

**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 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:**

**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, 6 and 7.**

# TWENTY FIRST CENTURY SCIENCE DATA SHEET

## Qualitative analysis

### Tests for ions with a positive charge

Ion	Test	Observation
calcium $\text{Ca}^{2+}$	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
copper $\text{Cu}^{2+}$	add dilute sodium hydroxide	a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(II) $\text{Fe}^{2+}$	add dilute sodium hydroxide	a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide

<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

<p><b>sulfate</b> <b>SO<sub>4</sub><sup>2-</sup></b></p>	<p><b>add dilute acid, then add barium chloride or barium nitrate</b></p>	<p><b>a white precipitate forms</b></p>
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**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 opposite 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	
	Triad B	calcium 40	strontium 88	barium 137	
	Triad C	chlorine 35.5	bromine 80	iodine 127	

- (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.**

<b>Element and relative atomic mass</b>		
<b>copper 63.5</b>	<b>silver 108</b>	<b>gold 197</b>

**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]**

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**[TOTAL: 8]**

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

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

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

**Describe TWO of these links.**

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**[2]**

**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>

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

**Complete the table by filling in the boxes.**

**TABLE 2**

<b>Metal</b>	<b>Number of electrons in outer shell of atom</b>	<b>Formula of metal chloride</b>
<b>potassium</b>	<b>1</b>	
<b>calcium</b>	<b>2</b>	<b><math>\text{CaCl}_2</math></b>
<b>gallium</b>	<b>3</b>	

**[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. See the table opposite.**

<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.**

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**[6]**

**[TOTAL: 6]**

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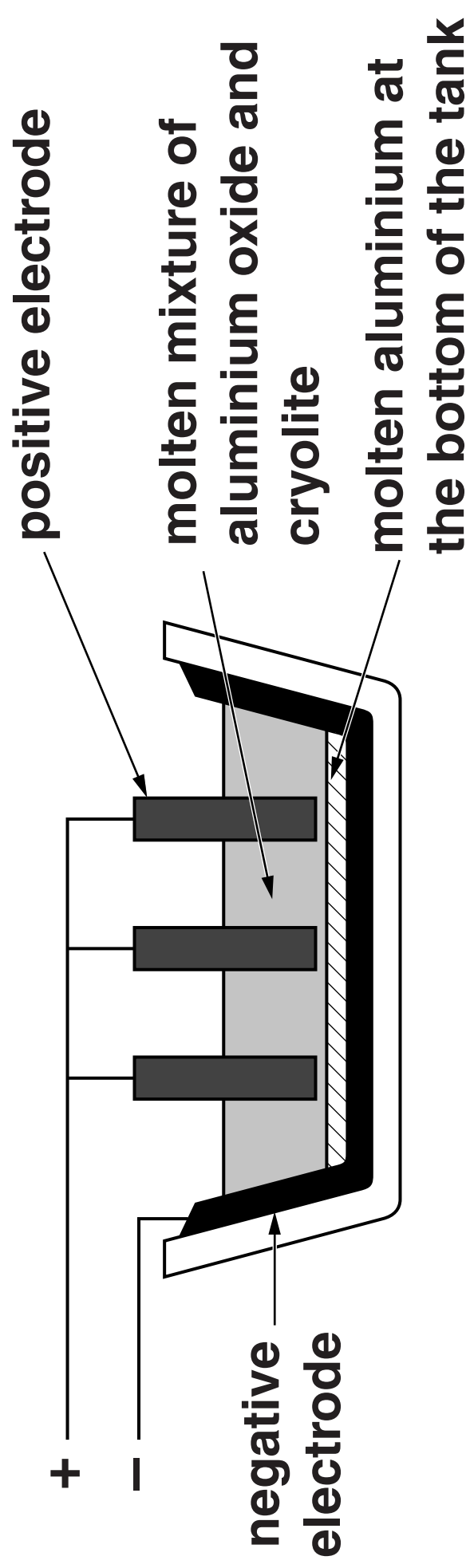
**4 This question is about extracting metals.**

**(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 electrolysis of 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 ( $\text{Al}^{3+}$ ) 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]**

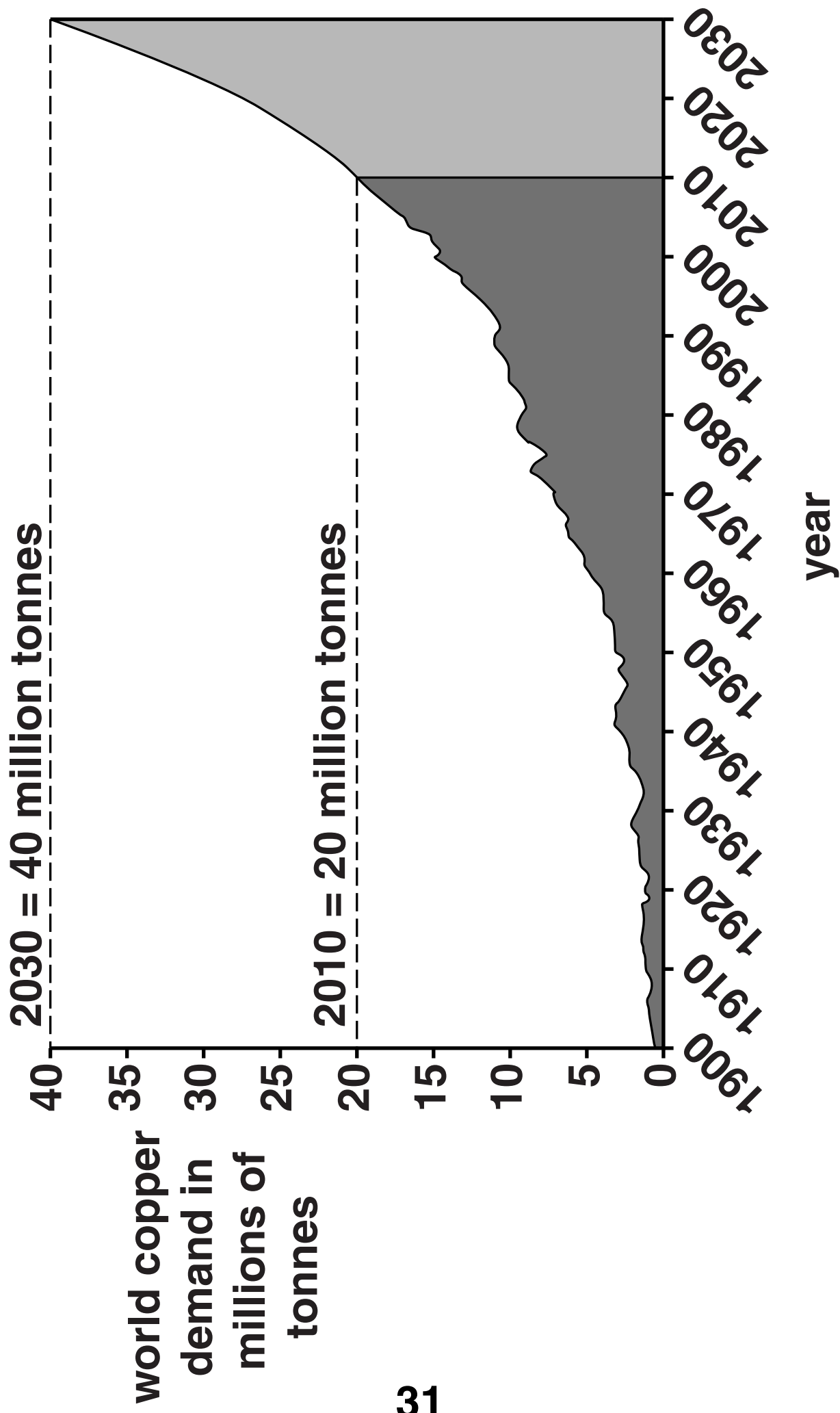
**5 Scientists are concerned about how the demand for copper is changing and how this will affect the supply of copper for the future.**

**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 below.**

<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.**



- (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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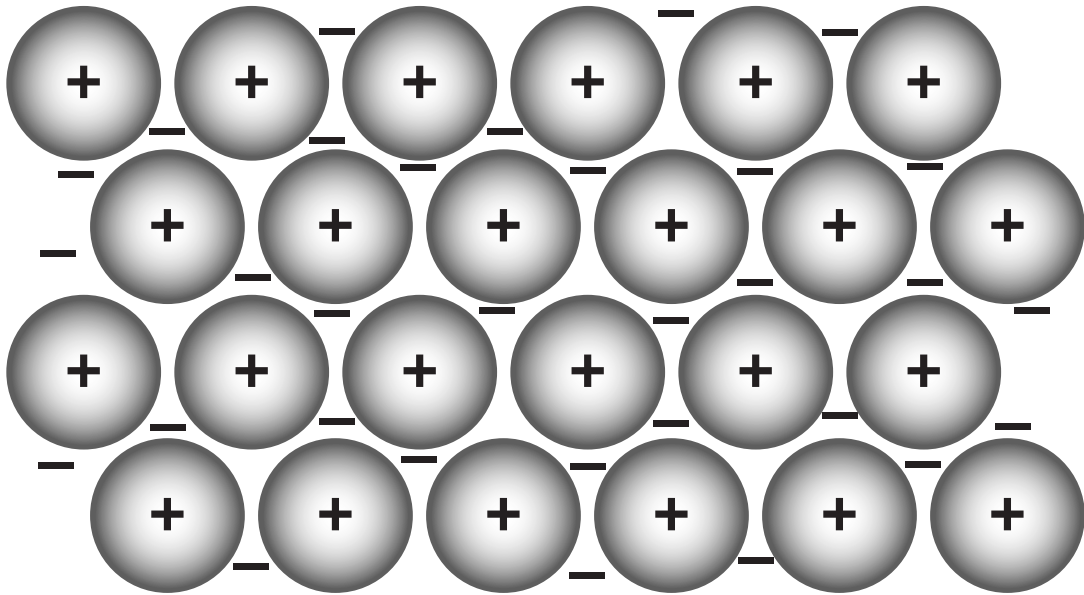
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**[6]**

**(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]**

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**QUESTION 5(d) BEGINS ON PAGE 38**

**(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.**

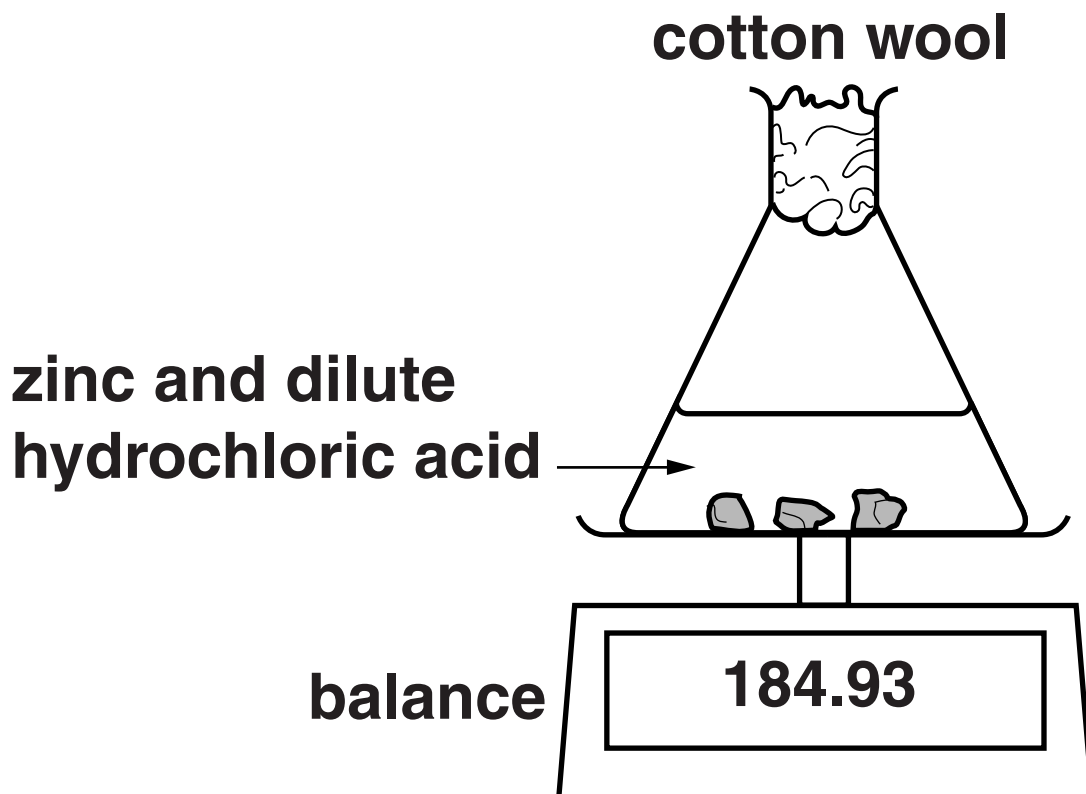
☐

**[2]**

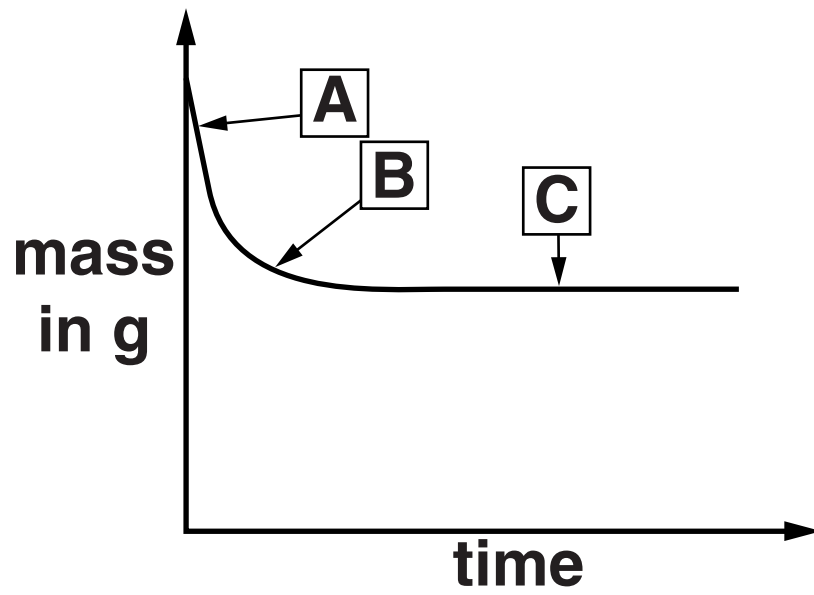
**[TOTAL: 11]**

- 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.**



**(a) Explain how and why the rate of reaction changes between points A, B and C, using ideas about the collisions between particles.**



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

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**[6]**

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

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

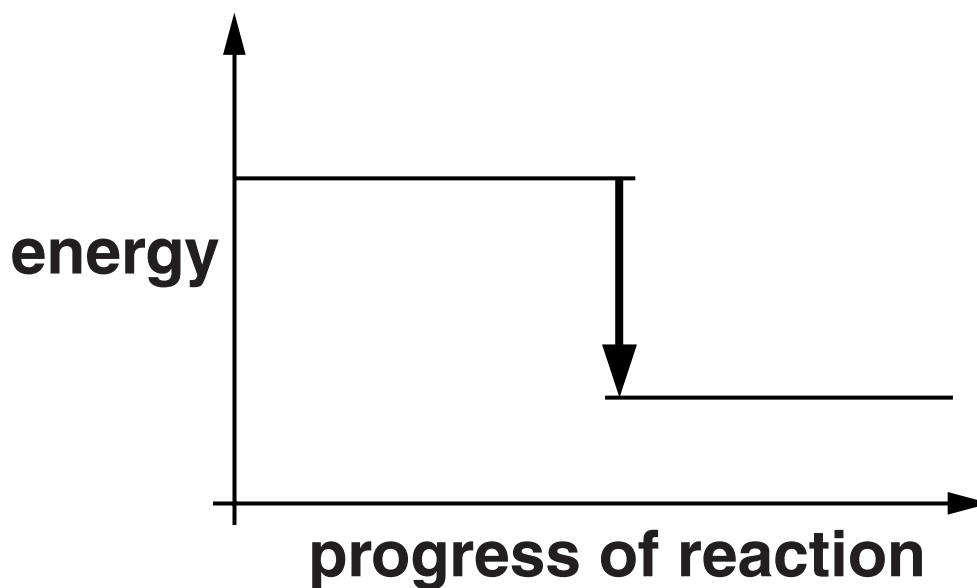
**(c) Liz reads an article on the internet which says that copper acts as a catalyst for this reaction.**

**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.**

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

**[1]**

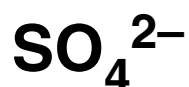
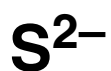
**[TOTAL: 11]**

**7 Eve has two beakers of dilute acid.**

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

**(a) Complete the boxes below 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**

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**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, 5, 6 and 7)**

**D add a few drops of dilute barium chloride (see data sheet pages 4, 5, 6 and 7)**

- (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.**

<b>Acid</b>	<b>Salt formed with dilute sodium hydroxide</b>	
	<b>Name</b>	<b>Formula</b>
<b>dilute hydrochloric acid</b>		
<b>dilute sulfuric acid</b>		

**[2]**

**[TOTAL: 10]**

**END OF QUESTION PAPER**

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