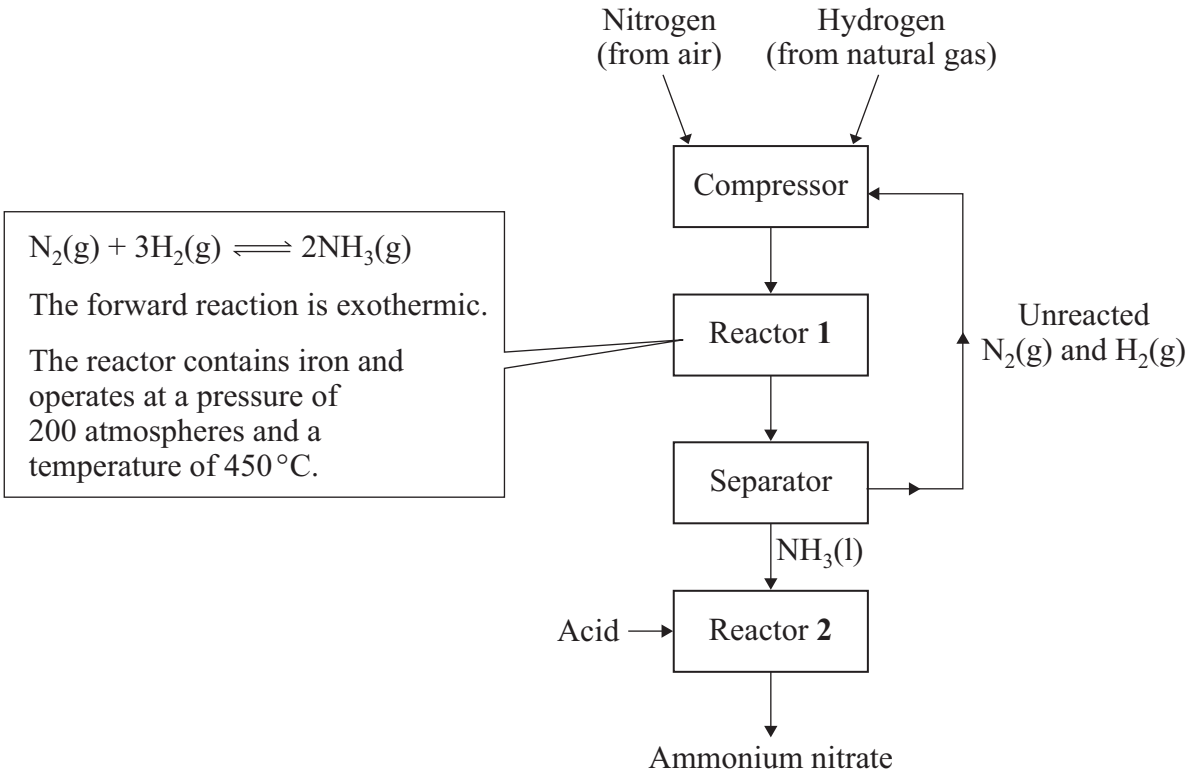
4.4.2.1 Reactions of acids with metals

Question 05

June 2009 | CHY2H | Original Q3 | Legacy

3 Ammonium nitrate is an important chemical. The diagram shows the main stages in the manufacture of ammonium nitrate.

Study the diagram and then answer the question.



3 (a) What is the purpose of the iron in reactor **1**?

.....

.....

(1 mark)

4.4.2.1 Reactions of acids with metals

Question 05 · continued

for mark

3 (b) Explain why the best yield of ammonia at equilibrium is obtained:

3 (b) (i) at low temperature

.....

.....

(1 mark)

3 (b) (ii) at high pressure.

.....

.....

(1 mark)

3 (c) The temperature used in reactor **1** is 450 °C.

Explain why a much lower temperature is **not** used.

.....

.....

(1 mark)

3 (d) A mixture of ammonia, nitrogen and hydrogen leaves reactor **1**.

In the separator, what is done to the mixture to separate the ammonia from the other gases?

.....

.....

(1 mark)

3 (e) Name the acid that reacts with ammonia in reactor **2** to make ammonium nitrate.

.....

.....

(1 mark)

6

4.4.2.1 Reactions of acids with metals

Question 06

November 2009 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

The equations show three reactions of the metal magnesium.

$$3Mg + Fe_2O_3 \rightarrow 3MgO + 2Fe$$

$$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$$

$$2Mg + O_2 \rightarrow 2MgO$$

8A Magnesium **cannot** be produced by heating magnesium oxide with carbon.

Which row in the table correctly shows the order of reactivity for iron, magnesium and carbon?

	Most reactive ⟶		**Least reactive**
1	magnesium	carbon	iron
2	magnesium	iron	carbon
3	iron	carbon	magnesium
4	carbon	iron	magnesium

8B When magnesium reacts with hydrochloric acid, hydrogen is given off.
When excess magnesium is used and all the acid has reacted, hydrogen continues to be given off from the remaining magnesium.

The probable reason is that . . .

1 magnesium reacts with water to form hydrogen and magnesium hydroxide.

2 magnesium reacts with water to form hydrogen and oxygen.

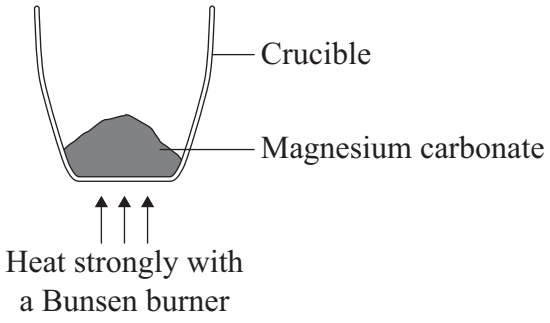
3 magnesium reacts with oxygen from the air to form hydrogen and magnesium oxide.

4 magnesium oxide decomposes to form magnesium, oxygen and hydrogen.

4.4.2.1 Reactions of acids with metals

Question 06 · continued

A student heated some magnesium carbonate in an open crucible.



The table shows the mass of the crucible and its contents at two-minute intervals.

Time in minutes	0	2	4	6	8
Mass of crucible and contents in grams	20.80	20.55	20.25	19.85	19.85

8C Which solid substances will the crucible contain after heating for two minutes?

1 magnesium carbonate only

2 magnesium oxide only

3 magnesium carbonate and magnesium oxide

4 magnesium and magnesium oxide

8D The student found that when the experiment was repeated using sodium carbonate instead of magnesium carbonate, there was no loss in mass.

The best conclusion that the student could make is that sodium carbonate . . .

1 does **not** decompose when heated.

2 only decomposes when heated gently.

3 only decomposes when heated to a very high temperature.

4 does **not** decompose at Bunsen burner temperatures.

4.4.2.1 Reactions of acids with metals

Question 07

March 2019 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about types of reactions.

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

A reduction

B combustion

C thermal decomposition

D corrosion

	Example of the type of reaction
1	Copper carbonate forms copper oxide and carbon dioxide when heated.
2	Hydrogen reacts with oxygen to produce water.
3	Carbon steels react when exposed to air and water.
4	Zinc is obtained from zinc oxide by removal of the oxygen.

4.4.2.1 Reactions of acids with metals

Question 08

March 2010 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

Titanium cannot be extracted by carbon reduction of its ore, which contains titanium dioxide, TiO_2

Titanium is obtained from titanium dioxide in two stages.

In **Stage 1**, the titanium dioxide is converted to titanium chloride ($TiCl_4$).

titanium dioxide + chlorine + carbon → titanium chloride + carbon dioxide

The possible escape of carbon dioxide and chlorine (a poisonous gas) can cause damage to the environment.

In **Stage 2**, the titanium chloride formed is reacted with sodium.

titanium chloride + sodium → titanium + sodium chloride

The sodium chloride formed is removed by washing the titanium with hydrochloric acid but the disposal of the acidic sodium chloride solution causes another environmental problem.

6A Which of the following is a correctly balanced equation for **Stage 2**?

1 $TiCl_4 + Na \rightarrow 4Ti + NaCl$

2 $TiCl_4 + Na \rightarrow Ti + 4NaCl$

3 $TiCl_4 + 4Na \rightarrow 4Ti + 4NaCl$

4 $TiC1_4 + 4Na \rightarrow Ti + 4NaCl$

6B Sodium, not carbon, is used to extract titanium from its compounds.

Which row in the table does this information suggest to be the order of reactivity for carbon, sodium and titanium?

	Most reactive →		**Least reactive**
1	Sodium	Titanium	Carbon
2	Sodium	Carbon	Titanium
3	Titanium	Sodium	Carbon
4	Carbon	Titanium	Sodium

4.4.2.1 Reactions of acids with metals

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

6C In **Stage 1**, the gases carbon dioxide and chlorine should **not** be allowed to escape into the air because . . .

1 both add to global dimming.

2 both are poisonous gases.

3 carbon dioxide adds to global warming and chlorine is toxic.

4 carbon dioxide adds to global dimming and chlorine is expensive.

6D In **Stage 2**, the best way to dispose of the acidic sodium chloride solution is . . .

1 to pump it into the ocean.

2 to pump it into landfill sites.

3 to boil the solution until all the acid has evaporated.

4 to separate the acid from the salt so that both can be used in other chemical processes.

4.4.2.1 Reactions of acids with metals

Question 09

November 2010 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

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

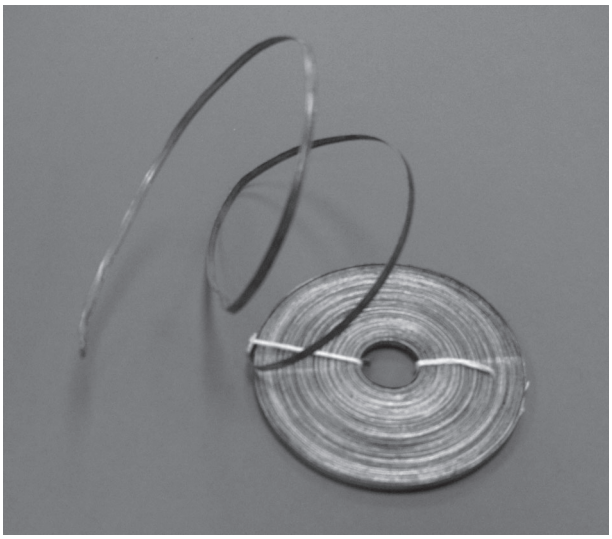
1	Aluminium is made when an electric current passes through a molten aluminium compound.
2	Gold can be found at the bottom of some streams.
3	Titanium is made by reacting titanium chloride with magnesium.
4	Zinc is made when a mixture of zinc oxide and carbon is heated.

4.4.2.1 Reactions of acids with metals

Question 10

January 2011 | CHY2H | Original Q3 | Legacy

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



Explain why metals can be shaped.

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.....

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(2 marks)

3 (b) 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:

$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$

3 (b) (i) Name the acid used to make magnesium sulfate.

..... acid

(1 mark)

4.4.2.1 Reactions of acids with metals

Question 10 · continued

3 (b) (ii) Use the equation to help you to describe what you would **observe** when magnesium reacts with the acid.

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(2 marks)

3 (b) (iii) The magnesium sulfate is in solution.

How could you obtain solid magnesium sulfate from this solution?

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(1 mark)

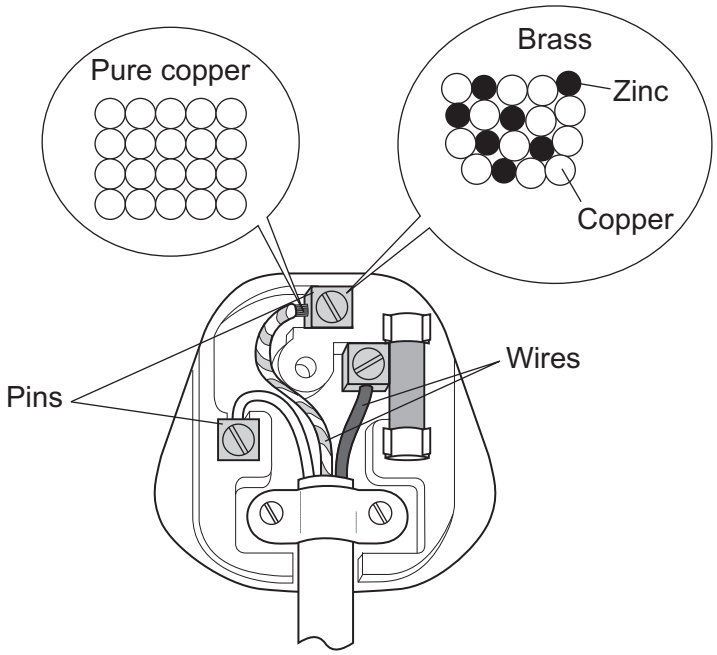
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4.4.2.1 Reactions of acids with metals

Question 11

June 2011 | CHY1H | Original Q3 | Legacy

3 The diagram shows an electric plug.



3 (a) Brass is used for the pins because it is harder than pure copper. Use the particle diagrams to help you to explain why.

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.....

.....

(2 marks)

Question 3 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 11 · continued

3 (b) An ore contains a mixture of zinc carbonate and lead carbonate. Zinc and lead are produced from this ore by two reactions.

3 (b) (i) **Reaction 1**: The carbonates in the ore are converted into a mixture of zinc oxide and lead oxide.

Name this type of reaction. .....

How is this reaction done? .....

.....

(2 marks)

3 (b) (ii) **Reaction 2**: The metal oxides are mixed with carbon and heated in a furnace to produce zinc and lead.

Explain why zinc and lead are produced.

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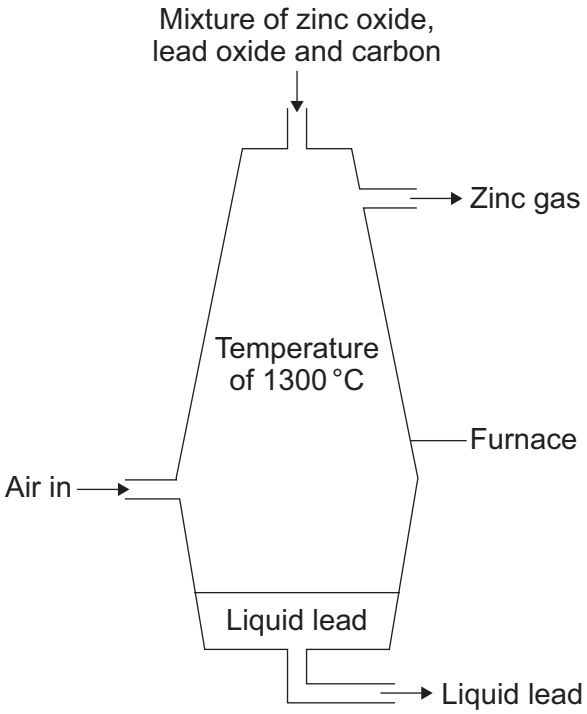
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(2 marks)

4.4.2.1 Reactions of acids with metals

Question 11 · continued

3 (b) (iii) The diagram represents a furnace used to produce zinc and lead from their oxides.



Metal	Melting point in °C	Boiling point in °C	Density in g per cm^3
Lead	328	1751	11.3
Zinc	420	908	7.1

Use the diagram and the information in the table to explain how zinc and lead are separated in the furnace.

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(2 marks)

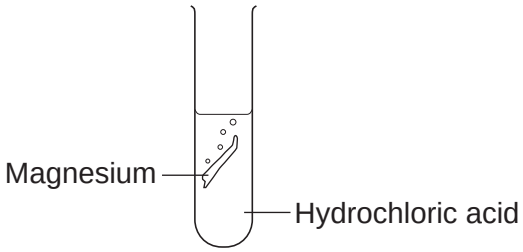
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4.4.2.1 Reactions of acids with metals

Question 12

June 2013 | CH2HP | Original Q2 | Legacy

2 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

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

1 .....

.....

2 .....

.....

(2 marks)

2 (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.

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4.4.2.1 Reactions of acids with metals

Question 13

June 2014 | CH1HP | Original Q4 | Legacy

4 Where copper ore has been mined there are areas of land that contain very low percentages of copper compounds.

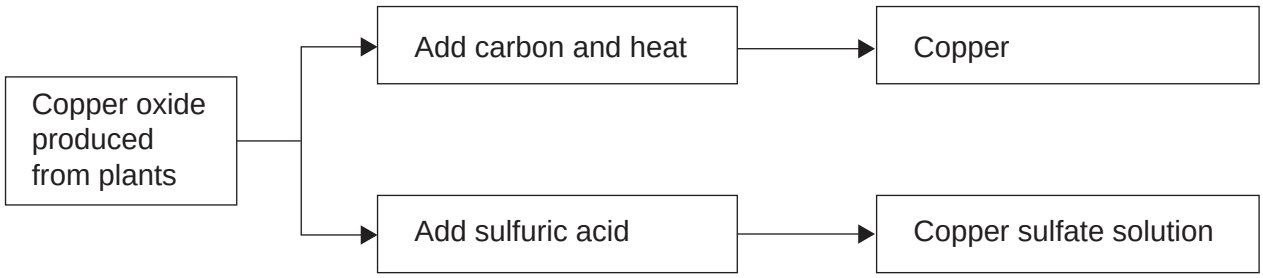
One way to extract the copper is to grow plants on the land.

The plants absorb copper compounds through their roots.

The plants are burned to produce copper oxide.

The copper oxide produced from plants can be reacted to produce copper or copper sulfate solution, as shown in **Figure 3**.

Figure 3



4 (a) (i) Complete the sentence.

[1 mark]

Using plants to extract metals is called ..... .

4 (a) (ii) Suggest **two** reasons why copper from these areas of land is **not** extracted by smelting.

[2 marks]

.....

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.....

.....

.....

4 (a) (iii) Complete and balance the chemical equation for the reaction of copper oxide with carbon.

[2 marks]

.....CuO + C ⟶ ..... + CO_2

4.4.2.1 Reactions of acids with metals

Question 13 · continued

4 (b) Copper is produced from copper sulfate solution by displacement using scrap iron or by electrolysis.

4 (b) (i) Use the Chemistry Data Sheet to help you to answer this question.

Give **two** reasons why scrap iron is used to displace copper.

[2 marks]

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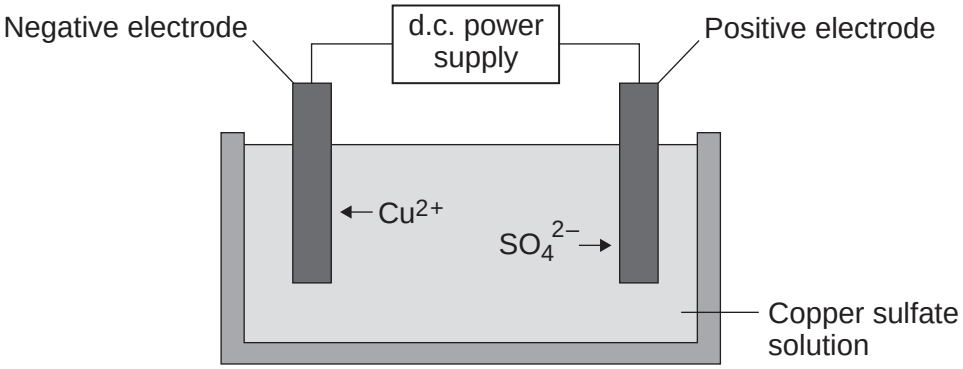
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4 (b) (ii) **Figure 4** shows the electrolysis of copper sulfate solution.

Figure 4



Describe what happens to the copper ions during electrolysis.

[2 marks]

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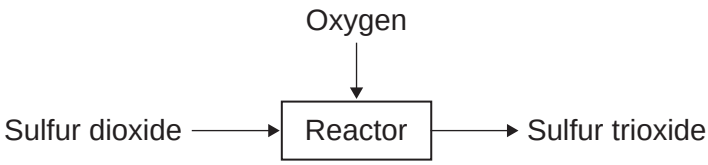
4.4.2.1 Reactions of acids with metals

Question 14

June 2014 | CH2HP | Original Q3 | Legacy

3 **Figure 2** represents a reaction in the production of sulfuric acid.

Figure 2



3 (a) Complete and balance the equation for the reaction.

[2 marks]

..... $SO_2(g)$ + ... (g) $\rightleftharpoons$ ..... $SO_3(g)$

3 (b) The conditions can affect the rate of the reaction.

3 (b) (i) The pressure of the reacting gases was increased.

State the effect of increasing the pressure on the rate of reaction.

Explain your answer in terms of particles.

[3 marks]

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4.4.2.1 Reactions of acids with metals

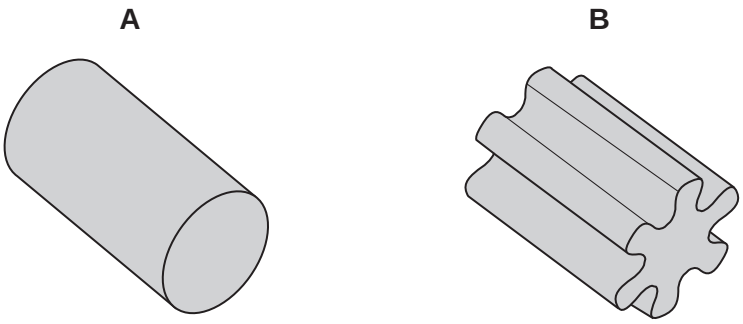
Question 14 · continued

3 (b) (ii) A catalyst is used for the reaction.

The gases pass through a layer containing pieces of the catalyst.

Figure 3 shows the shapes of pieces of catalyst.

Figure 3



Suggest and explain why shape **B** is more effective as a catalyst than shape **A**.

[2 marks]

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3 (c) The reaction is carried out at a high temperature to provide the reactants with the **activation energy**.

What is meant by the **activation energy**?

[1 mark]

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.....

4.4.2.1 Reactions of acids with metals

Question 14 · continued

3 (d) Sulfuric acid reacts with metals to produce salts.

3 (d) (i) A student concluded that potassium would **not** be a suitable metal to react with sulfuric acid.

Explain why.

[2 marks]

.....

.....

.....

.....

3 (d) (ii) A student reacted zinc metal with sulfuric acid to produce a salt and another product.

Complete the equation for this reaction.

[2 marks]

$Zn + H_2SO_4 \longrightarrow$ ..... + ...

3 (d) (iii) The student wanted to increase the rate of the reaction between the zinc and sulfuric acid.

State **one** way, other than using a catalyst, that the student could increase the rate of the reaction.

[1 mark]

.....

.....

13

4.4.2.1 Reactions of acids with metals

Question 15

June 2015 | CH2HP | Original Q5 | Legacy

5 This question is about compounds.

5 (a) **Table 2** gives information about the solubility of some compounds.

Table 2

Soluble compounds
All potassium and sodium salts
All nitrates
Chlorides, bromides and iodides, except those of silver and lead

Use information from **Table 2** to answer these questions.

5 (a) (i) Name a soluble compound that contains silver ions.

[1 mark]

.....

5 (a) (ii) Name a soluble compound that contains carbonate ions.

[1 mark]

.....

5 (b) Metal oxides react with acids to make salts.

What type of compound is a metal oxide?

[1 mark]

.....

4.4.2.1 Reactions of acids with metals

Question 15 · continued

5 (c) Lead nitrate solution is produced by reacting lead oxide with nitric acid.

5 (c) (i) State how solid lead nitrate can be obtained from lead nitrate solution.

[1 mark]

.....

.....

5 (c) (ii) Balance the equation for the reaction.

[1 mark]

$$PbO + HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$$

5 (c) (iii) Give the total number of atoms in the formula $Pb(NO_3)_2$

[1 mark]

.....

5 (d) An oxide of lead that does **not** have the formula PbO contains 6.21 g of lead and 0.72 g of oxygen.

Calculate the empirical formula of this lead oxide.

Relative atomic masses (A_r): O = 16; Pb = 207

You must show your working to gain full marks.

[4 marks]

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Empirical formula = ...

10

4.4.2.1 Reactions of acids with metals

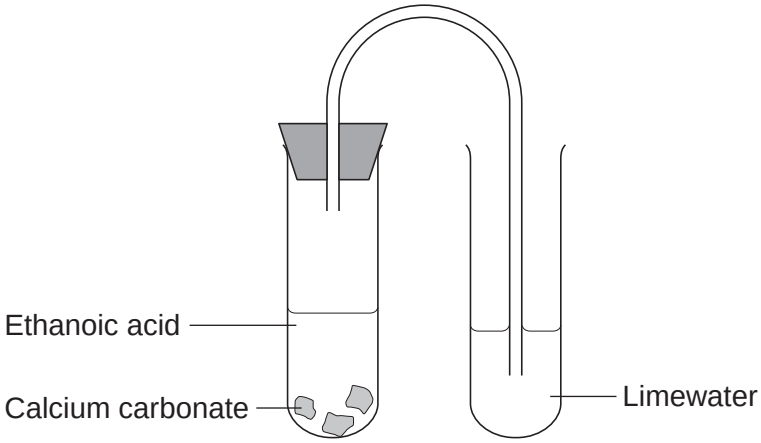
Question 16

June 2016 | CH3HP | Original Q1 | Legacy

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

1 (a) **Figure 1** shows the apparatus used to investigate the reaction of ethanoic acid with calcium carbonate.

Figure 1



1 (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 _____

_____

_____

_____

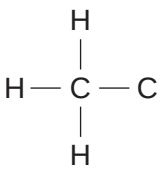
Question 1 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 16 · continued

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

[1 mark]



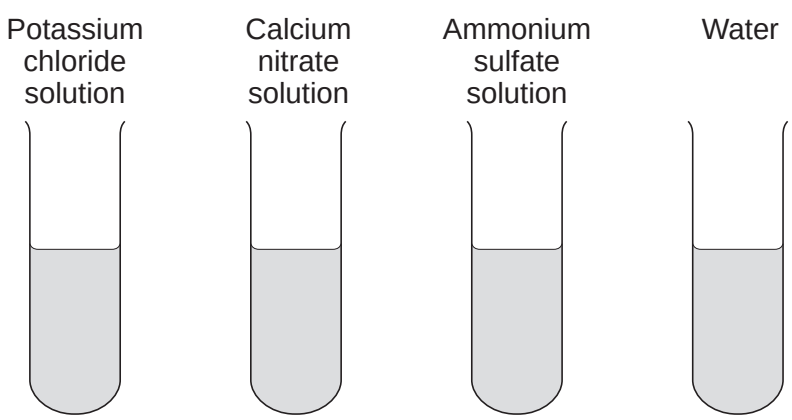
1 (a) (iii) Ethanoic acid is a carboxylic acid.
Complete the sentence.

[2 marks]

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

1 (b) **Figure 2** shows four test tubes containing three different salt solutions and water.

Figure 2



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	

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

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

[2 marks]

The flame colour for potassium ions is _____ .

The flame colour for calcium ions is _____ .

1 (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 | CH1HP | Original Q1 | Legacy

1 Elements are made of atoms.

1 (a) **Table 1** shows the atomic numbers and mass numbers of three atoms.

Table 1

Atom	Atomic number	Mass number
1	12	24
2	12	25
3	12	26

1 (a) (i) Suggest, in terms of the number of subatomic particles, why the atomic numbers of the three atoms are the same.

[1 mark]

_____

_____

1 (a) (ii) Explain, in terms of the number of subatomic particles, why the mass numbers of the three atoms are different.

[2 marks]

_____

_____

_____

1 (b) When elements react, their atoms join with other atoms to form compounds.

Sulfuric acid, H_2SO_4, is a compound.

1 (b) (i) How many elements are in the formula H_2SO_4?

[1 mark]

_____

1 (b) (ii) How many atoms are in the formula H_2SO_4?

[1 mark]

_____

4.4.2.1 Reactions of acids with metals

Question 17 · continued

1 (c) Sulfuric acid reacts with metal oxides.

$$\underset{\text{copper oxide}}{CuO} + \underset{\text{sulfuric acid}}{H_2SO_4} \longrightarrow \underset{\text{copper sulfate}}{CuSO_4} + \underset{\text{water}}{H_2O}$$

In a reaction, 159 g of copper oxide reacts with 196 g of sulfuric acid.

What is the mass of the products?

[1 mark]

Tick (✓) **one** box.

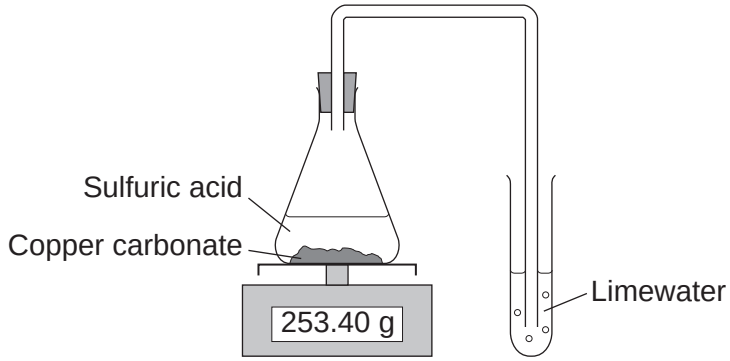
Mass of copper sulfate in g	Mass of water in g	Tick (✓)
30	7	
159	36	
196	18	
319	36	

4.4.2.1 Reactions of acids with metals

Question 17 · continued

1 (d) **Figure 1** shows apparatus used to investigate the reaction of sulfuric acid with copper carbonate.

Figure 1



Describe and explain the changes seen during the reaction.

[3 marks]

9

4.4.2.1 Reactions of acids with metals

Question 18

June 2018 | 8462/1H | Original Q1

0 1 Soluble salts are formed by reacting metal oxides with acids.

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

[1 mark]

0 1 . 2 Calcium nitrate contains the ions Ca^{2+} and NO_3^-

Give the formula of calcium nitrate.

[1 mark]

0 1 . 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 | 8462/2H | Original Q8

0 8 A student investigated how temperature affects the rate of reaction between magnesium carbonate and dilute hydrochloric acid.

This is the method used.

1. Heat hydrochloric acid to 30 ºC in a conical flask.
2. Add magnesium carbonate powder to the conical flask.
3. Measure the loss in mass of the flask and contents every 20 seconds for 140 seconds.
4. Repeat steps 1-3 with hydrochloric acid heated to 50 ºC

0 8 . 1 Explain why the contents of the conical flask lose mass.

[2 marks]

0 8 . 2 **Table 5** shows the student's results for hydrochloric acid at 30 ºC

Table 5

Time in seconds	Loss of mass in grams
0	0.00
20	0.26
40	0.48
60	0.67
80	0.82
100	0.91
120	0.96
140	0.99

4.4.2.1 Reactions of acids with metals

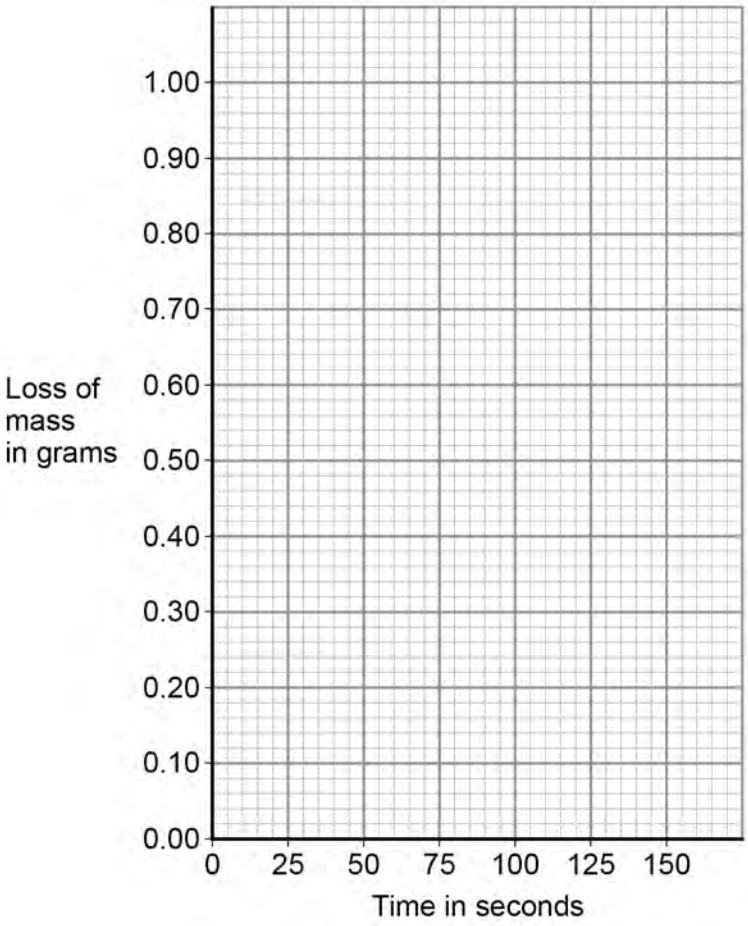
Question 19 · continued

Plot the data from **Table 5** on **Figure 6**.

Draw a line of best fit.

[3 marks]

Figure 6



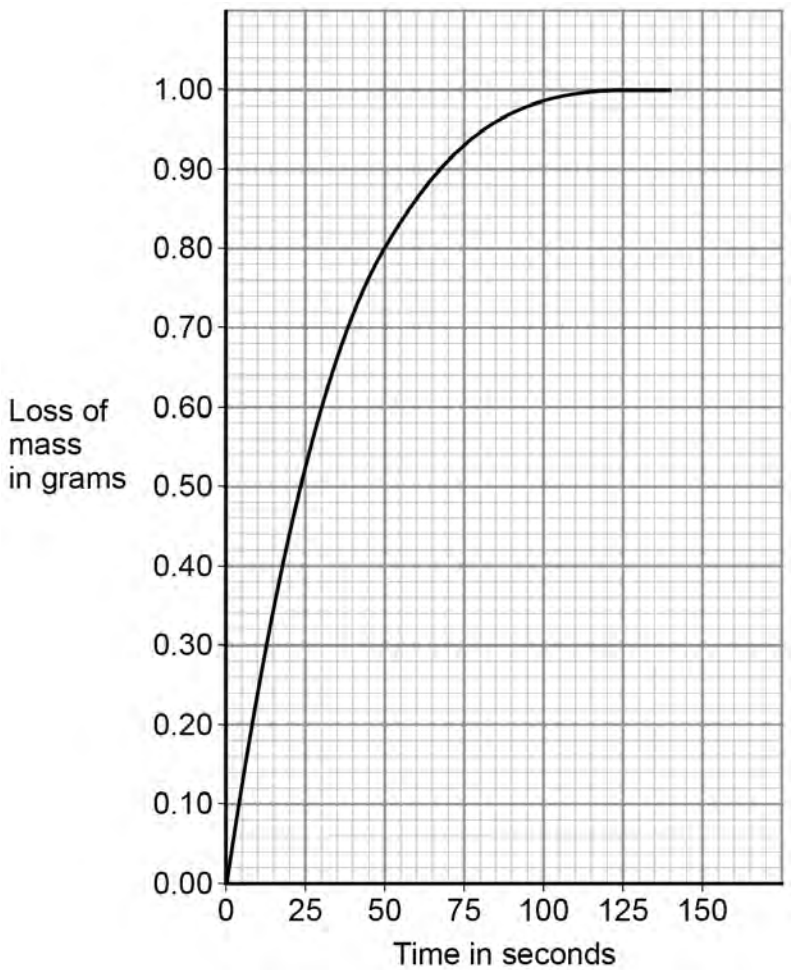
Question 8 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 19 · continued

Figure 7 shows the student's results for hydrochloric acid at 50 ºC

Figure 7



0 8 . 3 Determine the rate of reaction at 50 °C when the loss of mass is 0.95 g

Show your working on **Figure 7**.

Give your answer to 2 significant figures.

[4 marks]

Rate of reaction = _____ g/s

9

4.4.2.1 Reactions of acids with metals

Question 20

June 2019 | 8462/2H | Original Q2

0 2 This question is about lithium carbonate.

Lithium carbonate is used in medicines.

Figure 2 shows a tablet containing lithium carbonate.

Figure 2



0 2 . 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 2 . 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 2 . 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 | 8462/2H | Original Q3

0 3 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:

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

0 3 . 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.

0 3 . 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 3 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 21 · continued

Table 2 shows the results of the investigation.

Table 2

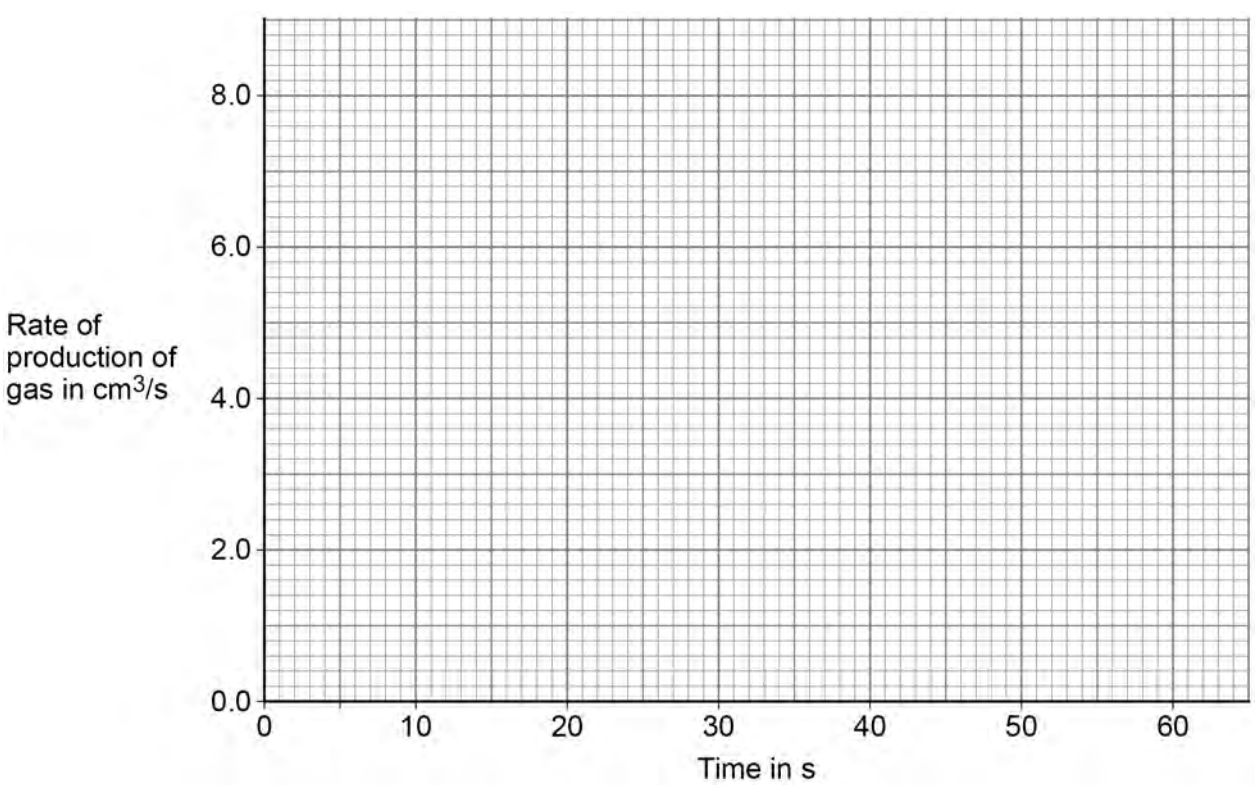
Time in s	Rate of production of gas in cm^3/s
10	6.9
20	3.9
30	2.0
40	0.9
50	0.3
60	0.0

0 3 . 3 Plot the data from **Table 2** on **Figure 3**.

You should draw a line of best fit.

[3 marks]

Figure 3



Question 21 · continued

0 3 . 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 3** and **Table 2**.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

0 3 . 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 | 8462/1H | Original Q2

0 2 This question is about metals and the reactivity series.

0 2 . 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 2 . 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 22 · continued

0 2 . 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 2 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 22 · continued

0 2 . 4 Metal **M** has two isotopes.

Table 2 shows the mass numbers and percentage abundances of the isotopes.

Table 2

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 23

November 2020 | 8462/1H | Original Q6

0 6 This question is about displacement reactions.

0 6 . 1 The displacement reaction between aluminium and iron oxide has a high activation energy.

What is meant by 'activation energy'?

[1 mark]

0 6 . 2 A mixture contains 1.00 kg of aluminium and 3.00 kg of iron oxide.

The equation for the reaction is:

$$2\,Al + Fe_2O_3 \rightarrow 2\,Fe + Al_2O_3$$

Show that aluminium is the limiting reactant.

Relative atomic masses (A_r): O = 16 Al = 27 Fe = 56

[4 marks]

4.4.2.1 Reactions of acids with metals

Question 23 · continued

Magnesium displaces zinc from zinc sulfate solution.

0 6 . 3 Complete the ionic equation for the reaction.

You should include state symbols.

[2 marks]

$$Mg(s) + Zn^{2+}(aq) \rightarrow _____ + _____$$

0 6 . 4 Explain why the reaction between magnesium atoms and zinc ions is both oxidation and reduction.

[2 marks]

9

4.4.2.1 Reactions of acids with metals

Question 24

November 2020 | 8462/2H | Original Q7

0 7 This question is about carboxylic acids.

Carboxylic acids belong to a homologous series.

Table 3 shows information about the first three carboxylic acids in this homologous series.

Table 3

Name	Formula	pH of a 0.01 mol/dm^3 solution
Methanoic acid		2.91
Ethanoic acid	CH_3COOH	3.39
	CH_3CH_2COOH	3.44

0 7 . 1 Complete **Table 3**.

[2 marks]

0 7 . 2 Ethanoic acid ionises in water.

The equation for the reaction is:

$$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$

Explain how the equation shows that ethanoic acid is a weak acid.

[2 marks]

4.4.2.1 Reactions of acids with metals

Question 24 · continued

0 7 . 3 A student adds a solution of ethanoic acid to zinc carbonate in an open flask on a balance.

Explain what happens to the mass of the flask and its contents during the reaction.

[3 marks]

0 7 . 4 The student compares the rates of the reaction of zinc carbonate with:

- 0.01 mol/dm^3 methanoic acid
- 0.01 mol/dm^3 ethanoic acid.

The rate of the reaction with methanoic acid is greater than the rate of the reaction with ethanoic acid.

Explain why.

You should refer to ions in your answer.

Use **Table 3**.

[3 marks]

4.4.2.1 Reactions of acids with metals

Question 24 · continued

Ethanoic acid reacts with ethanol to produce an ester.

0 7 . 5 Give the name of the ester produced when ethanoic acid reacts with ethanol.

[1 mark]

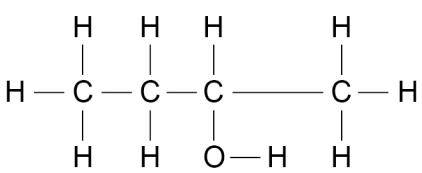
0 7 . 6 Hexanedioic acid and ethanediol join together to produce a polyester.

Ethanoic acid and ethanol join together in the same way to produce an ester.

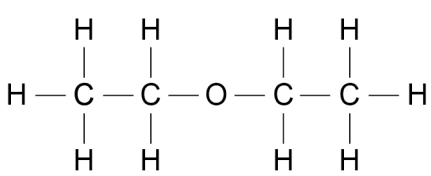
Which is the displayed structural formula of the ester produced when ethanoic acid reacts with ethanol?

[1 mark]

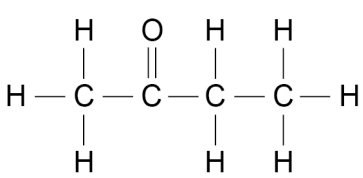
Tick (✓) **one** box.



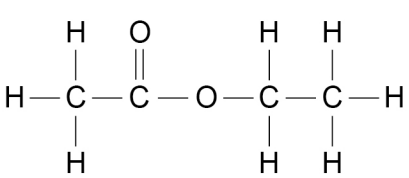
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12

4.4.2.1 Reactions of acids with metals

Question 25

November 2021 | 8462/2H | Original Q9

0 9 A student investigated how a change in concentration affects the rate of the reaction between zinc powder and sulfuric acid.

The equation for the reaction is:

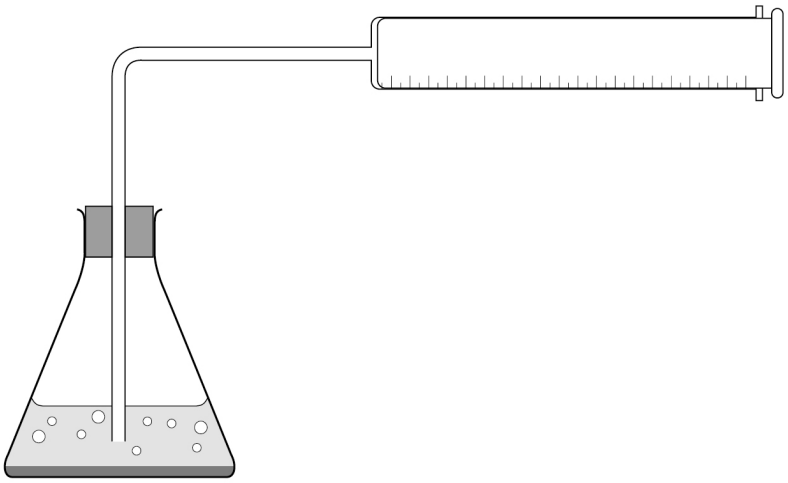
$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

This is the method used.

1. Pour 50 cm^3 of sulfuric acid of concentration 0.05 mol/dm^3 into a conical flask.
2. Add 0.2 g of zinc powder to the conical flask.
3. Put the stopper in the conical flask.
4. Measure the volume of gas collected every 30 seconds for 5 minutes.
5. Repeat steps 1 to 4 with sulfuric acid of concentration 0.10 mol/dm^3

Figure 8 shows the apparatus used.

Figure 8



0 9 . 1 The student made an error in setting up the apparatus in **Figure 8**.

What error did the student make?

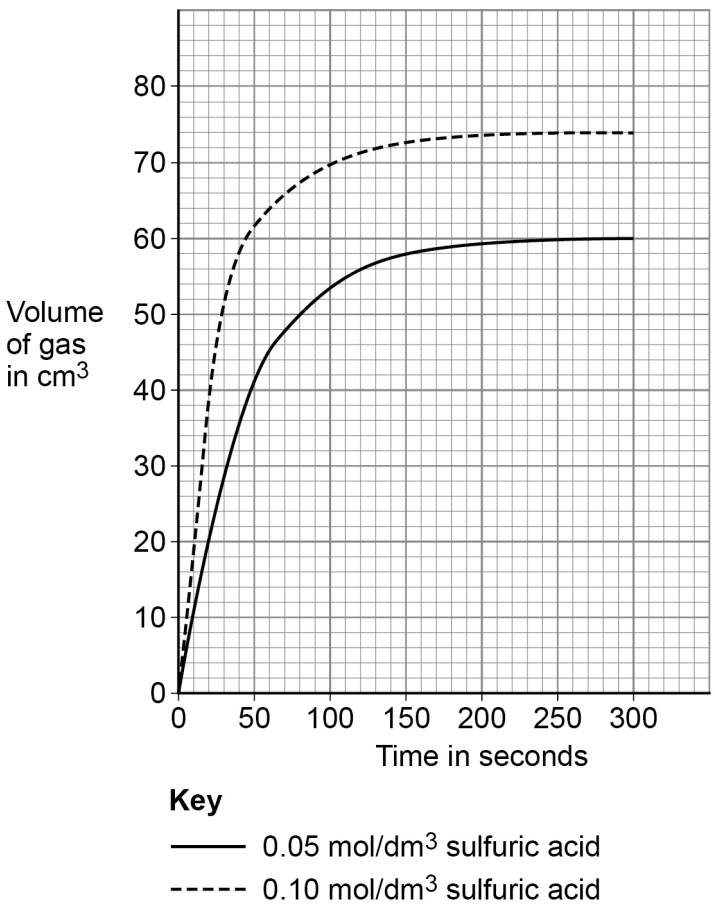
[1 mark]

Question 25 · continued

The student corrected the error.

Figure 9 shows the student's results.

Figure 9



0 9 . 2 Explain why the lines of best fit on **Figure 9** become horizontal.

[2 marks]

0 9 . 3 How does **Figure 9** show that zinc powder reacts more slowly with 0.05 mol/dm^3 sulfuric acid than with 0.10 mol/dm^3 sulfuric acid?

[1 mark]

4.4.2.1 Reactions of acids with metals

Question 25 · continued

0 9 . 4 Determine the rate of the reaction for 0.05 mol/dm^3 sulfuric acid at 80 seconds.

Show your working on **Figure 9**.

Give your answer to 2 significant figures.

[5 marks]

Rate of reaction (2 significant figures) = _____ cm^3/s

0 9 . 5 The activation energy for the reaction between zinc and sulfuric acid is lowered if a solution containing metal ions is added.

What is the most likely formula of the metal ions added?

[1 mark]

Tick (✓) **one** box.

Al^{3+} ☐

Ca^{2+} ☐

Cu^{2+} ☐

Na^{+} ☐

10

4.4.2.1 Reactions of acids with metals

Question 26

June 2022 | 8462/1H | Original Q4

0 4 This question is about zinc and compounds of zinc.

A student produces pure crystals of zinc chloride by reacting zinc oxide with hydrochloric acid.

The equation for the reaction is:

$$ZnO(s) + 2\,HCl(aq) \rightarrow ZnCl_2(aq) + H_2O(l)$$

0 4 . 1 The student adds zinc oxide to hydrochloric acid until the zinc oxide is in excess.

Give **one** observation that the student could make to show that the zinc oxide is in excess.

[1 mark]

0 4 . 2 Why is excess zinc oxide used rather than excess hydrochloric acid?

[1 mark]

0 4 . 3 Name **one other** compound that the student could add to hydrochloric acid to produce zinc chloride.

[1 mark]

0 4 . 4 Describe how the student should obtain crystals of zinc chloride from a solution of zinc chloride.

[2 marks]

4.4.2.1 Reactions of acids with metals

Question 26 · continued

Zinc chloride is also produced in a displacement reaction between zinc and copper chloride solution.

The equation for the reaction is:

$$Zn + CuCl_2 \rightarrow ZnCl_2 + Cu$$

0 4 . 5 Complete the ionic equation for this reaction.

[1 mark]

$$Zn + _____ \rightarrow Zn^{2+} + _____$$

0 4 . 6 Why is zinc described as being oxidised in this reaction?

[1 mark]

4.4.2.1 Reactions of acids with metals

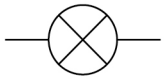
Question 26 · continued

0 4 . 7 Zinc and copper can be used with another substance to produce electricity.

Complete **Figure 7** to show how zinc, copper and another substance can be used to light a lamp.

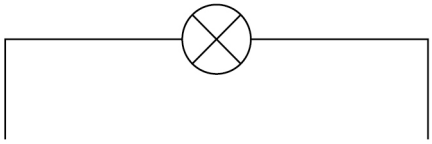
Label:

- zinc
- copper
- the other substance used.

The symbol  represents the lamp.

[3 marks]

Figure 7



4.4.2.1 Reactions of acids with metals

Question 27

June 2023 | 8462/1H | Original Q3

0 3 This question is about making a soluble salt.

0 3 . 1 Plan a method to make pure, dry crystals of zinc chloride from zinc carbonate and a dilute acid.

[6 marks]

0 3 . 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 28

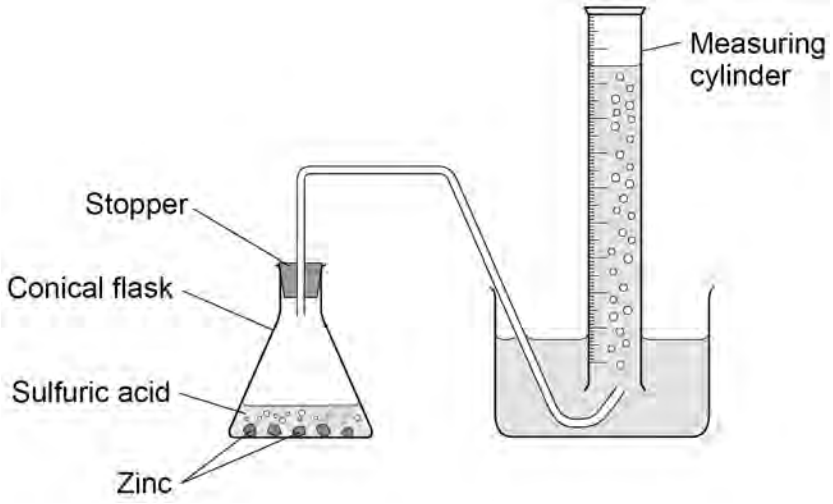
June 2023 | 8462/2H | Original Q1

0 1 A student investigated the rate of the reaction between zinc and sulfuric acid.

Hydrogen gas is produced during this reaction.

Figure 1 shows the apparatus.

Figure 1



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

[1 mark]

0 1 . 2 The student calculated the rate of the reaction for each trial.

Table 1 shows the results of the calculations.

Table 1

	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 1 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 28 · continued

0 1 . 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 1 . 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 29

June 2023 | 8462/2H | Original Q3

0 3 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.

0 3 . 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 29 · continued

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

0 3 . 2 Which instrumental method could be used to show the presence of potassium ions in the medicine?

[1 mark]

0 3 . 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 30

June 2024 | 8462/1H | Original Q1

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

[2 marks]

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

0 1 . 2 Give **one** observation the student could make during **Step 4** which shows that the copper carbonate is in excess.

[1 mark]

_____

_____

0 1 . 3 Give **one** reason for filtering the mixture in **Step 5**.

[1 mark]

_____

_____

4.4.2.1 Reactions of acids with metals

Question 30 · continued

0 1 . 4 Name the equipment that can be used to warm the filtrate **gently** in **Step 6**.

[1 mark]

0 1 . 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 1 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 30 · continued

0 1 . 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 _____

_____

1(

4.4.2.1 Reactions of acids with metals

Question 31

June 2024 | 8462/1H | Original Q9

0 9 This question is about acids and their reactions.

Acids can be either weak or strong.

0 9 . 1 What is meant by 'a **weak** acid'?

[2 marks]

0 9 . 2 Explain what happens to the pH of an acid as the acid is diluted with water.

[2 marks]

Question 9 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 31 · continued

0 9 . 3 A student does a titration to find the volume of acid needed to neutralise an alkali.

The student fills a burette with the acid.

Give **three** more steps the student must do before adding the acid to the alkali from the burette.

You should name any equipment used.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

0 9 . 4 The student titrated a solution containing 0.0045 moles of sodium hydroxide with 0.15 mol/dm^3 hydrochloric acid.

The equation for the reaction is:

$$NaOH + HCl \rightarrow NaCl + H_2O$$

Calculate the volume of hydrochloric acid in cm^3 needed in the titration.

[2 marks]

_____

_____

_____

Volume of acid = _____ cm^3

4.4.2.1 Reactions of acids with metals

Question 31 · continued

0 9 . 5 A calcium atom is larger than a magnesium atom.

Explain why calcium reacts more vigorously than magnesium with hydrochloric acid of the same concentration.

[3 marks]

12

4.4.2.1 Reactions of acids with metals

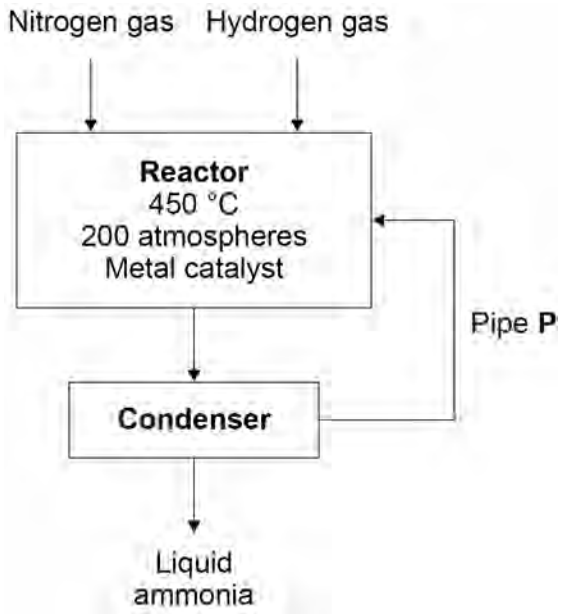
Question 32

0 2 This question is about ammonia and nitric acid.

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

Figure 1 represents the Haber process.

Figure 1



0 2 . 1 Pipe **P** links the condenser to the reactor.

Why is the condenser linked to the reactor?

Use **Figure 1**.

[1 mark]

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

[1 mark]

Question 32 · 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 2 . 3 Describe the test for oxygen gas.

Give the result if oxygen gas is present.

[2 marks]

Test _____

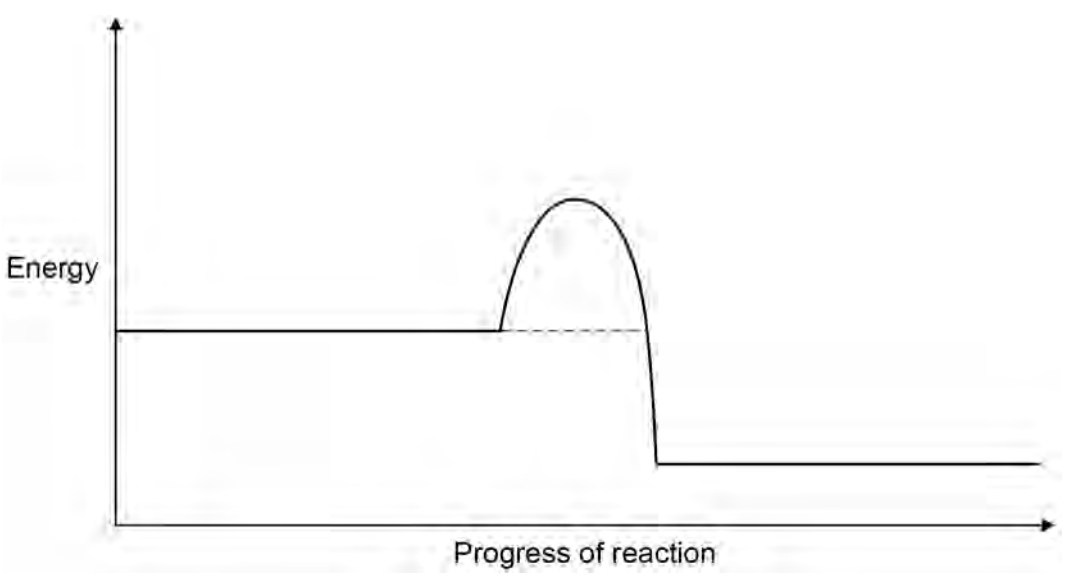
_____

Result _____

_____

Figure 2 represents the reaction profile of the catalysed reaction between ammonia and oxygen.

Figure 2



4.4.2.1 Reactions of acids with metals

Question 32 · continued

0 2 . 4 Complete the reaction profile for the catalysed reaction in **Figure 2**.

You should:

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

[2 marks]

0 2 . 5 How would **Figure 2** 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 2 . 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]

_____

_____

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4.4.2.1 Reactions of acids with metals

Question 33

June 2024 | 8462/2H | Original Q9

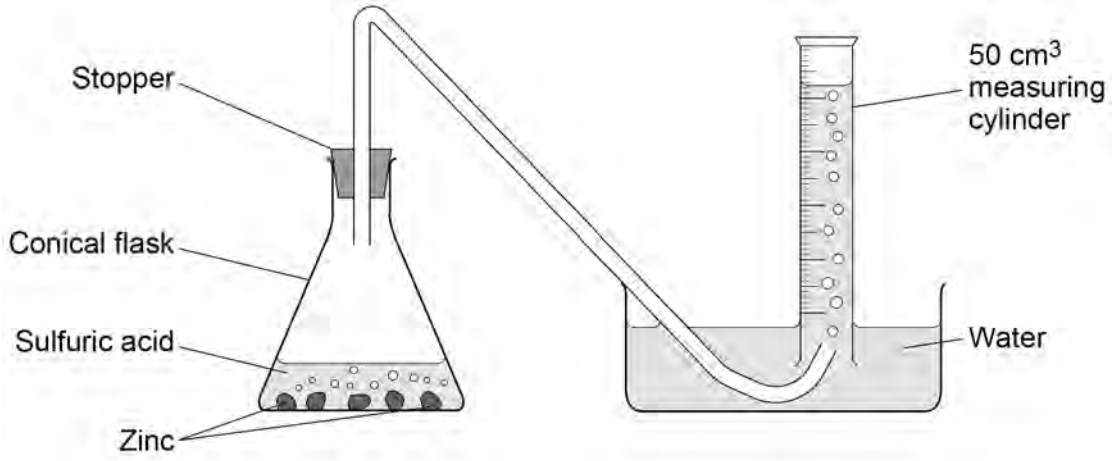
0 9 A student investigated the rate of the reaction between zinc and sulfuric acid.

The equation for the reaction is

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

Figure 10 shows the apparatus.

Figure 10



This is the method used.

1. Pour 50 cm^3 of sulfuric acid into the conical flask.
2. Add excess zinc to the conical flask.
3. Insert the stopper and start a timer.
4. Measure the volume of hydrogen collected in the 50 cm^3 measuring cylinder every 20 seconds for 180 seconds.

0 9 . 1 Explain why the volume of hydrogen collected in the 50 cm^3 measuring cylinder is less than the volume of hydrogen produced.

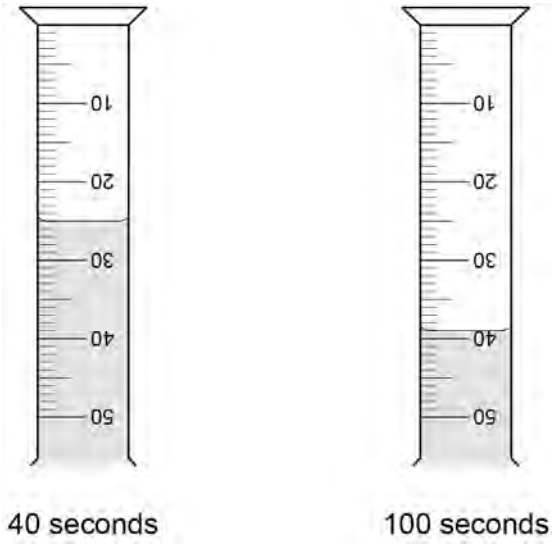
[2 marks]

4.4.2.1 Reactions of acids with metals

Question 33 · continued

Figure 11 shows the volumes of hydrogen collected in the 50 cm^3 measuring cylinder after 40 seconds and after 100 seconds.

Figure 11



0 9 . 2 Determine the number of moles of hydrogen collected between 40 seconds and 100 seconds.

The volume of one mole of any gas at room temperature and pressure is 24 dm^3.

[4 marks]

Moles of hydrogen = _____

Question 9 continues on the next page

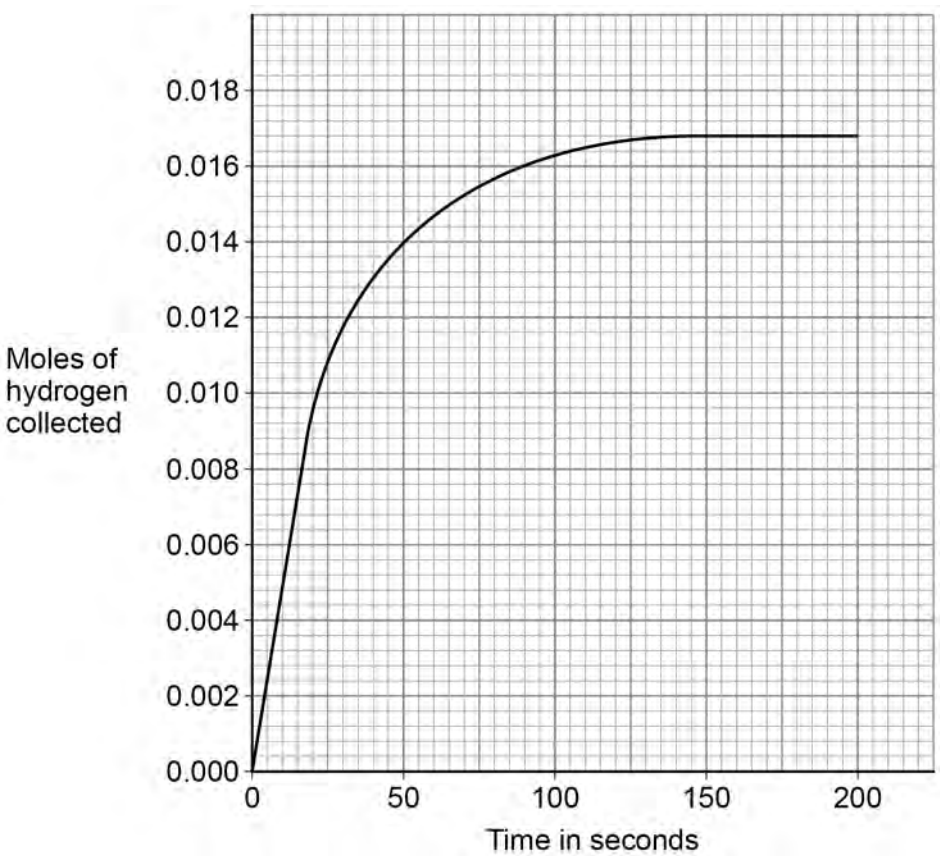
A different student investigated how the concentration of sulfuric acid affected the rate of the reaction.

0 9 . 3 The student did a different experiment using sulfuric acid of concentration 0.40 mol/dm^3.

The student calculated the number of moles of hydrogen collected after every 20 seconds.

Figure 12 shows the results.

Figure 12



4.4.2.1 Reactions of acids with metals

Question 33 · continued

Determine the rate of reaction at 45 seconds.

You should draw a tangent on **Figure 12**.

Give your answer in standard form.

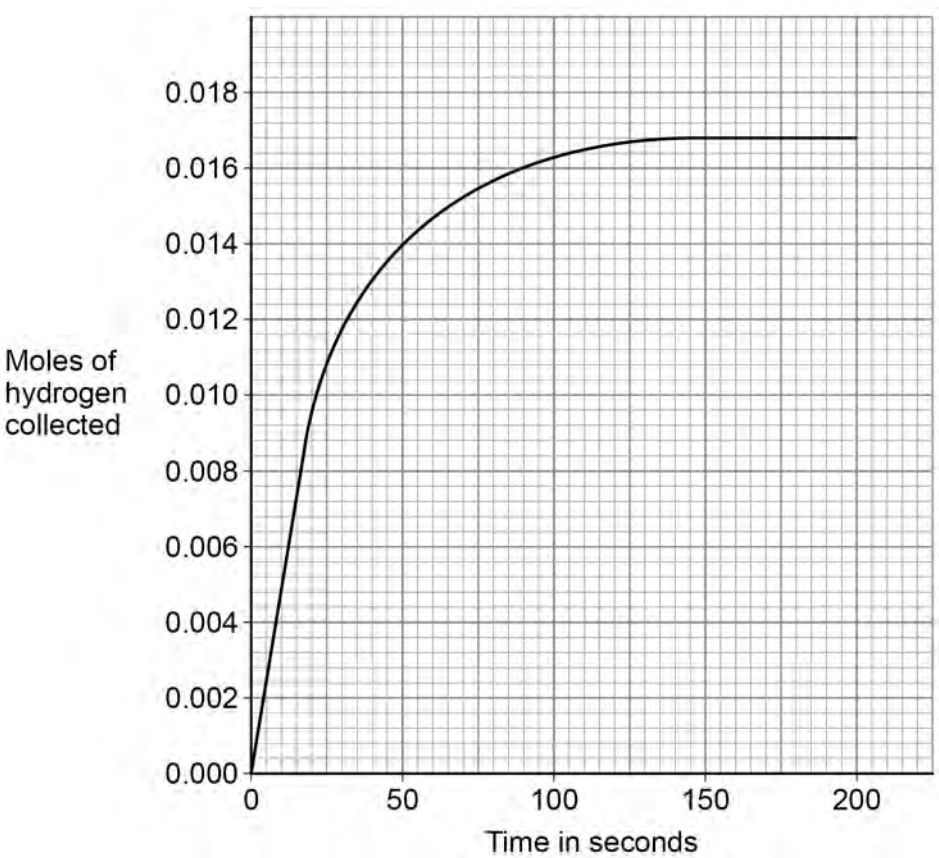
[5 marks]

Rate of reaction (in standard form) = _____ mol/s

Question 9 continues on the next page

0 9 . 4 **Figure 13** shows the results for 0.40 mol/dm^3 sulfuric acid.

Figure 13



The student repeated the experiment using 0.20 mol/dm^3 sulfuric acid instead of 0.40 mol/dm^3 sulfuric acid.

Excess zinc was used in each experiment.

Sketch a line on **Figure 13** to show the results you would expect.

[2 marks]

4.4.2.1 Reactions of acids with metals

Question 33 · continued

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0 9 . 5 Explain how increasing the temperature would affect the rate of reaction between zinc and sulfuric acid.

[3 marks]

16

4.4.2.1 Reactions of acids with metals

Question 34

June 2025 | 8462/2H | Original Q6

0 6 A student analysed three solutions, **A**, **B** and **C**.

Each solution contained one ionic compound.

The student added a few drops of sodium hydroxide solution to solution **A**.

Solution **A** produced a white precipitate.

Aluminium ions produce a white precipitate with a few drops of sodium hydroxide solution.

0 6 . 1 Name **one other** metal ion which produces a white precipitate with a few drops of sodium hydroxide solution.

[1 mark]

_____

0 6 . 2 Describe how the student could confirm the presence of aluminium ions in solution **A**.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

4.4.2.1 Reactions of acids with metals

Question 34 · continued

The student tested solution **B** to identify the ions present.

0 6 . 3 The student did a flame test on solution **B**.

An orange-red flame was produced.

Write the symbol for the metal ion in solution **B**.

[1 mark]

0 6 . 4 The student added dilute nitric acid followed by silver nitrate solution to solution **B**.

A white precipitate was produced.

Write the symbol for the non-metal ion in solution **B**.

[1 mark]

Question 6 continues on the next page

4.4.2.1 Reactions of acids with metals

Question 34 · continued

The student added 1.0 mol/dm^3 nitric acid to solution **C**.

Bubbles of gas were produced.

0 6 . 5 Describe a test on the bubbles of gas that confirms that solution **C** contained carbonate ions.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 6 . 6 The student repeated the test on solution **C** using 1.0 mol/dm^3 ethanoic acid instead of 1.0 mol/dm^3 nitric acid.

Bubbles of gas were produced more slowly using ethanoic acid.

Explain why.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

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