AQA

GCSE
CHEMISTRY

H

Higher Tier   Paper 1

Thursday 17 May 2018   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 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

- There are 100 marks available on this paper.
- 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	
TOTAL	

0 1 Soluble salts are formed by reacting metal oxides with acids.

0 1 . 1 Give one other type of substance that can react with an acid to form a soluble salt.

[1 mark]

0 1 . 2 Calcium nitrate contains the ions Ca^{2+} and NO_3^-

Give the formula of calcium nitrate.

[1 mark]

0 1 . 3 Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

[6 marks]

Do not write outside the box

8

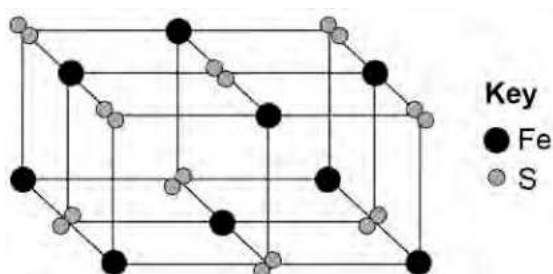Turn over for the next question

| 0 | 2 | This question is about metals and metal compounds.

| 0 | 2 | 1 | Iron pyrites is an ionic compound.

Figure 1 shows a structure for iron pyrites.

Figure 1

Determine the formula of iron pyrites.

Use Figure 1.

[1 mark]

| 0 | 2 | 2 | An atom of iron is represented as 5626Fe

Give the number of protons, neutrons and electrons in this atom of iron.

[3 marks]

Number of protons

Number of neutrons _____

Number of electrons _____

| 0 | 2 | 3 | Iron is a transition metal.

Sodium is a Group 1 metal.

Give two differences between the properties of iron and sodium.

[2 marks]

1

_____

2

_____

_____

Nickel is extracted from nickel oxide by reduction with carbon.

0 2 . 4 Explain why carbon can be used to extract nickel from nickel oxide.

[2 marks]

_____

_____

_____

_____

0 2 . 5 An equation for the reaction is:

$NiO + C \rightarrow Ni + CO$

Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (Ar): C = 12 Ni = 59

Relative formula mass (Mr): NiO = 75

Give your answer to 3 significant figures.

[3 marks]

_____

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_____

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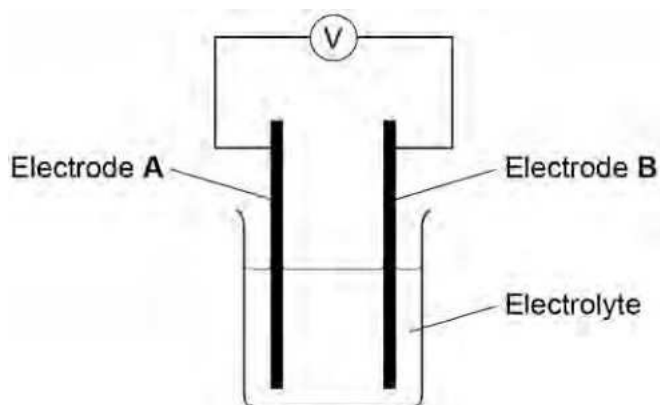Percentage atom economy = _____ %

11

Turn over ▶

0 3   Chemical reactions can produce electricity.

0 3 . 1   Figure 2 shows a simple cell.

Figure 2

Which of these combinations would not give a zero reading on the voltmeter in Figure 2?

[1 mark]

Tick one box.

Electrode A	Electrode B	Electrolyte	
Copper	Copper	Sodium chloride solution	
Zinc	Zinc	Water	
Copper	Zinc	Sodium chloride solution	
Copper	Zinc	Water	

Alkaline batteries are non-rechargeable.

0 3 . 2 Why do alkaline batteries eventually stop working?

[1 mark]

_____

_____

0 3 . 3 Why can alkaline batteries not be recharged?

[1 mark]

_____

_____

Question 3 continues on the next page

Turn over ▶

Hydrogen fuel cells and rechargeable lithium-ion batteries can be used to power electric cars.

| 0 | 3 | . | 4 |

Complete the balanced equation for the overall reaction in a hydrogen fuel cell.

[2 marks]

_____ H2 + _____ ⬚ _____ H2O

| 0 | 3 | . | 5 |

Table 1 shows data about different ways to power electric cars.

Table 1

	Hydrogen fuel cell	Rechargeable lithium-ion battery
Time taken to refuel or recharge in minutes 5 30		
Distance travelled before refuelling or recharging in miles Up to 415 Up to 240		
Distance travelled per unit of energy in km 22 66		
~~Cost of refuelling or recharging~~ in £ 50 3		
Minimum cost of car in £ 60 000 18 000		

Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars.
Use Table 1 and your own knowledge.

[6 marks]

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Turn over for the next question

11

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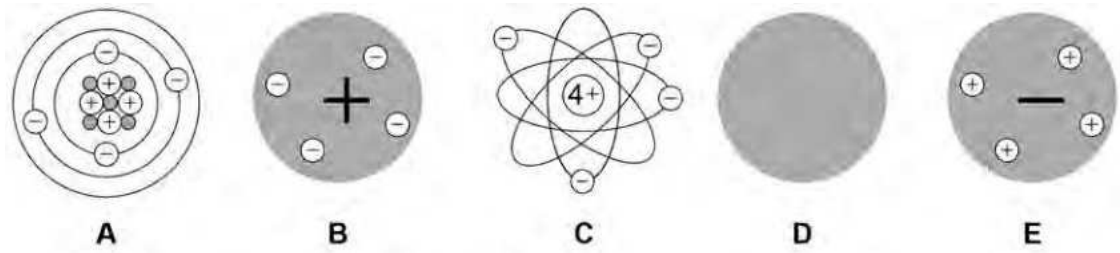
0 4   Figure 3 represents different models of the atom.

Figure 3

0 4 . 1   Which diagram shows the plum pudding model of the atom?

Tick one box.

[1 mark]

A ☐   B ☐   C ☐   D ☐   E ☐

0 4 . 2   Which diagram shows the model of the atom developed from the alpha particle scattering experiment?

Tick one box.

[1 mark]

A ☐   B ☐   C ☐   D ☐   E ☐

0 4 . 3   Which diagram shows the model of the atom resulting from Bohr's work?

Tick one box.

[1 mark]

A ☐ B ☐ C ☐ D ☐ E ☐

0 4 . 4 Define the mass number of an atom.

[1 mark]

_____

_____

0 4 . 5 Element X has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

• 60% of 69X

• 40% of 71X

Estimate the relative atomic mass of element X.

[1 mark]

Tick one box.

< 69.5 ☐

Between 69.5 and 70.0 ☐

Between 70.0 and 70.5 ☐

> 70.5 ☐

0 4 . 6 Chadwick's experimental work on the atom led to a better understanding of isotopes.

Explain how his work led to this understanding.

[3 marks]

_____

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8

Turn over ▶

0 5 A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.
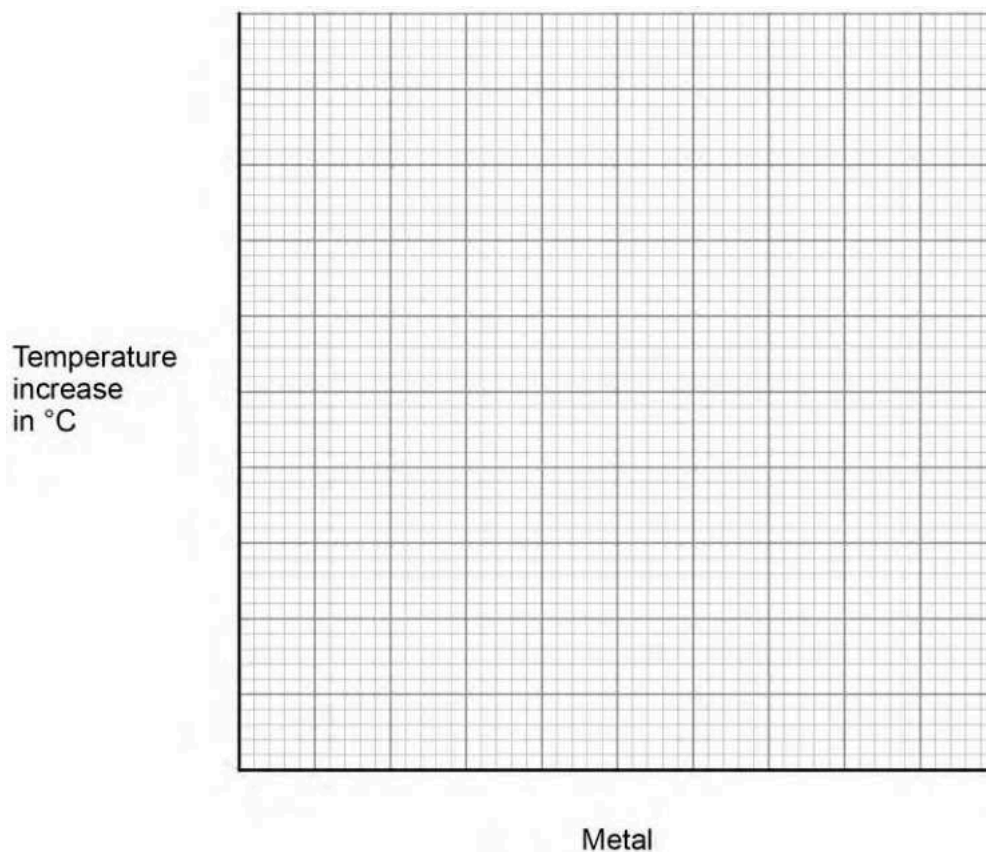
Table 2 shows the student's results.

Table 2

Metal	Temperature increase in °C
Copper	0
Iron	13
Magnesium	43
Zinc	17

0 5 . 1 Plot the data from Table 2 on Figure 4 as a bar chart.

[2 marks]

Figure 4

Temperature increase in °C

Metal

12

0 5 2 The student concluded that the reactions between the metals and copper sulfate solution are endothermic.

Give one reason why this conclusion is not correct.

[1 mark]

0 5 3 The temperature change depends on the reactivity of the metal.

The student's results are used to place copper, iron, magnesium and zinc in order of their reactivity.
Describe a method to find the position of an unknown metal in this reactivity series.

Your method should give valid results.

[4 marks]

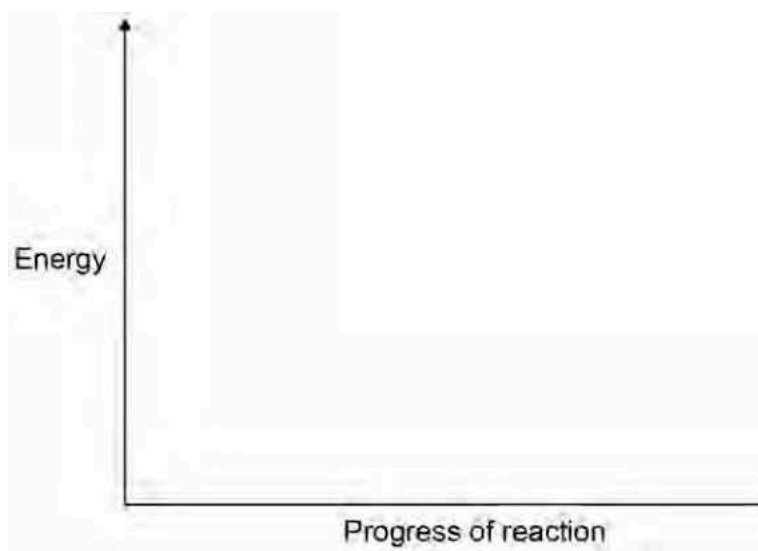Question 5 continues on the next page

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13

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0 5 4   Draw a fully labelled reaction profile for the reaction between zinc and copper sulfate solution on Figure 5.

[3 marks]

Figure 5

10

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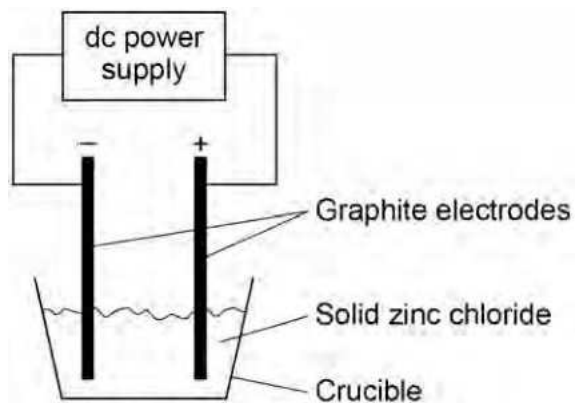
ANSWER IN THE SPACES PROVIDED

Turn over ►

15

0 6　A student investigated the electrolysis of different substances.

Figure 6 shows the apparatus.

Figure 6

0 6 . 1　Explain why electrolysis would not take place in the apparatus shown in Figure 6.

[2 marks]

_____

_____

_____

0 6 . 2　Explain why graphite conducts electricity.

Answer in terms of the structure and bonding in graphite.
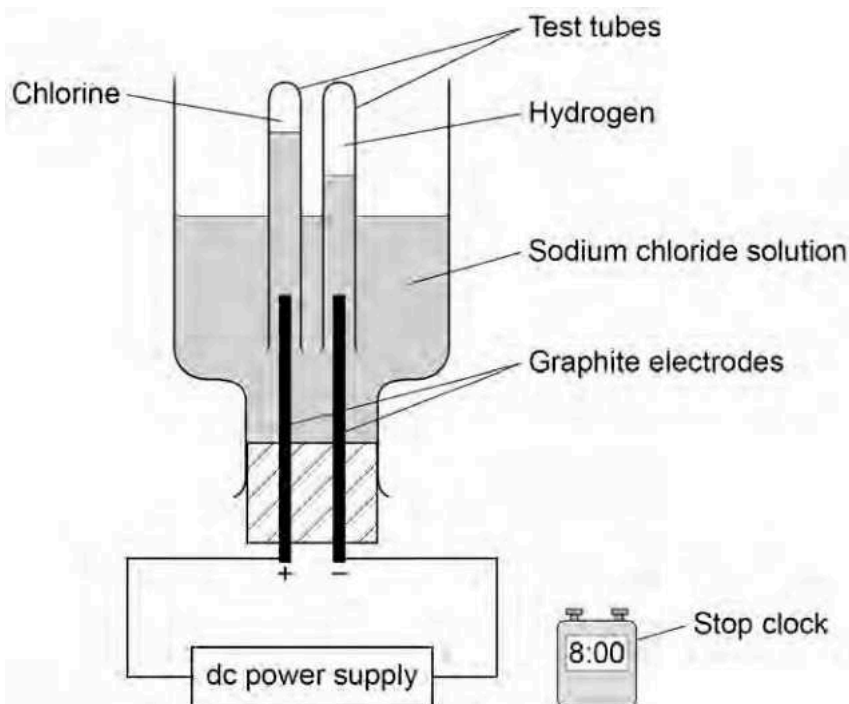
[3 marks]

_____

_____

_____

_____

The student investigated how the volume of gases produced changes with time in the electrolysis of sodium chloride solution.

Figure 7 shows the apparatus.

Figure 7

The student made an error in selecting the apparatus for this investigation.

0 6 . 3

How should the apparatus be changed?
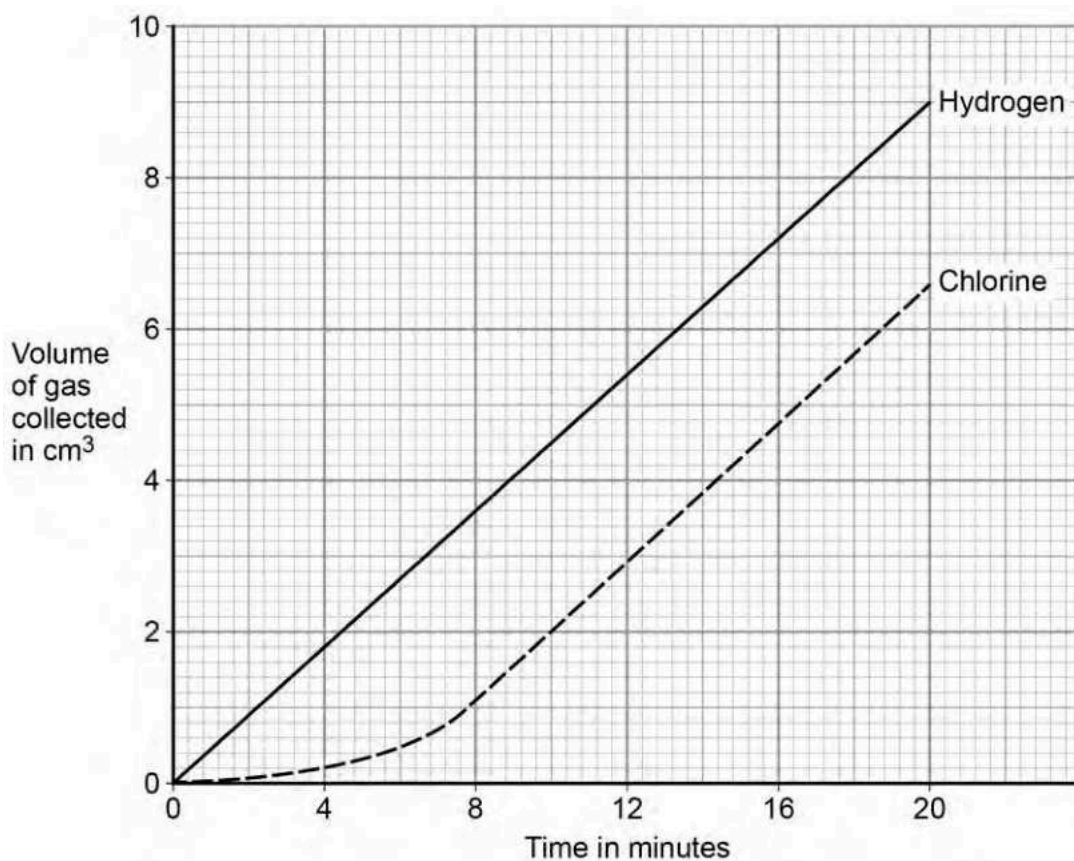
Give one reason for your answer.

[2 marks]

Turn over ▶

17

Another student used the correct apparatus.

This student measured the volumes of gases collected every minute for 20 minutes.
Figure 8 shows the student's results.

Figure 8

0 6 . 4   Describe the trends shown in the results.

Use values from Figure 8.

[3 marks]

0 6 5 The number of moles of each gas produced at the electrodes is the same.

No gas escapes from the apparatus.

Suggest one reason for the difference in volume of each gas collected.

[1 mark]

0 6 6 Calculate the amount in moles of chlorine collected after 20 minutes.

Use Figure 8.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm3

Give your answer in standard form.

[3 marks]

Moles of chlorine = _____ mol

14

Turn over for the next question

Turn over ▶

| 0 | 7 | This question is about Group 7 elements.

Chlorine is more reactive than iodine.

| 0 | 7 . 1 | Name the products formed when chlorine solution reacts with potassium iodide solution.

[1 mark]

_____

_____

| 0 | 7 . 2 | Explain why chlorine is more reactive than iodine.

[3 marks]

_____

_____

_____

_____

_____

| 0 | 7 . 3 | Chlorine reacts with hydrogen to form hydrogen chloride.

Explain why hydrogen chloride is a gas at room temperature.

Answer in terms of structure and bonding.

[3 marks]

_____

_____

_____

_____

_____

| 0 | 7 | 4 | Bromine reacts with methane in sunlight.

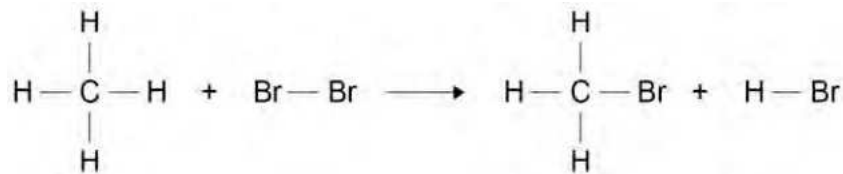Figure 9 shows the displayed formulae for the reaction of bromine with methane.

Figure 9

Table 3 shows the bond energies and the overall energy change in the reaction.

Table 3

		C___H Br___Br CBr	H___Br	Overall energy change
Energy in kJ/mol 412 193		X	366	– 51

Calculate the bond energy X for the C___Br bond.

Use Figure 9 and Table 3.

[4 marks]

Bond energy X = _____ kJ/mol

11

Turn over ▶

21

0 8 Titanium is a transition metal.

Titanium is extracted from titanium dioxide in a two stage industrial process.

Stage 1 $TiO_2 + 2\ C + 2\ Cl_2 \rightarrow TiCl_4 + 2\ CO$

Stage 2 $TiCl_4 + 4\ Na \rightarrow Ti + 4\ NaCl$

0 8 . 1 Suggest one hazard associated with Stage 1.

[1 mark]

_____

_____

0 8 . 2 Water must be kept away from the reaction in Stage 2.

Give one reason why it would be hazardous if water came into contact with sodium.

[1 mark]

_____

_____

0 8 . 3 Suggest why the reaction in Stage 2 is carried out in an atmosphere of argon and not in air.

[2 marks]

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_____

_____

0 8 . 4   Titanium chloride is a liquid at room temperature.

Explain why you would not expect titanium chloride to be a liquid at room temperature.

[3 marks]

_____

_____

_____

_____

_____

_____

In Stage 2, sodium displaces titanium from titanium chloride.

0 8 . 5   Sodium atoms are oxidised to sodium ions in this reaction.

Why is this an oxidation reaction?

[1 mark]

_____

_____

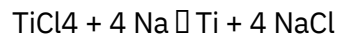0 8 . 6   Complete the half equation for the oxidation reaction.

[1 mark]

$$Na \quad \square \quad \underline{\hspace{2cm}} \quad + \quad \underline{\hspace{2cm}}$$

Turn over ▶

0 8 . 7   In Stage 2, 40 kg of titanium chloride was added to 20 kg of sodium.

The equation for the reaction is:

TiCl4 + 4 Na ☐ Ti + 4 NaCl

Relative atomic masses (*Ar*): Na = 23 Cl = 35.5 Ti = 48 Explain why

titanium chloride is the limiting reactant.

You must show your working.

[4 marks]

0 8 . 8   For a Stage 2 reaction the percentage yield was 92.3%

The theoretical maximum mass of titanium produced in this batch was 13.5 kg.

Calculate the actual mass of titanium produced.

[2 marks]

Mass of titanium = _____ kg

15

0 9 This question is about acids and alkalis.

0 9 . 1 Dilute hydrochloric acid is a strong acid.

Explain why an acid can be described as both strong and dilute.

[2 marks]

_____

_____

_____

_____

0 9 . 2 A 1.0×10^{-3} mol/dm3 solution of hydrochloric acid has a pH of 3.0

What is the pH of a 1.0×10^{-5} mol/dm3 solution of hydrochloric acid?

[1 mark]

pH = _____

Question 9 continues on the next page

Turn over ►

A student titrated 25.0 cm3 portions of dilute sulfuric acid with a 0.105 mol/dm3 sodium hydroxide solution.

| 0 | 9 | . | 3 | Table 4 shows the student's results.

Table 4

	Titration 1	Titration 2	Titration 3	Titration 4	Titration 5
Volume of sodium hydroxide solution in cm3	23.50	21.10	22.10	22.15	22.15

The equation for the reaction is:

2 NaOH + H2SO4 ⬚ Na2SO4 + 2 H2O
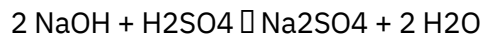
Calculate the concentration of the sulfuric acid in mol/dm3

Use only the student's concordant results.

Concordant results are those within 0.10 cm3 of each other.

[5 marks]

_____

_____

_____

_____

_____ mol/dm3

_____

_____

_____

_____

Concentration of sulfuric acid = _____

0 9 . 4 Explain why the student should use a pipette to measure the dilute sulfuric acid and a burette to measure the sodium hydroxide solution.

[2 marks]

_____

_____

_____

_____

0 9 . 5 Calculate the mass of sodium hydroxide in 30.0 cm3 of a 0.105 mol/dm3 solution.

Relative formula mass (*Mr*): NaOH = 40

[2 marks]

_____

_____

_____

Mass of sodium hydroxide = _____ g

12

END OF QUESTIONS

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