A

Surname ______

Other Names ______

Centre Number ______

Candidate Number ______

Candidate Signature ______

GCSE
CHEMISTRY

H

Higher Tier Paper 1

8462/1H

Thursday 16 May 2019 Morning

Time allowed: 1 hour 45 minutes

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

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INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions in the spaces provided. Do not write on blank pages.**
- **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

Answer ALL questions in the spaces provided.

0 1 **This question is about the periodic table.**

In the 19th century, some scientists tried to classify the elements by arranging them in order of their atomic weights.

FIGURE 1, on page 5, shows the periodic table Mendeleev produced in 1869.

His periodic table was more widely accepted than previous versions.

0 1 . 1 **The atomic weight of tellurium (Te) is 128 and that of iodine (I) is 127**

Why did Mendeleev reverse the order of these two elements? [1 mark]

FIGURE 1

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Period 1	H						
Period 2	Li	Be	B	C	N	O	F
Period 3	Na	Mg	Al	Si	P	S	Cl
Period 4	K Cu	Ca Zn	* *	Ti *	V As	Cr Se	Mn Br
Period 5	Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	* I

[Turn over]

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0 1 . 2 **Mendeleev left spaces marked with an asterisk ***

He left these spaces because he thought missing elements belonged there.

Why did Mendeleev's periodic table become more widely accepted than previous versions? [3 marks]

REPEAT OF FIGURE 1

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Period 1	H						
Period 2	Li	Be	B	C	N	O	F
Period 3	Na	Mg	Al	Si	P	S	Cl
Period 4	K Cu	Ca Zn	* *	Ti *	V As	Cr Se	Mn Br
Period 5	Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	* I

0 1 . 3 **Mendeleev arranged the elements in order of their atomic weight.**

What is the modern name for atomic weight? [1 mark]

Tick (✓) ONE box.

☐ **Atomic number**

☐ **Mass number**

☐ **Relative atomic mass**

☐ **Relative formula mass**

[Turn over]

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0 1 . 4 **Complete the sentence.**

In the modern periodic table, the elements

are arranged in order of ______________________________

____

[1 mark]

Chlorine, iodine and astatine are in Group 7 of the modern periodic table.

0 1 . 5 Astatine (At) is below iodine in Group 7.

Predict:

- the formula of an astatine molecule
- the state of astatine at room temperature.

[2 marks]

Formula of astatine molecule

State at room temperature

0 1 . 6 **Sodium is in Group 1 of the modern periodic table.**

Describe what you would see when sodium reacts with chlorine.
[2 marks]

10

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0 2 This question is about acids and alkalis.

0 2 . 1 Which ion do all acids produce in aqueous solution? [1 mark]

Tick (✓) ONE box.

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

0 2 . 2 Calcium hydroxide solution reacts with an acid to form calcium chloride.

Complete the word equation for the reaction.
[2 marks]

calcium hydroxide + ________________ acid →

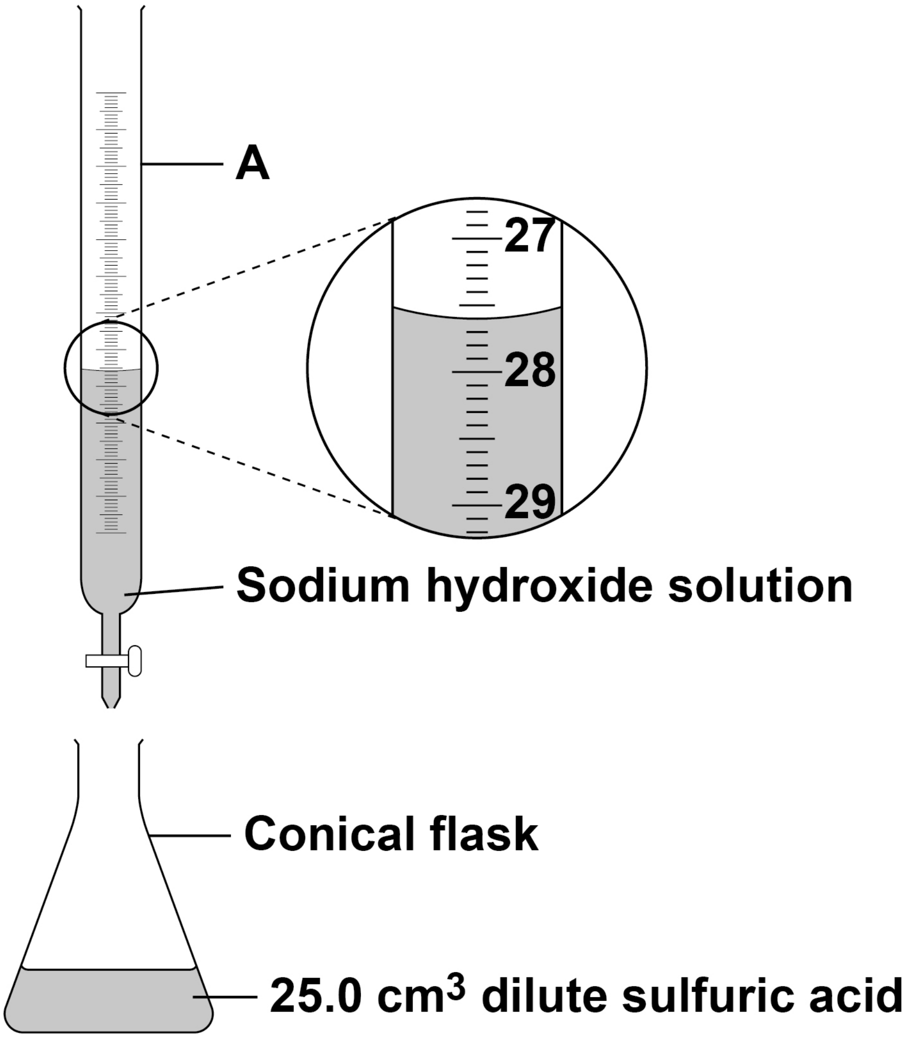
calcium chloride + ________________

[Turn over]

A student investigates the volume of sodium hydroxide solution that reacts with 25.0 cm^3 of dilute sulfuric acid.

FIGURE 2 shows the apparatus the student uses.

FIGURE 2



Use FIGURE 2 to answer Questions 02.3 and 02.4

0 2 . 3 Name apparatus A. [1 mark]

____

____

0 2 . 4 What is the reading on apparatus A? [1 mark]

____________________________ cm^3

[Turn over]

0 2 . 5 **The higher the concentration of a sample of dilute sulfuric acid, the greater the volume of sodium hydroxide needed to neutralise the acid.**

The student tested two samples of dilute sulfuric acid, P and Q.

Describe how the student could use titrations to find which sample, P or Q, is more concentrated. [6 marks]

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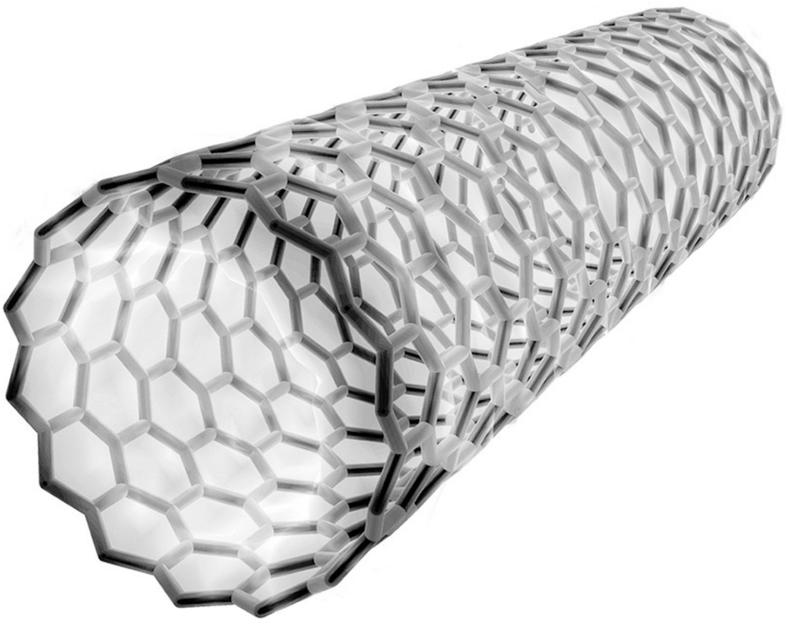
[Turn over]

0 3 **This question is about materials and their properties.**

0 3 . 1 **FIGURE 3 shows a carbon nanotube.**

FIGURE 3



The structure and bonding in a carbon nanotube are similar to graphene.

Carbon nanotubes are used in electronics because they conduct electricity.

Explain why carbon nanotubes conduct electricity. [2 marks]

[Turn over]

0 3 . 2 FIGURE 4 shows a badminton racket.

FIGURE 4

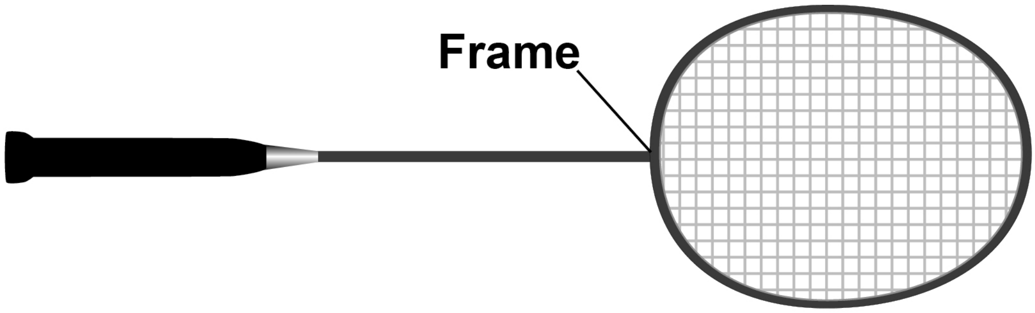


TABLE 1 shows some properties of materials.

The materials could be used to make badminton racket frames.

TABLE 1

Material	Density in g/cm^3	Relative strength	Relative stiffness
Aluminium	2.7	0.3	69
Carbon nanotube	1.5	60	1000
Wood	0.71	0.1	10

Evaluate the use of the materials to make badminton racket frames.

Use TABLE 1. [4 marks]

[Turn over]

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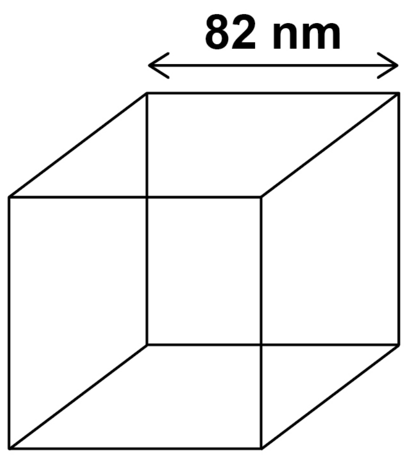
[Turn over]

Zinc oxide can be produced as nanoparticles and as fine particles.

0 3 . 3 **A nanoparticle of zinc oxide is a cube of side 82 nm**

FIGURE 5 represents a nanoparticle of zinc oxide.

FIGURE 5



Calculate the surface area of a nanoparticle of zinc oxide.

Give your answer in standard form. [3 marks]

Surface area = ______________________ nm^2

0 3 . 4 Some suncreams contain zinc oxide as nanoparticles or as fine particles.

Suggest ONE reason why it costs less to use nanoparticles rather than fine particles in suncreams. [1 mark]

[Turn over]

10

0 4 This question is about atomic structure.

0 4 . 1 Atoms contain subatomic particles.

TABLE 2 shows properties of two subatomic particles.

Complete TABLE 2. [2 marks]

TABLE 2

Name of particle	Relative mass	Relative charge
neutron		
		+1

An element X has two isotopes.

The isotopes have different mass numbers.

0 4 . 2 Define mass number. [1 mark]

0 4 . 3 Why is the mass number different in the two isotopes? [1 mark]

[Turn over]

0 4 . 4 **The model of the atom changed as new evidence was discovered.**

The plum pudding model suggested that the atom was a ball of positive charge with electrons embedded in it.

Evidence from the alpha particle scattering experiment led to a change in the model of the atom from the plum pudding model.

Explain how. [4 marks]

[Turn over]

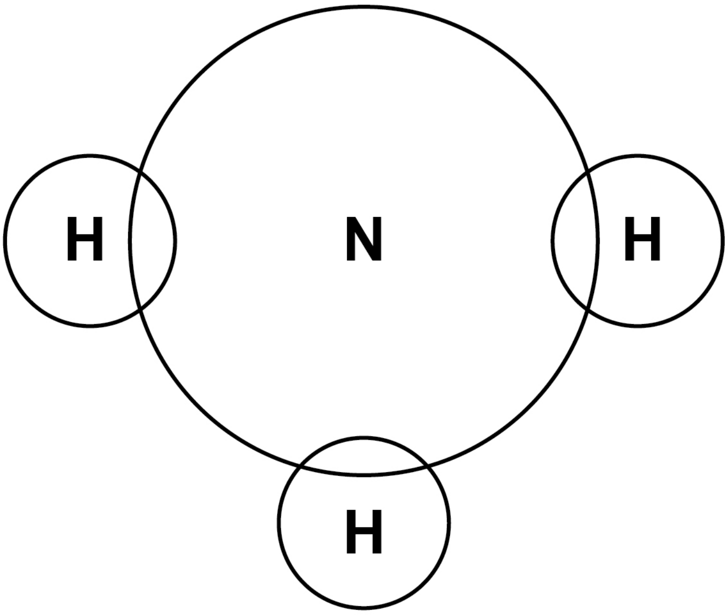
8

0 5 **This question is about ammonia, NH_3**

0 5 . 1 **Complete the dot and cross diagram for the ammonia molecule shown in FIGURE 6.**

Show only the electrons in the outer shell of each atom. [2 marks]

FIGURE 6



0 5 . 2 **Give ONE limitation of using a dot and cross diagram to represent an ammonia molecule. [1 mark]**

0 5 . 3 **Explain why ammonia has a low boiling point.**

You should refer to structure and bonding in your answer. [3 marks]

[Turn over]

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Ammonia reacts with oxygen in the presence of a metal oxide catalyst to produce nitrogen and water.

0 5 . 4 Which metal oxide is most likely to be a catalyst for this reaction? [1 mark]

Tick (✓) ONE box.

- [ ] **CaO**
- [ ] **Cr_2O_3**
- [ ] **MgO**
- [ ] **Na_2O**

[Turn over]

FIGURE 7 shows the displayed formula equation for the reaction.

FIGURE 7

$$4\ \begin{array}{c}H-N-H\\ \vert\\ H\end{array} \ + \ 3\ O{=}O \longrightarrow 2\ N{\equiv}N \ + \ 6\ H-O-H$$

TABLE 3 shows some bond energies.

TABLE 3

Bond	N — H	O ═ O	N ≡ N	O — H
Bond energy in kJ/mol	391	498	945	464

0 5 . 5 **Calculate the overall energy change for the reaction.**

Use FIGURE 7 and TABLE 3. [3 marks]

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Overall energy change = ____________________ kJ

[Turn over]

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0 5 . 6 **Explain why the reaction between ammonia and oxygen is exothermic.**

Use values from your calculation in Question 05.5 [2 marks]

[Turn over]

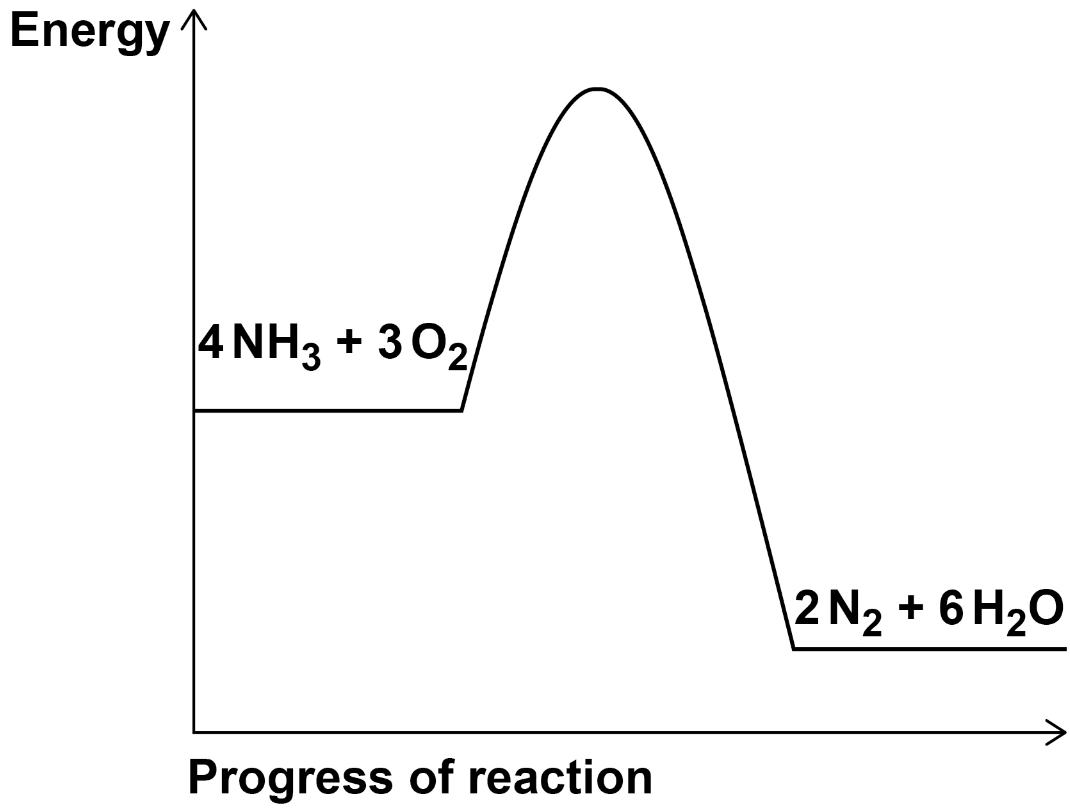
0 5 . 7 FIGURE 8 shows the reaction profile for the reaction between ammonia and oxygen.

Complete FIGURE 8 by labelling the:

- activation energy
- overall energy change.

[2 marks]

FIGURE 8



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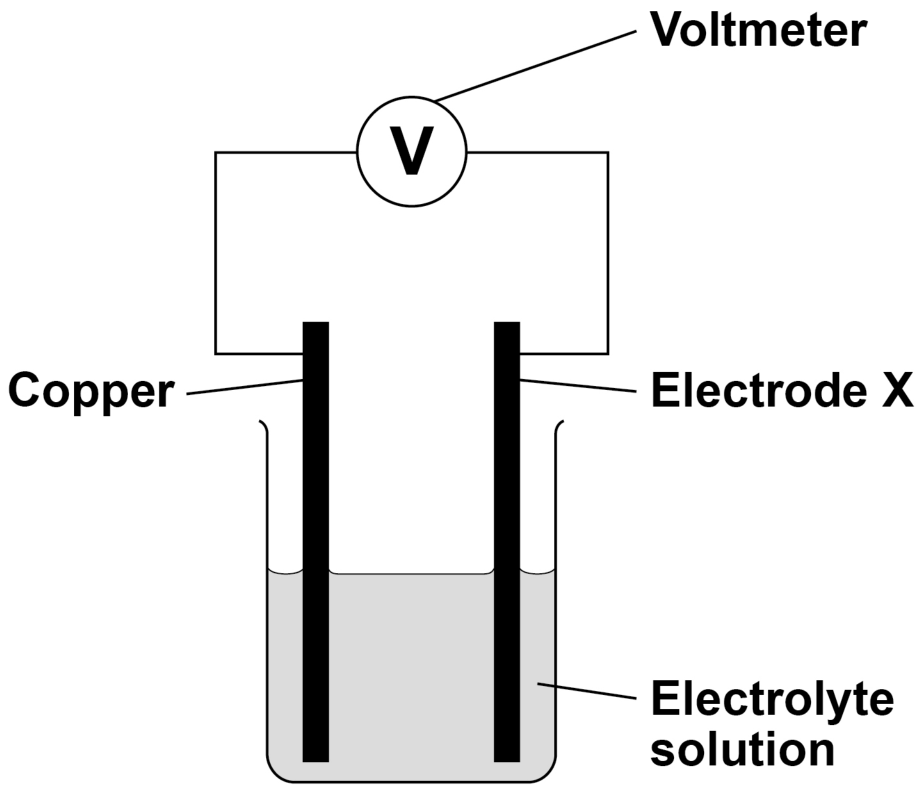
[Turn over]

0 6 This question is about chemical cells.

A student investigated the voltage produced by different chemical cells.

FIGURE 9 shows the apparatus.

FIGURE 9



This is the method used.

1. Use cobalt as electrode X.
2. Record the cell voltage.
3. Repeat steps 1 and 2 using different metals as electrode X.

0 6 . 1 **Suggest TWO control variables used in this investigation. [2 marks]**

1 ____________________

____

____

2 ____________________

____

____

[Turn over]

TABLE 4 shows the student's results.

TABLE 4

Electrode X	Voltage of cell in volts
cobalt	+0.62
copper	0.00
magnesium	+2.71
nickel	+0.59
silver	–0.46
tin	+0.48

0 6 . 2 **Write the six metals used for electrode X in order of reactivity.**

Use TABLE 4.

Justify your order of reactivity. [4 marks]

Most reactive ______________________________

____

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Least reactive ______________________________

Justification ______________________________

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____

0 6 . 3 **Which of the following pairs of metals would produce the greatest voltage when used as the electrodes in the cell?**

Use TABLE 4, on page 46. [1 mark]

Tick (✓) ONE box.

- [ ] **Magnesium and cobalt**
- [ ] **Magnesium and tin**
- [ ] **Nickel and cobalt**
- [ ] **Nickel and tin**

0 6 . 4 **Hydrogen fuel cells can be used to power different forms of transport.**

Some diesel trains are being converted to run on hydrogen fuel cells.

A newspaper article referred to the converted trains as the new 'steam trains'.

Suggest why. [2 marks]

[Turn over]

9

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

Aluminium is produced by electrolysing a molten mixture of aluminium oxide and cryolite.

0 7 . 1 **Explain why a mixture is used as the electrolyte instead of using only aluminium oxide. [2 marks]**

07.2 **What happens at the negative electrode during the production of aluminium? [1 mark]**

Tick (✓) ONE box.

- [ ] **Aluminium atoms gain electrons.**
- [ ] **Aluminium atoms lose electrons.**
- [ ] **Aluminium ions gain electrons.**
- [ ] **Aluminium ions lose electrons.**

07.3 **Oxygen is produced at the positive electrode.**

Complete the balanced half-equation for the process at the positive electrode. [2 marks]

$$\longrightarrow \quad O_2 \quad + $$

0 7 . 4 **Explain why the positive electrode must be continually replaced. [3 marks]**

0 7 . 5 **The overall equation for the electrolysis of aluminium oxide is:**

$2\ Al_2O_3 \rightarrow 4\ Al + 3\ O_2$

Calculate the mass of oxygen produced when 2000 kg of aluminium oxide is completely electrolysed.

Relative atomic masses (A_r): O = 16 Al = 27
[4 marks]

Mass of oxygen = ______________________ kg

[Turn over]

Sodium metal and chlorine gas are produced by the electrolysis of molten sodium chloride.

0 7 . 6 Explain why sodium chloride solution CANNOT be used as the electrolyte to produce sodium metal. [2 marks]

0 7 . 7 **Calculate the volume of 150 kg of chlorine gas at room temperature and pressure.**

The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3

Relative formula mass (M_r): Cl_2 = 71
[2 marks]

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Volume = ______________________________ dm^3

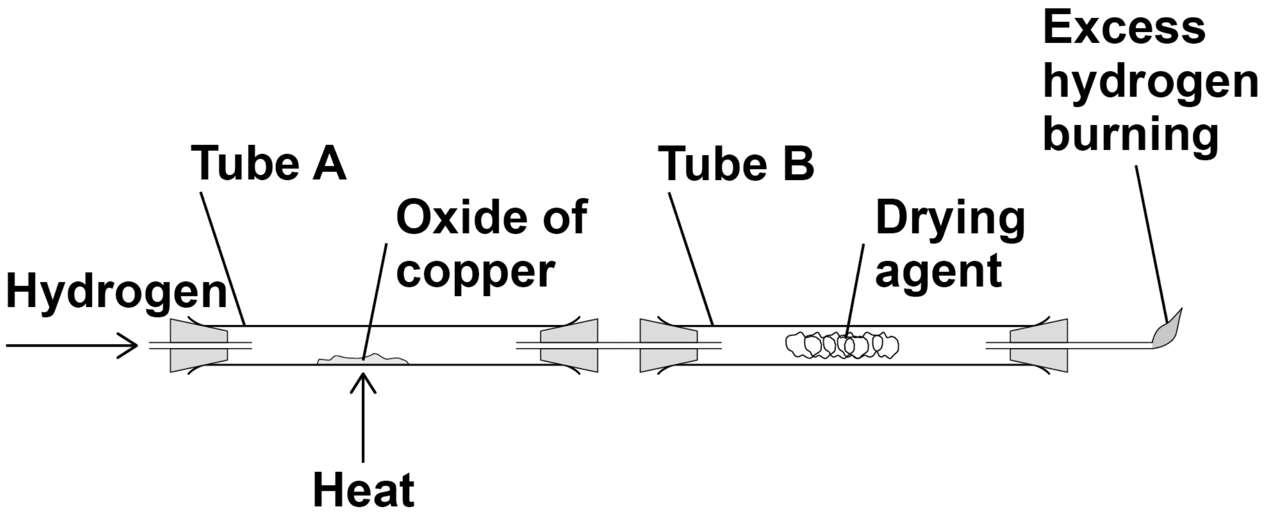
16

0 8 Copper forms two oxides, Cu_2O and CuO

A teacher investigated an oxide of copper.

FIGURE 10 shows the apparatus.

FIGURE 10



This is the method used.

1. Weigh empty tube A.
2. Add some of the oxide of copper to tube A.
3. Weigh tube A and the oxide of copper.
4. Weigh tube B and drying agent.
5. Pass hydrogen through the apparatus and light the flame at the end.
6. Heat tube A for 2 minutes.
7. Reweigh tube A and contents.
8. Repeat steps 5 to 7 until the mass no longer changes.

9. Reweigh tube B and contents.

10. Repeat steps 1 to 9 with different masses of the oxide of copper.

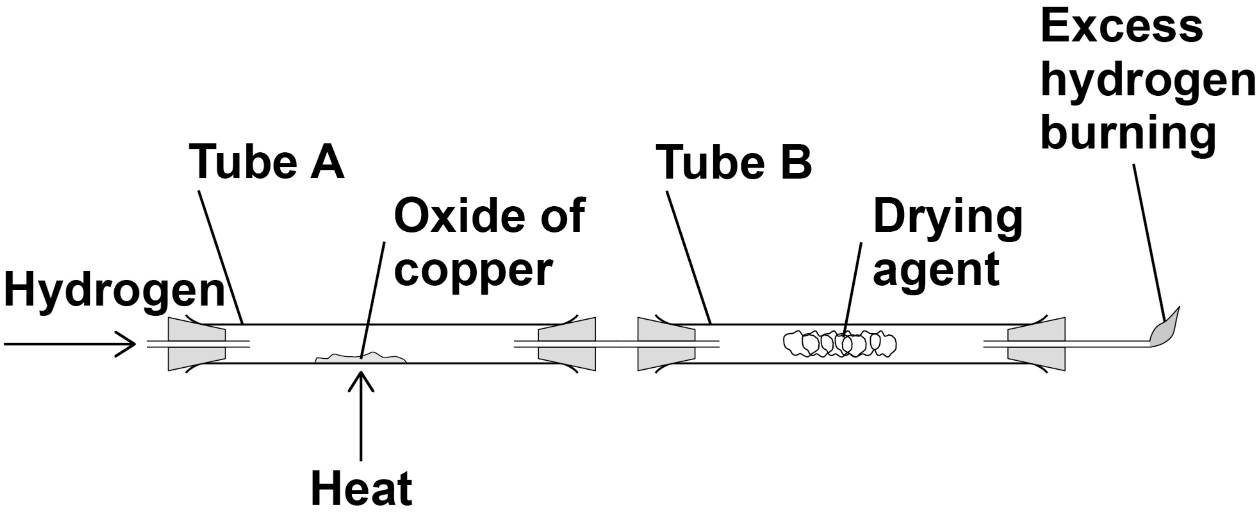
0 8 . 1 Suggest ONE reason why step 8 is needed. [1 mark]

0 8 . 2 Explain why the excess hydrogen must be burned off. [2 marks]

[Turn over]

FIGURE 10 is repeated here.

FIGURE 10



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[Turn over]

TABLE 5 shows the teacher's results.

TABLE 5

	Mass in g
Tube A empty	105.72
Tube A and oxide of copper before heating	115.47
Tube A and contents after 2 minutes	114.62
Tube A and contents after 4 minutes	114.38
Tube A and contents after 6 minutes	114.38
Tube B and contents at start	120.93
Tube B and contents at end	123.38

When an oxide of copper is heated in a stream of hydrogen, the word equation for the reaction is:

copper oxide + hydrogen → copper + water

0 8 . 3 **Determine the mass of copper and the mass of water produced in this experiment.**

Use TABLE 5. [2 marks]

____

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____

Mass of copper = ________________________ g

Mass of water = __________________________ g

[Turn over]

0 8 . 4 **The teacher repeated the experiment with a different sample of the oxide of copper.**

The teacher found that the oxide of copper produced 2.54 g of copper and 0.72 g of water.

Two possible equations for the reaction are:

EQUATION 1: $Cu_2O + H_2 \rightarrow 2\,Cu + H_2O$

EQUATION 2: $CuO + H_2 \rightarrow Cu + H_2O$

Determine which is the correct equation for the reaction in the teacher's experiment.

Relative atomic masses (A_r):

H = 1 O = 16 Cu = 63.5

[3 marks]

[Turn over]

8

0 9 A student investigated the temperature change in the reaction between dilute sulfuric acid and potassium hydroxide solution.

This is the method used.

1. Measure 25.0 cm^3 potassium hydroxide solution into a polystyrene cup.
2. Record the temperature of the solution.
3. Add 2.0 cm^3 dilute sulfuric acid.
4. Stir the solution.
5. Record the temperature of the solution.
6. Repeat steps 3 to 5 until a total of 20.0 cm^3 dilute sulfuric acid has been added.

0 9 . 1 **Suggest why the student used a polystyrene cup rather than a glass beaker for the reaction. [2 marks]**

[Turn over]

TABLE 6 shows some of the student's results.

TABLE 6

Volume of dilute sulfuric acid added in cm^3	Temperature in °C
0.0	18.9
2.0	21.7
4.0	23.6
6.0	25.0
8.0	26.1
10.0	27.1

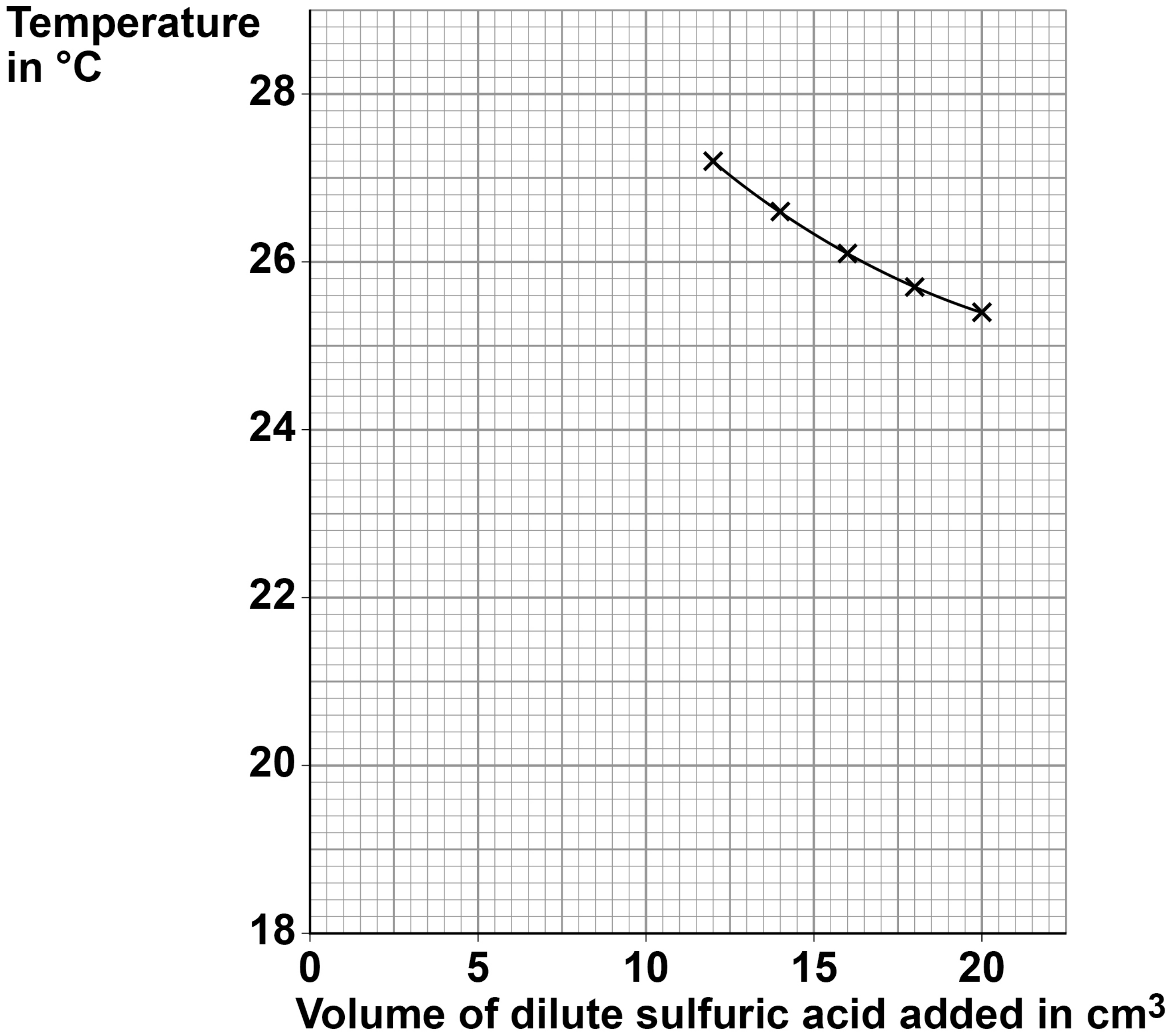
FIGURE 11, on the opposite page, shows some of the data from the investigation.

0 9 . 2 Complete FIGURE 11:

- **plot the data from TABLE 6 above**
- **draw a line of best fit through these points**
- **extend the lines of best fit until they cross.**

[4 marks]

FIGURE 11



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0 9 . 3 Determine the volume of dilute sulfuric acid needed to react completely with 25.0 cm^3 of the potassium hydroxide solution.

Use FIGURE 11, on page 67. [1 mark]

Volume of dilute sulfuric acid to react completely =

____________________________ cm^3

0 9 . 4 Determine the overall temperature change when the reaction is complete.

Use FIGURE 11. [1 mark]

____

____

____

Overall temperature change = ____________ °C

[Turn over]

0 9 . 5 **The student repeated the investigation.**

The student used solutions that had different concentrations from the first investigation.

The student found that 15.5 cm^3 of 0.500 mol/dm^3 dilute sulfuric acid completely reacted with 25.0 cm^3 of potassium hydroxide solution.

The equation for the reaction is:

$$2\,KOH + H_2SO_4 \rightarrow K_2SO_4 + 2\,H_2O$$

Calculate the concentration of the potassium hydroxide solution in mol/dm^3 and in g/dm^3

Relative atomic masses (A_r):

H = 1 O = 16 K = 39 [6 marks]

Concentration in mol/dm^3 =

______________________________ mol/dm^3

Concentration in g/dm^3 =

______________________________ g/dm^3

END OF QUESTIONS

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For Examiner's Use	
Question	Mark
1	
2	
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8	
9	
TOTAL	

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