

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS  
GCSE**

**A172/01**

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

**Modules C4 C5 C6 (Foundation Tier)**

**TUESDAY 9 JUNE 2015: Afternoon**

**DURATION: 1 hour**

**plus your additional time allowance**

**MODIFIED ENLARGED 24pt**

<b>Candidate forename</b>		<b>Candidate surname</b>	
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<b>Centre number</b>						<b>Candidate number</b>				
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**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 4–6.**

# TWENTY FIRST CENTURY SCIENCE DATA SHEET

## Qualitative analysis

### Tests for ions with a positive charge

ION	TEST	OBSERVATION
<b>calcium <math>\text{Ca}^{2+}</math></b>	<b>add dilute sodium hydroxide</b>	<b>a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide</b>
<b>copper <math>\text{Cu}^{2+}</math></b>	<b>add dilute sodium hydroxide</b>	<b>a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide</b>

<b>iron(II) <math>\text{Fe}^{2+}</math></b>	<b>add dilute sodium hydroxide</b>	<b>a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide</b>
<b>iron(III) <math>\text{Fe}^{3+}</math></b>	<b>add dilute sodium hydroxide</b>	<b>a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide</b>
<b>zinc <math>\text{Zn}^{2+}</math></b>	<b>add dilute sodium hydroxide</b>	<b>a white precipitate forms; the precipitate dissolves in excess sodium hydroxide</b>

## Tests for ions with a negative charge

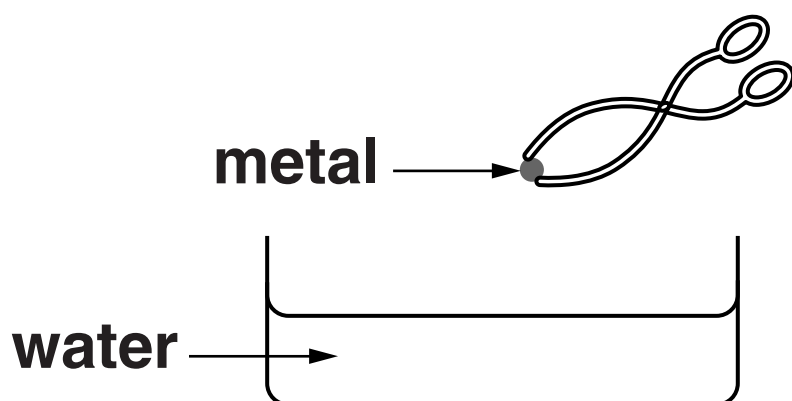
ION	TEST	OBSERVATION
carbonate $\text{CO}_3^{2-}$	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)
chloride $\text{Cl}^-$	add dilute nitric acid, then add silver nitrate	a white precipitate forms
bromide $\text{Br}^-$	add dilute nitric acid, then add silver nitrate	a cream precipitate forms
iodide $\text{I}^-$	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms
sulfate $\text{SO}_4^{2-}$	add dilute acid, then add barium chloride or barium nitrate	a white precipitate forms

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**Answer ALL the questions.**

- 1 Jack investigates the reactions of some Group 1 metals with water.**

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



**Jack does experiments using lithium, sodium and potassium.**

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



**The table shows his results.**

<b>METAL</b>	<b>TIME TAKEN FOR THE REACTION TO FINISH IN s</b>
<b>lithium</b>	<b>35</b>
<b>sodium</b>	<b>12</b>
<b>potassium</b>	<b>5</b>

**(a) What does the table show about the reactivity of the Group 1 metals?**

**Explain your answer.**

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**[2]**

**(b) Jack adds a small piece of potassium to water in a beaker. He adds some Universal Indicator to the water. He uses a thermometer to measure the temperature change during the reaction. He writes down his observations.**

**Draw straight lines to connect each  
OBSERVATION on the left with the  
correct REASON on the right.**

**OBSERVATION**

**Universal  
Indicator turns  
blue.**

**A flame appears  
around the  
potassium.**

**The temperature  
of the water  
increases.**

**Potassium stays  
on the surface of  
the water.**

**REASON**

**A flammable  
gas is made.**

**The reaction is  
exothermic.**

**Potassium  
has a very low  
density.**

**An alkali is  
made.**

**[2]**

**(c) Potassium is stored in oil.**

**Jack leaves a piece of potassium out of the oil for a few minutes. He notices that the shiny surface of the potassium becomes dull very quickly.**

**What is the potassium reacting with?**

**Put a ring around the correct answer.**

**hydrogen**

**oxygen**

**nitrogen**

**chlorine**

**[1]**

**[TOTAL: 5]**

- 2 **Abbi does some experiments to investigate the reactivity of Group 7 elements.**

**GROUP 7**

<b>F</b> <b>fluorine</b>
<b>Cl</b> <b>chlorine</b>
<b>Br</b> <b>bromine</b>
<b>I</b> <b>iodine</b>

- (a) **For safety, Abbi does all of the experiments in a fume cupboard. Why is this necessary?**

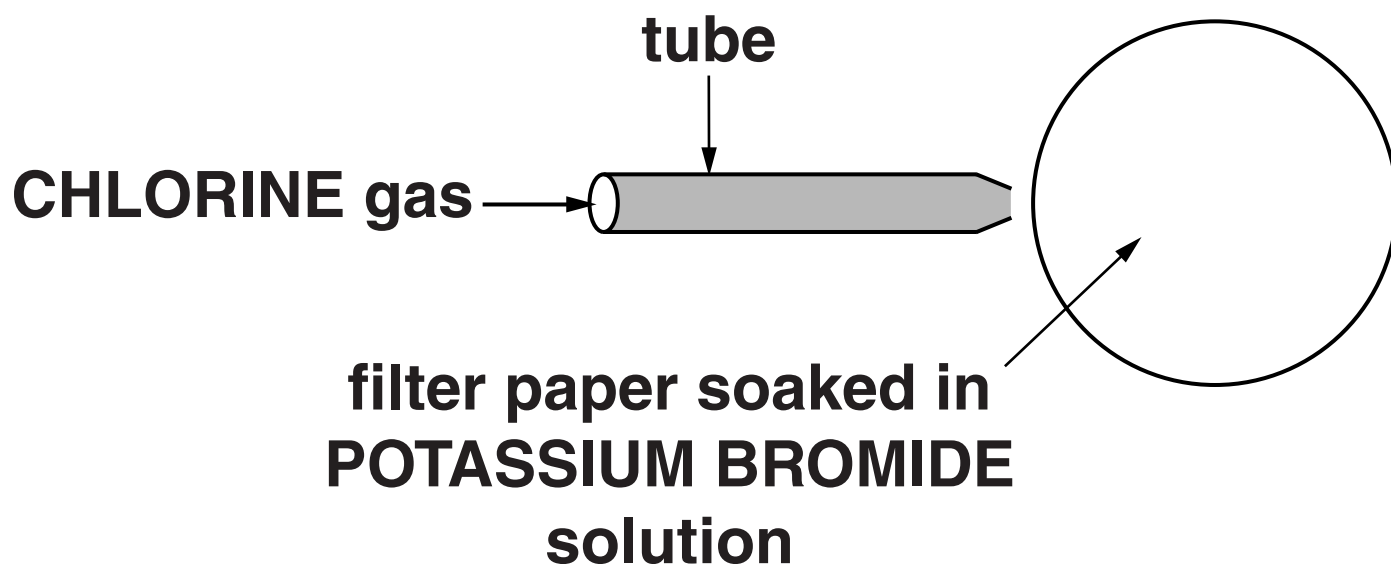
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**[1]**

**(b) Abbi passes chlorine gas over a filter paper soaked in potassium bromide solution. Chlorine gas is blown onto the filter paper down a tube.**



**The filter paper goes orange because bromine is made.**

**(i) Complete the word equation opposite for this reaction. [1]**

chlorine + potassium bromide → bromine +

potassium

\_\_\_\_\_

**(ii) What is the name for this type of reaction?**

**Put a ring around the correct answer.**

**combustion**

**displacement**

**electrolysis**

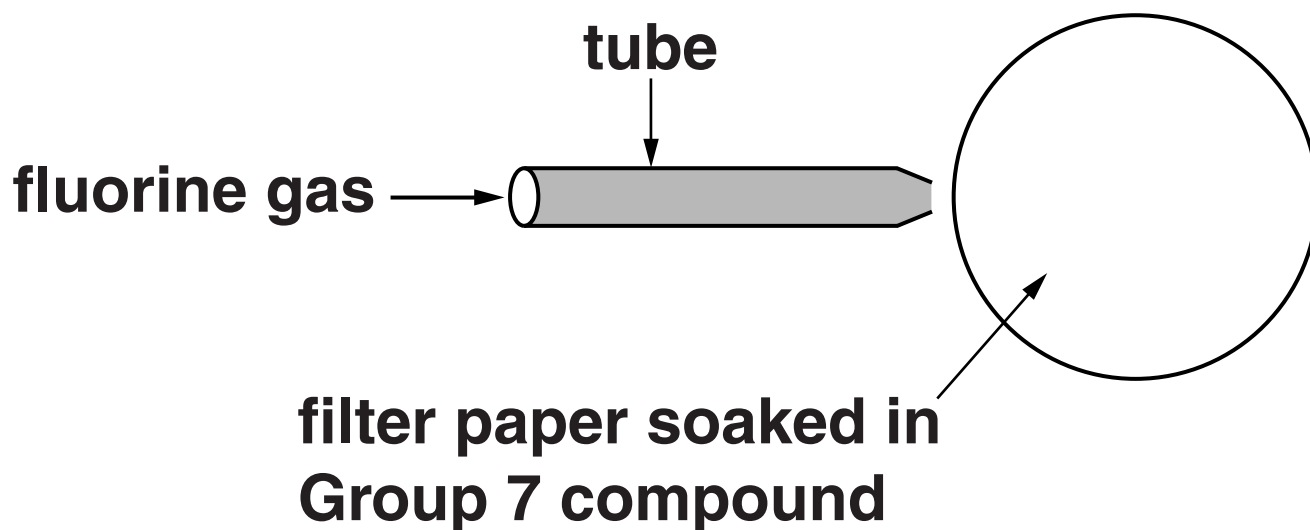
**neutralisation**

**[1]**



**(c) Abbi does some experiments using fluorine.**

**She passes fluorine gas down a tube onto the filter papers.**



**The table shows her results.**

<b>GAS</b>	<b>COMPOUND ON FILTER PAPER</b>	<b>COLOUR CHANGE</b>
<b>fluorine</b>	<b>potassium chloride</b>	<b>paper goes pale green</b>
<b>fluorine</b>	<b>potassium bromide</b>	<b>paper goes orange</b>
<b>fluorine</b>	<b>potassium iodide</b>	<b>grey solid appears on paper</b>

**Explain why these colour changes happen.**



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

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**[6]**

**[TOTAL: 9]**

**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.**

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**[3]**

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

**Explain why.**

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**[2]**

**[TOTAL: 5]**

**4 Liz collects some samples of rock.**

**She thinks that the samples contain limestone.**

**(a) Limestone rock is mainly calcium carbonate.**

**Liz tests the rock. She adds dilute acid and tests the gas given off using limewater.**

**What results does Liz expect if the rock contains CARBONATE ions?  
(See data sheet, pages 4–6)**

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

**A blue precipitate is made.**

☐

**The rock turns yellow.**

☐

**The acid turns red.**

☐

**The limewater turns milky.**

☐

**Carbon dioxide is produced.**

☐

**[1]**

**(b) Limestone is a solid mineral.**

**In which part of the Earth are solid minerals found?**

**Put a ring around the correct answer.**

**atmosphere**

**hydrosphere**

**lithosphere**

**[1]**

**(c) On Earth, limestone only forms in large amounts of water.**

**Scientists have sent space probes to Mars.**

**The space probes test rock on Mars to see if it contains limestone.**

**So far no limestone has been found.**

**Explain why the scientists are interested in collecting data about limestone on Mars.**

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[2]

**[TOTAL: 4]**



**5 Lee looks up some data about some molecular substances.**

<b>Substance</b>	<b>Formula</b>	<b>Relative formula mass</b>	<b>State at room temperature</b>
<b>nitrogen</b>	<b>N<sub>2</sub></b>	<b>28</b>	
<b>oxygen</b>		<b>32</b>	<b>gas</b>
<b>carbon dioxide</b>	<b>CO<sub>2</sub></b>	<b>44</b>	<b>gas</b>
<b>water</b>	<b>H<sub>2</sub>O</b>	<b>18</b>	<b>liquid</b>

**(a) Complete the table by filling in the blank spaces. [2]**

**(b) All of the substances in the table are MOLECULAR.**

**What does molecular mean?**

**Put a tick (✓) in the box next to the correct answer.**

**many ions bonded together**

☐

**a large structure of identical atoms**

☐

**a small number of atoms bonded together**

☐

**a structure of protons and electrons**

☐

**[1]**

**(c) Lee looks at the data and has this idea.**

**I think that if a molecular substance has a relative formula mass of less than 100 it is always a gas.**

**Does the data in the table support Lee's idea?**

**Explain your reasoning.**

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**[3]**

**[TOTAL: 6]**

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**6 Metals can be extracted from metal oxides by heating with carbon.**

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



**Why is this a reduction reaction?**

**Put a tick (✓) in the box next to the correct answer.**

**Too much carbon dioxide is made.**

☐

**The copper oxide loses oxygen.**

☐

**The mass gets higher.**

☐

**The process is not very efficient.**

☐

**[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.**

**Why does using less energy reduce the COST TO THE COMPANY and the COST TO THE ENVIRONMENT?**

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

**Using less energy uses less fuel.**

☐

**Some fuels are less flammable than others.**

☐

**All fuels burn to give off energy.**

☐

**Using more fuel gives off more pollutant gases.**

☐

**Different types of fuel can be used for the process.**

☐

**[2]**

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

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**[2]**

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

↑  
32  
more  
reactive  
metal

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



**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.**

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**[6]**

**[TOTAL: 11]**

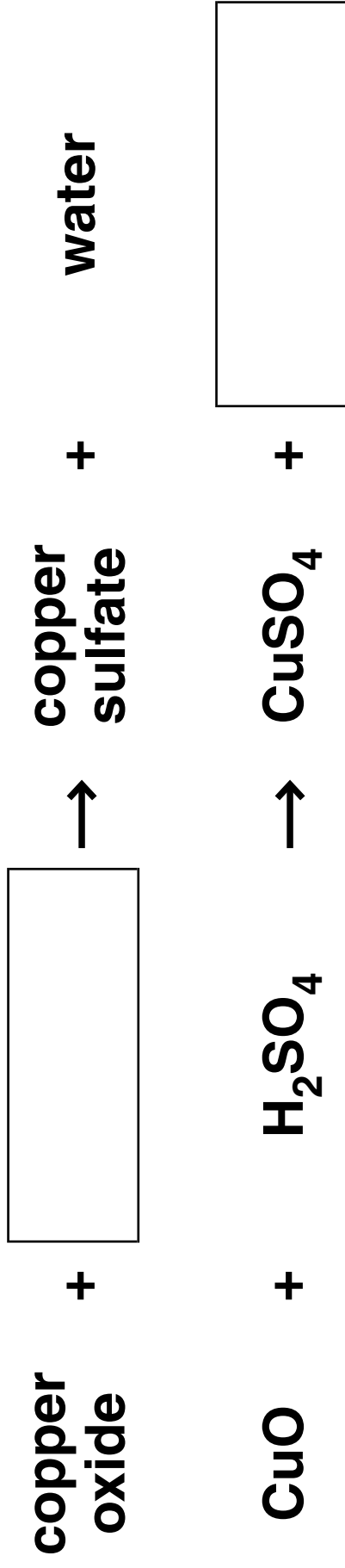
**7 Sam works for a company that makes chemicals to kill fungi on plants.**

**One of the chemicals the company makes is copper sulfate.**

**(a) Sam makes some copper sulfate from copper oxide.**

**Complete the WORD and SYMBOL equation opposite for the reaction.**

**[2]**



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

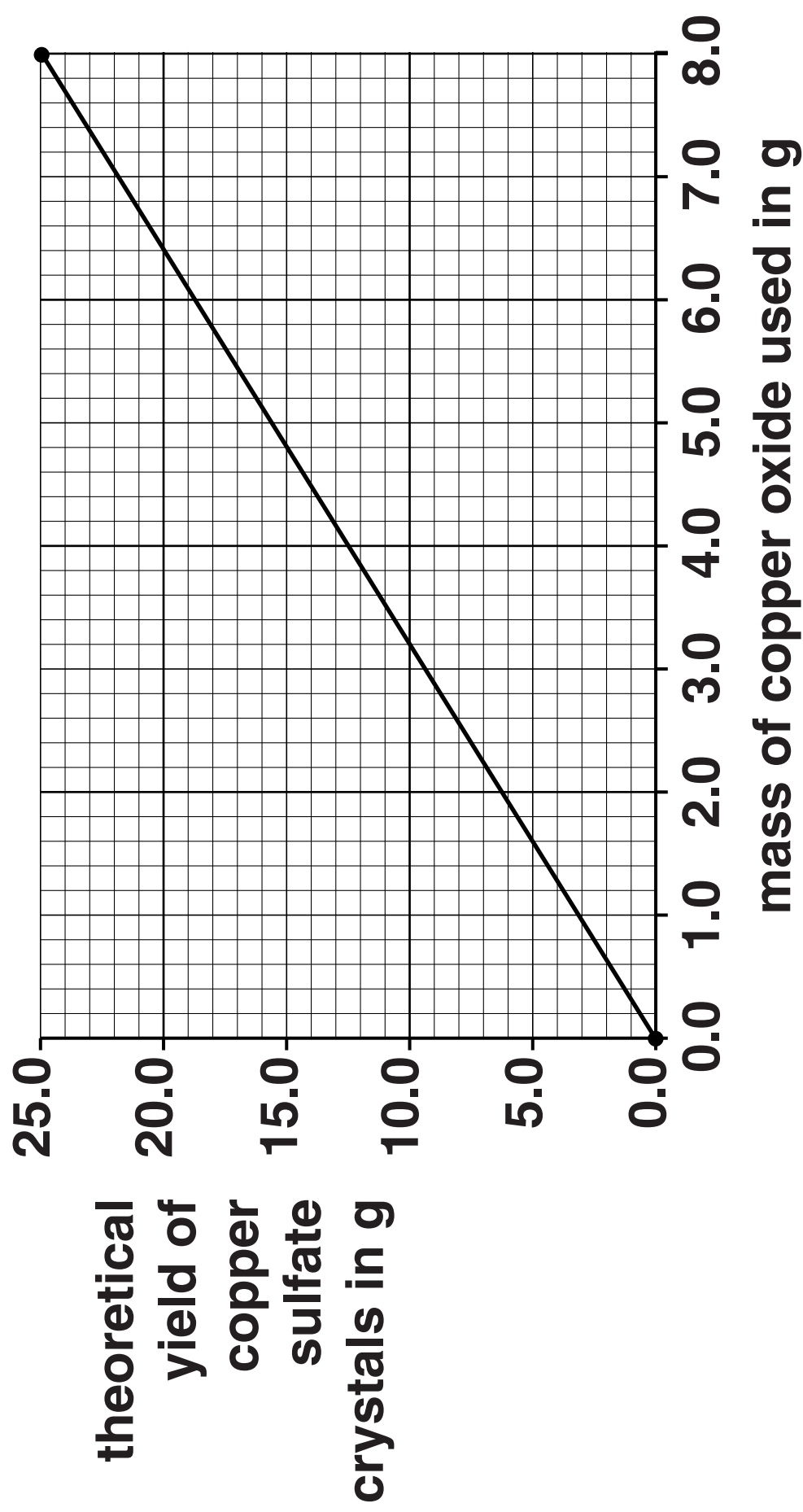
**(i) What mass of copper oxide would Sam need to make 10 g of copper sulfate crystals?**

\_\_\_\_\_ **[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) In practice, Sam finds that he makes a lower mass of copper sulfate crystals than he predicts.**

**Which statements can explain why this happens?**

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

**There are impurities in the copper oxide.** ☐

**Sam adds too much acid.** ☐

**Sam has not dried his crystals thoroughly.** ☐

**Some chemicals are lost during the experiment.** ☐

**The rate of the reaction was too fast.** ☐

**[2]**

**[TOTAL: 7]**

**8 Acid rain contains a dilute solution of sulfuric acid.**

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

**(a) What can be used to measure acidity?**

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

**a gas syringe**

☐

**Universal Indicator**

☐

**a measuring cylinder**

☐

**a pH meter**

☐

**[1]**

**(b) A water company treats a lake with calcium hydroxide to neutralise acidity.**

**What is the pH when the water is neutral?**

**Put a ring around the correct answer.**

**1**

**4**

**7**

**9**

**14**

**[1]**



**(c) The water company measures the temperature of the surface of the lake after neutralisation.**

**They find that the temperature has increased.**

**Why do some reactions cause an increase in temperature?**

**Put a tick (✓) in the box next to the correct answer.**

**Some reactions give out energy.**

☐

**Some reactions are endothermic.**

☐

**Reactions need energy to start.**

☐

**Reactions are faster at higher temperatures.**

☐

**[1]**

**(d) The calcium hydroxide is dropped into the lake from a helicopter.**

**The calcium hydroxide is a fine powder and not large pieces.**

**What effect does using a fine powder rather than large pieces have on the rate of the reaction?**

**Explain your answer.**

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**[2]**

**[TOTAL: 5]**

**9 Joe does some experiments to investigate the rate of a reaction.**

**(a) He measures the time taken for the reaction to finish at different temperatures.**

<b>Temperature in °C</b>	<b>Time taken for reaction to finish in s</b>
<b>20</b>	<b>45</b>
<b>30</b>	<b>25</b>
<b>40</b>	<b>15</b>
<b>50</b>	<b>8</b>

**Explain what the results show about the rate of reaction.**

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**[2]**

**(b) Joe investigates the effect of some catalysts on the reaction.  
He writes down which metal ion is in each catalyst.**

**He measures the time taken for the reaction to finish when each catalyst is used.**

**The results are shown opposite.**

**Joe talks about his results with Eve.**

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

**Eve says ‘I think the higher the charge on the metal ion, the better the catalyst works.’**

<b>Experiment</b>		<b>Metal ion in catalyst</b>	<b>Formula</b>	<b>Time taken for reaction to finish in s</b>
<b>Group 1 elements</b>	<b>1</b>	<b>no catalyst</b>		<b>45</b>
	<b>2</b>	<b>sodium</b>	<b>Na<sup>+</sup></b>	<b>45</b>
	<b>3</b>	<b>potassium</b>	<b>K<sup>+</sup></b>	<b>45</b>
	<b>4</b>	<b>cobalt</b>	<b>Co<sup>2+</sup></b>	<b>15</b>
	<b>5</b>	<b>iron</b>	<b>Fe<sup>3+</sup></b>	<b>22</b>
<b>Other elements</b>				

**Do the results in the table support the ideas of Joe and Eve? Explain your answer.**



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

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**[6]**

**[TOTAL: 8]**

**END OF QUESTION PAPER**

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