OCR
Oxford Cambridge and RSA

Tuesday 13 June 2023 – Morning

GCSE (9–1) Chemistry A (Gateway Science)

J248/04 Paper 4 (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Chemistry A (inside this document)

You can use:
- a scientific or graphical calculator
- an HB pencil

H

* J 2 4 8 0 4 *

* 9 1 3 0 7 5 8 1 7 8 *

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

Section A

You should spend a **maximum** of **30 minutes** on this section.

Write your answer to each question in the box provided.

1 Crude oil is a resource that is being made extremely slowly.

Which word describes a resource that is being made extremely slowly?

A Finite

B Hydrocarbon

C Non-renewable

D Petrochemical

Your answer ☐ **[1]**

2 The Group 7 element fluorine is a gas at room temperature and pressure.

The Group 7 elements show a trend in boiling points going down the group.

Which row shows the boiling points of the Group 7 elements?

	Boiling Point (°C)			
	Fluorine	**Chlorine**	**Bromine**	**Iodine**
A	–188	59	184	–15
B	–188	–34	59	184
C	188	184	59	–15
D	–15	184	188	59

Your answer ☐ **[1]**

3 Copper can be extracted from copper ore by heating the copper ore with carbon.

Copper can also be extracted by bioleaching.

What is an **advantage** of bioleaching?

A It can produce sulfuric acid.

B It extracts copper, which is then purified by electrolysis.

C It is done at low temperatures.

D It is slow.

Your answer ☐ **[1]**

4 Which gas was the most abundant in the Earth's early atmosphere?

A Argon

B Carbon dioxide

C Nitrogen

D Oxygen

Your answer ☐ **[1]**

5 This is the balanced symbol equation for the reaction of copper oxide with carbon.

$2CuO + C \rightarrow 2Cu + CO_2$

What happens to the copper oxide in this reaction?

A It is neutralised.

B It is oxidised.

C It is reduced.

D It is thermally decomposed.

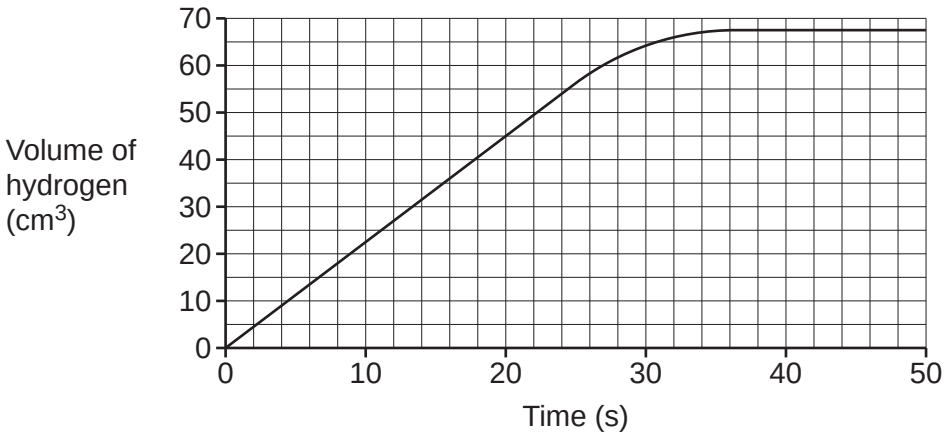
Your answer ☐ **[1]**

6 Which row in the table shows three greenhouse gases?

A	argon	carbon dioxide	nitrogen
B	carbon dioxide	methane	water vapour
C	hydrogen	methane	water vapour
D	carbon dioxide	nitrogen	water vapour

Your answer ☐ **[1]**

7 The graph shows the volume of hydrogen gas made in an experiment.



What is the rate of reaction when the time is 20 s?

A 0.44 cm^3 / s

B 2.25 cm^3 / s

C 25 cm^3 / s

D 900 cm^3 / s

Your answer ☐ **[1]**

8 Why are alloys stronger than the pure metals which they are made from?

A Alloys combine the properties of the metals they are made from.

B Alloys contain atoms of different sizes.

C Alloys contain different atoms bonded together.

D Alloys have strong bonds between their molecules.

Your answer ☐ **[1]**

9 Which statement about chemical cells is correct?

A They produce a voltage indefinitely.

B They produce a voltage once all of the reactants are used up.

C They produce a voltage until one of the reactants is completely used up.

D They produce a voltage until the reactants are partly used up.

Your answer ☐ **[1]**

10 Which of these homologous series can form addition polymers?

A Alcohols and carboxylic acids

B Alkenes and alkanes

C Alkenes only

D Carboxylic acids only

Your answer ☐ **[1]**

11 Which statement about the greenhouse effect is correct?

A Greenhouse gases absorb all the infrared radiation that is emitted by the Earth's surface.

B Greenhouse gases make up a large percentage of the Earth's current atmosphere.

C The greenhouse effect is caused by the absorption and reflection of infrared radiation by greenhouse gases.

D The higher the concentration of greenhouse gases in the Earth's atmosphere, the colder the Earth is likely to become.

Your answer ☐ **[1]**

12 Ethane is a very small hydrocarbon molecule.

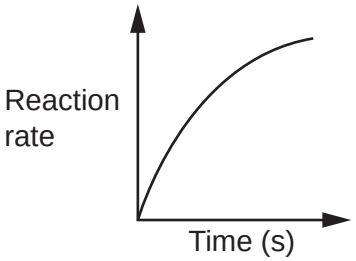
Which row about ethane is correct?

	Easy to ignite?	Boiling point
A	✓	high
B	✗	high
C	✓	low
D	✗	low

Your answer ☐ **[1]**

13 Which graph shows a dynamic equilibrium?

A



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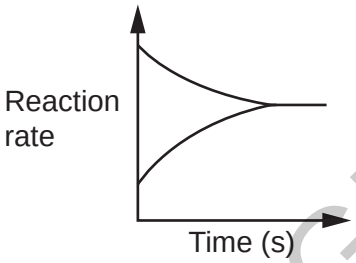

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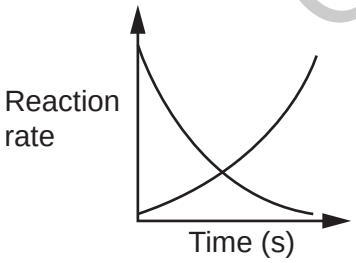

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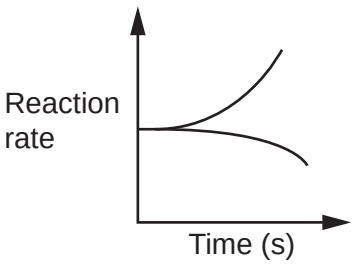
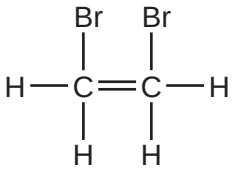


Your answer ☐ **[1]**

14 Ethene, C_2H_4, reacts with bromine in an addition reaction.

What is the structural formula of the product?

A



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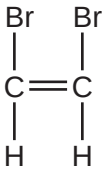

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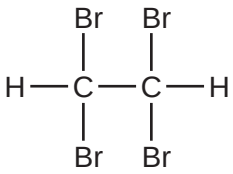

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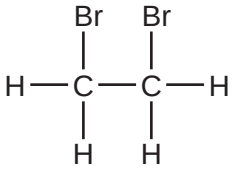

Your answer ☐ **[1]**

15 What is the half equation for the reaction at the **anode** in a hydrogen/oxygen fuel cell?

A $2H_2 + O_2 \rightarrow 2H_2O$

B $2H_2 \rightarrow 4H^+ + 4e^-$

C $4H^+ + 4e^- \rightarrow 2H_2$

D $4H^+ + O_2 + 4e^- \rightarrow 2H_2O$

Your answer ☐ **[1]**

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Section B

16 A student investigates two solutions, **A** and **B**.

They know that
- one solution contains a halide ion
- the other solution contains a different anion.

They test 2 cm^3 of each solution for the halide ion using this method:

- Add a few drops of dilute hydrochloric acid and shake.
- Add a few drops of silver nitrate solution.
- Record the colour of the precipitate.

(a) The teacher says that the student should have used a different acid instead of dilute hydrochloric acid.

(i) State the name of the acid the student should have used.

..... **[1]**

(ii) Explain why using dilute hydrochloric acid would affect the results of this test.

.....

.....

..... **[2]**

(b) The student repeats the test for halide ions using the correct acid and silver nitrate solution.

They also test each solution using a few drops of dilute hydrochloric acid followed by a few drops of barium chloride solution.

The table shows their results.

Solution	Observation with silver nitrate solution	Observation with barium chloride solution
A	cream precipitate	no change
B	no change	white precipitate

State the name of the anion in each solution.

Solution **A** .....

Solution **B** ..... **[2]**

(c) Solution **A** also contains copper ions, Cu^{2+}.

Copper ions react with hydroxide ions, OH^-, to make a precipitate of copper(II) hydroxide.

Write the **balanced ionic** equation for this reaction. Include the state symbols.

..... **[3]**

(d) Barium chloride solid is toxic if swallowed and harmful if inhaled.

Barium chloride solutions with concentrations of 21 g / dm^3 are suitable for experiments in school.

Calculate the mass of barium chloride that should be dissolved in 25 cm^3 of water to make a solution with a concentration of 21 g / dm^3.

Use the equation:

$$\text{concentration} = \frac{\text{mass}}{\text{volume}}$$

Give your answer to **2** significant figures.

Mass of barium chloride = ... g **[3]**

17 The table shows information about three different polymers, **A**, **B** and **C**.

Tensile strength is the amount of load a material can take before it breaks.

	Melting point (°C)	Softening temperature (°C)	Stiffness (MPa)	Tensile strength (MPa)
A	130	72	980	15
B	240	95	3200	65
C	250	75	2400	50

(a) A company wants to use a polymer to make a disposable cup for hot drinks.

Suggest and explain which polymer, **A**, **B or C**, the company should use.

Polymer .....

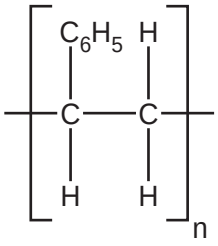
Reason .....

.....

.....

..... **[3]**

(b) This is the repeating unit in polymer **B**.



Draw the structure of the **monomer** from which polymer **B** is made.

[2]

(c) Some substances are naturally occurring polymers.

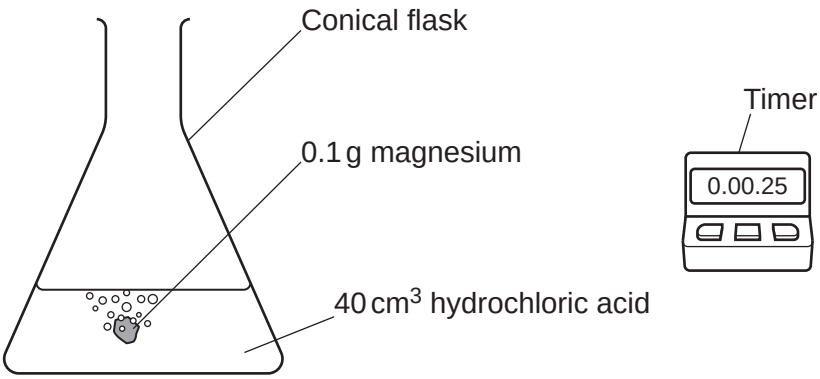
Draw lines to connect each **monomer** with its naturally occurring **polymer**.

Monomer	Polymer
amino acids	DNA
nucleotides	proteins
sugars	starch

[2]

18 A teacher investigates the reaction between hydrochloric acid and magnesium.

The diagram shows the teacher's experiment.



The teacher uses five different concentrations of hydrochloric acid. Each time they react the hydrochloric acid with 0.1 g of magnesium powder.

The table shows the teacher's results.

Concentration of hydrochloric acid (mol / dm^3)	Time for magnesium powder to react (s)
0.5	117
1.0	82
1.5	48
2.0	24
2.5	16

(a) Write the **balanced symbol** equation for the reaction between hydrochloric acid, HC*l*, and magnesium.

..... **[2]**

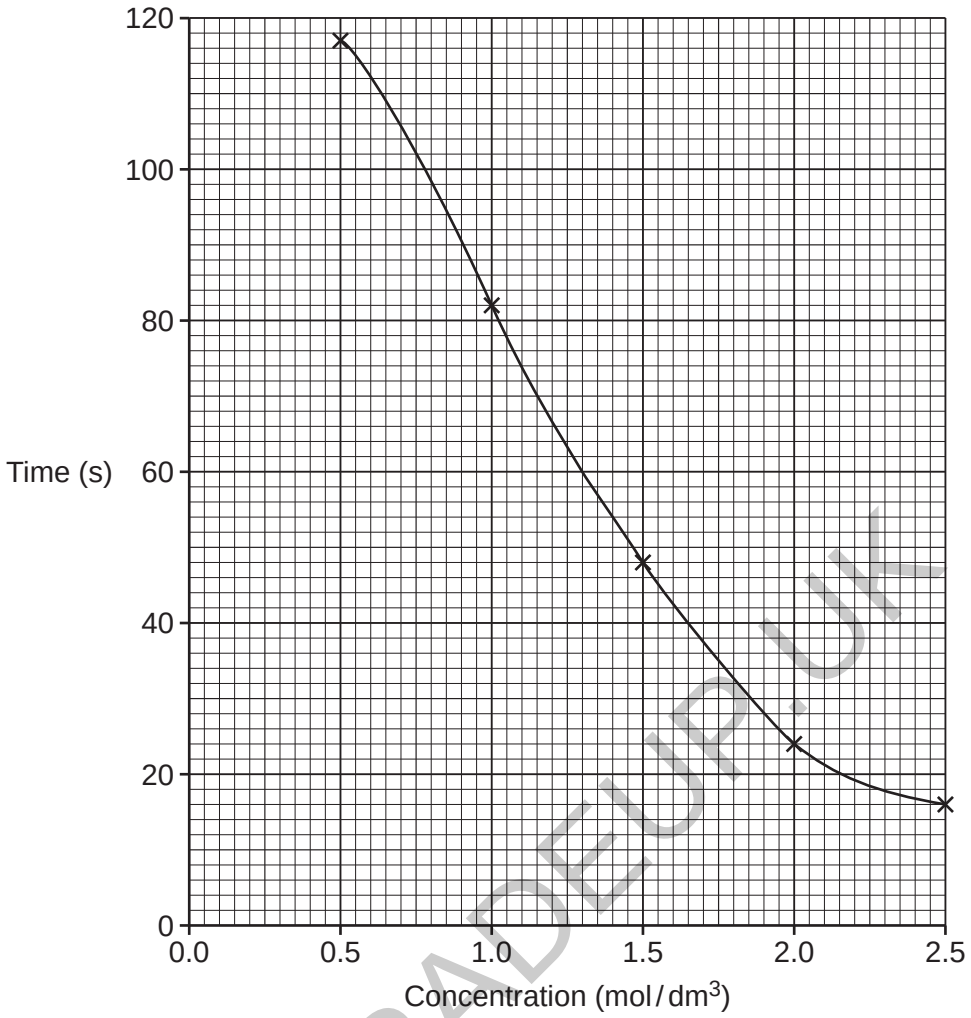
(b) The teacher says, 'The reaction is faster the more concentrated the hydrochloric acid'.

Use the results to explain why the teacher is **correct**.

.....

..... **[1]**

(c) The graph shows the teacher's results.



(i) Use the graph to deduce the time for magnesium powder to react if 1.3 mol / dm^3 hydrochloric acid is used.

Time = ... s **[1]**

(ii) The teacher repeats the experiment with 0.1 g of magnesium **ribbon**.

Draw a line on the graph to show the results you would expect the teacher to get. **[2]**

(d) The teacher used 0.1 g of magnesium.

0.1 g of magnesium reacts with hydrochloric acid to make 0.008 g of hydrogen gas.

Calculate the volume occupied by 0.008 g of hydrogen gas **in cm^3**.

Relative atomic mass (A_r): H = 1.0

Volume of hydrogen gas = ... cm^3 **[4]**

19* A life-cycle assessment looks at the potential environmental impact at each stage of the life of a product.

A car manufacturer does a life-cycle assessment for cars made from

- steel
- aluminium.

The table gives information about the life-cycle impact of cars made from steel and aluminium.

	Steel	**Aluminium**
Production CO_2 emissions from mining the ore, extracting the metal, to manufacturing the car	6444 kg	9794 kg
Driving CO_2 emissions from the use of petrol or diesel	37 054 kg	36 248 kg
End of life CO_2 emissions saved by recycling metals rather than extracting new metals	 –1546 kg	 –3634 kg

Evaluate which type of metal has the smallest environmental impact over its lifetime.
Use the information in the table, and your own knowledge of how metals are extracted.

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..... **[6]**

20 Butane, C_4H_{10}, is an alkane.

Butane undergoes complete combustion in oxygen.

(a) Write the **balanced symbol** equation for the complete combustion of butane.

..... **[2]**

(b) **Table 20.1** lists the energy given out when 1 g of different alkanes burn.

Table 20.1

Alkane	Energy given out (kJ)
butane	49.2
ethane	52.6
methane	55.6
propane	50.4

State the relationship between the number of carbon atoms in the alkane and the energy given out.

.....

..... **[1]**

(c) Butane is found in the LPG fraction when crude oil is separated into different fractions by fractional distillation.

Table 20.2 shows some information about four other molecules that are found in four different fractions.

Table 20.2

Molecule	Formula	Boiling point (°C)
heptadecane	$C_{17}H_{36}$	302
eicosane	$C_{20}H_{42}$	342
tetracosane	$C_{24}H_{50}$	
octacosane	$C_{28}H_{58}$	436

(i) Predict the boiling point of tetracosane.

Boiling point of tetracosane = ... °C **[1]**

(ii) Octacosane is separated lower down the fractionating column than the other three molecules in **Table 20.2**.

Explain why using ideas about intermolecular forces.

.....

.....

.....

..... **[3]**

(d) Cracking breaks down large molecules produced in fractional distillation into more useful molecules.

The equation shows the cracking of octacosane to make dodecane and **one** other product.

Complete and balance the equation.

$$\underset{\text{octacosane}}{C_{28}H_{58}} \longrightarrow \underset{\text{dodecane}}{C_{12}H_{26}} + \text{.....}$$

[2]

(e) **Table 20.3** shows the percentage supply and demand for some of the different fractions obtained from crude oil.

Table 20.3

Fraction	Percentage supply (%)	Percentage demand (%)
LPG	2	4
petrol	5	23
naphtha	8	5
kerosene	12	7
diesel oil	17	23
fuel oil	56	38

More petrol can be obtained by cracking another fraction.

Suggest and explain which fraction is cracked to obtain petrol.

Fraction .....

Reason .....

..... **[2]**

21 Methanol, CH_3OH, is made in industry by reacting carbon monoxide with hydrogen.

This is the equation for the reaction.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

(a) A temperature of 250 °C and a pressure of 100 atmospheres is used for the reaction.

(i) Describe and explain the effect on the yield of methanol from using a pressure of 15 atmospheres.

.....

.....

.....

..... **[3]**

(ii) The yield of methanol is greater when a temperature of 150 °C is used instead of 250 °C.

Suggest why a temperature of 150 °C is **not** used in industry.

.....

..... **[1]**

(b) A catalyst is used to speed up the reaction.

Describe the effect on the position of equilibrium from using a catalyst.

.....

..... **[1]**

(c) A factory makes some methanol.

They predict they will make 60 tonnes of methanol. The reaction has a percentage yield of 78%.

Calculate the mass of methanol they actually make.

Mass of methanol = ... tonnes **[3]**

(d) **(i)** Draw the structural formula of methanol, CH_3OH.

[2]

(ii) State the **functional group** in methanol.

..... **[1]**

(e) Methanol can be oxidised to methanoic acid.

State the **oxidising agent** used in this reaction.

..... **[1]**

(f) Methanoic acid is a carboxylic acid.

Carboxylic acids react with alcohols to form an ester and one other product.

(i) What type of reaction is this?

Tick (✓) **one** box.

Addition ☐

Condensation ☐

Decomposition ☐

Neutralisation ☐

[1]

(ii) State the name of the other product in this type of reaction.

..... **[1]**

22 Group 7 elements (halogens) react with halides in solution.

Chlorine reacts with potassium bromide to form potassium chloride and bromine.

$Cl_2(g) + 2KBr(aq) \rightarrow 2KCl(aq) + Br_2(aq)$

(a) Describe what you would **observe** in the reaction.

..... **[1]**

(b) This is the half equation that shows what happens to chlorine.

$Cl_2 + 2e^- \rightarrow 2Cl^-$

(i) Explain why this half equation shows reduction.

..... **[1]**

(ii) Write the **balanced half** equation for the reaction of the bromide ions.

..... **[2]**

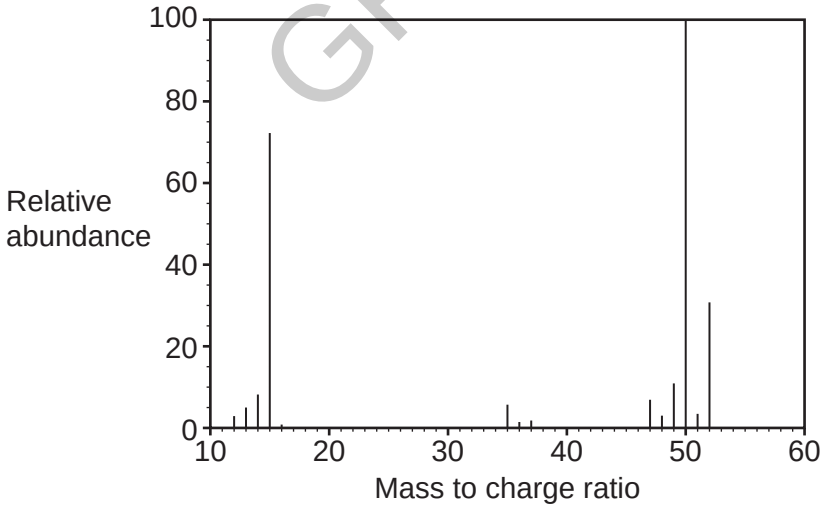
(c) Chlorine displaces bromine from potassium bromide because chlorine is more reactive than bromine.

Explain why chlorine is more reactive than bromine.

.....

..... **[2]**

(d) The diagram shows the mass spectrum for a compound containing chlorine.



State the **relative molecular mass** of this compound.

..... **[1]**

(e) Instrumental methods of analysis, such as mass spectrometry, have advantages over simple chemical methods of analysis.

State **two** advantages of instrumental methods of analysis.

1 .....

.....

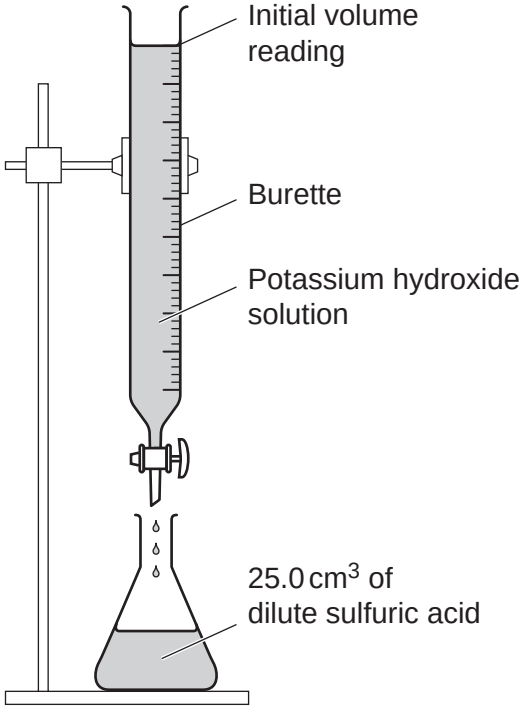
2 .....

.....

[2]

23 A student plans a titration experiment.

The diagram shows some of the apparatus they use.



(a) At the end of the titration, the student reads the final volume reading from the top of the meniscus instead of from the bottom of the meniscus.

How does the measured volume of potassium hydroxide compare to the actual volume?

Tick (✓) **one** box.

The measured volume will be greater than the actual volume. ☐

The measured volume will be smaller than the actual volume. ☐

The measured volume will be the same as the actual volume. ☐

[1]

(b) The student uses a potassium hydroxide solution with a concentration of 0.100 mol / dm^3 to neutralise the 25.0 cm^3 of dilute sulfuric acid.

The table shows the student's results.

Titration number	**1**	**2**	**3**	**4**
Final burette reading (cm^3)	24.1	26.6	26.0	26.8
Initial burette reading (cm^3)	0.0	1.5	2.1	2.8
Titre (volume of potassium hydroxide solution used) (cm^3)	24.1	25.1	23.9	24.0

(i) Calculate the average titre using the student's concordant results.

Average titre = ... cm^3 **[1]**

(ii) This is the equation for the reaction in this experiment.

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

Calculate the concentration of sulfuric acid **in g / dm^3**.

Relative atomic mass (A_r): H = 1.0 O = 16.0 S = 32.0

Concentration of sulfuric acid = ... g / dm^3 **[5]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).