

Please write clearly in block capitals.

Centre number

--	--	--	--	--

Candidate number

--	--	--	--

Surname

---

Forename(s)

---

Candidate signature

---

# GCSE CHEMISTRY

# H

Higher Tier Paper 1

Thursday 16 May 2019

Morning

Time allowed: 1 hour 45 minutes

## Materials

For this paper you must have:

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

## Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or 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.

For Examiner's Use

Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
<b>TOTAL</b>	



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** shows the periodic table Mendeleev produced in 1869.

His periodic table was more widely accepted than previous versions.

**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 . 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]**

---



---



**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]**

---

---

---

---

---

---

---

**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

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

**[1 mark]**

In the modern periodic table, the elements are arranged in order of

---

Turn over ►



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**



**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<sup>+</sup>

H<sup>-</sup>

O<sup>2-</sup>

OH<sup>-</sup>

**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 + \_\_\_\_\_

**Question 2 continues on the next page**

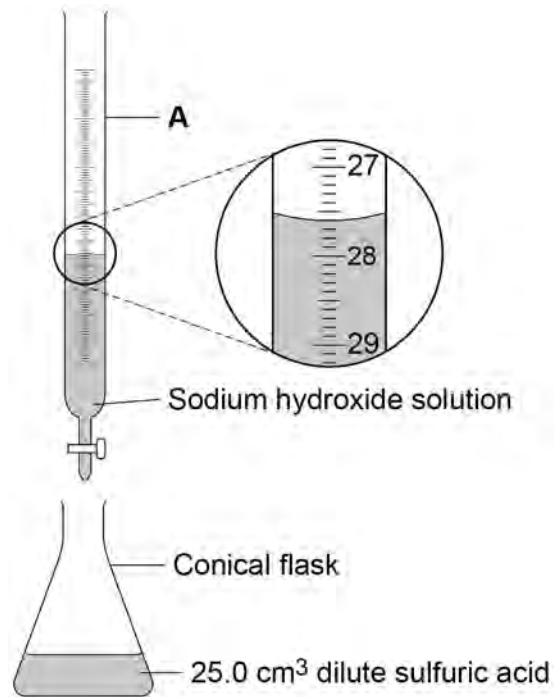
**Turn over ►**



A student investigates the volume of sodium hydroxide solution that reacts with  $25.0 \text{ cm}^3$  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]

\_\_\_\_\_  $\text{cm}^3$



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]**

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

**Turn over ►**



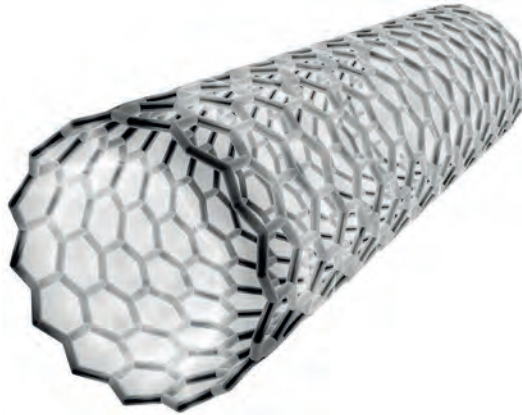
0 3

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]**

---

---

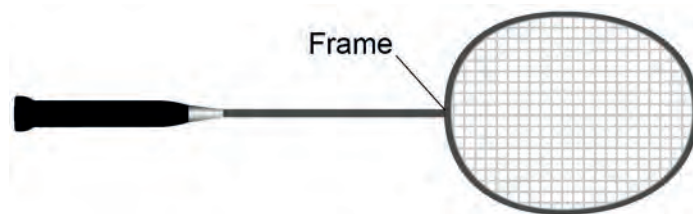
---

---

0 3 . 2

**Figure 4** shows a badminton racket.

**Figure 4**





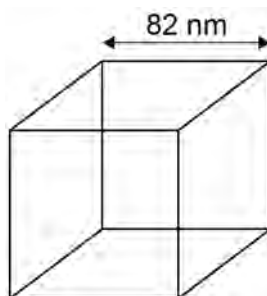


Zinc oxide can be produced as nanoparticles and as fine particles.

**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<sup>2</sup>

**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]**

---



---



**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]**

---



---

**Question 4 continues on the next page**

**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]**

---

---

---

---

---

---

---

---

---

---

8
---



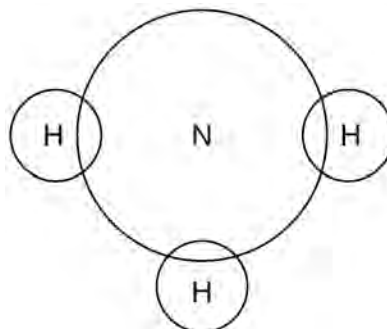
0 5

This question is about ammonia,  $\text{NH}_3$ 

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 ►**

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

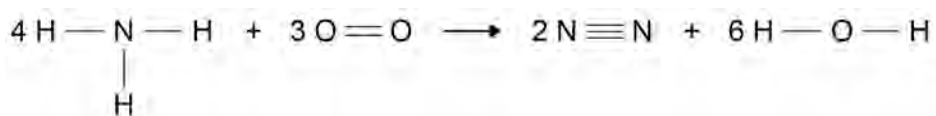
Cr<sub>2</sub>O<sub>3</sub>

MgO

Na<sub>2</sub>O

**Figure 7** shows the displayed formula equation for the reaction.

**Figure 7**



**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]**

---

---

---

---

---

---

---

Overall energy change = \_\_\_\_\_ kJ

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

Use values from your calculation in Question **05.5**

**[2 marks]**

---

---

---

---

---

---

**Question 5 continues on the next page**

**Turn over ►**



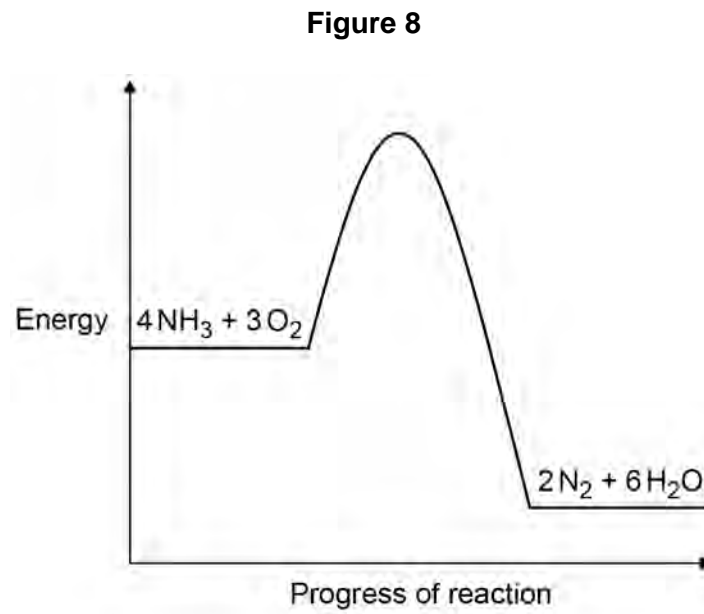
0 5 . 7

**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]



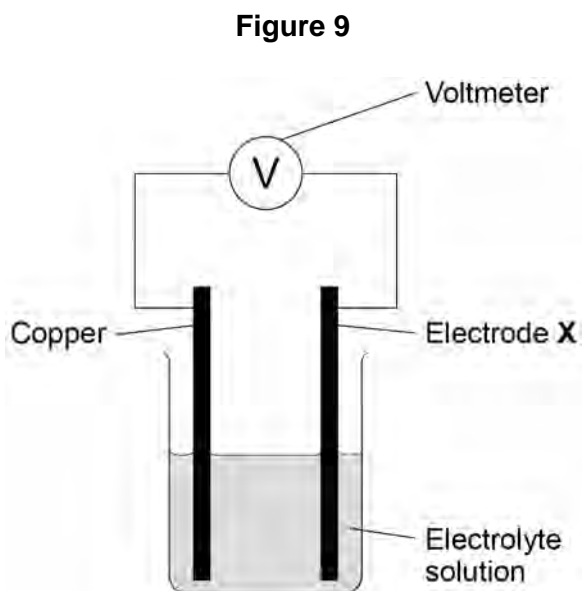


0 6

This question is about chemical cells.

A student investigated the voltage produced by different chemical cells.

**Figure 9** shows the apparatus.



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 \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Least reactive \_\_\_\_\_

Justification \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



**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**.

**[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 ►



**0 7**

This question is about electrolysis.

Aluminium is produced by electrolysis of 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]**

---

---

---

---

**0 7 . 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.

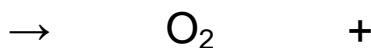
Aluminium ions gain electrons.

Aluminium ions lose electrons.

**0 7 . 3**

Oxygen is produced at the positive electrode.

Complete the balanced half-equation for the process at the positive electrode.

**[2 marks]**

07.4

Explain why the positive electrode must be continually replaced.

**[3 marks]**

---

---

---

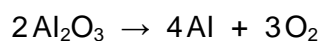
---

---

---

07.5

The overall equation for the electrolysis of aluminium oxide is:



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  $24.0 \text{ dm}^3$

Relative formula mass ( $M_r$ ):  $\text{Cl}_2 = 71$

**[2 marks]**

---

---

---

---

Volume = \_\_\_\_\_  $\text{dm}^3$

16



**Turn over for the next question**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**

**Turn over ►**



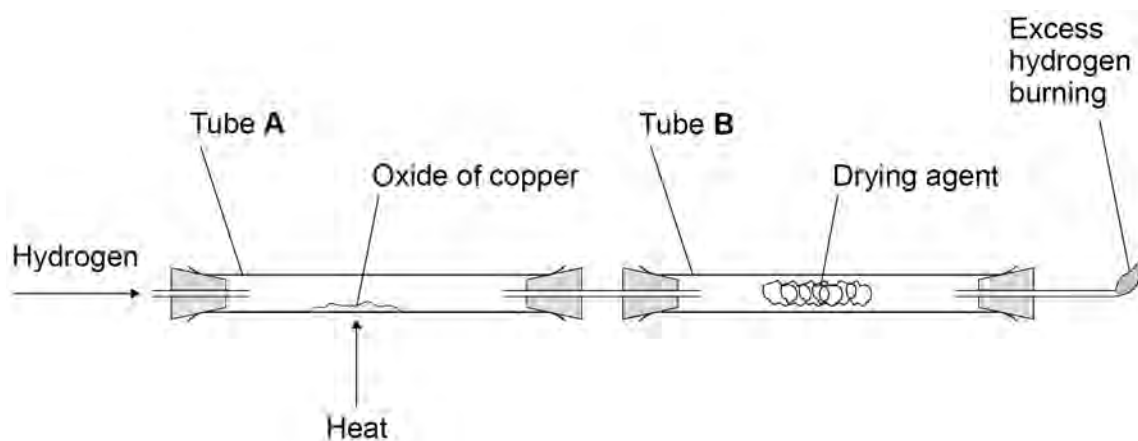
0 8

Copper forms two oxides,  $\text{Cu}_2\text{O}$  and  $\text{CuO}$

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]**

---

---

---

---

**Question 8 continues on the next page**

**Turn over ►**



Figure 10 is repeated here.

Figure 10

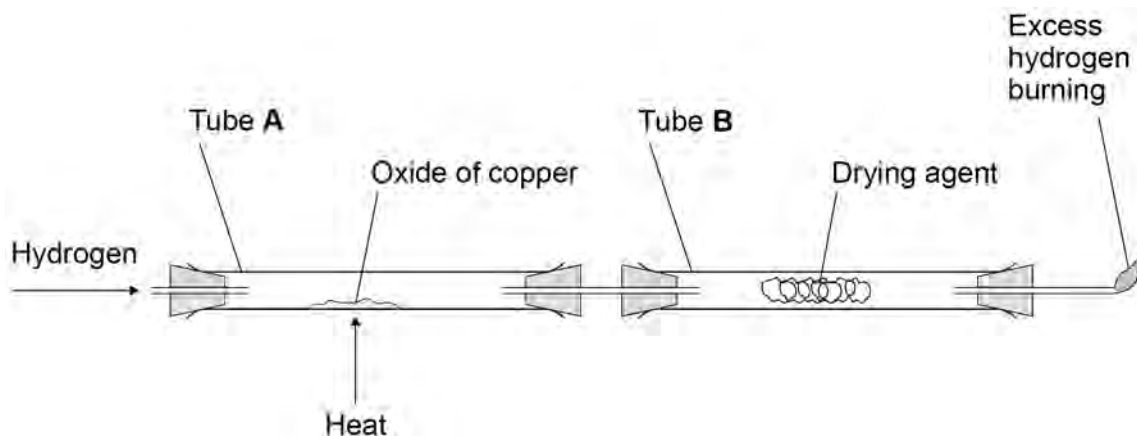


Table 5 shows the teacher's results.

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:



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

Use **Table 5**.

**[2 marks]**

---



---



---



---

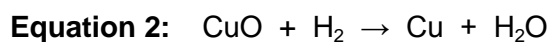
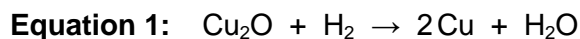
Mass of copper = \_\_\_\_\_ g

Mass of water = \_\_\_\_\_ g

**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:



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]**

---



---



---



---



---



---

8

**Turn over for the next question**

**Turn over ►**



**There are no questions printed on this page**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**



**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<sup>3</sup> potassium hydroxide solution into a polystyrene cup.
2. Record the temperature of the solution.
3. Add 2.0 cm<sup>3</sup> 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<sup>3</sup> 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]**

---

---

---

---

**Question 9 continues on the next page**

**Turn over ►**

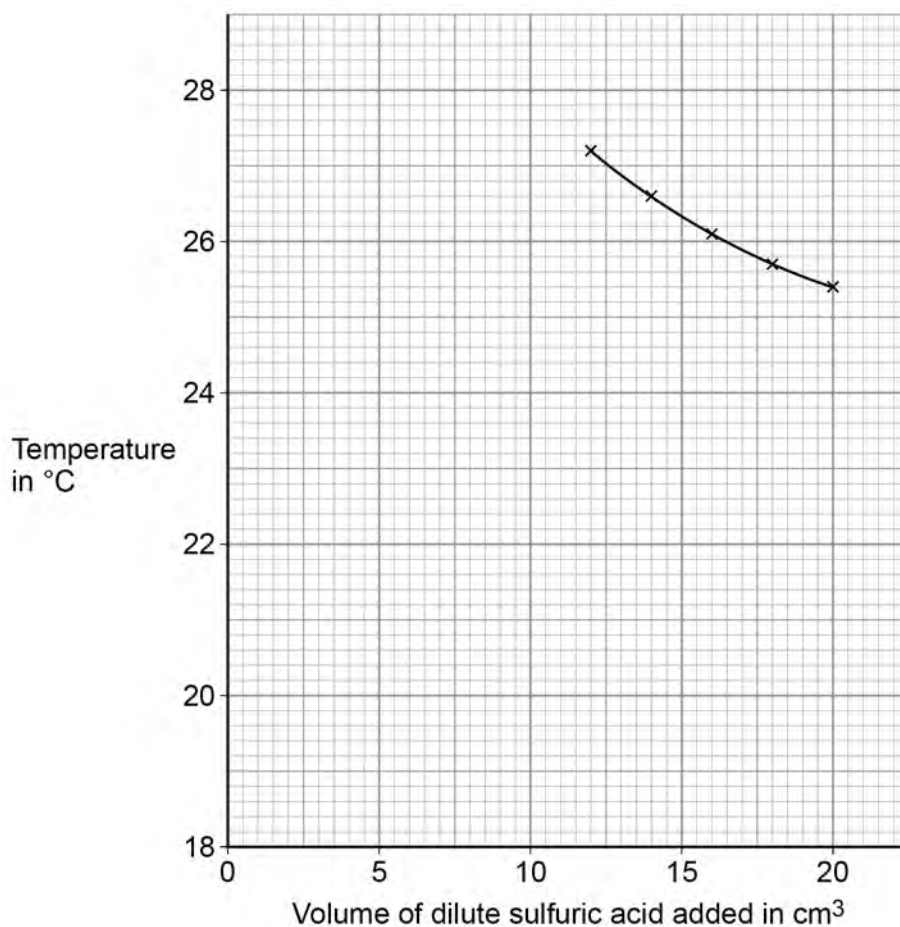
**Table 6** shows some of the student's results.

**Table 6**

Volume of dilute sulfuric acid added in cm <sup>3</sup>	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** shows some of the data from the investigation.

**Figure 11**



**0 9 . 2** Complete **Figure 11**:

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

**[4 marks]**

**0 9 . 3** Determine the volume of dilute sulfuric acid needed to react completely with 25.0 cm<sup>3</sup> of the potassium hydroxide solution.

Use **Figure 11**.

**[1 mark]**

Volume of dilute sulfuric acid to react completely = \_\_\_\_\_ cm<sup>3</sup>

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

Use **Figure 11**.

**[1 mark]**

\_\_\_\_\_  
\_\_\_\_\_

Overall temperature change = \_\_\_\_\_ °C

**Question 9 continues on the next page**

**Turn over ►**



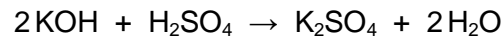
0 9 . 5

The student repeated the investigation.

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

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

The equation for the reaction is:



Calculate the concentration of the potassium hydroxide solution in mol/dm<sup>3</sup> and in g/dm<sup>3</sup>

Relative atomic masses ( $A_r$ ): H = 1    O = 16    K = 39

[6 marks]

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

Concentration in mol/dm<sup>3</sup> = \_\_\_\_\_ mol/dm<sup>3</sup>

Concentration in g/dm<sup>3</sup> = \_\_\_\_\_ g/dm<sup>3</sup>

**END OF QUESTIONS**

**Copyright information**

For confidentiality purposes acknowledgements of third-party copyright material are published in a separate booklet which is available for free download from [www.aqa.org.uk](http://www.aqa.org.uk) after the live examination series.

Copyright © 2019 AQA and its licensors. All rights reserved.

14

