

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS  
GCSE**

**A172/02**

**TWENTY FIRST CENTURY SCIENCE  
CHEMISTRY A/ADDITIONAL SCIENCE A  
Modules C4 C5 C6 (Higher Tier)**

**TUESDAY 10 JUNE 2014: Afternoon**

**DURATION: 1 hour  
plus your additional time allowance**

**MODIFIED ENLARGED**

<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:**

**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 and 5.**

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# TWENTY FIRST CENTURY SCIENCE DATA SHEET

## Qualitative analysis

### Tests for ions with a positive charge

<b>Ion</b>	<b>Test</b>	<b>Observation</b>
<b>calcium Ca<sup>2+</sup></b>	<b>add dilute sodium hydroxide</b>	<b>a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide</b>
<b>copper Cu<sup>2+</sup></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) Fe<sup>2+</sup></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) Fe<sup>3+</sup></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 Zn<sup>2+</sup></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

**Answer ALL the questions.**

- 1 Johann Döbereiner was one of the first chemists to organise elements by their properties.**

**He found out that some sets of three elements seem to fit together because they have similar properties.**

**He called these sets of elements ‘triads’.**

- (a) One triad contained the three elements, lithium, sodium and potassium.**

**All three elements react with water to give similar products.**

**Give TWO ways that the products of the reaction of the three elements with water are similar.**

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**[2]**

(b) The table shows some elements that could be considered to be triads.

<b>Triad A</b>	<b>lithium</b>	<b>sodium</b>	<b>potassium</b>
<b>Triad B</b>	<b>calcium</b>	<b>strontium</b>	<b>barium</b>
<b>Triad C</b>	<b>chlorine</b>	<b>bromine</b>	<b>iodine</b>
<b>Triad D</b>	<b>carbon</b>	<b>nitrogen</b>	<b>oxygen</b>

Most of these triads now fit into groups in the modern Periodic Table.

Which triad does not?

Explain your answer.

triad \_\_\_\_\_

explanation \_\_\_\_\_

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[2]

(c) Döbereiner looked at the relative atomic masses of the elements in some triads.

He noticed that the relative atomic mass of the 'middle' element was close to the mean relative atomic mass of the other two.

The table shows some examples of elements that appear to fit his pattern.

	Element and relative atomic mass			Mean relative atomic mass of first and third element
Triad A	lithium 7	sodium 23	potassium 39	23
Triad B	calcium 40	strontium 88	barium 137	89
Triad C	chlorine 35.5	bromine 80	iodine 127	81

(i) Döbereiner asked other scientists to evaluate his data and ideas.

What TWO things would Döbereiner expect the other scientists to do?

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[2]



- (ii) Döbereiner found that some elements with similar properties did NOT fit the atomic mass pattern.

Three of these elements are copper, silver and gold.

Element and relative atomic mass		
copper 63.5	silver 108	gold 197

How does this data show that copper, silver and gold do NOT fit Döbereiner's atomic mass pattern?

Use a calculation to support your answer.

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[2]

[TOTAL: 8]

**2 Chlorine reacts with metals in many groups of the Periodic Table to make metal chlorides.**

**(a) TABLE 1 shows some information about metals and metal chlorides.**

**TABLE 1**

<b>Metal</b>	<b>Number of electrons in outer shell of atom</b>	<b>Formula of metal ion</b>	<b>Formula of metal chloride</b>
<b>lithium</b>	<b>1</b>	<b>Li<sup>+</sup></b>	<b>LiCl</b>
<b>sodium</b>	<b>1</b>	<b>Na<sup>+</sup></b>	<b>NaCl</b>
<b>beryllium</b>	<b>2</b>	<b>Be<sup>2+</sup></b>	<b>BeCl<sub>2</sub></b>
<b>magnesium</b>	<b>2</b>	<b>Mg<sup>2+</sup></b>	<b>MgCl<sub>2</sub></b>
<b>aluminium</b>	<b>3</b>	<b>Al<sup>3+</sup></b>	<b>AlCl<sub>3</sub></b>

**There are links between the information in the columns in the table.**

**Describe TWO of these links.**

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**[2]**

(b) TABLE 2 shows information about other metals and metal chlorides.

Complete the table by filling in the boxes.

TABLE 2

Metal	Number of electrons in outer shell of atom	Formula of metal chloride
potassium	1	
calcium	2	$\text{CaCl}_2$
gallium	3	

[2]

(c) Iron reacts with chlorine to form iron chloride,  $\text{FeCl}_3$ .

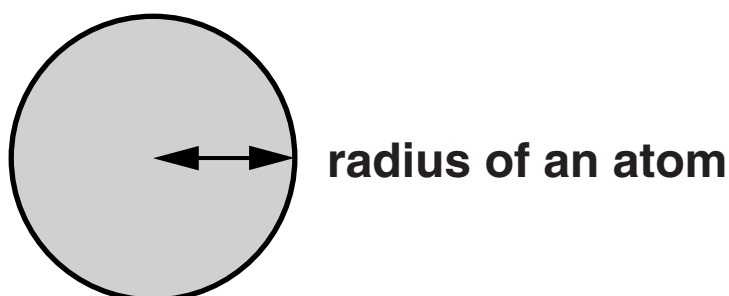
What are the symbols for the two ions in this compound?

\_\_\_\_\_ and \_\_\_\_\_ [2]

[TOTAL: 6]

**3 Joe does some research about atoms of Group 1 elements.**

**He finds data about the radius of each atom.**



**He also finds data about the energy needed to remove one electron from the outer shell (energy level) of each atom.**

<b>Element name</b>	<b>Total number of electrons in each atom</b>	<b>Radius of the atom in pm</b>	<b>Energy needed to remove one outer shell electron in arbitrary units</b>
<b>lithium</b>	<b>3</b>	<b>152</b>	<b>520</b>
<b>sodium</b>	<b>11</b>	<b>186</b>	<b>490</b>
<b>potassium</b>	<b>19</b>	<b>231</b>	<b>420</b>

**Joe works out the number of electron shells in each atom and puts forward a hypothesis.**

**Joe says, 'I can see trends in both the radius of each atom and in the energy needed to remove an electron from its outer shell.'**

**I think both trends are linked to the number of electron shells in each atom.'**

**What trends does the table show? How does the number of ELECTRON SHELLS in each atom link to these trends?**

**You may use diagrams to show the electron shells in each atom to support your answer.**



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

**[6]**

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**[TOTAL: 6]**

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**QUESTION 4 BEGINS ON PAGE 16**

**4 This question is about extracting metals.**

- (a) Aluminium is extracted from aluminium oxide by electrolysis.**

**The melting point of PURE aluminium oxide is about 2000 °C.**

**In the industrial process, aluminium oxide is mixed with cryolite. The MIXTURE melts at 900 °C.**

**The process works at about 1000 °C. Molten aluminium collects at the bottom of the electrolysis tank. See the diagram opposite.**

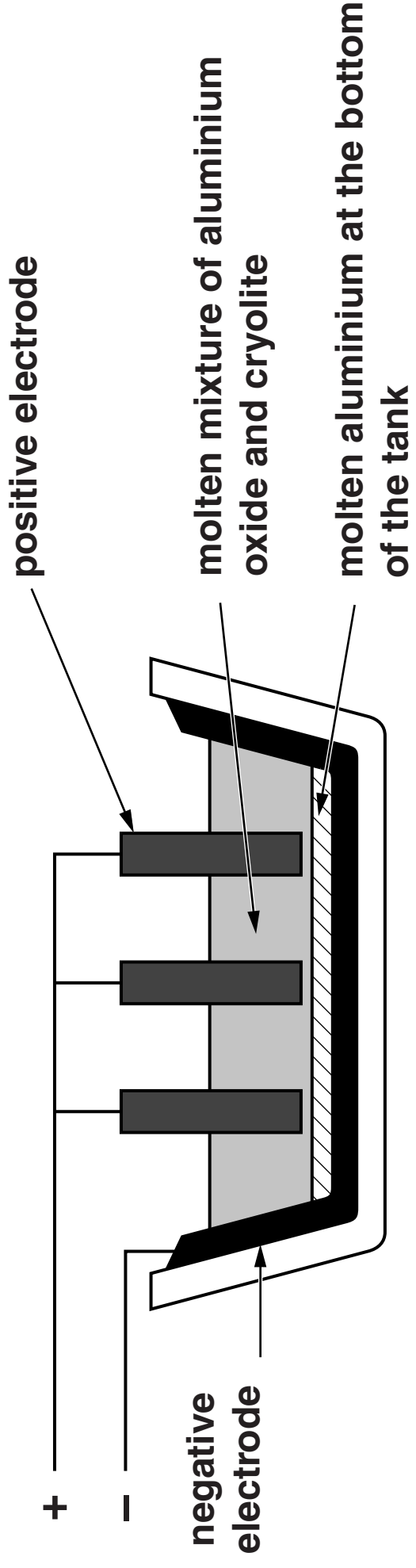
- (i) Which of the following statements about electrolysing aluminium oxide are TRUE and which are FALSE?**

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

	<b>TRUE</b>	<b>FALSE</b>
<b>Melting pure aluminium oxide uses more energy than melting a mixture of aluminium oxide and cryolite.</b>		
<b>After the mixture melts, it contains ions arranged in a regular lattice.</b>		
<b>The melting point of aluminium is above 1000 °C.</b>		
<b>A gas is made at the positive electrode.</b>		
<b>Below 900 °C the mixture does not conduct electricity.</b>		

**[2]**





- (ii) Aluminium ions ( $Al^{3+}$ ) are attracted to the negative electrode.

Explain what happens to aluminium ions at the negative electrode.

You may use an equation to support your answer.

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[2]

- (b) Copper can be extracted by heating copper oxide, CuO, with carbon.**

**The products of the reaction are carbon dioxide and copper.**

- (i) Write a balanced, symbol equation for the reaction.**

**[2]**

- (ii) The reaction between copper oxide and carbon involves REDUCTION.**

**What does reduction mean?**

\_\_\_\_\_ **[1]**

- (iii) Why is it NOT possible to extract aluminium from aluminium oxide by heating with carbon?**

\_\_\_\_\_ **[1]**

**[TOTAL: 8]**

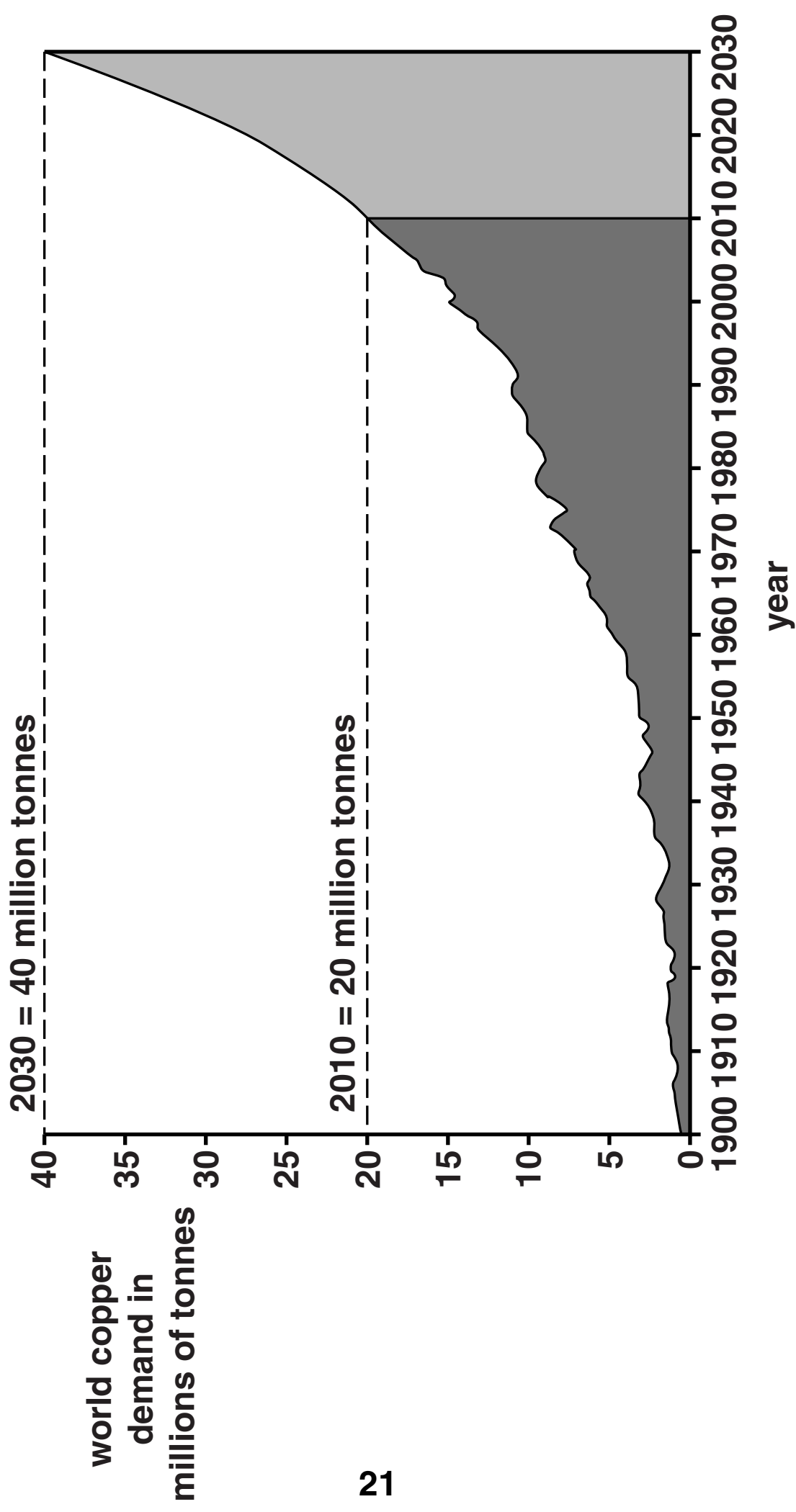
- 5 Scientists are concerned about how the demand for copper is changing and how this will affect the supply of copper for the future.**

**The graph opposite shows how the total world DEMAND for copper has changed since 1900. The graph also shows the predicted demand for copper between 2010 and 2030.**

**The SUPPLIES of copper in the world come from four main countries. The copper deposits left in these countries are shown in the table.**

<b>Country</b>	<b>Estimated copper deposits in millions of tonnes</b>
<b>Chile</b>	<b>140</b>
<b>United States</b>	<b>90</b>
<b>Canada</b>	<b>23</b>
<b>Poland</b>	<b>36</b>

**Even if all scrap copper is recycled, this meets less than 50% of the world demand for copper.**



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- (a) Scientists are very concerned about the balance between the supply and demand for copper from 2010 onwards.**

**Use the information about copper to discuss why they are so concerned.**



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

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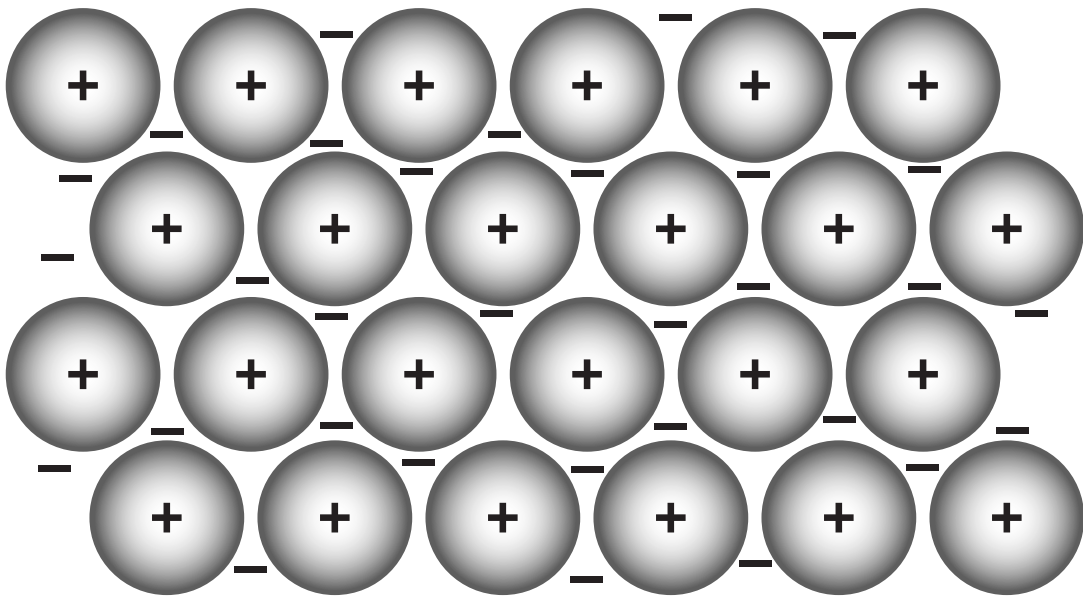
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**[6]**

(b) The diagram shows how the particles in copper metal are arranged.



Key



**Complete the key to the diagram by filling in the boxes.**

**Choose words from this list.**

**ELECTRON**

**NEGATIVE ION**

**NEUTRON**

**COPPER ATOM**

**COPPER ION**

**PROTON**

**[2]**

**(c) One reason why copper is useful is because it is malleable.**

**Which statement explains why copper is malleable?**

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

**Copper is a good electrical conductor.**

**Particles in copper can slide over each other.**

**Bonds in the metal structure are strong.**

**Metal particles are arranged in a regular crystal.**

**[1]**

**(d) People living near a copper mine are worried about the water that runs out of the mine.**

**They think that the water might contain copper ions or other metal ions.**

**A scientist tests for metal ions by adding dilute sodium hydroxide to the water.**

**Why is dilute sodium hydroxide used to test for metal ions?**

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

**Many metal hydroxides are insoluble.**

**The metals can be identified by the gases given off in the reactions.**

**Different metal ions react at different rates with sodium hydroxide.**

**Dilute sodium hydroxide is neutralised by the metal ions.**

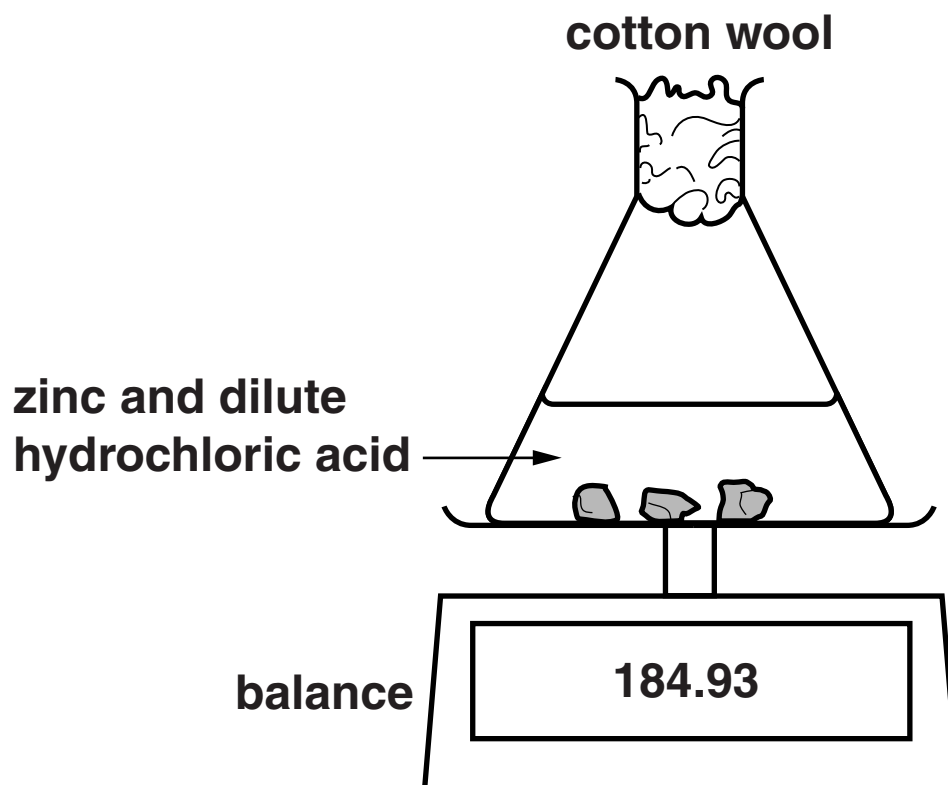
**Precipitates of metal compounds have characteristic colours.**

**[2]**

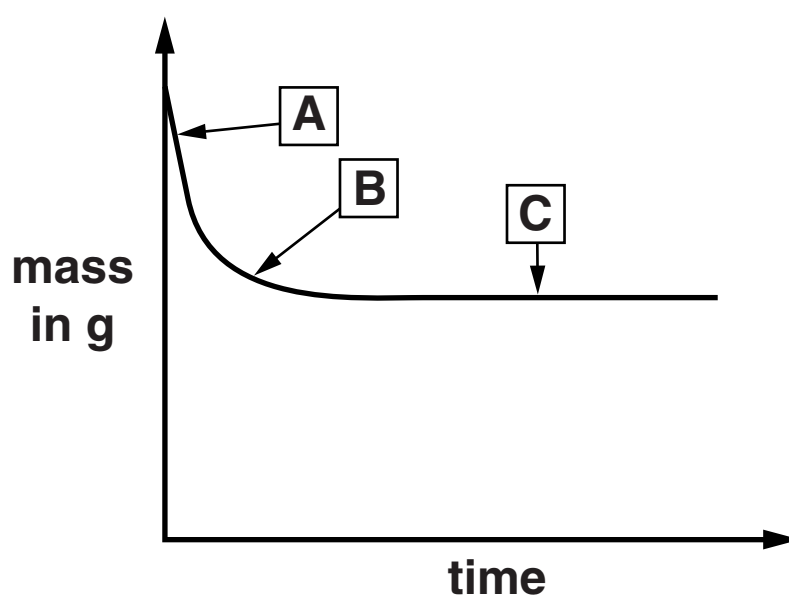
**[TOTAL: 11]**

6 Liz does an experiment to investigate the rate of reaction between zinc and dilute hydrochloric acid.

She measures the mass of the flask during the reaction.



Liz plots her results on the graph below.





**(b) What is the name of the salt that is made when zinc reacts with hydrochloric acid?**

\_\_\_\_\_ [1]

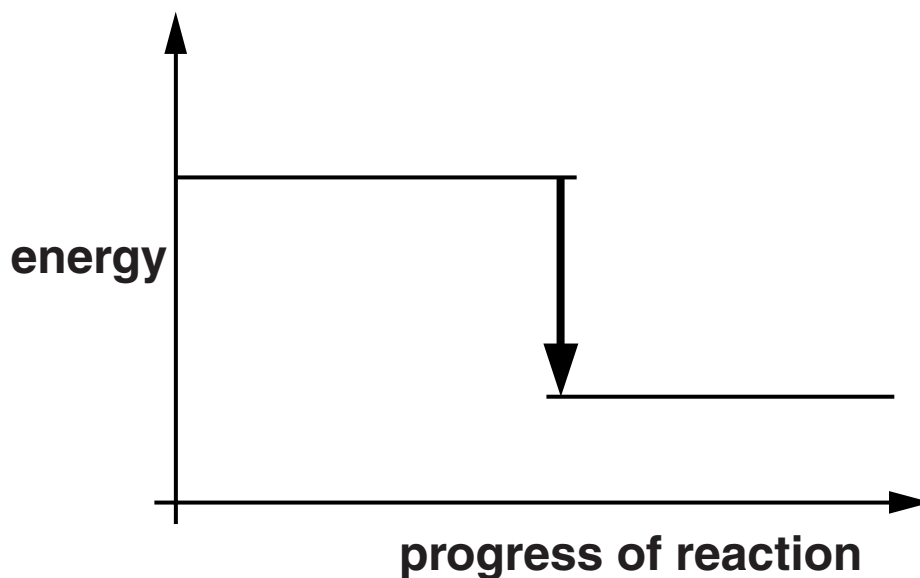
**(c) Liz reads an article on the internet which says that copper acts as a catalyst for this reaction.**

**She does an investigation to find out if this is true.**

**How should she do the investigation, and what results should she expect?**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [3]

(d) This is the energy level diagram for the reaction between zinc and hydrochloric acid.



Which statements about the diagram are TRUE and which are FALSE?

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

	TRUE	FALSE
The products are at a lower energy level than the reactants.		
The reaction is endothermic.		
The chemicals give out energy during the reaction.		
There is a temperature change during the reaction.		

[1]

[TOTAL: 11]

7 Eve has two beakers of dilute acid.

One contains dilute hydrochloric acid, one contains dilute sulfuric acid.

(a) Complete the boxes to show which ions are in each acid.

Choose from this list. You may use each symbol once, more than once or not at all.



ions in dilute  
hydrochloric acid

ions in dilute sulfuric  
acid

[2]



**(b) Eve does tests A, B, C and D on each acid.**

- A test pH using a pH meter**
- B add magnesium ribbon**
- C add a few drops of dilute silver nitrate  
(see data sheet pages 4 and 5)**
- D add a few drops of dilute barium chloride  
(see data sheet pages 4 and 5)**

**(i) Two tests give the SAME result with both hydrochloric acid and sulfuric acid.**

**Which two tests give the same result?**

**What will she SEE when she does each of these tests?**

**test** \_\_\_\_\_

**result** \_\_\_\_\_

\_\_\_\_\_

**test** \_\_\_\_\_

**result** \_\_\_\_\_

\_\_\_\_\_

**[3]**

- (ii) Two tests give a **DIFFERENT** result with hydrochloric acid and sulfuric acid.

Which two tests give a different result?

What will she **SEE** when she does each test?

test \_\_\_\_\_

result for each acid \_\_\_\_\_

\_\_\_\_\_

test \_\_\_\_\_

result for each acid \_\_\_\_\_

\_\_\_\_\_

[3]

- (c) Both dilute hydrochloric acid and dilute sulfuric acid are neutralised when they react with dilute sodium hydroxide.

Complete the table to show the name and formula of the salt that is made from each acid.

Acid	Salt formed with dilute sodium hydroxide	
	Name	Formula
dilute hydrochloric acid		
dilute sulfuric acid		

[2]

[TOTAL: 10]

**END OF QUESTION PAPER**



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