AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.8.3.5

Sulfates

Past-paper questions

Tier	**Higher**
Question groups	**14**
Available paper years	**2008–2024**

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.

4.8.3.5 Sulfates

Question 01

6 (a) Four bottles of chemicals made in the 1880s were found recently in a cupboard during a Health and Safety inspection at Lovell Laboratories.



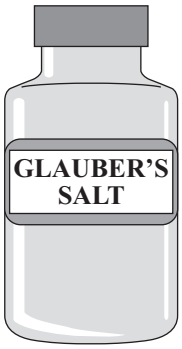
Sodium carbonate



Sodium chloride



Sodium nitrate



Sodium sulfate

The chemicals are correctly named.

You are provided with the following reagents:

- aluminium powder
- barium chloride solution acidified with dilute hydrochloric acid
- dilute hydrochloric acid
- silver nitrate solution acidified with dilute nitric acid
- sodium hydroxide solution.

4.8.3.5 Sulfates

Question 01 · continued

BLANK

(i) Describe tests to show that these chemicals are correctly named.

In each case give the reagent(s) you would use and state what you would see.

Test and result for carbonate ions:

.....

.....

Test and result for chloride ions:

.....

.....

Test and result for nitrate ions:

.....

.....

Test and result for sulfate ions:

.....

.....

(5 marks)

(ii) Suggest why a flame test would **not** distinguish between these four chemicals.

.....

(1 mark)

(b) Instrumental methods of analysis linked to computers can be used to identify chemicals.

Describe **two** advantages of using instrumental methods of analysis.

.....

.....

.....

.....

(2 marks)

8

4.8.3.5 Sulfates

Question 02

4 Alums are salts. They have been used since ancient times in dyeing and medicine and still have many uses today.

Three alums are shown in the table:

Name	Ions present		
Ammonium alum	NH_4^+	Al^{3+}	SO_4^{2-}
Potassium alum	K^+	Al^{3+}	SO_4^{2-}
Sodium alum	Na^+	Al^{3+}	SO_4^{2-}

4 (a) These alums contain sulfate ions (SO_4^{2-}).

Describe and give the result of a chemical test to show this.

Test .....

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Result .....

.....

(2 marks)

4 (b) These alums contain aluminium ions (Al^{3+}).

Describe how sodium hydroxide solution can be used to show this.

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(2 marks)

4.8.3.5 Sulfates

Question 02 · continued

for mark

4 (c) Aluminium ions do not give a colour in flame tests. However, flame tests can be used to distinguish between these three alums.

Explain how these three alums could be identified from the results of flame tests.

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(2 marks)

6

Turn over for the next question

4.8.3.5 Sulfates

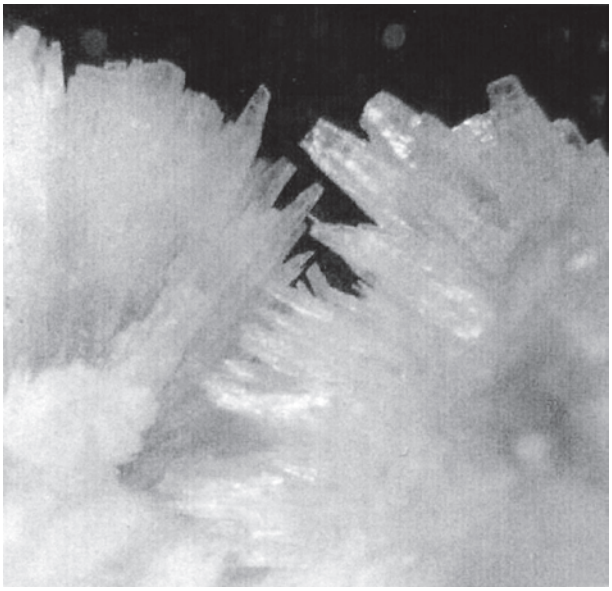
Question 03

June 2010 | CHY2H | Original Q2 | Legacy

2 (a) Read the article about the mineral strontianite.

Strontianite is a mineral that was discovered near the village of Strontian in Scotland. At first some scientists thought that strontianite was barium carbonate.

Strontianite



In 1790, Professor Adair Crawford and William Cruikshank were both lecturers in chemistry and doctors of medicine. They investigated the properties of strontianite. They found that strontianite had different properties from barium carbonate. They concluded that strontianite contained a new element.

After this, other scientists also showed that strontianite and barium carbonate had different properties. Strontianite is now known to be strontium carbonate.

2 (a) (i) What evidence did Crawford and Cruikshank use to prove that strontianite was **not** barium carbonate?

.....

.....

(1 mark)

2 (a) (ii) Crawford and Cruikshank's conclusion was immediately accepted by other scientists. Suggest why.

.....

.....

(1 mark)

2 (a) (iii) How was the reliability of the work of Crawford and Cruikshank confirmed?

.....

.....

(1 mark)

4.8.3.5 Sulfates

Question 03 · continued

2 (b) One of Crawford and Cruikshank's experiments was repeated in a school laboratory. Samples of strontianite and barium carbonate were reacted with hydrochloric acid to produce strontium chloride and barium chloride.

Solid strontium chloride and solid barium chloride were separately added to water. The change in temperature of the water was measured.

The results of the experiments are shown below.

	Experiment 1 Strontium chloride dissolved in water	**Experiment 2** Barium chloride dissolved in water
Temperature of water before adding the chloride in ºC	19.5	19.6
Temperature of water after adding the chloride in ºC	21.2	17.5

2 (b) (i) State **one** variable that should be controlled to make it a fair test.

.....

.....

(1 mark)

2 (b) (ii) Which experiment, **1** or **2**, is endothermic?

Explain how you know.

Experiment ☐ because .....

.....

(1 mark)

2 (b) (iii) The results prove that strontium chloride and barium chloride must be different even if all of the variables had not been controlled when they were dissolved. Explain why.

.....

.....

(1 mark)

2 (c) In 1808, Humphry Davy was the first person to extract strontium. He did this by the electrolysis of molten strontium chloride. Strontium formed at the negative electrode.

Suggest why strontium ions are attracted to the negative electrode.

.....

.....

(1 mark)

7

4.8.3.5 Sulfates

Question 04

5 Read the information in the box and then answer the questions.

Seidlitz Powder is the name of a medicine.

Seidlitz Powder comes as two powders. One powder is wrapped in white paper and contains tartaric acid ($C_4H_6O_6$). The other powder is wrapped in blue paper and contains potassium sodium tartrate ($KNaC_4H_4O_6$) and sodium hydrogencarbonate ($NaHCO_3$).

The contents of the blue paper are completely dissolved in water and then the contents of the white paper are added.

The equation which represents this reaction is:

$$C_4H_6O_6\,(aq) + 2NaHCO_3\,(aq) \longrightarrow Na_2C_4H_4O_6\,(aq) + 2H_2O\,(l) + 2CO_2\,(g)$$

5 (a) Describe and give the result of a test to identify the gas produced in this reaction.

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.....

(2 marks)

5 (b) One of the chemicals in Seidlitz Powder is potassium sodium tartrate ($KNaC_4H_4O_6$).

Suggest why it would be difficult to identify **both** potassium ions and sodium ions in potassium sodium tartrate using a flame test.

.....

.....

(1 mark)

4.8.3.5 Sulfates

Question 04 · continued

5 (c) Some Seidlitz Powder was bought on the Internet. However, when tested, it was found to be only magnesium sulfate.

5 (c) (i) Describe and give the result of a chemical test to show that magnesium sulfate contains sulfate ions.

Test .....

.....

Result .....

.....

(2 marks)

5 (c) (ii) Magnesium sulfate contains magnesium ions.

Describe what you **see** when sodium hydroxide solution is added to a solution of magnesium sulfate.

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(1 mark)

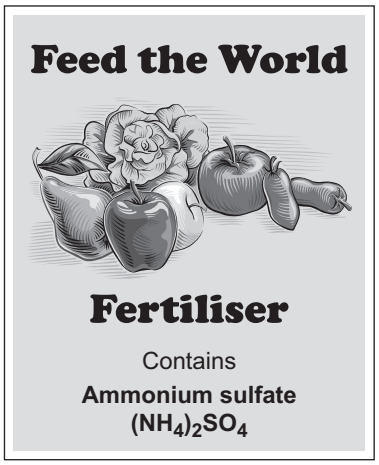
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4.8.3.5 Sulfates

Question 05

June 2011 | CHY3H | Original Q5 | Legacy

5 Ammonium sulfate is an artificial fertiliser.



5 (a) (i) When this fertiliser is warmed with sodium hydroxide solution, ammonia gas is given off. Describe and give the result of a test for ammonia gas.

Test .....

.....

Result .....

.....

(2 marks)

5 (a) (ii) Describe and give the result of a chemical test to show that this fertiliser contains sulfate ions (SO_4^{2-}).

Test .....

.....

Result .....

.....

(2 marks)

5 (b) Ammonium sulfate is made by reacting sulfuric acid (a *strong* acid) with ammonia solution (a *weak* alkali).

5 (b) (i) Explain the meaning of *strong* in terms of ionisation.

.....

(1 mark)

4.8.3.5 Sulfates

Question 05 · continued

5 (b) (ii) A student made some ammonium sulfate in a school laboratory.

The student carried out a titration, using a suitable indicator, to find the volumes of sulfuric acid and ammonia solution that should be reacted together.

Name a suitable indicator for strong acid-weak alkali titrations.

.....

(1 mark)

5 (b) (iii) The student found that 25.0 cm^3 of ammonia solution reacted completely with 32.0 cm^3 of sulfuric acid of concentration 0.050 moles per cubic decimetre.

The equation that represents this reaction is:

$$H_2SO_4\,(aq) + 2NH_3\,(aq) \rightarrow (NH_4)_2SO_4\,(aq)$$

Calculate the concentration of this ammonia solution in moles per cubic decimetre.

.....

.....

.....

.....

.....

Concentration = ... moles per cubic decimetre

(3 marks)

5 (b) (iv) Use your answer to (b)(iii) to calculate the concentration of ammonia in grams per cubic decimetre.

(If you did not answer part (b)(iii), assume that the concentration of the ammonia solution is 0.15 moles per cubic decimetre. This is **not** the correct answer to part (b)(iii).)

Relative formula mass of ammonia (NH_3) = 17.

.....

.....

.....

Concentration = ... grams per cubic decimetre

(2 marks)

11

4.8.3.5 Sulfates

Question 06

June 2014 | CH3HP | Original Q7 | Legacy

7 The colours of fireworks are produced by chemicals.

Figure 10



7 (a) Information about four chemicals is given in **Table 2**.

Complete **Table 2**.

[2 marks]

Table 2

Chemical	Colour produced in firework
barium chloride	green
..... carbonate	crimson
sodium nitrate	.....
calcium sulfate	red

4.8.3.5 Sulfates

Question 06 · continued

7 (b) Describe a test to show that barium chloride solution contains chloride ions.

Give the result of the test.

[2 marks]

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.....

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7 (c) A student did two tests on a solution of compound **X**.

Test 1
Sodium hydroxide solution was added.
A blue precipitate was formed.

Test 2
Dilute hydrochloric acid was added.
Barium chloride solution was then added.
A white precipitate was formed.

The student concluded that compound **X** is iron(II) sulfate.

Is the student's conclusion correct?

Explain your answer.

[3 marks]

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.....

.....

7

4.8.3.5 Sulfates

Question 07

7 This question is about chemical analysis.

7 (a) A student has solutions of three compounds, **X**, **Y** and **Z**.

The student uses tests to identify the ions in the three compounds.

The student records the results of the tests in **Table 1**.

Table 1

	Test			
Compound	**Flame test**	**Add sodium hydroxide solution**	**Add hydrochloric acid and barium chloride solution**	**Add nitric acid and silver nitrate solution**
X	no colour	green precipitate	white precipitate	no reaction
Y	yellow flame	no reaction	no reaction	yellow precipitate
Z	no colour	brown precipitate	no reaction	cream precipitate

Identify the **two** ions present in each compound, **X**, **Y** and **Z**.

[3 marks]

X .....

Y .....

Z .....

7 (b) A chemist needs to find the concentration of a solution of barium hydroxide.
Barium hydroxide solution is an alkali.

The chemist could find the concentration of the barium hydroxide solution using two different methods.

Method 1

- An excess of sodium sulfate solution is added to 25 cm^3 of the barium hydroxide solution. A precipitate of barium sulfate is formed.
- The precipitate of barium sulfate is filtered, dried and weighed.
- The concentration of the barium hydroxide solution is calculated from the mass of barium sulfate produced.

4.8.3.5 Sulfates

Question 07 · continued

Method 2

- 25 cm^3 of the barium hydroxide solution is titrated with hydrochloric acid of known concentration.
- The concentration of the barium hydroxide solution is calculated from the result of the titration.

Compare the advantages and disadvantages of the two methods.

[5 marks]

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4.8.3.5 Sulfates

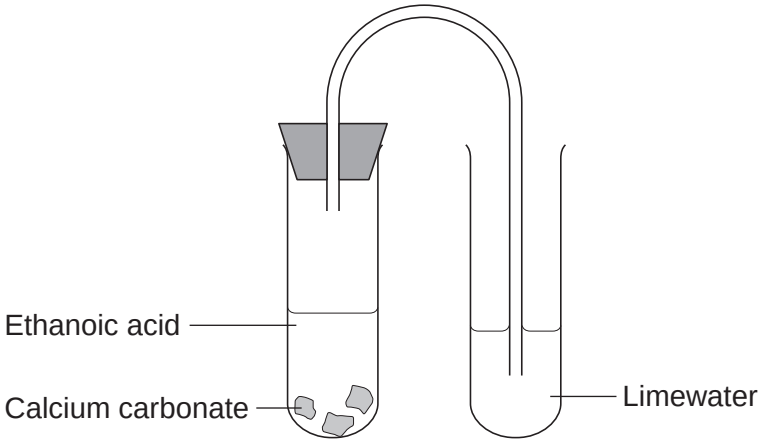
Question 08

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 _____

_____

_____

_____

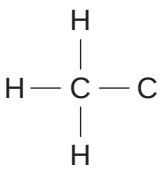
Question 1 continues on the next page

4.8.3.5 Sulfates

Question 08 · continued

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

[1 mark]



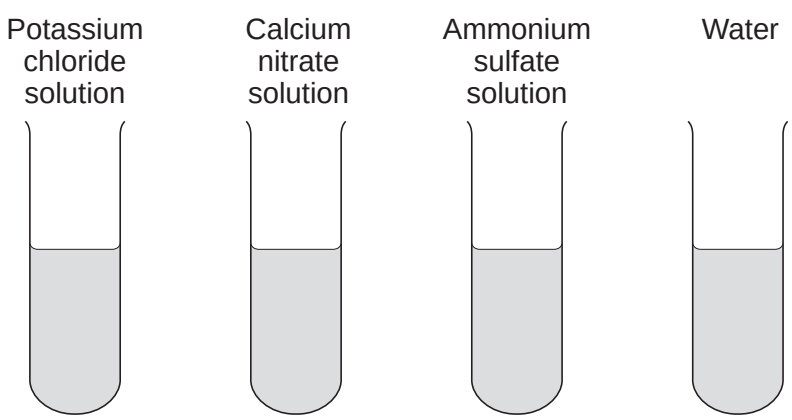
1 (a) (iii) Ethanoic acid is a carboxylic acid.
Complete the sentence.

[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.

4.8.3.5 Sulfates

Question 08 · 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

4.8.3.5 Sulfates

Question 09

June 2018 | 8462/2H | Original Q1

0 1 This question is about chemicals in fireworks.

Coloured flames are produced because of the metal ions present in fireworks.

0 1 . 1 What colour flame would sodium ions produce?

[1 mark]

0 1 . 2 Name a metal ion that would produce a green flame.

[1 mark]

0 1 . 3 Some fireworks contain a mixture of metal ions.

Why is it difficult to identify the metal ions from the colour of the flame?

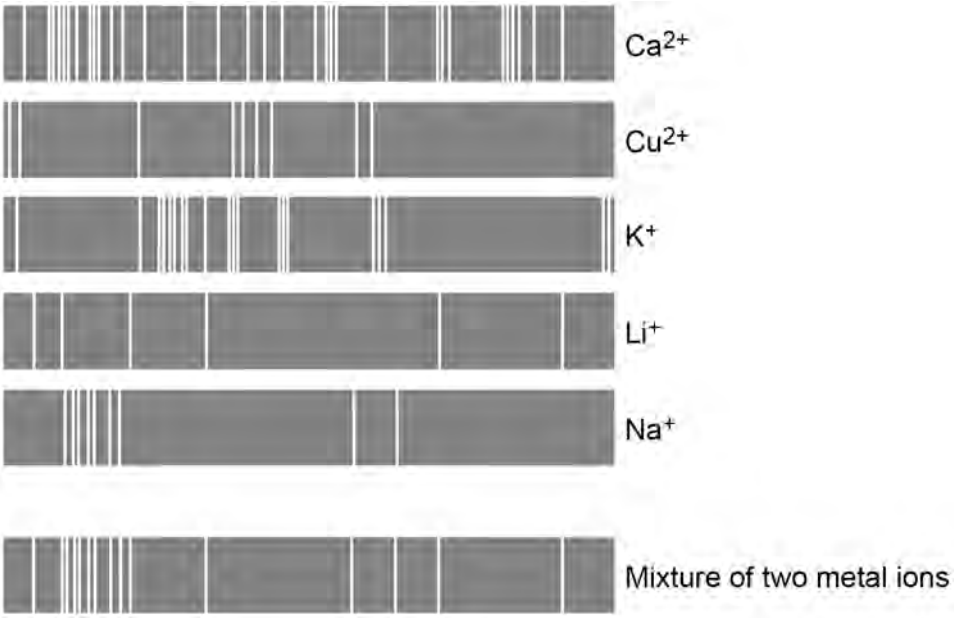
[1 mark]

0 1 . 4 Flame emission spectroscopy is used to identify metal ions in a firework.

Figure 1 shows:

- the flame emission spectra of five individual metal ions
- a flame emission spectrum for a mixture of two metal ions.

Figure 1



Which **two** metal ions are in the mixture?

[2 marks]

Tick **two** boxes.

Ca^{2+} ☐

Cu^{2+} ☐

K^+ ☐

Li^+ ☐

Na^+ ☐

Question 09 · continued

The compounds in fireworks also contain non-metal ions.

A scientist tests a solution of the chemicals used in a firework.

0 1 . 5 Silver nitrate solution and dilute nitric acid are added to the solution.

A cream precipitate forms.

Which ion is shown to be present by the cream precipitate?

[1 mark]

0 1 . 6 Describe a test to show the presence of sulfate ions in the solution.

Give the result of the test if there are sulfate ions in the solution.

[3 marks]

Test

Result

9

4.8.3.5 Sulfates

Question 10

June 2019 | 8462/2H | Original Q7

0 7 A large amount of aluminium sulfate was accidentally added to the drinking water supply at a water treatment works.

0 7 . 1 Describe a test to show that the drinking water contained aluminium ions.

Give the result of the test.

[3 marks]

Test _____

_____

Result _____

_____

_____

_____

0 7 . 2 Describe a test to show that the drinking water contained sulfate ions.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

4.8.3.5 Sulfates

Question 10 · continued

0 7 . 3 Plan an investigation to find the total mass of dissolved solids in a 100 cm^3 sample of the drinking water.

Your investigation should produce valid results.

[4 marks]

9

4.8.3.5 Sulfates

Question 11

November 2020 | 8462/2H | Original Q1

0 1 This question is about chemical analysis.

A student tested copper sulfate solution and calcium iodide solution using flame tests.

This is the method used.

1. Dip a metal wire in copper sulfate solution.

2. Put the metal wire in a blue Bunsen burner flame.

3. Record the flame colour produced.

4. Repeat steps 1 to 3 using the same metal wire but using calcium iodide solution.

0 1 . 1 What flame colour is produced by copper sulfate solution?

[1 mark]

0 1 . 2 Calcium compounds produce an orange-red flame colour.

The student left out an important step before reusing the metal wire.

The student's method did **not** produce a distinct orange-red flame colour using calcium iodide solution.

Explain why.

[2 marks]

4.8.3.5 Sulfates

Question 11 · continued

0 1 . 3 The student added sodium hydroxide solution to:

- copper sulfate solution
- calcium iodide solution.

Give the results of the tests.

[2 marks]

Copper sulfate solution _____

_____

Calcium iodide solution _____

_____

0 1 . 4 To test for sulfate ions the student added dilute hydrochloric acid to copper sulfate solution.

Name the solution that would show the presence of sulfate ions when added to this mixture.

[1 mark]

_____

0 1 . 5 To test for iodide ions the student added dilute nitric acid to calcium iodide solution.

Name the solution that would show the presence of iodide ions when added to this mixture.

Give the result of the test.

[2 marks]

Solution _____

Result _____

_____

8

4.8.3.5 Sulfates

Question 12

November 2021 | 8462/2H | Original Q7

0 7 Potash alum is a chemical compound.

The formula of potash alum is $KAl(SO_4)_2$

0 7 . 1 Give a test to identify the Group 1 metal ion in potash alum.

You should include the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 7 . 2 Name **one** instrumental method that could identify the Group 1 metal ion **and** show the concentration of the ion in a solution of potash alum.

[1 mark]

_____

_____

4.8.3.5 Sulfates

Question 12 · continued

A student identifies the other metal ion in potash alum.

The student tests a solution of potash alum by adding sodium hydroxide solution until a change is seen.

0 7 . 3 Give the result of this test.

[1 mark]

0 7 . 4 This test gives the same result for several metal ions.

What additional step is needed so that the other metal ion in potash alum can be identified?

Give the result of this additional step.

[2 marks]

Additional step

Result

0 7 . 5 Describe a test to identify the presence of sulfate ions in a solution of potash alum.

Give the result of the test.

[3 marks]

Test

Result

9

4.8.3.5 Sulfates

Question 13

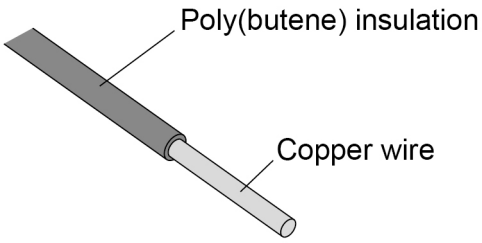
June 2022 | 8462/2H | Original Q1

0 1 This question is about copper wire and copper compounds.

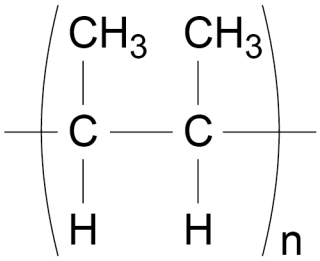
Copper is used to make electrical wires.

Figure 1 shows how copper electrical wire is insulated using an addition polymer called poly(butene).

Figure 1



0 1 . 1 The addition polymer poly(butene) has the displayed structural formula:

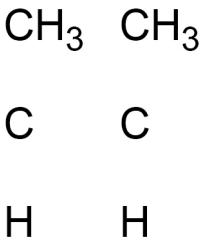


Poly(butene) is produced from the monomer butene.

Complete **Figure 2** to show the displayed structural formula of butene.

[2 marks]

Figure 2



4.8.3.5 Sulfates

Question 13 · continued

Copper can be obtained by recycling scrap copper wire.

0 1 . 2 Suggest why poly(butene) insulation must be removed from scrap copper wire before the copper is recycled.

[1 mark]

0 1 . 3 Describe how scrap copper wire can be recycled to make new copper water pipes.

[2 marks]

0 1 . 4 Suggest **two** reasons why recycling scrap copper is more sustainable than extracting copper from copper ores.

[2 marks]

1

2

Question 1 continues on the next page

4.8.3.5 Sulfates

Question 13 · continued

Copper sulfate is a compound of copper.

Copper sulfate solution contains copper(II) ions and sulfate ions.

0 1 . 5 A solution can be added to copper sulfate solution to show the presence of copper(II) ions.

Name the solution added.

Give the result of the test.

[2 marks]

Name of solution added _____

_____

Result _____

_____

0 1 . 6 Describe **one** test to show the presence of sulfate ions in copper sulfate solution.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

11

4.8.3.5 Sulfates

Question 14

June 2024 | 8462/2H | Original Q7

0 7 This question is about sulfuric acid.

0 7 . 1 Sulfuric acid contains sulfate ions.

Describe the test for the presence of sulfate ions in sulfuric acid.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

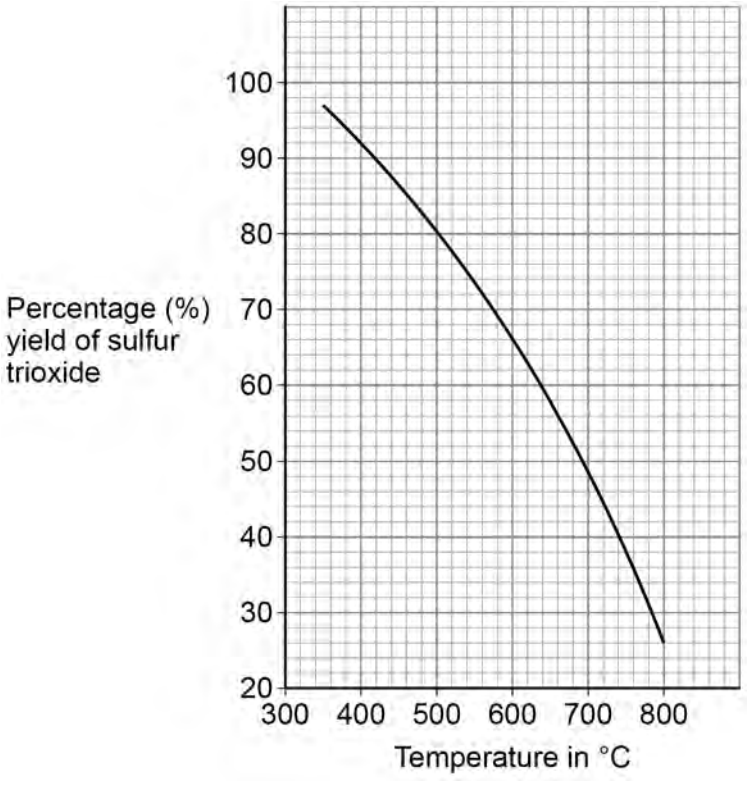
_____

One stage in the industrial production of sulfuric acid is the reaction of sulfur dioxide with oxygen to produce sulfur trioxide.

This reversible reaction reaches dynamic equilibrium.

Figure 7 shows the percentage yield of sulfur trioxide in this reaction at different temperatures.

Figure 7



Question 14 · continued

0 7 . 2 Which statement about the forward reaction is correct?

Use **Figure 7**.

[1 mark]

Tick (✓) **one** box.

- The yield is greater at higher temperatures because the reaction is exothermic. ☐
- The yield is greater at higher temperatures because the reaction is endothermic. ☐
- The yield is smaller at higher temperatures because the reaction is exothermic. ☐
- The yield is smaller at higher temperatures because the reaction is endothermic. ☐

The equation for the reaction is:

$$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$$

0 7 . 3 Explain why the percentage yield of sulfur trioxide in this reaction is greater if the pressure is higher.

[2 marks]

0 7 . 4 In industry, the reaction is done at 450 °C and atmospheric pressure.

Under these conditions the yield of sulfur trioxide is 86%.

Suggest **two** reasons why a higher pressure is **not** used.

[2 marks]

1

2

4.8.3.5 Sulfates

Question 14 · continued

0 7 . 5 This reaction uses a catalyst to increase the rate of the reaction.

The catalyst is a metal oxide.

Which is the most likely metal in the metal oxide catalyst?

Use the periodic table.

[1 mark]

Tick (✓) **one** box.

Aluminium (Al) ☐

Barium (Ba) ☐

Potassium (K) ☐

Vanadium (V) ☐

8