AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.2.2

Neutralisation of acids and salt production

Past-paper questions

Tier	**Higher**
Question groups	**10**
Available paper years	**2018–2024**

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.

5.4.2.2 Neutralisation of acids and salt production

Question 01

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

0 3 A student plans a method to prepare pure crystals of copper sulfate.

The student's method is:

1. Add one spatula of calcium carbonate to dilute hydrochloric acid in a beaker.
2. When the fizzing stops, heat the solution with a Bunsen burner until all the liquid is gone.

The method contains several errors and does not produce copper sulfate crystals.

Explain the improvements the student should make to the method so that pure crystals of copper sulfate are produced.

[6 marks]

6

5.4.2.2 Neutralisation of acids and salt production

Question 02

0 6 Bleach is a solution of sodium hypochlorite (NaClO).

Chlorine gas is produced when bleach reacts with hydrochloric acid.

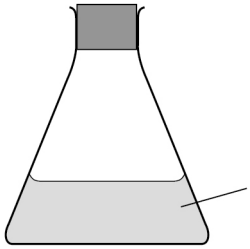
$$NaClO(aq) + 2HCl(aq) \rightleftharpoons NaCl(aq) + H_2O(l) + Cl_2(g)$$

0 6 . 1 Give the test and result for chlorine gas.

[2 marks]

Figure 8 shows a sealed flask of sodium hypochlorite and hydrochloric acid at equilibrium.

Figure 8



0 6 . 2 Explain why equilibrium is reached in this reaction.

[2 marks]

5.4.2.2 Neutralisation of acids and salt production

Question 02 · continued

0 6 . 3 The stopper in **Figure 8** is removed and hydrochloric acid is added.

The stopper is replaced.

Explain what happens to the equilibrium.

[4 marks]

Question 6 continues on the next page

5.4.2.2 Neutralisation of acids and salt production

Question 02 · continued

Chlorine gas is also produced when hydrogen chloride decomposes.

$$2HCl(g) \rightleftharpoons H_2(g) + Cl_2(g)$$

The forward reaction is endothermic.

0 6 . 4 Predict the effect of increasing the temperature on the amount of chlorine gas produced at equilibrium.

Explain your answer using Le Chatelier's Principle.

[2 marks]

0 6 . 5 Explain the effect of increasing the pressure on this equilibrium.

[2 marks]

12

5.4.2.2 Neutralisation of acids and salt production

Question 03

0 2 This question is about salts.

Ammonium nitrate solution is produced when ammonia gas reacts with nitric acid.

0 2 . 1 Give the state symbol for ammonium nitrate solution.

[1 mark]

_____

0 2 . 2 What is the formula of nitric acid?

[1 mark]

Tick (✓) **one** box.

HCl ☐

HNO_3 ☐

H_2SO_4 ☐

NH_4OH ☐

0 2 . 3 Ammonia gas dissolves in water to produce ammonia solution.

Ammonia solution contains hydroxide ions, OH^-

A student adds universal indicator to solutions of nitric acid and ammonia.

What colour is observed in each solution?

[2 marks]

Colour in nitric acid _____

Colour in ammonia solution _____

5.4.2.2 Neutralisation of acids and salt production

Question 03 · continued

0 2 . 4 The student gradually added nitric acid to ammonia solution.

Which row, **A**, **B**, **C** or **D**, shows the change in pH as the nitric acid is added until in excess?

[1 mark]

Tick (✓) **one** box.

	pH of ammonia solution at start	pH after addition of excess nitric acid	
A	10	7	☐
B	2	10	☐
C	7	1	☐
D	10	2	☐

0 2 . 5 Calculate the percentage by mass of oxygen in ammonium nitrate (NH_4NO_3).

Relative atomic masses (A_r): H = 1 N = 14 O = 16

Relative formula mass (M_r): NH_4NO_3 = 80

[3 marks]

Percentage by mass of oxygen = _____ %

Question 2 continues on the next page

5.4.2.2 Neutralisation of acids and salt production

Question 03 · continued

0 2 . 6 Describe a method to investigate how the temperature changes when different masses of ammonium nitrate are dissolved in water.

You do **not** need to write about safety precautions.

[6 marks]

14

5.4.2.2 Neutralisation of acids and salt production

Question 04

0 4 This question is about acids, alkalis and bases.

A student reacted zinc oxide powder with hydrochloric acid to produce zinc chloride solution.

0 4 . 1 Complete the equation for the reaction by writing the state symbols.

[2 marks]

$$ZnO(\quad) + 2\,HCl(\quad) \rightarrow ZnCl_2(\quad) + H_2O(\quad)$$

0 4 . 2 Give **one** way that the student could speed up the reaction between zinc oxide powder and hydrochloric acid.

[1 mark]

Hydrochloric acid was the limiting reactant.

0 4 . 3 How could the student know when all the hydrochloric acid has reacted?

[1 mark]

0 4 . 4 How could the student obtain zinc chloride solution from the reaction mixture when all the hydrochloric acid has reacted?

[1 mark]

0 4 . 5 Describe how zinc chloride crystals are produced from zinc chloride solution.

[2 marks]

Sulfuric acid and sodium hydroxide react to produce sodium sulfate.

0 4 . 6 Sulfuric acid is gradually added to sodium hydroxide solution.

The pH of the mixture changes as the sulfuric acid is added until in excess.

Suggest the pH at:

- the start before sulfuric acid is added
- the end when sulfuric acid is in excess.

[2 marks]

pH at start = _____

pH at end = _____

0 4 . 7 Complete the symbol equation for the preparation of sodium sulfate.

You should balance the equation.

[2 marks]

_____ $NaOH$ + H_2SO_4 → _____ + _____

Question 4 continues on the next page

5.4.2.2 Neutralisation of acids and salt production

Question 04 · continued

0 4 . 8 A solution of hydrochloric acid had a hydrogen ion concentration of 1.0 mol/dm^3

Water was added to the hydrochloric acid until the pH increased by 1

What was the hydrogen ion concentration of the hydrochloric acid after water had been added?

[1 mark]

Tick (✓) **one** box.

100 mol/dm^3 ☐

10 mol/dm^3 ☐

0.10 mol/dm^3 ☐

0.010 mol/dm^3 ☐

12

5.4.2.2 Neutralisation of acids and salt production

Question 05

November 2021 | 8464/C/1H | Original Q2

0 2 Acids react to produce salts.

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

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

[1 mark]

Tick (✓) **one** box.

- Decreases ☐
- Stays the same ☐
- Increases ☐

0 2 . 3 What is the state symbol for nitric acid?

[1 mark]

_____

5.4.2.2 Neutralisation of acids and salt production

Question 05 · continued

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 2 . 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 2 . 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 2 continues on the next page

5.4.2.2 Neutralisation of acids and salt production

Question 05 · continued

0 2 . 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

5.4.2.2 Neutralisation of acids and salt production

Question 06

June 2022 | 8464/C/1H | Original Q1

0 1 This question is about salts.

Green copper carbonate and sulfuric acid can be used to produce blue copper sulfate crystals.

0 1 . 1 **Excess** copper carbonate is added to sulfuric acid.

Give **three** observations you would make.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

0 1 . 2 How can the excess copper carbonate be removed?

[1 mark]

_____

_____

0 1 . 3 The pH of the solution changes during the reaction.

What is the pH of the solution at the end of the reaction?

[1 mark]

pH = _____

0 1 . 4 Copper carbonate and sulfuric acid react to produce copper sulfate.

What type of reaction is this?

[1 mark]

_____

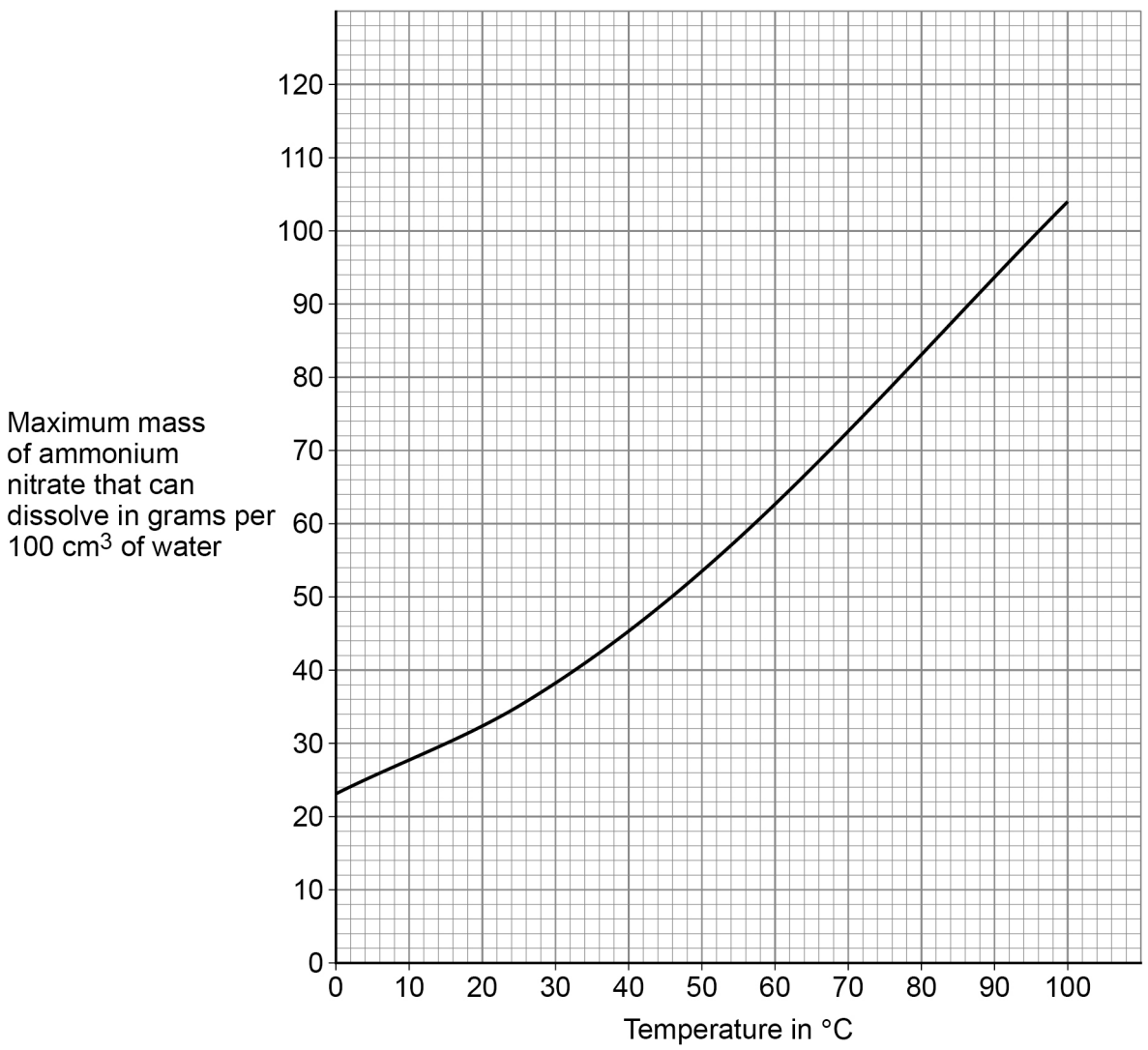
5.4.2.2 Neutralisation of acids and salt production

Question 06 · continued

0 1 . 5 Ammonium nitrate is a salt.

Figure 1 shows the maximum mass of ammonium nitrate that can dissolve in 100 cm^3 of water at different temperatures.

Figure 1



5.4.2.2 Neutralisation of acids and salt production

Question 06 · continued

A student adds ammonium nitrate to water at 80 °C until no more dissolves.

The student cools 100 cm^3 of this solution of ammonium nitrate from 80 °C to 20 °C to produce crystals of ammonium nitrate.

Determine the mass of ammonium nitrate that crystallises on cooling 100 cm^3 of this solution from 80 °C to 20 °C

[3 marks]

Mass = _____ g

9

5.4.2.2 Neutralisation of acids and salt production

Question 07

June 2022 | 8464/C/2H | Original Q2

0 2 . 1 Water that is safe to drink is called potable water.

Compare how easily potable water can be obtained from:

- waste water (sewage)
- ground water (fresh water).

[6 marks]

Question 2 continues on the next page

5.4.2.2 Neutralisation of acids and salt production

Question 07 · continued

A scientist produced potable water from 150 cm^3 of salty water.

0 2 . 2 Which process can be used to produce potable water from salty water?

[1 mark]

Tick (✓) **one** box.

- Distillation ☐
- Electrolysis ☐
- Filtration ☐
- Sterilisation ☐

0 2 . 3 The salty water contains sodium chloride.

The scientist collected 2.40 g of sodium chloride from 150 cm^3 of salty water.

Calculate the concentration of sodium chloride in grams per dm^3

[3 marks]

Concentration of sodium chloride = _____ g/dm^3

10

5.4.2.2 Neutralisation of acids and salt production

Question 08

June 2023 | 8464/C/1H | Original Q1

0 1 This question is about carbon dioxide.

Carbon dioxide is soluble in water and forms an acidic solution.

0 1 . 1 Which ion makes the solution acidic?

[1 mark]

_____

0 1 . 2 Name an indicator that could be used to test if the solution is acidic.

Give the result of the test.

[2 marks]

Indicator _____

Result _____

_____

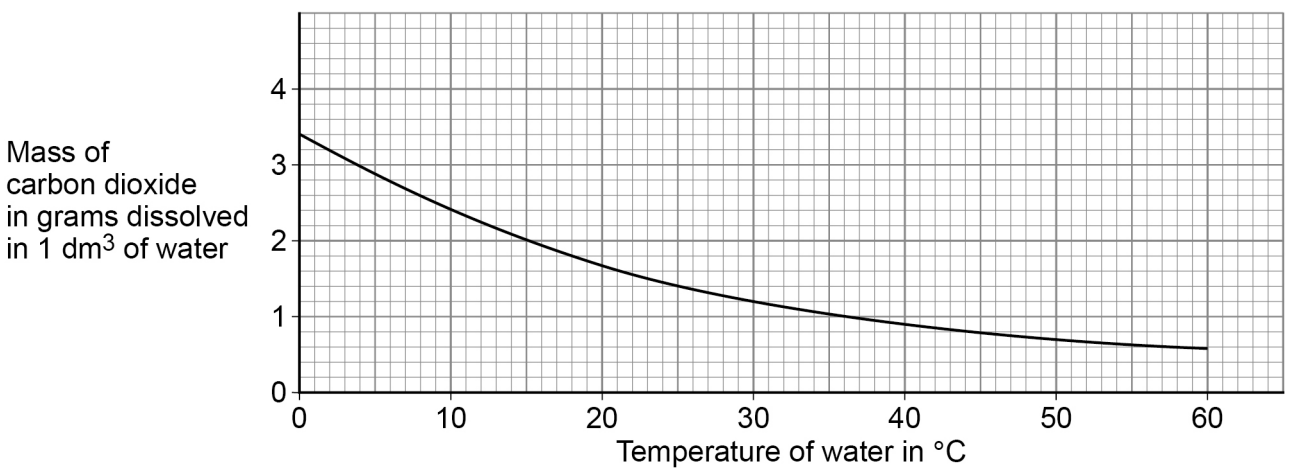
Question 1 continues on the next page

5.4.2.2 Neutralisation of acids and salt production

Question 08 · continued

Figure 1 shows the mass of carbon dioxide that will dissolve in 1 dm^3 of water at different temperatures.

Figure 1



0 1 . 3 How does the solubility of carbon dioxide change as the temperature of the water increases?

[1 mark]

Tick (✓) **one** box.

The solubility decreases ☐

The solubility does not change ☐

The solubility increases ☐

5.4.2.2 Neutralisation of acids and salt production

Question 08 · continued

0 1 . 4 Carbon dioxide dissolves in water to form an acidic solution.

How does the pH of the solution change as the temperature of the water increases?

Use **Figure 1**.

[1 mark]

Tick (✓) **one** box.

pH of the solution decreases ☐

pH of the solution does not change ☐

pH of the solution increases ☐

Calcium carbonate reacts with hydrochloric acid to produce carbon dioxide.

The equation for the reaction is:

$$CaCO_3(s) + 2\,HCl(aq) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(\mathbf{x})$$

0 1 . 5 What is the state symbol (**x**) in the equation?

[1 mark]

Tick (✓) **one** box.

(aq) ☐ (g) ☐ (l) ☐ (s) ☐

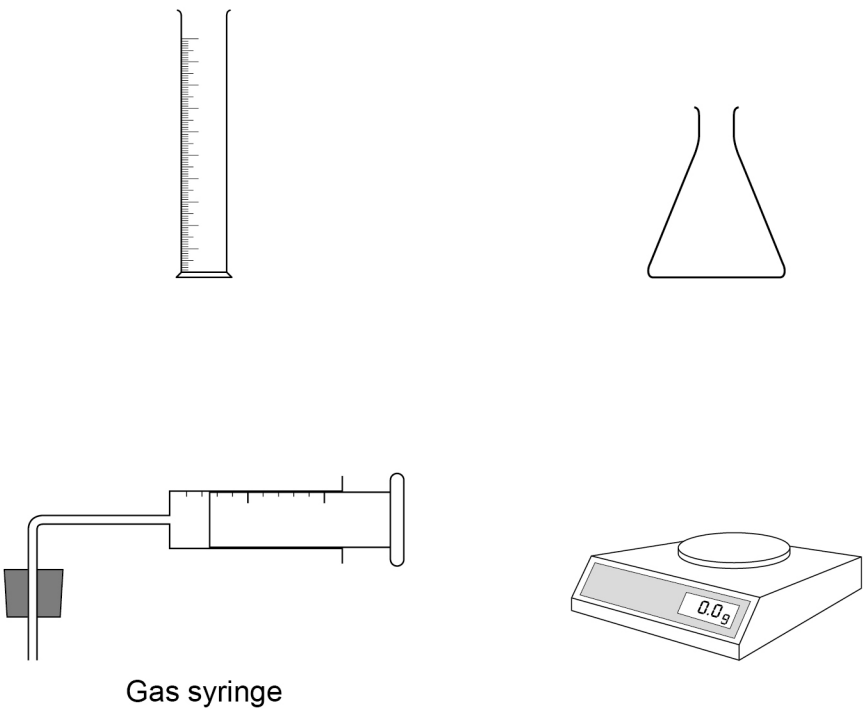
Question 1 continues on the next page

5.4.2.2 Neutralisation of acids and salt production

Question 08 · continued

0 1 . 6 **Figure 2** shows equipment a student used for an investigation.

Figure 2



Gas syringe

5.4.2.2 Neutralisation of acids and salt production

Question 08 · continued

The student investigated the volume of carbon dioxide produced when different masses of calcium carbonate react with hydrochloric acid.

Describe a method the student could use.

[6 marks]

12

5.4.2.2 Neutralisation of acids and salt production

Question 09

June 2023 | 8464/C/1H | Original Q6

0 6 Acids react with some metals to produce soluble salts.

A student adds magnesium to hydrochloric acid until no more acid reacts and excess magnesium remains.

The equation for the reaction is:

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

0 6 . 1 Describe how solid magnesium chloride is obtained from the reaction mixture.

[2 marks]

0 6 . 2 The reaction between magnesium and hydrochloric acid is a redox reaction.

Explain what happens to the magnesium atoms in this reaction.

[2 marks]

5.4.2.2 Neutralisation of acids and salt production

Question 09 · continued

0 6 . 3 0.72 g of magnesium is added to 100 cm^3 of hydrochloric acid.

The hydrochloric acid is in excess.

Calculate the concentration of the magnesium chloride ($MgCl_2$) solution produced in g/dm^3.

Relative atomic mass (A_r): Mg = 24

Relative formula mass (M_r): $MgCl_2$ = 95

[6 marks]

Concentration = _____ g/dm^3

10

5.4.2.2 Neutralisation of acids and salt production

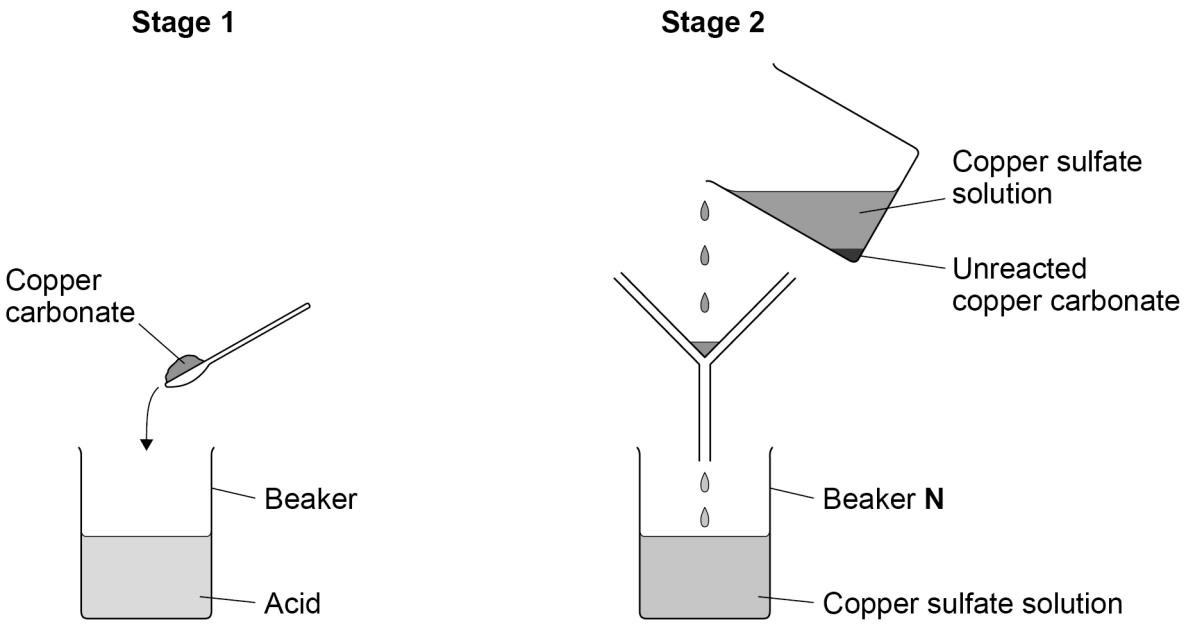
Question 10

June 2024 | 8464/C/1H | Original Q2

0 2 A student prepared copper sulfate by reacting an acid with excess copper carbonate.

Figure 3 shows the first two stages in the preparation of copper sulfate.

Figure 3



0 2 . 1 What is the formula of the acid used to prepare copper sulfate?

[1 mark]

Tick (✓) **one** box.

- HCl ☐
- HNO_3 ☐
- H_2SO_4 ☐

5.4.2.2 Neutralisation of acids and salt production

Question 10 · continued

0 2 . 2 Why is excess copper carbonate used in **stage 1**?

[1 mark]

0 2 . 3 Beaker **N** contained copper sulfate solution.

Describe how the student could produce copper sulfate crystals from the copper sulfate solution in beaker **N**.

[2 marks]

Question 2 continues on the next page

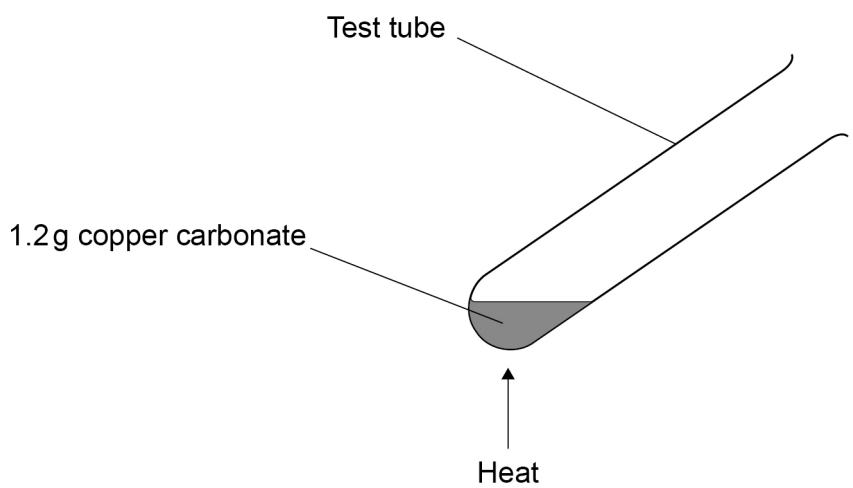
Question 10 · continued

A student investigated the thermal decomposition of copper carbonate.

Copper carbonate decomposes to form two products.

Figure 4 shows the apparatus.

Figure 4



This is the method used.

1. Add 1.2 g of copper carbonate to a test tube.
2. Heat the test tube and contents until the mass does not change.
3. Record the mass of the contents of the test tube after heating.
4. Repeat steps 1 to 3 with different masses of copper carbonate.

Table 1 shows the results.

Table 1

Mass of copper carbonate in test tube before heating in grams	Mass of the contents of test tube after heating in grams
1.2	0.8
2.4	1.7
3.6	2.2
4.8	3.1
6.0	3.9

5.4.2.2 Neutralisation of acids and salt production

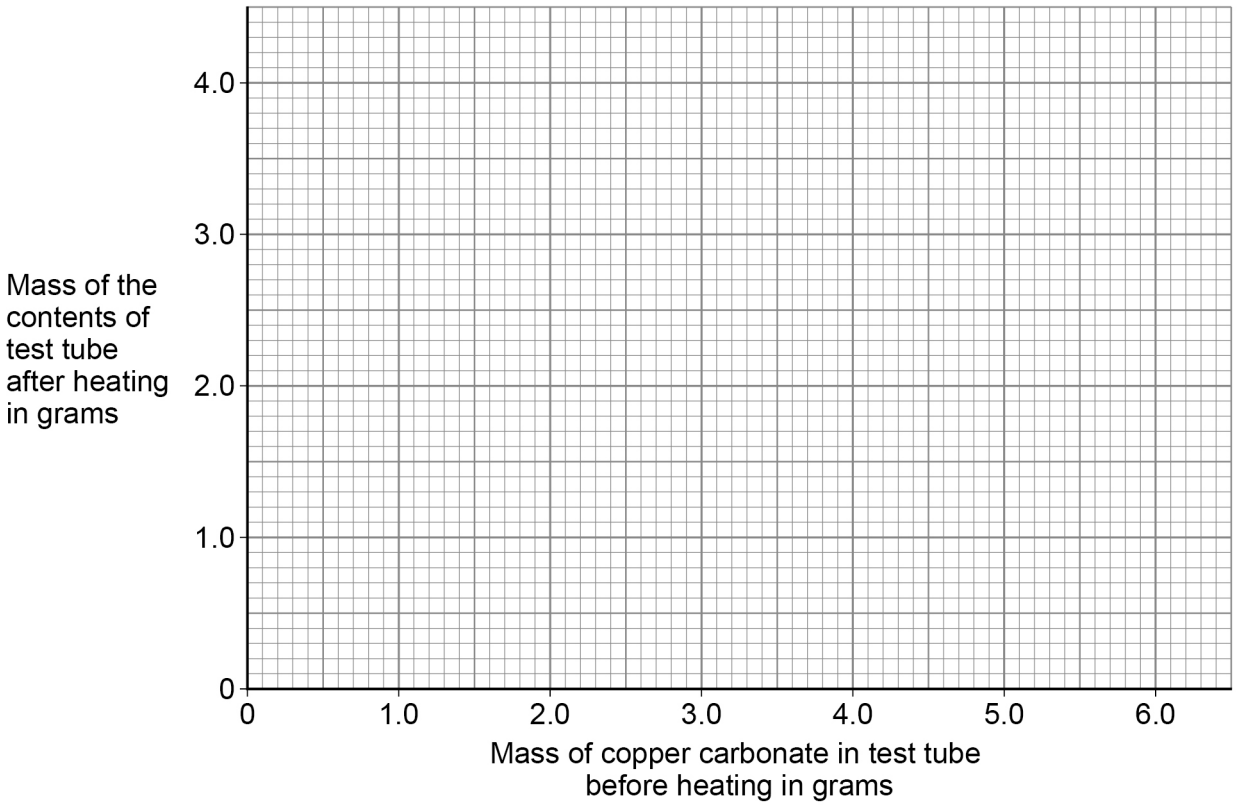
Question 10 · continued

0 2 . 4 Plot the data from **Table 1** on **Figure 5**.

Draw a line of best fit.

[3 marks]

Figure 5



0 2 . 5 Why does the mass of the contents of the test tube decrease in mass when copper carbonate is thermally decomposed?

[1 mark]

8