



**Surname** \_\_\_\_\_

**Forename(s)** \_\_\_\_\_

**Centre Number** \_\_\_\_\_

**Candidate Number** \_\_\_\_\_

**Candidate Signature** \_\_\_\_\_

**I declare this is my own work.**

**GCSE**

**CHEMISTRY**

**H**

**Higher Tier Paper 1**

**8462/1H**

**Monday 22 May 2023**

**Morning**

**Time allowed: 1 hour 45 minutes**

**[Turn over]**



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**At the front of this book, write your surname and forename(s), your centre number, your candidate number and add your signature.**

## **MATERIALS**

**For this paper you must have:**

- **a ruler**
- **a scientific calculator**
- **the periodic table (enclosed).**

**[Turn over]**



## INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Pencil should only be used for drawing.**
- **Answer ALL questions in the spaces provided. Do not write on blank pages.**
- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**
- **Do all rough work in this book. Cross through any work you do not want to be marked.**
- **In all calculations, show clearly how you work out your answer.**



## **INFORMATION**

- **The maximum mark for this paper is 100.**
- **The marks for questions are shown in brackets.**
- **You are expected to use a calculator where appropriate.**
- **You are reminded of the need for good English and clear presentation in your answers.**

**DO NOT TURN OVER UNTIL TOLD TO DO SO**



0	1
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**Discoveries in chemistry led to a better understanding of atomic structure.**

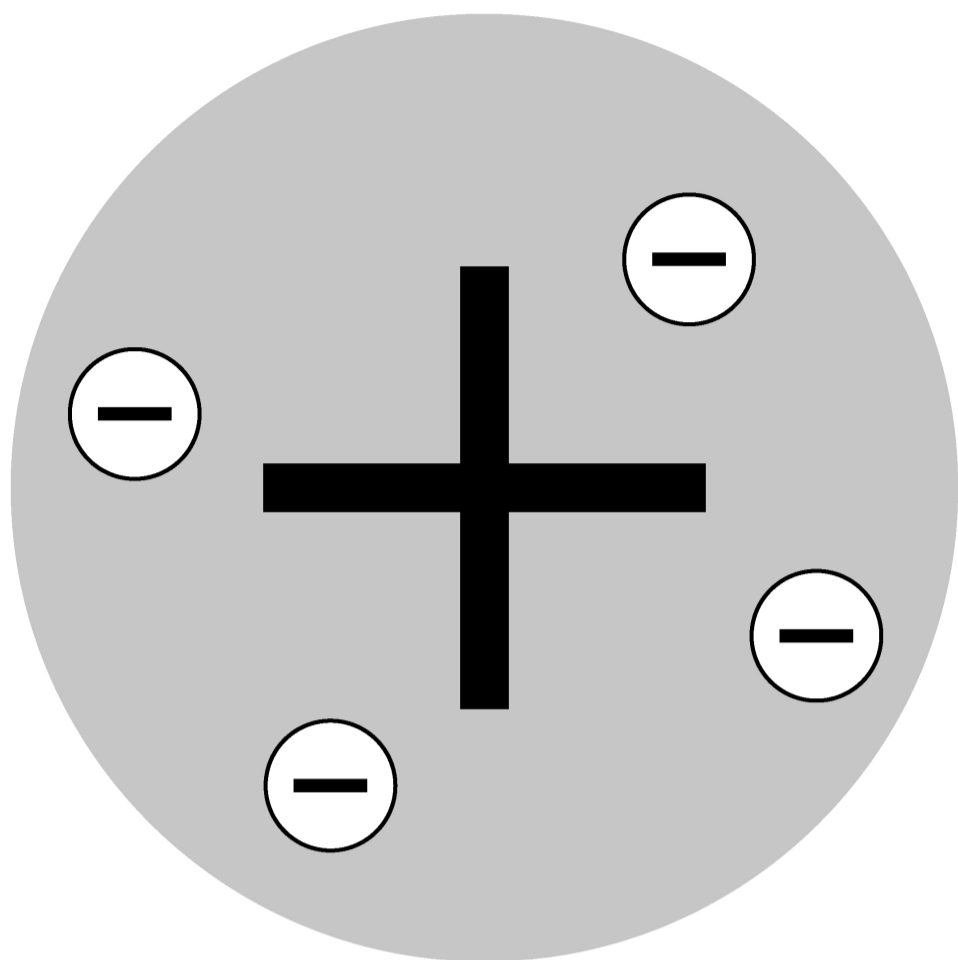
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**Atoms were originally thought to be tiny spheres that could not be divided.**

**The plum pudding model of the atom was then developed.**

**FIGURE 1, on the opposite page, represents the plum pudding model of the atom.**



**FIGURE 1**

**Describe the plum pudding model of the atom. [2 marks]**

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**[Turn over]**



0	1	.	2
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**Atoms contain electrons, neutrons and protons.**

**Write these three particles in order of their discovery. [1 mark]**

**Earliest** \_\_\_\_\_

\_\_\_\_\_

**Latest** \_\_\_\_\_



**Very few atoms of the element  
tennessine (Ts) have ever been  
identified.**

**The atomic number of tennessine is 117**

**0 1 . 3**

**Predict the number of outer shell  
electrons in an atom of tennessine.**

**Give ONE reason for your answer.**

**Use the periodic table. [2 marks]**

**Number of outer shell electrons \_\_\_\_\_**

**Reason \_\_\_\_\_**

\_\_\_\_\_

\_\_\_\_\_

**[Turn over]**



0	1	.	4
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**Tennessine was first identified by a small group of scientists in 2010.**

**Suggest ONE reason why tennessine was NOT accepted as a new element by other scientists until 2015. [1 mark]**

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**[Turn over]**



01.5

The discovery of isotopes explained why some relative atomic masses are not whole numbers.

Element R has two isotopes.

TABLE 1 shows the mass numbers and percentage abundances of the isotopes of element R.

TABLE 1

MASS NUMBER	PERCENTAGE ABUNDANCE (%)
6	7.6
7	92.4



**Calculate the relative atomic mass ( $A_r$ ) of element R.**

**Give your answer to 1 decimal place.  
[3 marks]**

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**Relative atomic mass (1 decimal place) =**

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**[Turn over]**

9



0	2
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**This question is about temperature changes.**

**A student investigated the change in temperature of a solution when different masses of ammonium nitrate were dissolved in water.**

**This is the method used.**

- 1. Measure 200 cm<sup>3</sup> of water into a polystyrene cup.**
- 2. Measure the temperature of the water.**
- 3. Add 4.0 g of ammonium nitrate to the water.**
- 4. Stir the solution until all the ammonium nitrate has dissolved.**



5. Measure the lowest temperature reached by the solution.
6. Repeat steps 1 to 5 with different masses of ammonium nitrate.

**0 2 . 1**

**Give the independent variable and the dependent variable in the investigation.**

**[2 marks]**

**Independent variable**

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**Dependent variable**

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**[Turn over]**



**TABLE 2 shows the results.**

**TABLE 2**

<b>Mass of ammonium nitrate added in grams</b>	<b>Lowest temperature of solution in °C</b>
<b>4.0</b>	<b>18.2</b>
<b>8.0</b>	<b>16.2</b>
<b>12.0</b>	<b>15.2</b>
<b>16.0</b>	<b>13.6</b>
<b>20.0</b>	<b>12.4</b>
<b>24.0</b>	<b>10.6</b>

**0 2 . 2**

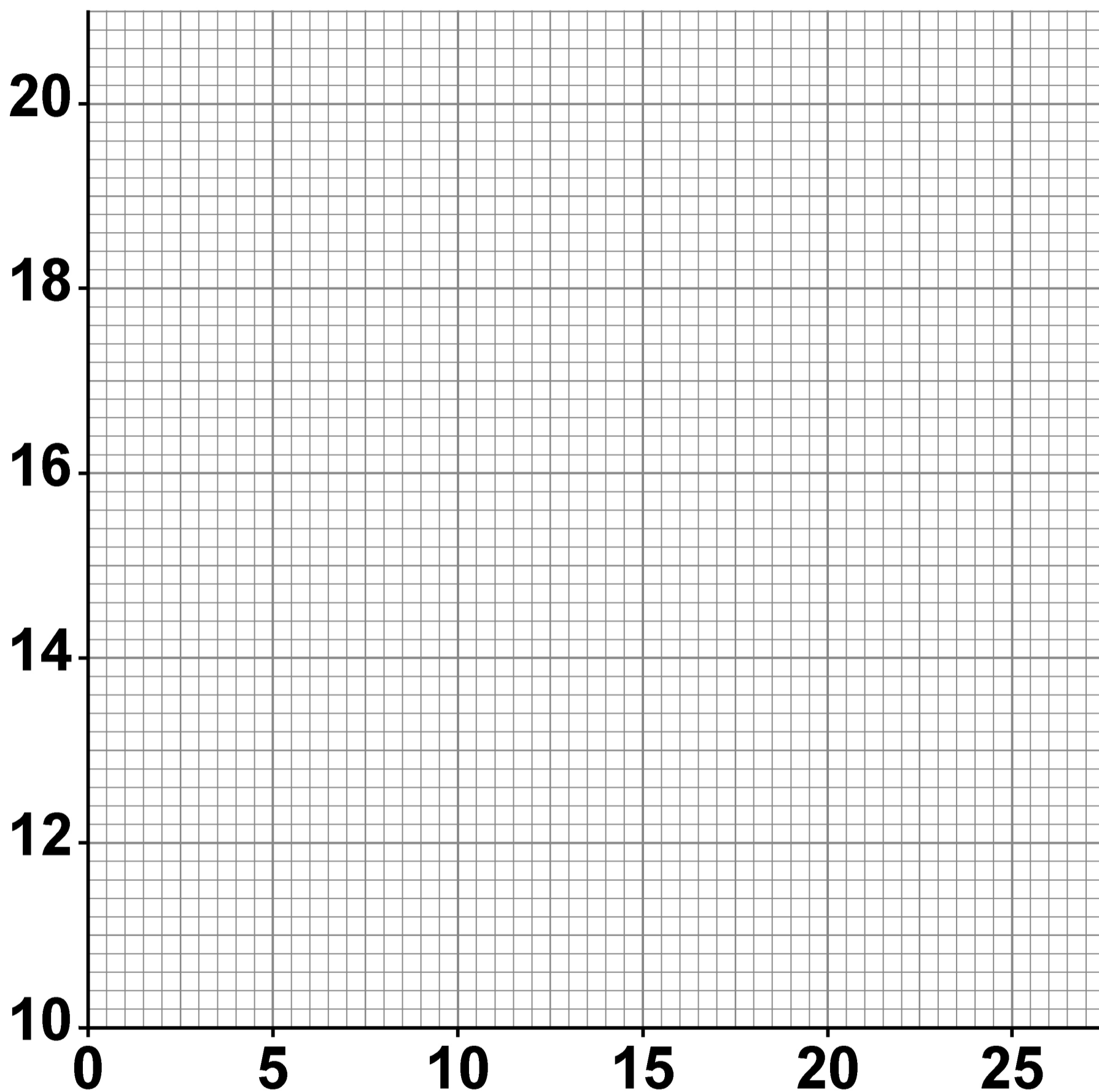
**Plot the data from TABLE 2 on FIGURE 2, on the opposite page.**

**Draw a line of best fit. [3 marks]**



**FIGURE 2**

**Lowest temperature  
of solution in °C**



**Mass of ammonium nitrate  
added in grams**

**[Turn over]**



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0	2	.	3
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**Determine the initial temperature of the water.**

**You should extend your line of best fit on FIGURE 2, on page 17. [2 marks]**

**Initial temperature of the water =**  
\_\_\_\_\_ °C

0	2	.	4
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**How do the results show that dissolving ammonium nitrate in water is endothermic? [1 mark]**

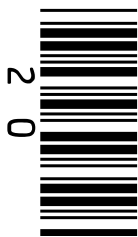
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**[Turn over]**



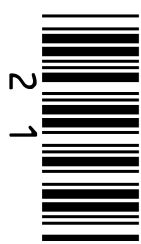


The student repeated the experiment three more times.

TABLE 3 shows the results for 8.0 g of ammonium nitrate.

TABLE 3

	Trial 1	Trial 2	Trial 3	Trial 4	Mean
Lowest temperature of solution in °C	16.2	16.6	16.8	16.4	16.5



02.5

The student recorded the mean lowest temperature of the solution for 8.0 g of ammonium nitrate as  $16.5 \pm 0.3$  °C.

Explain why the student included  $\pm 0.3$  °C after the mean lowest temperature. [2 marks]

21

[Turn over]

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**02.6**

**What type of error is shown by the results in TABLE 3, on page 20?  
[1 mark]**

**Tick (✓) ONE box.**

☐

**Random error**

☐

**Systematic error**

☐

**Zero error**

**[Turn over]**

<b>11</b>



0	3
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**This question is about making a soluble salt.**

0	3	.	1
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**Plan a method to make pure, dry crystals of zinc chloride from zinc carbonate and a dilute acid. [6 marks]**

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**[Turn over]**



0	3	.	2
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**Name TWO other substances that can each be reacted with a dilute acid to make zinc chloride.**

**Do NOT refer to zinc carbonate in your answer. [2 marks]**

**1** \_\_\_\_\_

**2** \_\_\_\_\_

<hr/>
<b>8</b>



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**[Turn over]**



0	4
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**This question is about hydrogen and compounds of hydrogen.**

**FIGURE 3 shows the displayed formulae for the reaction between hydrogen and chlorine.**

**FIGURE 3**



**TABLE 4 shows the bond energies.**

**TABLE 4**

Bond	H — H	Cl — Cl	H — Cl
Bond energy in kJ/mol	436	346	432



0	4	.	1
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**Which expression shows how to calculate the overall energy change for the reaction in FIGURE 3?**

**Use TABLE 4. [1 mark]**

**Tick (✓) ONE box.**

☐

**436 + 346 + 432 kJ/mol**

☐

**436 + 346 + (2 × 432) kJ/mol**

☐

**436 + 346 – 432 kJ/mol**

☐

**436 + 346 – (2 × 432) kJ/mol**

**[Turn over]**



**The reaction between hydrogen and chlorine is exothermic.**

**0 4 . 2**

**Explain why this reaction releases energy to the surroundings. [2 marks]**

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**[Turn over]**



0	4	.	3
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**FIGURE 4, on the opposite page, shows part of a reaction profile for the reaction between hydrogen and chlorine.**

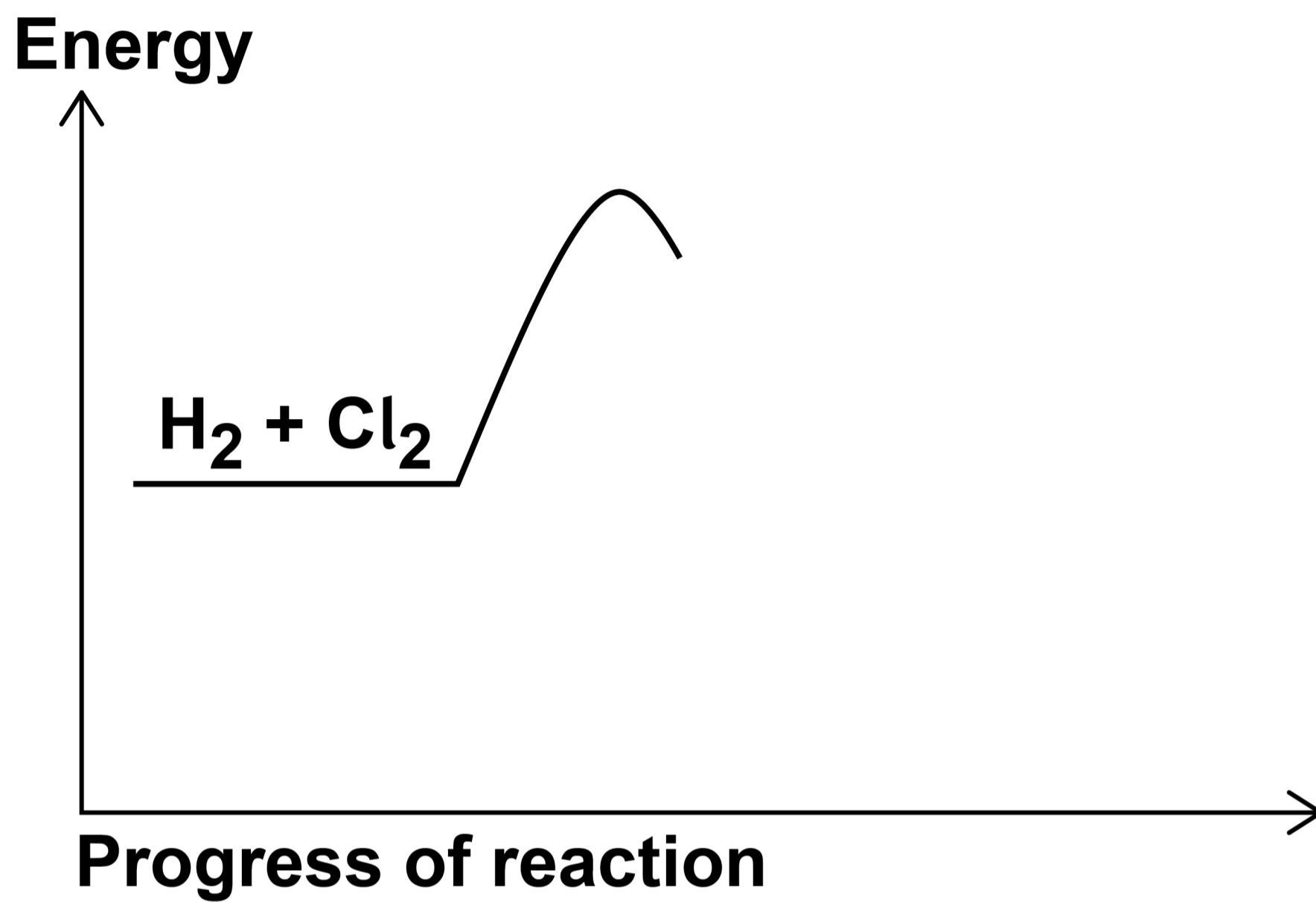
**Complete the reaction profile in FIGURE 4.**

**You should:**

- label the activation energy**
- label the overall energy change.**

**[3 marks]**

FIGURE 4



[Turn over]



0	4	.	4
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**Draw a dot and cross diagram for a molecule of hydrogen chloride (HCl).**

**Show the outer shell electrons only.  
[2 marks]**



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**[Turn over]**

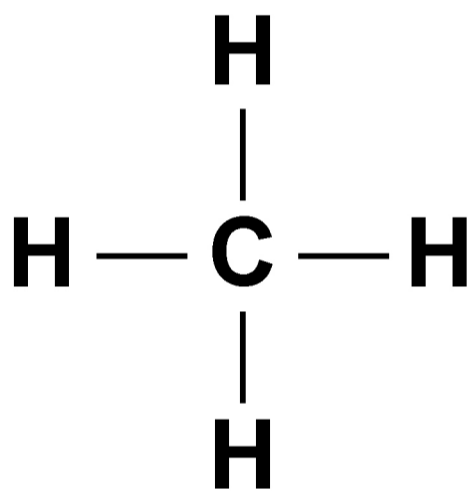


0	4	.	5
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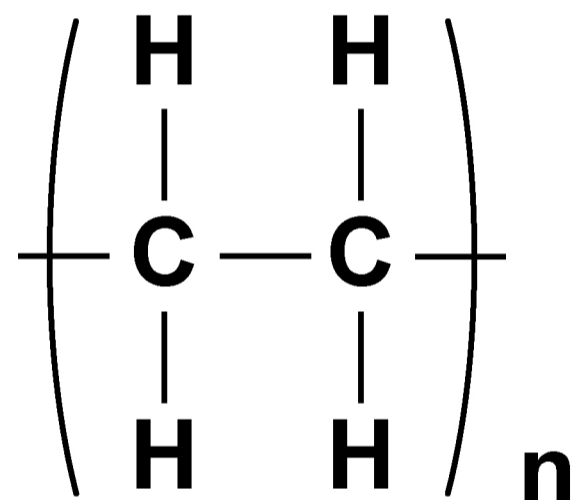
**FIGURE 5** represents molecules of methane and of poly(ethene).

## **FIGURE 5**

### **Methane**



### **Poly(ethene)**



**Methane is a gas at room temperature but poly(ethene) is a solid at room temperature.**



**Explain why methane and poly(ethene) exist in different states at room temperature. [4 marks]**

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**[Turn over]**

12



0	5
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**This question is about acids and alkalis.**

0	5	.	1
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**Ethanoic acid is a weak acid.**

**What is meant by ‘weak acid’?**

**Answer in terms of ionisation. [1 mark]**

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0	5	.	2
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**The concentration of an acid can be measured in mol/dm<sup>3</sup>.**



**Which combination of changes  
INCREASES the concentration of an  
acid? [1 mark]**

**Tick (✓) ONE box.**

☐

**The mass of acid dissolved is  
halved and the volume of the  
solution is halved.**

☐

**The mass of acid dissolved is  
halved and the volume of the  
solution is doubled.**

☐

**The mass of acid dissolved is  
doubled and the volume of the  
solution is halved.**

☐

**The mass of acid dissolved is  
doubled and the volume of the  
solution is doubled.**

**[Turn over]**



0	5	.	3
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**The concentration of an acid can be determined by titration.**

**An indicator is added to an alkali in a flask.**

**Name an indicator that can be used in this titration.**

**Give the colour change of the indicator when acid from a burette is added to the alkali in the flask. [2 marks]**

**Name of indicator** \_\_\_\_\_

**Colour change**  
**from** \_\_\_\_\_ **to** \_\_\_\_\_



0	5	.	4
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**Sodium carbonate dissolves in water to produce an alkaline solution.**

**Give the formula of the ion that makes a solution alkaline. [1 mark]**

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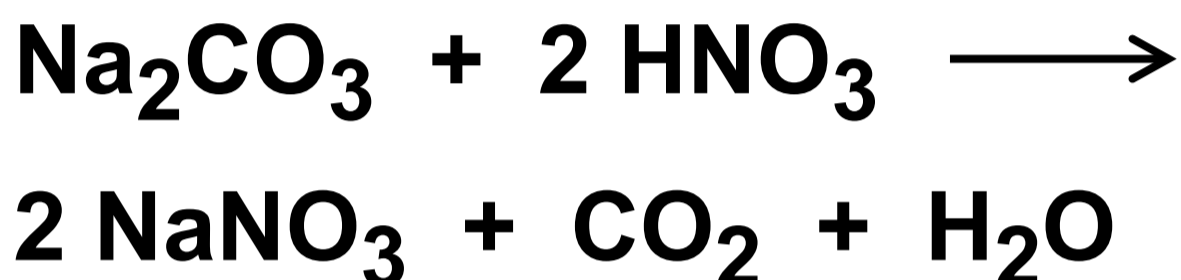
**[Turn over]**



0	5	.	5
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**A student does a titration using sodium carbonate solution and nitric acid.**

**The equation for the reaction is:**



**25.0 cm<sup>3</sup> of 0.124 mol/dm<sup>3</sup> sodium carbonate solution is neutralised by 23.6 cm<sup>3</sup> of nitric acid.**

**Calculate the concentration of the nitric acid.**

**Give your answer to 3 significant figures.**



**You should calculate:**

- **the number of moles of sodium carbonate in  $25.0 \text{ cm}^3$  of the solution**
- **the number of moles of nitric acid in  $23.6 \text{ cm}^3$  of the nitric acid**
- **the concentration of the nitric acid in  $\text{mol/dm}^3$ .**

**[5 marks]**

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**[Turn over]**



[illegible]

**Concentration (3 significant figures) =**  
**mol/dm<sup>3</sup>**



**When hydrochloric acid dissolves in water, hydrogen ions ( $\text{H}^+$ ) and chloride ions ( $\text{Cl}^-$ ) are produced.**

**0 5 . 6**

**A solution of hydrochloric acid with pH 4.5 has a concentration of  $\text{H}^+$  ions of  $3.16 \times 10^{-5} \text{ mol/dm}^3$ .**

**What is the concentration of  $\text{H}^+$  ions in a solution of hydrochloric acid with pH 2.5? [1 mark]**

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**Concentration of  $\text{H}^+$  ions =**  
**\_\_\_\_\_  $\text{mol/dm}^3$**

**[Turn over]**



0	5	.	7
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**Which element has atoms that have the same electronic structure as the chloride ion?**

**Use the periodic table. [1 mark]**

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12



0	6
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**This question is about uses of metals in electrical wires.**

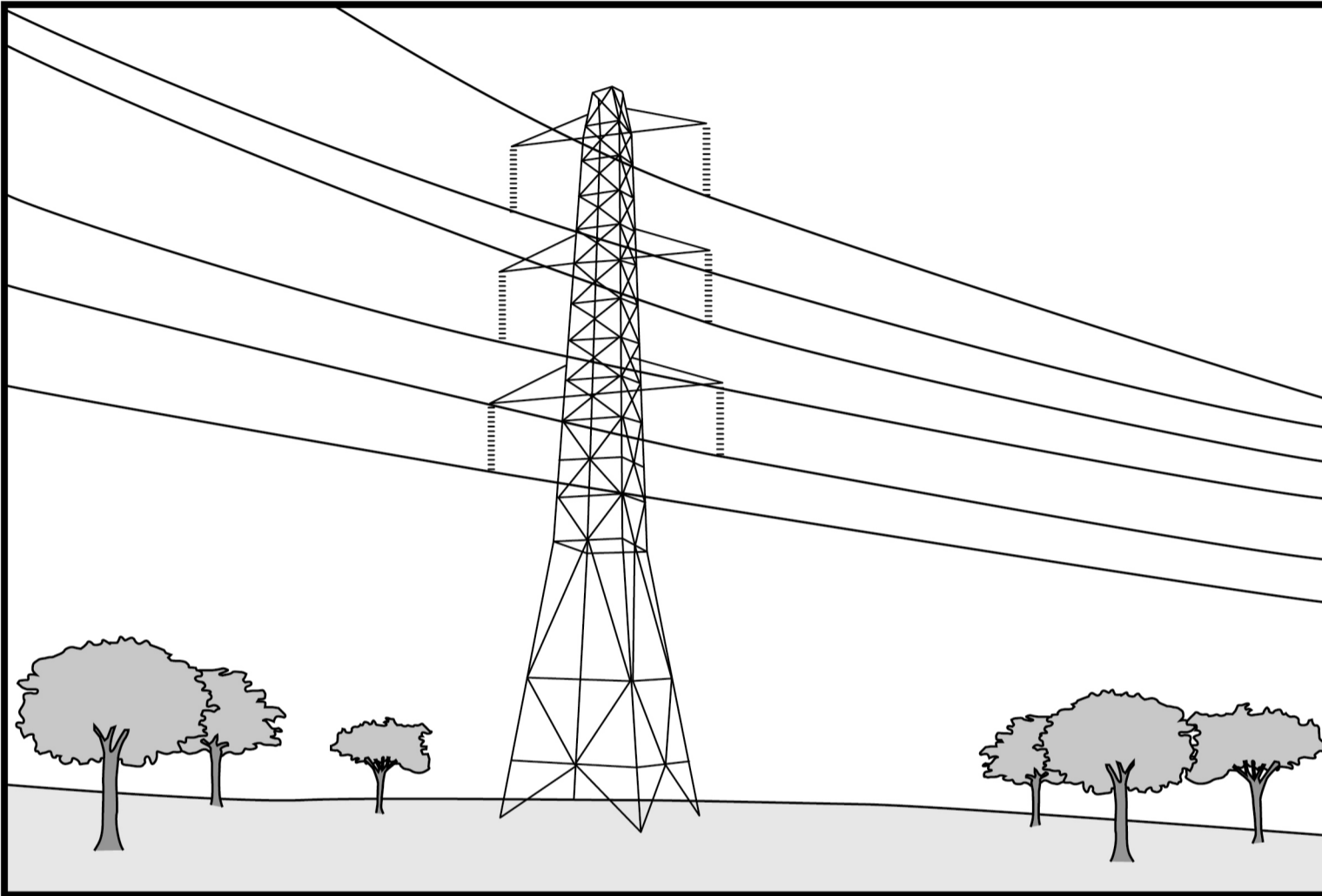
**Electrical wires can be made from:**

- **aluminium**
- **copper**
- **silver.**

**FIGURE 6, on pages 48 and 49, shows three uses of electrical wires.**

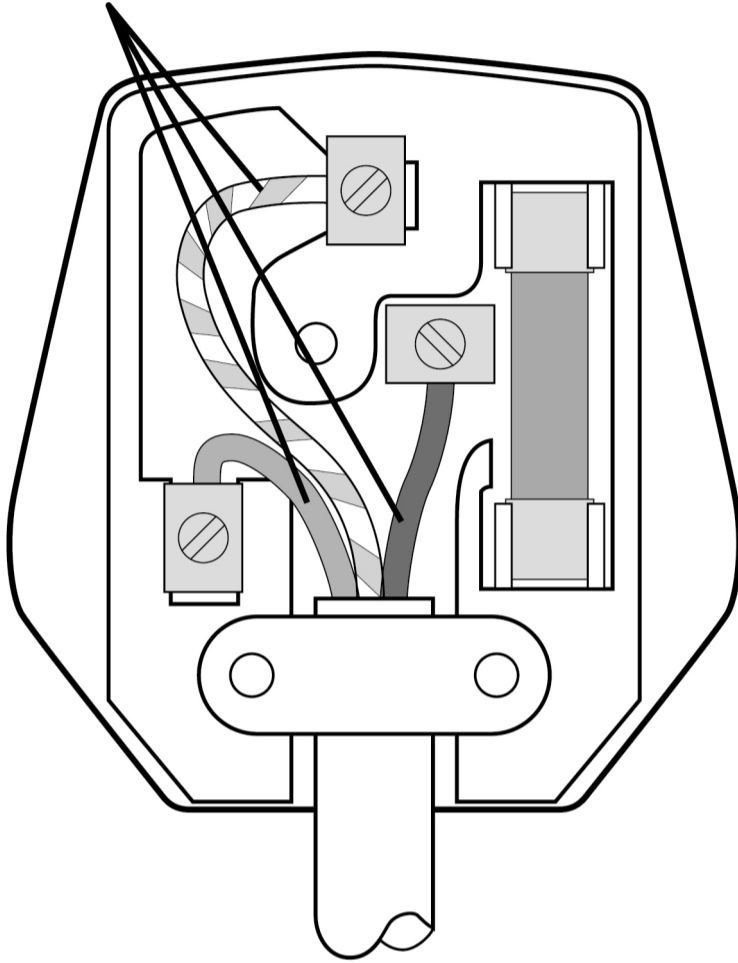
**[Turn over]**



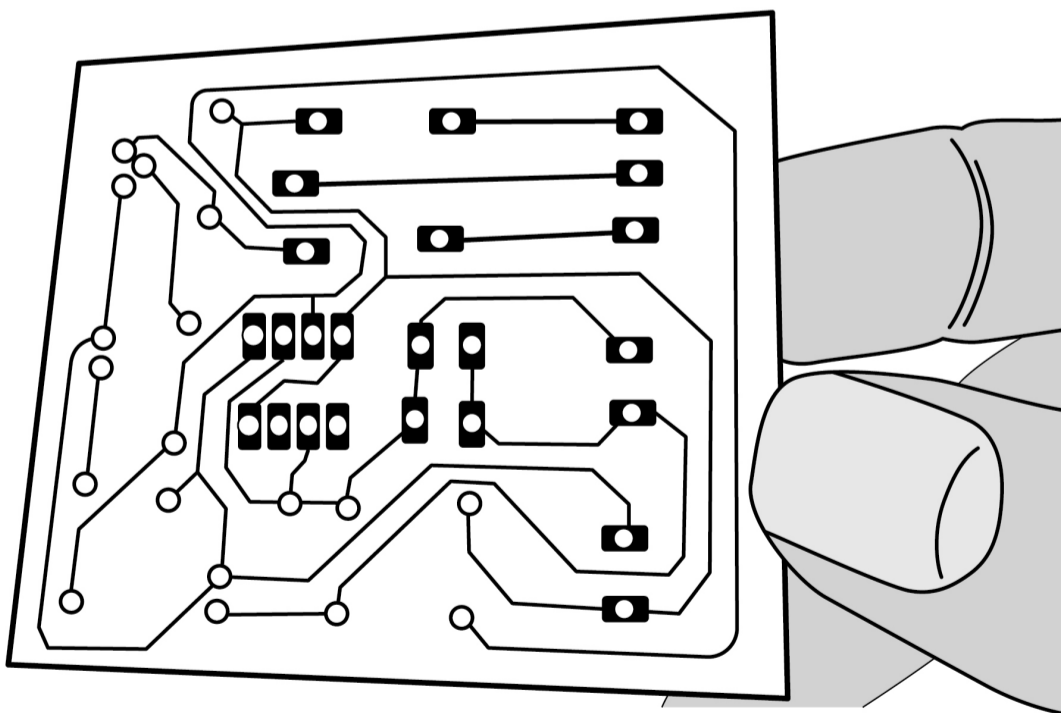
**FIGURE 6****Overhead power cables**

## Wiring in homes

### Electrical wires



### Printed circuit boards



**[Turn over]**



**TABLE 5 shows information about the metals.**

**The higher the value for electrical conductivity, the better the metal is at conducting electricity.**

**TABLE 5**

	<b>Aluminium</b>	<b>Copper</b>	<b>Silver</b>
<b>Electrical conductivity in arbitrary units</b>	<b>37.7</b>	<b>59.6</b>	<b>63.0</b>
<b>Density in g/cm<sup>3</sup></b>	<b>2.7</b>	<b>9.0</b>	<b>10.5</b>
<b>Cost of metal per kg in £</b>	<b>1.50</b>	<b>7.00</b>	<b>640.00</b>



0	6	.	1
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**Evaluate the use of aluminium, copper and silver for the types of electrical wires shown in FIGURE 6, on pages 48 and 49.**

**Use TABLE 5. [4 marks]**

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**[Turn over]**



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06.2

**Describe how metals conduct electricity.  
[3 marks]**

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**[Turn over]**



0	6	.	3
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**Electrical wires are usually made of pure metals and NOT alloys. This is because pure metals are better electrical conductors.**

**Suggest why alloys do NOT conduct electricity as well as pure metals.**

**Answer in terms of structure and bonding. [2 marks]**

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9
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0	7
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**This question is about electrolysis.**

**Aluminium is manufactured by electrolysing a molten mixture of aluminium oxide ( $\text{Al}_2\text{O}_3$ ) and cryolite ( $\text{Na}_3\text{AlF}_6$ ).**

0	7	.	1
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**Complete the half equation for the reaction occurring at the negative electrode. [1 mark]**



**[Turn over]**



0	7	.	2
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**Cryolite contains  $\text{Na}^+$  ions as well as  $\text{Al}^{3+}$  ions.**

**Suggest ONE reason why sodium is NOT a product of the electrolysis. [1 mark]**

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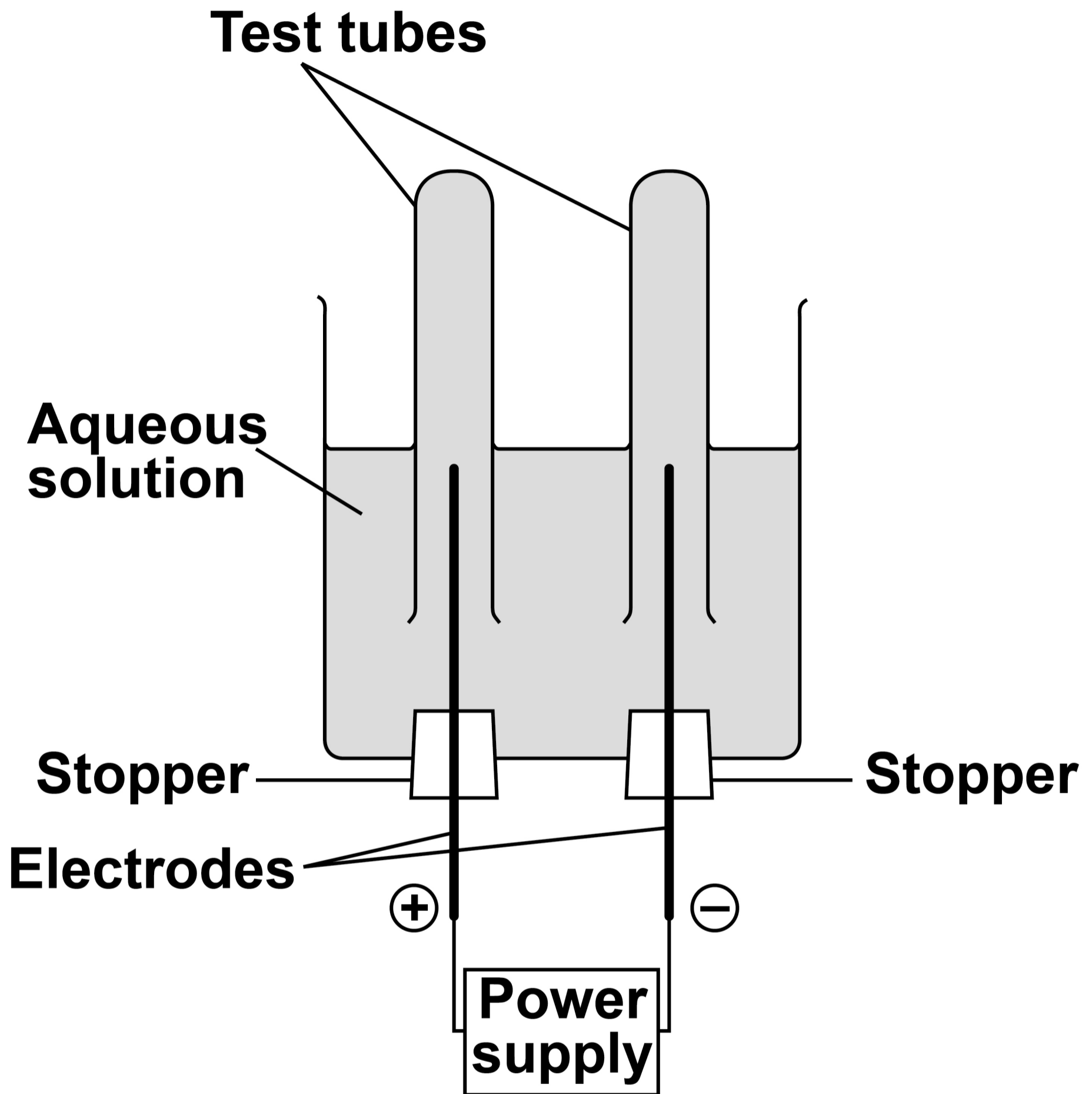


**A student investigated the electrolysis of an aqueous solution of a different compound.**

**FIGURE 7, on page 58, shows the apparatus.**

**[Turn over]**



**FIGURE 7**

Hydrogen was produced at the negative electrode and oxygen was produced at the positive electrode.



0	7	.	3
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**Explain how oxygen was produced from water during the electrolysis of this aqueous solution. [4 marks]**

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**[Turn over]**



0	7	.	4
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**The student compared the volumes of the two gases collected.**

**How can the student change the apparatus in FIGURE 7, on page 58, to compare the volumes of the two gases produced more accurately?**

**Give ONE reason for your answer.**

**[2 marks]**

**Change** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Reason** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



0	7	.	5
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The overall equation for the reaction is:



What is the volume of oxygen produced when 20 cm<sup>3</sup> of hydrogen has been produced? [1 mark]

Tick (✓) ONE box.

☐

10 cm<sup>3</sup>

☐

20 cm<sup>3</sup>

☐

30 cm<sup>3</sup>

☐

40 cm<sup>3</sup>

[Turn over]

9



0	8
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**This question is about elements in the periodic table.**

0	8	.	1
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**Argon has the atomic number 18**

**Explain why argon does NOT form compounds.**

**Answer in terms of electrons. [2 marks]**

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0	8	.	2
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**Phosphorus (P) is the element below nitrogen in the periodic table.**

**Predict the formula of the compound formed between phosphorus and hydrogen. [1 mark]**

**Formula = \_\_\_\_\_**

**[Turn over]**



0	8	.	3
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**Tellurium is the element with atomic number 52**

**Predict whether tellurium reacts with metals.**

**Explain your answer.**

**Answer in terms of the position of tellurium in the periodic table. [2 marks]**

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**Barium (Ba) is an element in Group 2 of the periodic table.**

**Barium reacts with hydrochloric acid.**

**0 8 . 4**

**Suggest TWO observations that could be made when barium reacts with hydrochloric acid. [2 marks]**

**1** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**2** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**[Turn over]**



0	8	.	5
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**Write a balanced symbol equation for the reaction between barium and hydrochloric acid. [3 marks]**



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10



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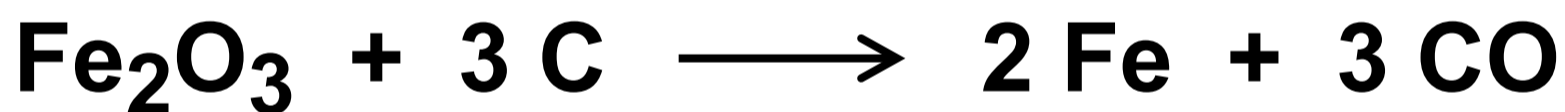


0	9
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**This question is about displacement reactions.**

**Iron is extracted from iron oxide by a displacement reaction with carbon.**

**The equation for the reaction is:**



0	9	.	1
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**Which substance in the equation is reduced?**

**Give ONE reason for your answer.**

**Answer in terms of oxygen. [2 marks]**

**Substance reduced** \_\_\_\_\_

**Reason** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**[Turn over]**



0	9	.	2
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**Which expression shows how to calculate the mass of carbon needed to produce 1 mole of iron from iron oxide?**

**Relative atomic mass ( $A_r$ ):     C = 12**

**[1 mark]**

**Tick (✓) ONE box.**

<input type="checkbox"/>	$\frac{1}{3} \times 12 \text{ g}$
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<input type="checkbox"/>	$\frac{3}{2} \times 12 \text{ g}$
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<input type="checkbox"/>	$1 \times 12 \text{ g}$
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<input type="checkbox"/>	$3 \times 12 \text{ g}$
--------------------------	-------------------------



**A student investigated displacement reactions of four different metals represented by A, B, C and D.**

**A, B, C and D are NOT the actual chemical symbols for the metals.**

**The student:**

- **added each metal to aqueous solutions of the metal nitrates**
- **observed whether a reaction took place.**

**TABLE 6, on page 72, shows information about three of the reaction mixtures.**

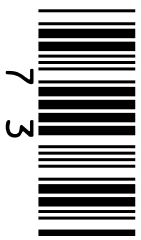
**[Turn over]**





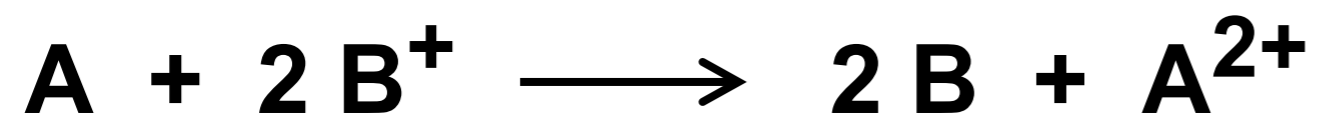
TABLE 6

REACTION	METAL	METAL NITRATE SOLUTION	EQUATION
1	A	$\text{BNO}_3$	$\begin{array}{l} \text{A} + 2 \text{BNO}_3 \longrightarrow \\ 2 \text{B} + \text{A}(\text{NO}_3)_2 \end{array}$
2	C	$\text{A}(\text{NO}_3)_2$	$\begin{array}{l} 2 \text{C} + 3 \text{A}(\text{NO}_3)_2 \longrightarrow \\ 3 \text{A} + 2 \text{C}(\text{NO}_3)_3 \end{array}$
3	C	$\text{D}(\text{NO}_3)_2$	no reaction



09.3

The ionic equation for REACTION 1 is:



Why is this a redox reaction? [1 mark]

Tick (✓) ONE box.

☐

A gains electrons and  $\text{B}^+$  loses electrons.

☐

A loses electrons and  $\text{B}^+$  gains electrons.

☐

Both A and  $\text{B}^+$  gain electrons.

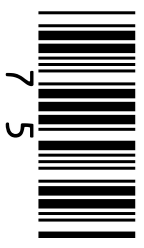
☐

Both A and  $\text{B}^+$  lose electrons.

[Turn over]



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09.4

**Which of the four metals has the greatest tendency to form positive ions?**

**Use TABLE 6, on page 72. [1 mark]**

**Tick (✓) ONE box.**

☐

**A**

☐

**B**

☐

**C**

☐

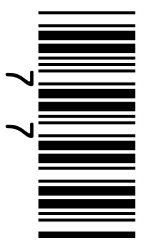
**D**

**[Turn over]**



REPEAT OF TABLE 6

REACTION	METAL	METAL NITRATE SOLUTION	EQUATION
1	A	$\text{BNO}_3$	$\begin{array}{l} \text{A} + 2 \text{BNO}_3 \longrightarrow \\ 2 \text{B} + \text{A}(\text{NO}_3)_2 \end{array}$
2	C	$\text{A}(\text{NO}_3)_2$	$\begin{array}{l} 2 \text{C} + 3 \text{A}(\text{NO}_3)_2 \longrightarrow \\ 3 \text{A} + 2 \text{C}(\text{NO}_3)_3 \end{array}$
3	C	$\text{D}(\text{NO}_3)_2$	no reaction



09.5

The nitrate ion has the formula  $\text{NO}_3^-$

Which of the four metals could be aluminium?

Explain your answer.

Use TABLE 6. [3 marks]

Metal \_\_\_\_\_

Explanation \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

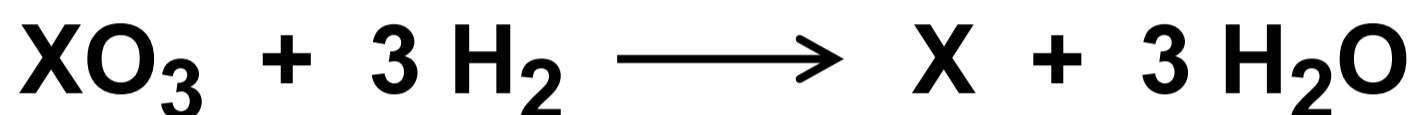
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[Turn over]

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**Metal X is extracted from an oxide of metal X by reaction with hydrogen.**

**The equation for the reaction is:**



**The percentage atom economy for obtaining metal X by this method is 77.3%.**

**Calculate the relative atomic mass ( $A_r$ ) of metal X.**

**Relative atomic masses**

**( $A_r$ ):    H = 1    O = 16**

**[4 marks]**



**[Turn over]**



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**This question is about titanium dioxide ( $\text{TiO}_2$ ).**

1	0	.	1
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**Self-cleaning windows are coated with a layer of nanoparticles of titanium dioxide.**

**Titanium dioxide:**

- **helps sunlight break down dirt particles**
- **attracts water, so dirt is washed away by rain.**

**Nanoparticles of titanium dioxide are used instead of fine particles of titanium dioxide for coating self-cleaning windows.**



**Suggest TWO reasons why. [2 marks]**

**1** \_\_\_\_\_  
\_\_\_\_\_  
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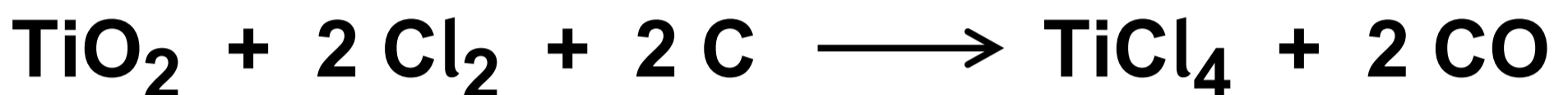
**2** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**[Turn over]**

1	0	.	2
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**Titanium is extracted from titanium dioxide in a two-stage process.**

**The equation for the first stage in the process is:**



**Calculate the volume of chlorine gas needed to react completely with 100 kg of titanium dioxide.**

**Relative atomic masses**

**( $A_r$ ):    O = 16    Ti = 48**

**The volume of one mole of gas = 24 dm<sup>3</sup>  
[6 marks]**





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Volume = \_\_\_\_\_ dm<sup>3</sup>

END OF QUESTIONS

8



**Additional page, if required.**  
**Write the question numbers in the left-hand margin.**


**Additional page, if required.**  
**Write the question numbers in the left-hand margin.**


**Additional page, if required.**

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Question	Mark
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