AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.2.1

# Reactions of acids with metals

## Past-paper questions

| | |
|---|---|
| Tier | **Foundation** |
| Question groups | **11** |
| Available paper years | **2018–2025** |

## 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.

### 5.4.2.1 Reactions of acids with metals

**Question 01**

June 2018 | 8464/C/1F | Original Q3

**0 3** This question is about acids and bases.

**0 3 . 1** Which ion is found in all acids?

**[1 mark]**

Tick **one** box.

$Cl^-$ ☐ $H^+$ ☐ $Na^+$ ☐ $OH^-$ ☐

**0 3 . 2** Zinc nitrate can be produced by reacting an acid and a metal oxide.

Name the acid and the metal oxide used to produce zinc nitrate.

**[2 marks]**

Acid _____

Metal oxide _____

**0 3 . 3** In an equation, zinc nitrate is written as $Zn(NO_3)_2(aq)$.

What does (aq) mean?

**[1 mark]**

Tick **one** box.

Dissolved in water ☐

Insoluble ☐

Not all reacted ☐

Reactant ☐

**0 3 . 4** The pH of a solution is 8

Some hydrochloric acid is added to the solution.

Suggest the pH of the solution after mixing.

**[1 mark]**

pH = _____

5.4.2.1 Reactions of acids with metals

Question 01 · continued



**0 3 . 5** **Table 2** shows the solubility of three solids in water at room temperature.

**Table 2**

| Solid | The mass of the solid that dissolves in 100 $cm^3$ of water |
|---|---|
| Phosphorus oxide | 50 g |
| Silicon dioxide | 0 g |
| Sodium hydroxide | 100 g |

A teacher labelled these three solids **A**, **B** and **C**.

She gave a student the information shown in **Table 3**

**Table 3**

| Solid | Observation when added to water | pH of the solid in water |
|---|---|---|
| **A** | colourless solution | 14 |
| **B** | colourless solution | 2 |
| **C** | solid does not dissolve | 7 |

Describe a method that could be used to identify each of the three solids **A**, **B** and **C**.

You must use an indicator in the method.

Use information in **Table 2** and **Table 3**

**[4 marks]**

9

**5.4.2.1 Reactions of acids with metals**

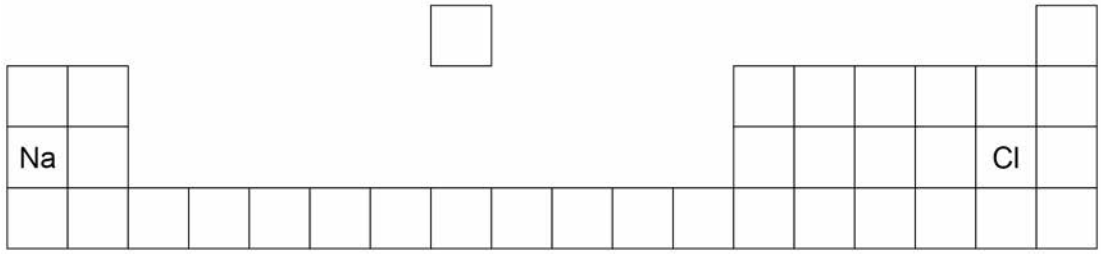
**Question 02**

June 2018 | 8464/C/1F | Original Q6

**0 6** This question is about sodium and chlorine.

**Figure 13** shows the positions of sodium and chlorine in the periodic table.

**Figure 13**




**0 6 . 1** State **one** difference and **one** similarity in the electronic structure of sodium and of chlorine.

**[2 marks]**

Difference _____

_____

Similarity _____

_____

**0 6 . 2** Sodium atoms react with chlorine atoms to produce sodium chloride (NaCl).

Describe what happens when a sodium atom reacts with a chlorine atom.

Write about electron transfer in your answer.

**[4 marks]**

_____

_____

_____

_____

_____

_____

_____

_____

5.4.2.1 Reactions of acids with metals

Question 02 · continued

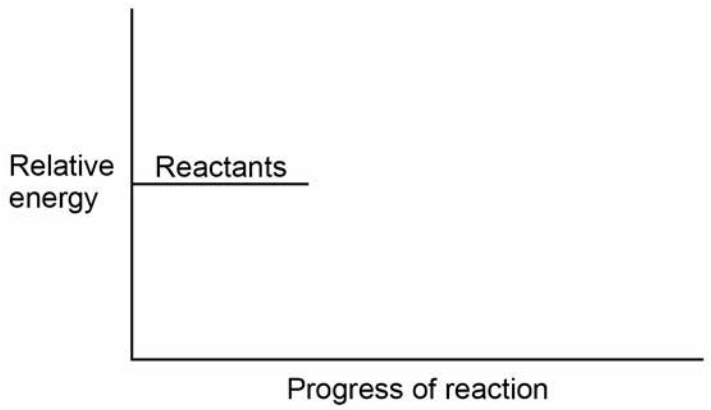


**0 6 . 3** The reaction between sodium and chlorine is an exothermic reaction.

Complete the reaction profile for the reaction between sodium and chlorine.

**[2 marks]**

**Figure 14**




8

### 5.4.2.1 Reactions of acids with metals

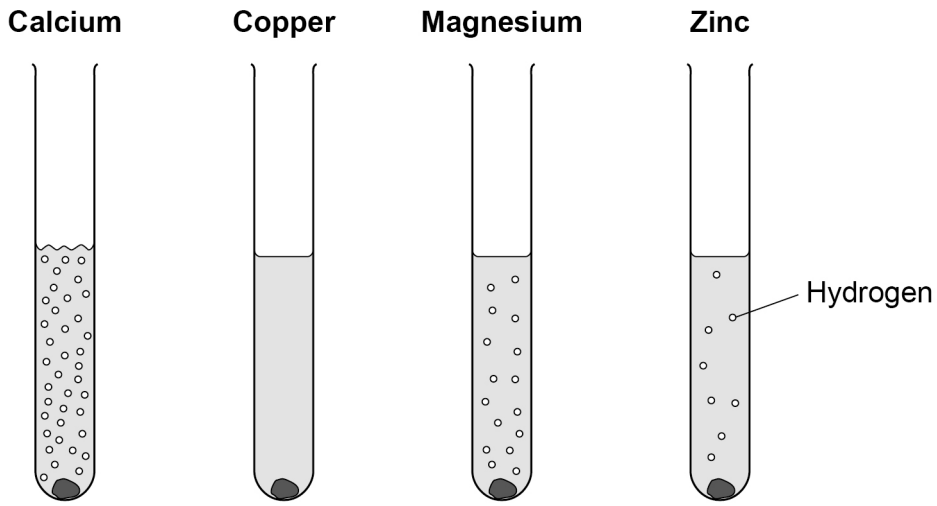
**Question 03**

June 2019 | 8464/C/1F | Original Q6

**0 6** This question is about reactions of metals.

**Figure 7** shows what happens when calcium, copper, magnesium and zinc are added to hydrochloric acid.

**Figure 7**




**0 6 . 1** What is the order of decreasing reactivity of these four metals?

**[1 mark]**

Tick (✓) **one** box.

Zn Ca Cu Mg ☐

Ca Cu Mg Zn ☐

Cu Zn Ca Mg ☐

Ca Mg Zn Cu ☐

5.4.2.1 Reactions of acids with metals

Question 03 · continued



A student wants to make a fair comparison of the reactivity of the metals with hydrochloric acid.

**0 6 . 2** Name **two** variables that must be kept constant.

**[2 marks]**

1 _____

_____

2 _____

_____

**0 6 . 3** What is the independent variable in this reaction?

**[1 mark]**

_____

_____

**0 6 . 4** Predict the reactivity of beryllium compared with magnesium.

Give a reason for your answer.

Use the periodic table.

**[2 marks]**

_____

Reason _____

_____

_____

**0 6 . 5** A solution of hydrochloric acid contains 3.2 g of hydrogen chloride in 50 $cm^3$

Calculate the concentration of hydrogen chloride in g per $dm^3$

**[3 marks]**

_____

_____

_____

_____

Concentration = _____ g per $dm^3$

9

### 5.4.2.1 Reactions of acids with metals

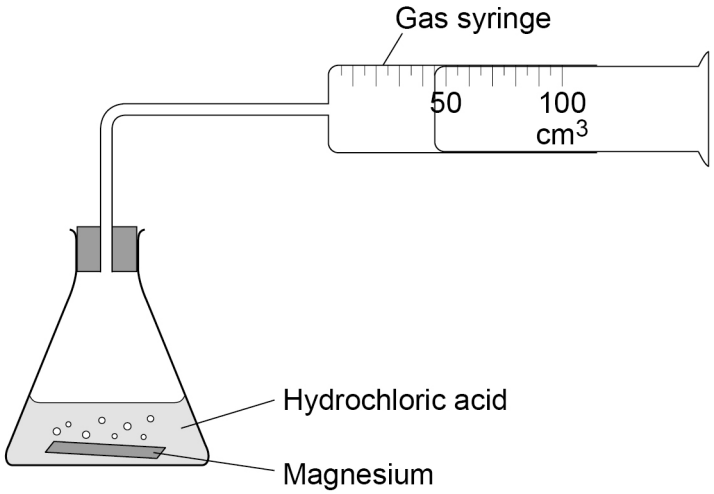
**Question 04**

June 2019 | 8464/C/2F | Original Q3

**0 3** A student investigated the rate of the reaction between magnesium and hydrochloric acid.

**Figure 4** shows the apparatus the student used.

**Figure 4**




**0 3 . 1** Balance the equation for the reaction.

**[1 mark]**

$$Mg + ____ HCl \rightarrow MgCl_2 + H_2$$

**0 3 . 2** The student used 50 $cm^3$ of hydrochloric acid.

Which apparatus would measure 50 $cm^3$ of hydrochloric acid with the greatest accuracy?

**[1 mark]**

Tick (✓) **one** box.

50 $cm^3$ beaker ☐

50 $cm^3$ conical flask ☐

50 $cm^3$ measuring cylinder ☐

**5.4.2.1 Reactions of acids with metals**

**Question 04 · continued** June 2019 | 8464/C/2F | Original Q3

**0 3 . 3** The student measured the volume of gas produced every 20 seconds for 2 minutes.

The volume of gas was zero at the start of the experiment.

The measured volumes of gas were:

26 $cm^3$ 38 $cm^3$ 47 $cm^3$ 55 $cm^3$ 59 $cm^3$ 60 $cm^3$

Complete **Table 2** to show these results.

**[4 marks]**

**Table 2**

| | |
|---|---|
| 0 | 0 |
| | |
| | |
| | |
| | |
| | |
| | |

**0 3 . 4** The volumes of gas were lower than expected.

Suggest **one** reason.

**[1 mark]**

**0 3 . 5** The student repeated the experiment using different concentrations of hydrochloric acid.

Give **two** variables the student should keep the same.

**[2 marks]**

1 _____

2 _____

5.4.2.1 Reactions of acids with metals

Question 04 · continued



**0 3 . 6** Complete the sentences.

**[3 marks]**

As the concentration of the hydrochloric acid increased, the rate of the reaction _____ .

This is because there were more acid _____ in each cubic centimetre ($cm^3$).

So the collisions happened more _____ .

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### 5.4.2.1 Reactions of acids with metals

**Question 05**

November 2020 | 8464/C/1F | Original Q1

**0 1** This question is about acids and bases.

**0 1 . 1** What is the pH of sulfuric acid?

**[1 mark]**

Tick (✓) **one** box.

1 ☐ 7 ☐ 14 ☐

**0 1 . 2** An acid reacts with zinc to produce zinc chloride and hydrogen.

Which acid reacts with zinc to produce zinc chloride?

**[1 mark]**

Tick (✓) **one** box.

Hydrochloric acid ☐

Nitric acid ☐

Sulfuric acid ☐

**0 1 . 3** What type of substance is zinc chloride?

**[1 mark]**

Tick (✓) **one** box.

Alkali ☐ Base ☐ Salt ☐

5.4.2.1 Reactions of acids with metals

Question 05 · continued



**0 1 . 4** An alkali is a base in solution.

Which compound is an alkali?

**[1 mark]**

Tick (✓) **one** box.

Sodium hydroxide ☐

Sodium nitrate ☐

Sodium sulfate ☐

**0 1 . 5** The formula of the copper ion is $Cu^{2+}$

The formula of the oxide ion is $O^{2-}$

What is the formula of copper oxide?

**[1 mark]**

Tick (✓) **one** box.

$Cu_2O_2$ ☐ $CuO_2$ ☐ CuO ☐

**Question 1 continues on the next page**

5.4.2.1 Reactions of acids with metals

Question 05 · continued



A student reacts an acid with copper oxide.

**0 1 . 6** The reaction between the acid and copper oxide is very slow at room temperature.

How could the student speed up the reaction?

**[1 mark]**

**0 1 . 7** Complete the sentence to show how the student makes sure that **all** the acid reacts.

Choose the answer from the box.

**[1 mark]**

| | | | |
|---|---|---|---|
| **in excess** | **in solution** | **molten** | **soluble** |

The student adds copper oxide to the acid until the

copper oxide is _____.

5.4.2.1 Reactions of acids with metals

Question 05 · continued

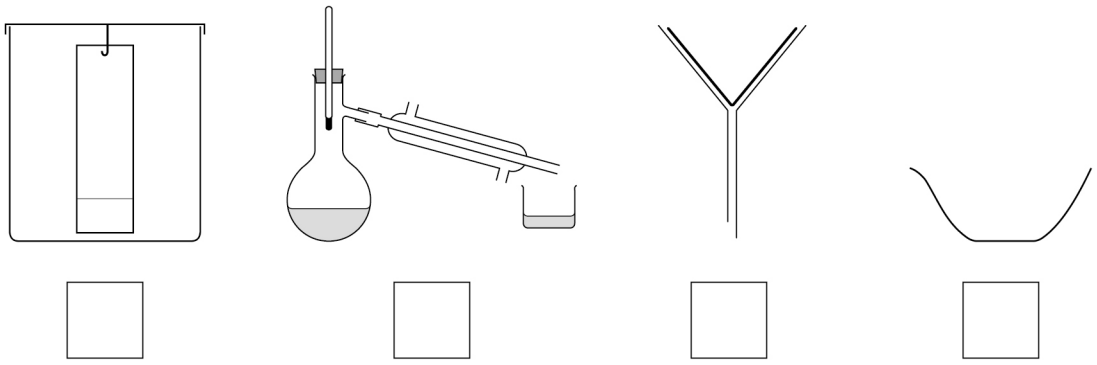


**0 1 . 8** The student filters the unreacted copper oxide from the solution.

Which apparatus does the student use?

**[1 mark]**

Tick (✓) **one** box.



**0 1 . 9** What process is used to produce crystals of a salt from a salt solution?

**[1 mark]**

_____

_____

9

### 5.4.2.1 Reactions of acids with metals

**Question 06**

November 2021 | 8464/C/1F | Original Q7

**0 7** Acids react to produce salts.

Universal indicator is added to water and then nitric acid is added to the mixture.

**0 7 . 1** Give the colour change when nitric acid is added to the mixture of universal indicator and water.

**[1 mark]**

Tick (✓) **one** box.

- Blue to red ☐
- Green to purple ☐
- Green to red ☐
- Red to purple ☐

**0 7 . 2** What happens to the pH of water when nitric acid is added?

**[1 mark]**

Tick (✓) **one** box.

- Decreases ☐
- Stays the same ☐
- Increases ☐

**0 7 . 3** What is the state symbol for nitric acid?

**[1 mark]**

_____

**5.4.2.1 Reactions of acids with metals**

**Question 06 · continued** November 2021 | 8464/C/1F | Original Q7

Zinc carbonate reacts with nitric acid.

The word equation for the reaction is:

zinc carbonate (white solid) + nitric acid → zinc nitrate (colourless solution) + water + carbon dioxide

**0 7 . 4** Give **two** observations that would be made when zinc carbonate is added to nitric acid until the zinc carbonate is in excess.

**[2 marks]**

1 _____

_____

2 _____

_____

**0 7 . 5** The formula of the zinc ion is $Zn^{2+}$

The formula of the nitrate ion is $NO_3^-$

What is the formula for zinc nitrate?

**[1 mark]**

Tick (✓) **one** box.

- $ZnNO_3$ ☐
- $Zn(NO_3)_2$ ☐
- $Zn_2NO_3$ ☐
- $Zn_2(NO_3)_2$ ☐

**Question 7 continues on the next page**

### 5.4.2.1 Reactions of acids with metals

**Question 06 · continued**



**0 7 . 6** Acids react with insoluble metal oxides to produce salts.

Plan a method to produce a pure, dry sample of the soluble salt copper chloride from an acid and a metal oxide.

**[6 marks]**

12

5.4.2.1 Reactions of acids with metals

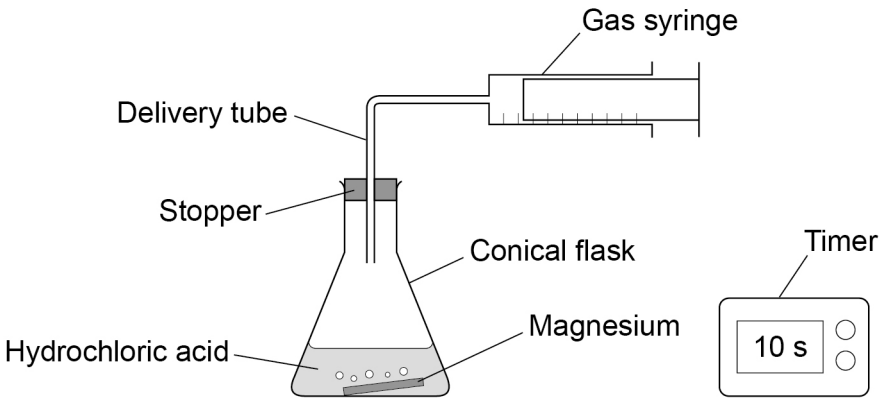
Question 07

November 2021 | 8464/C/2F | Original Q6

**0 6** A student investigated the reaction between magnesium and excess hydrochloric acid.

**Figure 5** shows the apparatus.

**Figure 5**




This is the method used.

1. Pour 50 $cm^3$ of hydrochloric acid into a conical flask.
2. Add a piece of magnesium.
3. Insert stopper and delivery tube and start a timer.
4. Collect the gas produced in a gas syringe.
5. Record the volume of gas produced every 20 seconds for 2 minutes.
6. Repeat steps 1 to 5 with higher concentrations of hydrochloric acid.

**0 6 . 1** Give the independent variable and **one** control variable in this investigation.

**[2 marks]**

Independent variable _____

Control variable _____

**Question 6 continues on the next page**

Question 07 · continued



**Table 3** shows the results from the first experiment using hydrochloric acid with a low concentration.

**Table 3**

| **Time in seconds** | 0 | 20 | 40 | 60 | 80 | 100 | 120 |
|---|---|---|---|---|---|---|---|
| **Volume of gas in cm$^3$** | 0 | 48 | 72 | 90 | 97 | 98 | 98 |

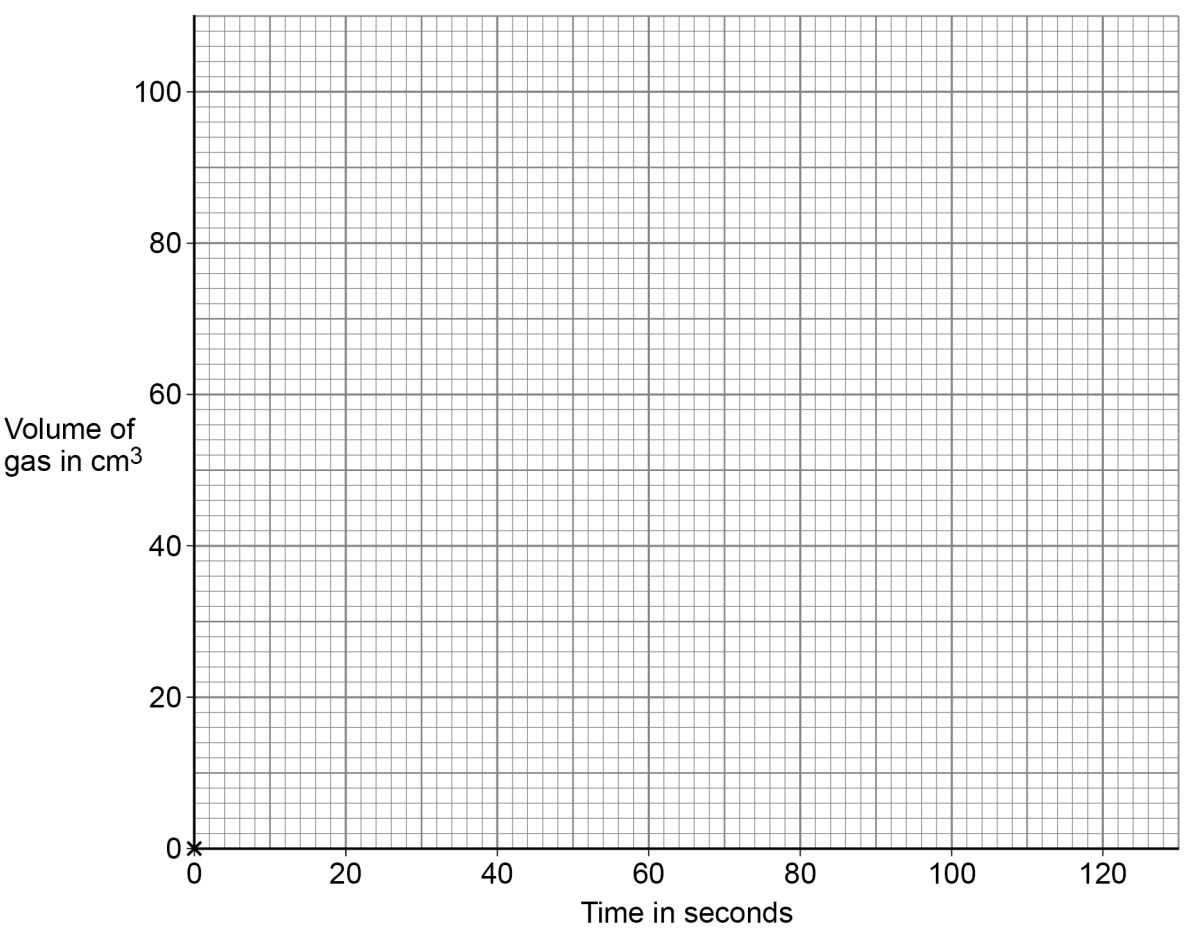
**0 6 . 2** Complete **Figure 6**.

You should:

- plot the data from **Table 3** (the point 0,0 has been plotted for you)
- draw a line of best fit.

**[3 marks]**

**Figure 6**



5.4.2.1 Reactions of acids with metals

Question 07 · continued



**0 6 . 3** How does the **rate** of this reaction change with time?

Use **Table 3**.

**[1 mark]**

Tick (✓) **one** box.

The rate decreases. ☐

The rate stays the same. ☐

The rate increases. ☐

**0 6 . 4** The student repeated the experiment using hydrochloric acid with a higher concentration.

Which statement is correct?

**[1 mark]**

Tick (✓) **one** box.

The activation energy for the reaction was higher. ☐

The magnesium reacted more quickly. ☐

The reaction finished at the same time. ☐

The total volume of gas collected was smaller. ☐

**Question 6 continues on the next page**

**5.4.2.1 Reactions of acids with metals**

**Question 07 · continued**



**0 6 . 5** Temperature also affects the rate of the reaction.

Explain how increasing the temperature affects the **rate** of the reaction.

You should refer to particles and collisions.

**[3 marks]**

10

5.4.2.1 Reactions of acids with metals

Question 08

June 2022 | 8464/C/1F | Original Q2

**0 2** This question is about hydrogen chloride and sodium hydroxide.

**0 2 . 1** A chlorine atom has 7 electrons in the outer shell.

A hydrogen atom has 1 electron in the outer shell.

**Figure 4** represents part of a dot and cross diagram for a molecule of hydrogen chloride.

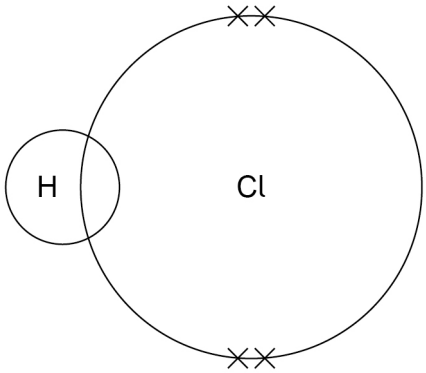
Complete the dot and cross diagram.

Use dots (o) and crosses (x) to represent electrons.

You should show only the electrons in the outer shells.

**[2 marks]**

**Figure 4**




**0 2 . 2** Hydrogen chloride dissolves in water to produce hydrochloric acid.

Hydrochloric acid reacts with sodium hydroxide solution.

Complete the word equation for the reaction between hydrochloric acid and sodium hydroxide.

**[1 mark]**

hydrochloric acid + sodium hydroxide → _____ + water

**Question 2 continues on the next page**

Question 08 · continued



Solutions of hydrochloric acid and sodium hydroxide are reacted and the temperature change is recorded.

**0 2 . 3** In the reaction, 3.65 g of hydrogen chloride reacts with 4.00 g of sodium hydroxide.

1.80 g of water is produced.

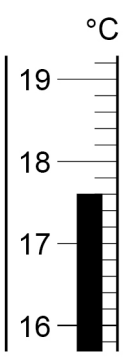
Calculate the mass of the other product.

**[1 mark]**

Mass = _____ g

**0 2 . 4** **Figure 5** shows part of the thermometer used to measure the temperature.

**Figure 5**




What is the temperature reading on the thermometer?

**[1 mark]**

Temperature = _____ °C

**0 2 . 5** In the reaction, the temperature increases.

What type of reaction is happening when the temperature increases?

**[1 mark]**

**0 2 . 6** Sodium hydroxide is an alkali.

Which **two** ions are in sodium hydroxide solution?

**[2 marks]**

Tick (✓) **two** boxes.

$Cl^-$ ☐ $H^+$ ☐ $Na^+$ ☐ $O^{2-}$ ☐ $OH^-$ ☐

8

### 5.4.2.1 Reactions of acids with metals

**Question 09**

June 2022 | 8464/C/1F | Original Q7

**0 7** Plan an investigation to find the order of reactivity of three metals.

You should use the temperature change when each metal reacts with hydrochloric acid.

**[6 marks]**

6

### 5.4.2.1 Reactions of acids with metals

**Question 10**

June 2024 | 8464/C/1F | Original Q5

**0 5** Magnesium chloride is a soluble salt.

**0 5 . 1** Magnesium reacts with hydrochloric acid to produce magnesium chloride and a gas.

Which gas is produced?

**[1 mark]**

Tick (✓) **one** box.

- Hydrogen ☐
- Nitrogen ☐
- Oxygen ☐

**Question 5 continues on the next page**

**5.4.2.1 Reactions of acids with metals**

**Question 10 · continued**



Magnesium chloride ($MgCl_2$) can be electrolysed when molten.

**0 5 . 2** Which represents molten magnesium chloride?

**[1 mark]**

Tick (✓) **one** box.

$MgCl_2(g)$ ☐

$MgCl_2(l)$ ☐

$MgCl_2(s)$ ☐

**0 5 . 3** Magnesium chloride contains $Mg^{2+}$ ions and $Cl^-$ ions.

Name the product at each electrode when molten magnesium chloride is electrolysed.

**[2 marks]**

Negative electrode _____

Positive electrode _____

5.4.2.1 Reactions of acids with metals

Question 10 · continued



A student investigated the reactivity of three metals: copper, magnesium and iron.

The student mixed each metal with each metal chloride solution.

**Table 6** shows the results.

**Table 6**

| | **Copper chloride solution** | **Magnesium chloride solution** | **Iron chloride solution** |
|---|---|---|---|
| **Copper** | No reaction | No reaction | No reaction |
| **Magnesium** | Reaction | No reaction | Reaction |
| **Iron** | Reaction | No reaction | No reaction |

**0 5 . 4** What is the order of reactivity for copper, magnesium and iron?

Give **two** reasons for your answer.

Use **Table 6**.

**[3 marks]**

Most reactive _____

_____

Least reactive _____

Reason 1 _____

_____

Reason 2 _____

_____

**Question 5 continues on the next page**

**5.4.2.1 Reactions of acids with metals**

**Question 10 · continued**



**0 5 . 5** When heated 0.72 g of magnesium reacts with iron oxide to produce 2.32 g of products.

Calculate the mass of iron oxide that reacts with 0.72 g of magnesium.

**[1 mark]**

Mass of iron oxide = _____ g

**0 5 . 6** The student used 30 $cm^3$ of magnesium chloride solution.

1 $dm^3$ of magnesium chloride solution contains 180 g of magnesium chloride.

1 $dm^3$ = 1000 $cm^3$

Calculate the mass of magnesium chloride in 30 $cm^3$ of magnesium chloride solution.

**[3 marks]**

Mass of magnesium chloride = _____ g

**11**

### 5.4.2.1 Reactions of acids with metals

**Question 11**

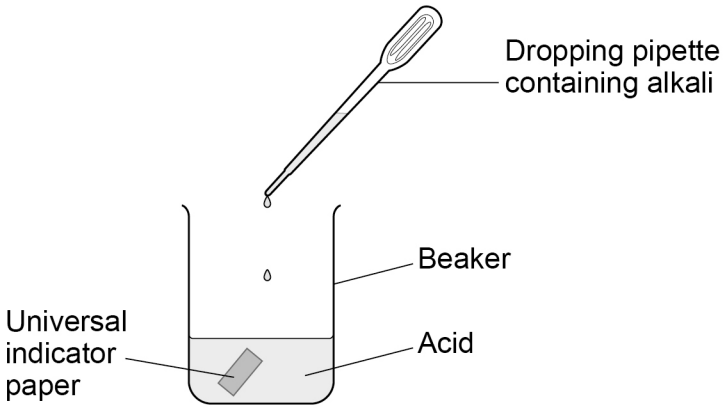
June 2025 | 8464/C/1F | Original Q5

**0 5** This question is about acids.

A student investigated the volume of an alkali needed to react completely with 25 $cm^3$ of an acid.

**Figure 10** shows the apparatus.

**Figure 10**




This is the method used.

1. Add 25 $cm^3$ of the acid to a beaker.
2. Add a piece of universal indicator paper to the acid.
3. Add the alkali drop by drop to the acid until the universal indicator paper changes colour to green.
4. Record the number of drops of alkali added.

**0 5 . 1** The method does **not** give an accurate volume of alkali needed to react completely with the acid.

Suggest **two** improvements to the method.

**[2 marks]**

1 _____

_____

2 _____

_____

5.4.2.1 Reactions of acids with metals

Question 11 · continued



**0 5 . 2** What is the pH of the solution when the universal indicator paper turns green?

**[1 mark]**

Tick (✓) **one** box.

1 ☐ 5 ☐ 7 ☐ 9 ☐

**0 5 . 3** What name is given to the reaction between an acid and an alkali?

**[1 mark]**

Tick (✓) **one** box.

Combustion ☐

Displacement ☐

Neutralisation ☐

**0 5 . 4** Which ion do all acids contain?

**[1 mark]**

Tick (✓) **one** box.

$Cl^-$ ☐ $H^+$ ☐ $Na^+$ ☐

**0 5 . 5** Name the acid that reacts with sodium hydroxide to produce sodium nitrate.

**[1 mark]**

_____

**Question 5 continues on the next page**

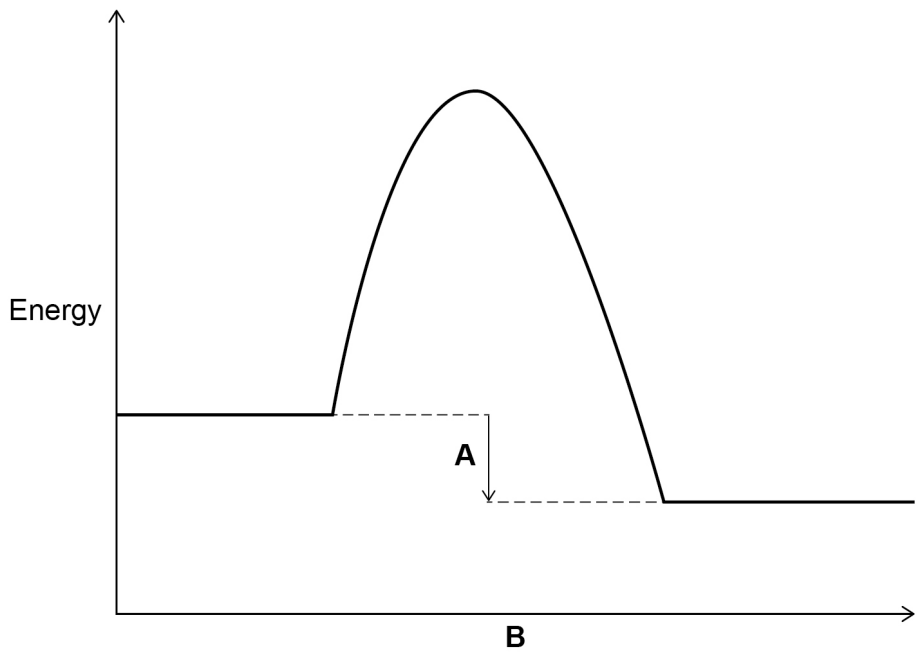
5.4.2.1 Reactions of acids with metals

Question 11 · continued



**0 5 . 6** **Figure 11** shows a reaction profile for the reaction between an acid and an alkali.

**Figure 11**




What do labels **A** and **B** represent on **Figure 11**?

Choose the answers from the box.

**[2 marks]**

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

**A** _____

**B** _____

**5.4.2.1 Reactions of acids with metals**

**Question 11 · continued**



Acids also react with insoluble solid substances to produce salt solutions.

**0 5 . 7** When making a salt solution, excess solid is added to the acid.

Draw the apparatus used to separate the excess solid from the salt solution by filtration.

The apparatus should collect:

- the excess solid
- the salt solution.

**[2 marks]**

**0 5 . 8** Solid **X** reacts with hydrochloric acid to produce zinc chloride and hydrogen gas.

Name solid **X**.

**[1 mark]**

**11**