

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS
GCSE**

A172/02

**TWENTY FIRST CENTURY SCIENCE
CHEMISTRY A/ADDITIONAL SCIENCE A**

Modules C4 C5 C6 (Higher Tier)

TUESDAY 9 JUNE 2015: Afternoon

DURATION: 1 hour

plus your additional time allowance

MODIFIED ENLARGED 24pt

| | | | | | | | | | | |
|-------------------------------|--|--|--|--|--|------------------------------|--|--|--|--|
| Candidate forename | | | | | | Candidate surname | | | | |
| Centre number | | | | | | Candidate number | | | | |

**Candidates answer on the Question Paper.
A calculator may be used for this paper.**

OCR SUPPLIED MATERIALS:

A copy of the Periodic Table

OTHER MATERIALS REQUIRED:

Pencil

Ruler (cm/mm)

READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.

Use black ink. HB pencil may be used for graphs and diagrams only.

Answer ALL the questions.

Read each question carefully. Make sure you know what you have to do before starting your answer.

Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

The quality of written communication is assessed in questions marked with a pencil (.

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 60.

Any blank pages are indicated.

A list of qualitative tests for ions is printed on pages 4–5.

BLANK PAGE

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Qualitative analysis

Tests for ions with a positive charge

| ION | TEST | OBSERVATION |
|--|------------------------------------|---|
| calcium Ca²⁺ | add dilute sodium hydroxide | a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide |
| copper Cu²⁺ | add dilute sodium hydroxide | a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide |
| iron(II) Fe²⁺ | add dilute sodium hydroxide | a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide |
| iron(III) Fe³⁺ | add dilute sodium hydroxide | a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide |
| zinc Zn²⁺ | add dilute sodium hydroxide | a white precipitate forms; the precipitate dissolves in excess sodium hydroxide |

Tests for ions with a negative charge

| ION | TEST | OBSERVATION |
|--|--|---|
| carbonate CO₃²⁻ | add dilute acid | the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky) |
| chloride Cl⁻ | add dilute nitric acid, then add silver nitrate | a white precipitate forms |
| bromide Br⁻ | add dilute nitric acid, then add silver nitrate | a cream precipitate forms |
| iodide I⁻ | add dilute nitric acid, then add silver nitrate | a yellow precipitate forms |
| sulfate SO₄²⁻ | add dilute acid, then add barium chloride or barium nitrate | a white precipitate forms |

1 Jack investigates the reactions of some Group 1 and Group 2 metals with water.

He adds a small piece of each metal to water and measures how long it takes for the reaction to finish.

He uses the same amount of metal and the same amount of water each time.

The table shows his results.

| METAL | GROUP | TIME TAKEN FOR REACTION TO FINISH IN s |
|-----------|-------|--|
| lithium | 1 | 35 |
| sodium | 1 | 12 |
| potassium | 1 | 5 |
| magnesium | 2 | not finished after 2 minutes |
| calcium | 2 | 40 |
| strontium | 2 | 9 |

(a) What conclusions can you make from the data about the reactivity of Group 1 and Group 2 metals with water?

[3]

(b) Which of the following statements about the reactions of the Group 1 metals with water are TRUE and which are FALSE?

Put a tick (✓) in one box in each row.

| | TRUE | FALSE |
|---|-------------|--------------|
| The reactions make hydrogen gas. | | |
| Each reaction makes a different metal oxide. | | |
| The reaction mixture gains mass during every reaction. | | |
| The pH of each solution is neutral at the end of the reaction. | | |

[2]

[TOTAL: 5]

2 Abbi does some experiments with Group 7 elements.

GROUP 7

| |
|-----------------------|
| F fluorine |
| Cl chlorine |
| Br bromine |
| I iodine |

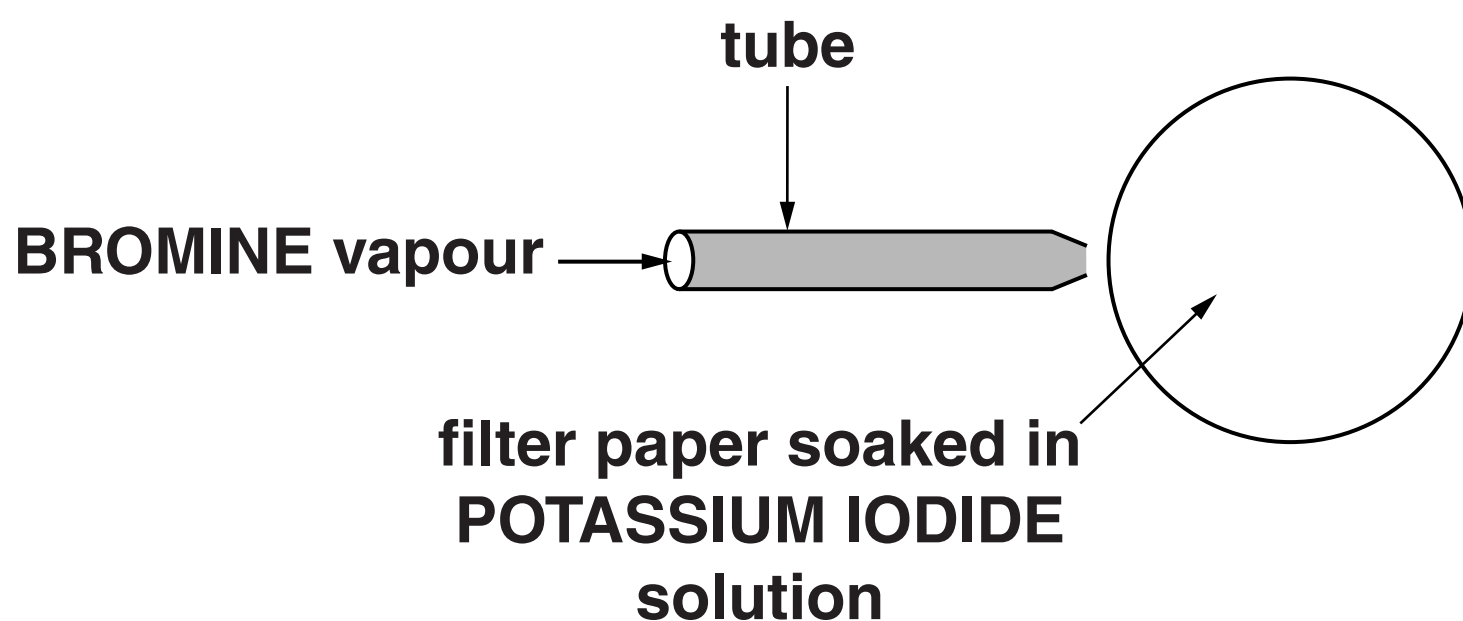
(a) Abbi does an experiment using chlorine.

She uses a fume cupboard.

Explain why chlorine is hazardous.

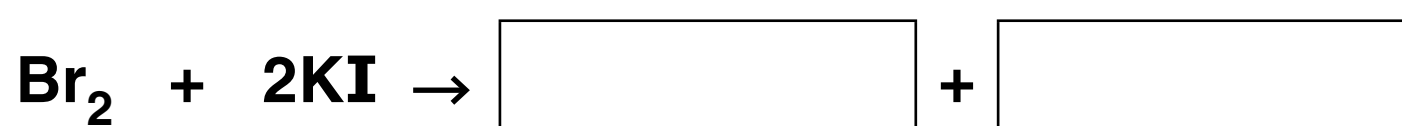
[2]

- (b) Abbi passes bromine vapour over a filter paper soaked in potassium iodide solution. Bromine vapour is blown onto the filter paper down a tube.



A grey solid appears on the filter paper because IODINE is made.

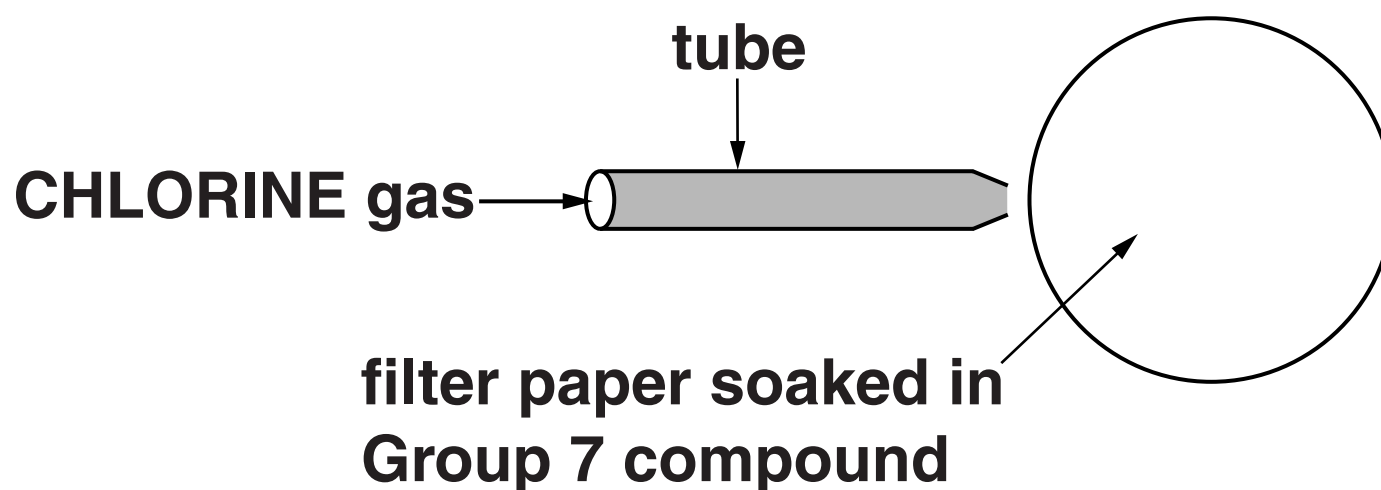
Complete the symbol equation for this reaction.



[2]

(c) Abbi repeats the experiment using chlorine gas.

She passes chlorine gas down a tube onto filter papers soaked in some other Group 7 compounds.



The table shows which compounds she uses.

| GAS | GROUP 7 COMPOUND ON FILTER PAPER |
|------------|---|
| chlorine | potassium fluoride |
| chlorine | potassium chloride |
| chlorine | potassium bromide |
| chlorine | potassium iodide |

Before the experiment the solutions of the compounds are all colourless.

State and explain what Abbi will SEE when chlorine gas passes over each Group 7 compound.



The quality of written communication will be assessed in your answer.

[6]

[TOTAL: 10]

3 Mendeleev developed the modern Periodic Table. Other scientists were involved.

MENDELEEV says ‘I have developed a new way of arranging the elements in a table.’

SCIENTIST 2 says ‘There are gaps in the table and problems with the order of some elements. This does not work for all elements.’

SCIENTIST 3 says ‘I have discovered a new element. Its properties mean that it could go in one of the gaps in Mendeleev’s table.’

SCIENTIST 4 says ‘I have discovered a different new element. The properties mean that it could go in a different gap.’

SCIENTIST 5 says ‘I am going to do the same experiments as Scientist 3 and Scientist 4, and look at the results.’

(a) Which TWO scientists are doing a peer review?

Explain how what they say is peer review.

[3]

(b) Mendeleev's ideas were supported by the discoveries of SCIENTIST 3 and SCIENTIST 4.

Explain why.

[2]

[TOTAL: 5]

4 Lee looks up some data about gases in the air.

| Gas in the air | Formula | Relative formula mass | Boiling point in °C | Percentage in air |
|-----------------------|-----------------------|------------------------------|----------------------------|--------------------------|
| nitrogen | N₂ | 28 | −196 | 78 |
| oxygen | O₂ | 32 | −183 | 21 |
| carbon dioxide | CO₂ | 44 | −57 | 0.04 |
| water vapour | H₂O | 18 | 100 | variable |

(a) All of the gases in the table are covalently bonded.

Which statements describe a covalent bond?

Put a tick (✓) in the boxes next to the TWO correct answers.

Ions attract together due to their opposite charges. ☐

The electrons between the atoms are attracted to each nucleus. ☐

Electrons are shared between atoms. ☐

The electrons of two atoms are attracted to each other. ☐

Electrons are transferred from one atom to another. ☐

[2]

(b) Lee looks at the data and writes down this idea.

I think that there is a correlation between the relative formula mass of a gas and its boiling point.

Does the data in the table support Lee’s idea?

Explain your reasoning.

[3]

(c) Alex also notices that there is a correlation between the relative masses of gases in the air and their percentages in air.

| Gas in the air | Relative mass | Percentage in air % |
|----------------|---------------|---------------------|
| nitrogen | 28 | 78 |
| oxygen | 32 | 21 |
| argon | 40 | 1 |
| carbon dioxide | 44 | 0.04 |

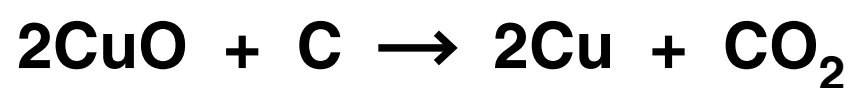
Use the data in the table to explain the difference between correlation and cause.

[2]

[TOTAL: 7]

5 Some metals can be extracted from metal oxides by heating with carbon.

(a) The equation shows what happens when copper oxide is heated with carbon.



(i) Which substance is oxidised and which substance is reduced in this reaction?

oxidised _____

reduced _____ **[1]**

(ii) Name the waste gas that is made in this reaction.

_____ **[1]**

(b) Large-scale metal extraction processes involve both costs and benefits.

(i) Companies choose metal extraction processes that use as little energy as possible.

Suggest why using less energy reduces both the COST TO THE COMPANY and the COST TO THE ENVIRONMENT.

[3]

(ii) Give TWO examples of the ways that people BENEFIT from large-scale metal extraction processes.

[2]

(c) The table shows some data about the most cost-effective methods for extracting metals from metal oxides.

↑
more
reactive
metal

| Metal oxide | Minimum temperature to make metal by heating with carbon in °C | Most cost-effective method of extraction |
|-----------------|--|--|
| calcium oxide | 2100 | electrolysis |
| magnesium oxide | 1600 | electrolysis |
| aluminium oxide | 2100 | electrolysis |
| zinc oxide | 900 | heating with carbon |
| iron oxide | 700 | heating with carbon |
| lead oxide | 400 | heating with carbon |
| copper oxide | 100 | heating with carbon |

Use the data to explain how the method chosen to extract a metal is related to its reactivity and the energy involved.



The quality of written communication will be assessed in your answer.

[6]

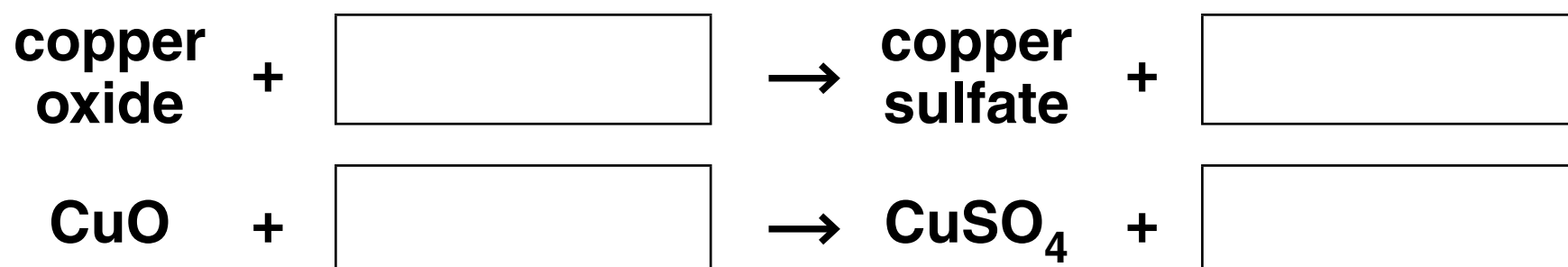
[TOTAL: 13]

- 6 Sam works for a company that makes chemicals to kill fungi on plants.

One of the chemicals the company makes is copper sulfate.

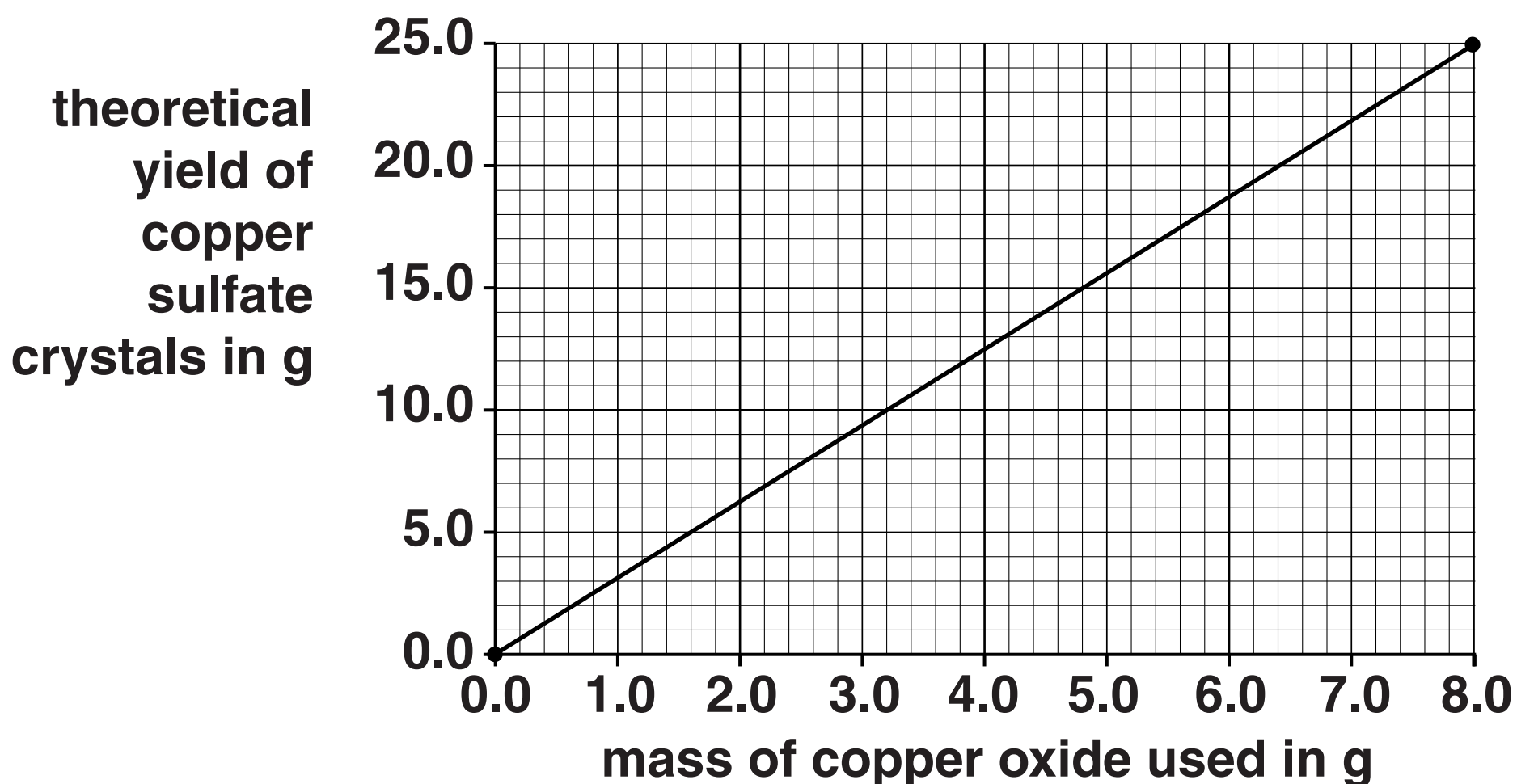
- (a) Sam makes some copper sulfate by reacting copper oxide with an acid.

Complete the WORD and SYMBOL equation for the reaction.



[2]

- (b) Sam draws a graph to show the theoretical yield of copper sulfate crystals that can be made from copper oxide.



- (i) What mass of copper oxide would Sam need to make 10 g of copper sulfate crystals?

_____ [1]

- (ii) The company makes the fungicide in large quantities.

Use your answer to (i) to work out how much copper oxide would be needed to make 5 kg of copper sulfate crystals.

_____ [2]

(iii) Complete the table to show the relative formula masses of copper oxide and copper sulfate.

| COMPOUND | FORMULA | RELATIVE FORMULA MASS |
|-----------------------|-------------------------|------------------------------|
| Copper oxide | CuO | |
| Copper sulfate | CuSO₄ | |

[2]

(iv) Copper sulfate crystals do not only contain copper sulfate.

The crystals also contain water molecules in their structure.

The values on the graph take this into account.

Compare your answers to (iii) with the graph to show that the crystals do not ONLY contain copper sulfate.

[2]

[TOTAL: 9]

7 Acid rain contains a dilute solution of sulfuric acid.

Acid rain causes some lakes to become too acidic, killing fish and other wildlife.

Water companies can treat the lakes with calcium hydroxide to neutralise acidity.

(a) Which ion causes the acidity in the lake?

Put a ring around the correct answer.

SO_4^{2-} H^+ OH^- O^{2-} SO_3^{2-} [1]

(b) Which ion in calcium hydroxide reacts to neutralise the acidity in the lake?

Put a ring around the correct answer.

Ca^{2+} H^+ OH^- O^{2-} H^- [1]

(c) The calcium hydroxide is dropped into the lakes from helicopters.

It is in the form of a fine powder to make sure that the reaction is as fast as possible.

Use ideas about collisions to explain why fine powders react faster than larger pieces.

_____ [3]

[TOTAL: 5]

8 Joe wants to find out how effective different compounds are when they are used as catalysts.

He does some experiments to find the time taken for a reaction to finish when different catalyst compounds are used.

The table shows some information about the catalysts he used and his results.

| Experiment | Catalyst | Positive ion in catalyst | Negative ion in catalyst | Time taken for reaction to finish in s |
|-------------------|---------------------------|---------------------------------|-----------------------------------|---|
| 1 | none | none | none | 45 |
| 2 | sodium chloride | Na⁺ | Cl⁻ | 45 |
| 3 | iron chloride | Fe²⁺ | Cl⁻ | 22 |
| 4 | potassium chloride | K⁺ | Cl⁻ | 45 |
| 5 | magnesium chloride | Mg²⁺ | Cl⁻ | 46 |
| 6 | sodium nitrate | Na⁺ | NO₃⁻ | 45 |
| 7 | iron nitrate | Fe²⁺ | NO₃⁻ | 22 |
| 8 | potassium nitrate | K⁺ | NO₃⁻ | 45 |
| 9 | magnesium nitrate | Mg²⁺ | NO₃⁻ | 46 |

Joe talks about his results with Eve and Jay.

Joe says ‘I think that Group 1 and Group 2 elements do not work as catalysts.’

Eve says ‘I think the effectiveness of the catalyst depends on which positive ion it contains.’

Jay says ‘I think the effectiveness of the catalyst depends on which negative ion it contains.’

Discuss whether or not the results in the table support the ideas of Joe, Eve and Jay.



The quality of written communication will be assessed in your answer.

[6]

[TOTAL: 6]

END OF QUESTION PAPER

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