Candidate Marks Report

Series : 6 2018

This candidate's script has been assessed using On-Screen Marking. The marks are therefore not shown on the script itself, but are summarised in the table below.

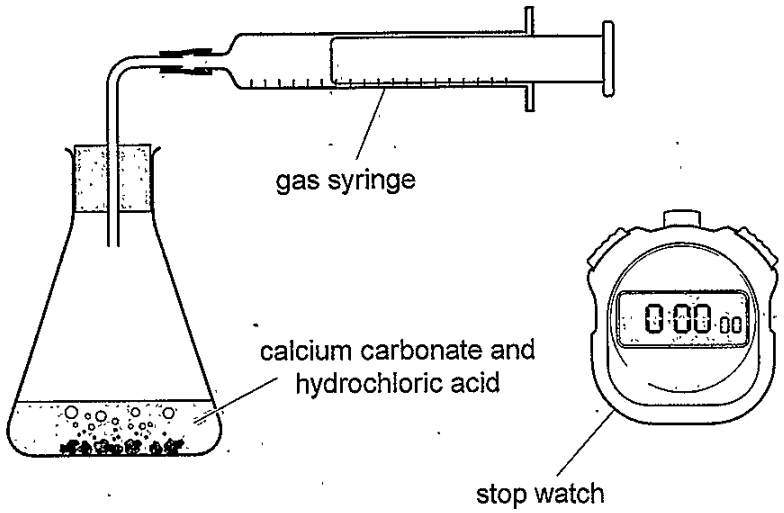
Centre No :		Assessment Code :	J258
Candidate No :		Component Code :	03
Candidate Name :			

Total Marks :

Answer **all** the questions.

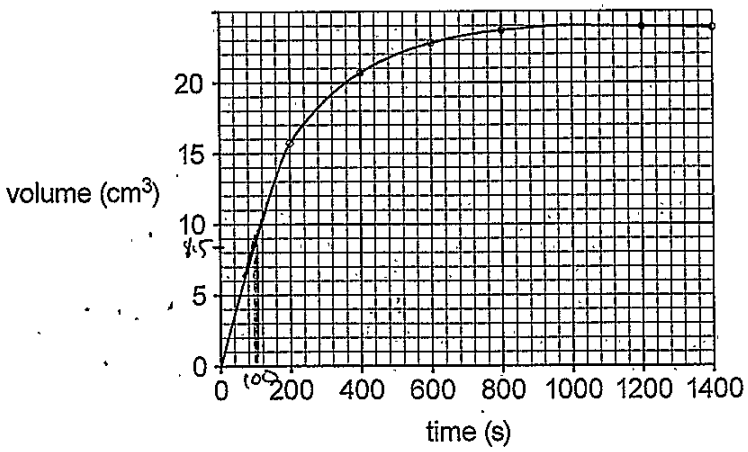
1 Calcium carbonate reacts with excess hydrochloric acid to make carbon dioxide.

Here is the apparatus Jack uses to investigate the reaction.



Jack records the volume of carbon dioxide made every 200 seconds.

Here is a graph of his results.



(a) Use the graph to calculate the rate of reaction over the first 100 s.

$\frac{dy}{dx} = \frac{8.5-0}{100-0} = \frac{8.5}{100} = 0.085$

Rate = 0.085 cm^3/s **[2]**

(b) Amaya wants to repeat Jack's experiment.

She uses the same mass of calcium carbonate.

She uses the same volume and concentration of hydrochloric acid.

Which **two** other factors does she need to keep the same?

1 The stopwatch used

2 the gas syringe used.

[2]

(c) Jack repeats his experiment with more concentrated hydrochloric acid.

He keeps **all** other factors the same. The rate of reaction is faster.

Explain why.

Write about particles in your answer.

A higher concentration means that there are more particles available to react in the same volume. The particles are more likely to collide, therefore the frequency of collisions is higher, increasing the rate of reaction. **[2]**

(d) 0.10 g of calcium carbonate makes 24 cm^3 of carbon dioxide. ÷1000

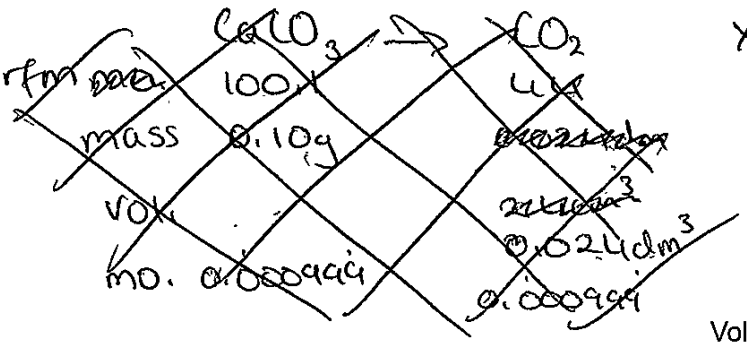
Jack uses 0.070 g of calcium carbonate.

What volume of carbon dioxide does he make?

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

vol. = mol x 24

mass = mo. x rfm



x0.7 (0.10g : 24cm3) x0.7
0.070g : 16.8

= 17 (2sf) cm^3

Volume = 17 cm^3 **[3]**

2 Fizzy water can be found naturally.

The water is fizzy because it contains dissolved carbon dioxide gas. The carbon dioxide comes from the decomposition of rocks that contain carbonate compounds.

One compound found in rocks is magnesium carbonate.

Ali investigates the decomposition of magnesium carbonate by heating a small amount in a test tube. This is the equation for the reaction.

$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$

(a) Ali weighs the test tube before and after heating.

The mass of the test tube after heating is less.

Ali says that this means the **law of conservation of mass** is not correct.

Explain why Ali is **wrong**.

It is correct as where she has heated the magnesium carbonate, carbon dioxide gas has been given off which would explain the decrease in mass. **[2]**

(b) Calculate the atom economy for the production of carbon dioxide in this reaction.

Use the formula: atom economy = $\frac{\text{mass of atoms in desired product}}{\text{total mass of atoms in reactants}} \times 100\%$

Give your answer to 1 decimal place.

$MgCO_3$

$= 24.3 + 12 + (16 \times 3)$

$= 84.3$

CO_2

$= 12 + (8 \times 16 \times 2)$

$= 44$

$\frac{44}{84.3} \times 100 = 52.1945\ldots\%$

Atom economy = 52.2 % **[4]**

(c) In theory, 42.0 g of $MgCO_3$ loses 22.0 g of carbon dioxide when it completely decomposes.

Ali heats 4.2 g of $MgCO_3$.

(i) Calculate the mass of carbon dioxide lost when 4.2 g of $MgCO_3$ completely decomposes.

$\frac{2.2}{10} = 2.2$

Mass = 2.2 g **[1]**

(ii) In Ali's experiment, the mass of carbon dioxide lost is 1.8 g.

Calculate the percentage yield of carbon dioxide in Ali's experiment.

$\frac{1.8}{2.2} \times 100 = 81.81\%$

~~$= 82$ (sf)~~

$= 81.8\%$

Percentage yield = 81.8 % **[1]**

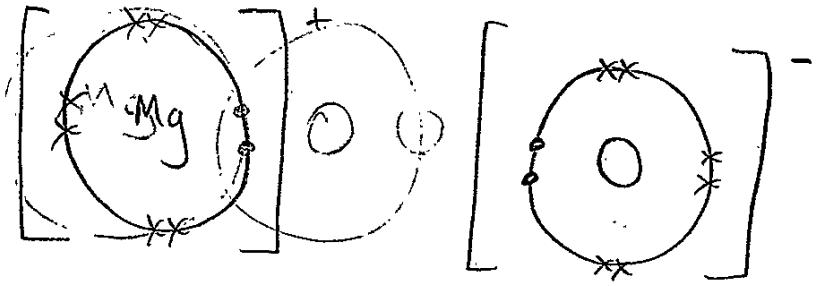
(d) Magnesium oxide, MgO, is an ionic compound.

Draw a 'dot and cross' diagram for the ions in magnesium oxide.

Show the outer electron shells only.

• = Mg

× = O



[2]

3 The table shows the properties of three polymers.

Polymer	Relative breaking strength	Flexibility	Temperature at which it softens (°C)
A	very high	fairly flexible	250
B	low	very flexible	70
C	fairly low	stiff	150

(a) A firm wants to make cups to hold boiling water.

Discuss the suitability of **each** polymer.

Polymer A would be quite suitable as the temperature is much higher than the temperature of boiling water (100°C). ~~but is~~ Polymer B is not suitable as it would soften while holding boiling water and is too flexible. Polymer C is the most suitable as it softens at 150°C, higher than 100°C, and is very stiff. [3]

(b) Which of polymers **A**, **B** and **C**, has the **weakest** intermolecular forces?

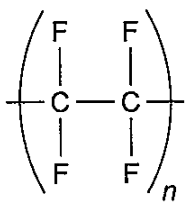
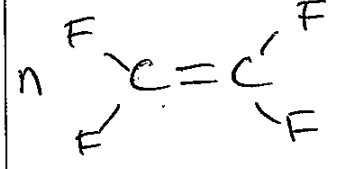
Give a reason for your answer.

Polymer B

Reason It softens at the lowest temperature meaning it requires the least amount of energy to break the bonds. [2]

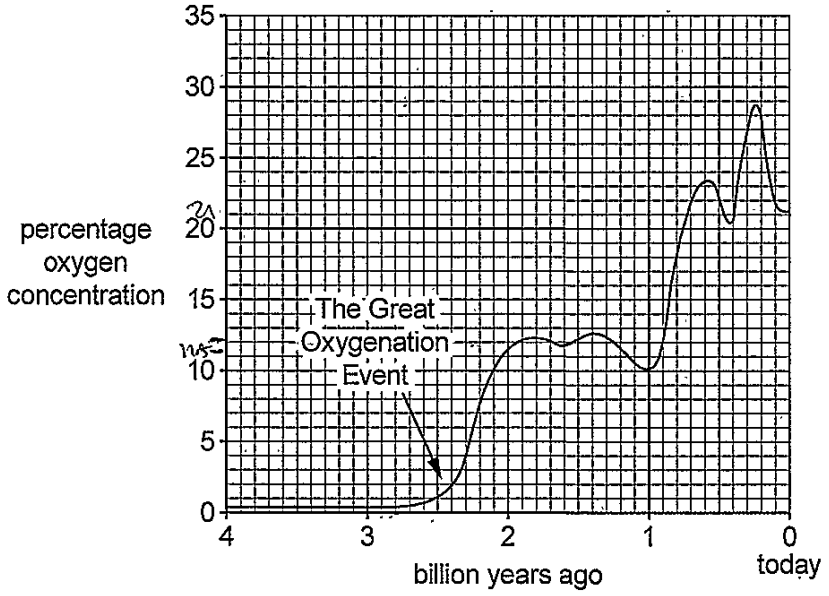
(c) Polymer **A** is an addition polymer.

Draw the structure of the monomer that forms polymer **A**. [1]

Repeating unit of polymer A	Structure of monomer
	

4 The percentage of oxygen gas in the Earth's atmosphere has generally increased over time.

This graph shows the percentage oxygen concentration in the Earth's atmosphere over the last 4 billion years.



(a) (i) Describe how the oxygen content of the Earth's atmosphere has changed during the last four billion years.

Generally, the oxygen content has increased. However, between 4 billion years ago and around 3.2 million years ago the content had not changed at all. [2]

(ii) The concentration of oxygen has increased from two billion years ago to today.

By what factor has it increased?

Factor = photosynthesis ..... [1]

(iii) Explain what caused the sudden increase in oxygen concentration 2.5 billion years ago and explain why the concentration did not continue to rise.

Vegetation had begun to thrive and it carried out photosynthesis which produces oxygen. It did not continue to rise as animals used the oxygen for respiration. [2]

(b) Iron pyrites in rocks was oxidised to compounds like iron(III) sulfate by the oxygen in the early atmosphere.

Complete the **balanced chemical** equation for this reaction.

2 FeS_2 + 7 O_2 → $Fe_2(SO_4)_3$ + SO_2

[1]

2Fe ← Fe → 2

4S ← S → 4

14 ← 2SO → 14

5 Ling carries out an investigation of the halogens.

(a) Ling reacts some chlorine solution with a solution of potassium bromide.

The solution turns brown.

Explain why.

Include an **ionic** equation in your answer.

$Cl_2^- + KBr \rightarrow KCl + Br_2$

The solution turns brown because a ~~desolate~~ chlorine is more reactive than bromine.

[3]

(b) Ling sees that the element astatine, At, is below iodine in Group 7.

She makes some predictions about astatine.

Which predictions about astatine are correct?

Tick (✓) **two** boxes.

- Astatine is white. ☐
- Astatine is a gas. ☐
- Astatine reacts with sodium to form NaAt. ☑
- Astatine is less reactive than iodine. ☑

[1]

6 Nanoparticles of cerium oxide, CeO_2, are added to diesel fuel.

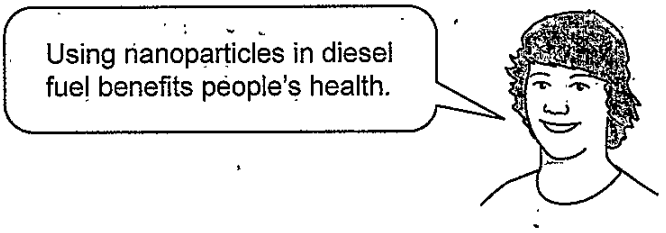
They act as a catalyst for the combustion of the fuel.

(a) Describe a property of nanoparticles that makes them good catalysts.

They have a large surface area to volume ratio meaning more of the particle is available to react [1]

(b) The addition of nanoparticles allows more complete combustion of the fuel.

Kai talks about nanoparticles in diesel fuel.



Evaluate Kai's statement.

In your answer give arguments **for** and **against** the use of nanoparticles.

Nanoparticle speed up reactions which makes them more useful and reduce the amount of harmful gas given off. However, scientists dos not know enough about the effects nanoparticles have on human health so we cannot say if they fully benefit humans. [3]

(c) CeO_2 contains O^{2-} ions.

Explain how the formula shows that Ce is present as Ce^{4+} ions.

Ce must have Ce^{4+} ions as 4:2 = 2:1 which would give 4:2 = 2:1 and there are 2 oxygens present. [1]

(d) A nanoparticle has a volume of $8 \times 10^{-27}\ m^3$.

A molecule has a volume of $4 \times 10^{-30}\ m^3$.

Estimate how many **moles** of this molecule there are in the nanoparticle.

Vol. = moles × 24 dm^3

$8 \times 10^{-27}\ m^3 = 8 \times 10^{-22}\ dm^3$

$\frac{8 \times 10^{-22}}{24} = 3.3 \times 10^{-23}$

$8 \times 10^{-27}\ m^3 = 8 \times 10^{-28}\ dm^3$

$4 \times 10^{-30}\ m^3 = 4 \times 10^{-31}\ dm^3$

$\frac{8 \times 10^{-28}}{4 \times 10^{-31}} = 2000$

Number of moles = 2000 mol [3]

7 This is an equation for a reaction that occurs in a lightning flash.

$N_2 + O_2 \rightleftharpoons 2NO$

Very high temperatures are needed.

(a) (i) Explain how you can tell that this equation refers to an equilibrium.

It uses the symbol for a reversable reaction [1]

(ii) Use ideas about rates to explain what is happening when the reaction reaches dynamic equilibrium.

When the reaction reaches dynamic equilibrium ~~there~~ it is the rate is the same in ~~some the same rate in~~ its the forwards reaction as in the backwards reaction. [2]

(b) Scientists can use this reaction to make nitrogen compounds from gases in the air.

(i) Suggest a use for these compounds.

Catalytic converters. [1]

(ii) The scientists discuss increasing the pressure on the reaction.

Describe and explain the effect on the equilibrium position.

The equilibrium will lie closer to the forwards reaction as there is a higher rate of reaction in the reactants. [2]

(c) There are several ways of making nitrogen compounds from nitrogen gas in industry.

Give **two** reasons why scientists may choose this reaction and **one** against.

Reason for There is a lot of nitrogen in the atmosphere so it is easy to obtain.

Reason for Obtaining nitrogen is cheap.

Reason against ~~Most~~ Some nitrogen compounds are greenhouse ~~gas~~ gases and harm the environment. [3]

8 Manganese is a metallic element.

(a) Manganese is made by heating manganese oxide, MnO_2, with carbon.

Carbon monoxide is also formed.

(i) Write a **balanced chemical** equation for this reaction.

Include state symbols in your equation.

$MnO_{2(s)} + 2C_{(aq)} \longrightarrow 2CO_{(g)} + Mn_{(s)}$ **[2]**

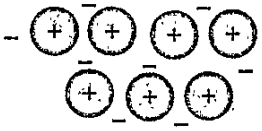
(ii) Explain why carbon can be used to extract manganese from its compounds.

Use ideas about reactivity and reduction in your answer.

Carbon can be used as it is more reactive than manganese, so carbon displacement will take place. Electrons are gained so reduction would take place. **[2]**

(b) Explain how the atoms are held together in a metal.

Refer to this diagram in your answer.



There is a strong electrostatic attraction between the delocalised electrons and positively charged atoms. **[3]**

9 Jane has a sample of a white powder, compound **A**.

(a) Jane carries out a flame test on compound **A** and sees a lilac flame.

What can Jane conclude about compound **A**?

Potassium It contains potassium [1]

(b) Jane looks at the emission spectrum of compound **A**.

(i) Describe what an emission spectrum looks like.

An emission spectrum shows the colours emitted by ~~given off by~~ an element. It is a bar with 6 strips of colour at certain points. [2]

(ii) Describe how Jane could use the spectrum to confirm her answer to **(a)**.

Re Use a ~~refren~~ reference spectrum for potassium. [1]

(c) Jane has a solution of compound **B**, sodium sulfate, Na_2SO_4.

She adds acidified barium chloride solution, $BaCl_2$, to a solution of compound **B**.

(i) What does she **see** when she does this?

A white precipitate. [1]

(ii) Write a **balanced chemical** equation for the reaction that occurs.

$Na_2SO_4 + BaCl_2 \rightarrow$ [2]

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10 Hydrogen for use as a fuel can be made by the electrolysis of water.

(a) Which statements about the electrolysis of water are correct?

Ticks (✓) **two** boxes.

The equation for the formation of hydrogen gas is $2H^+ + 2e^- \rightarrow H$. ☐

Hydrogen is produced at the cathode. ☐

Water contains H^+ and OH^- ions. ✓

Hydrogen ions are oxidised. ✓

[1]

(b) This is an equation for the overall reaction that happens when water is electrolysed.

$2H–O–H \rightarrow 2H–H + O=O$

Bond	Energy change (kJ/mol)
H–H	434
O=O	498
O–H	464

Use data in the table to calculate the energy needed to break and make bonds during the reaction.

Use your answers to calculate the energy change of the reaction.

2H-O-H
= 464x4 = 1856

2H-H
= 434x2
= 868

O=O
= 498

868+498 = 1366

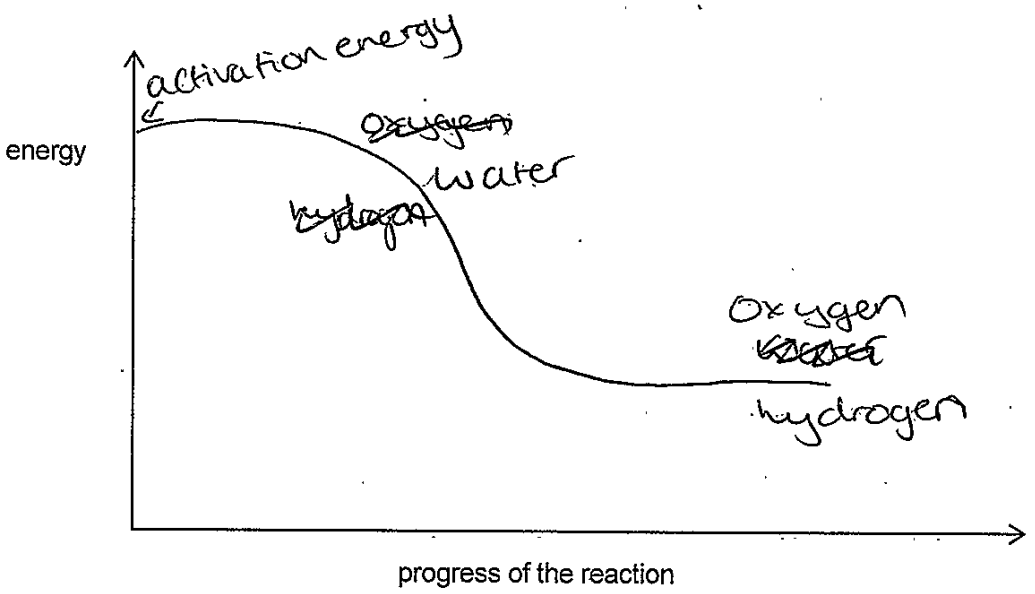
1856-1366 = 490

Energy change = 490 kJ/mol **[3]**

(c) Complete the reaction profile for the electrolysis of water.

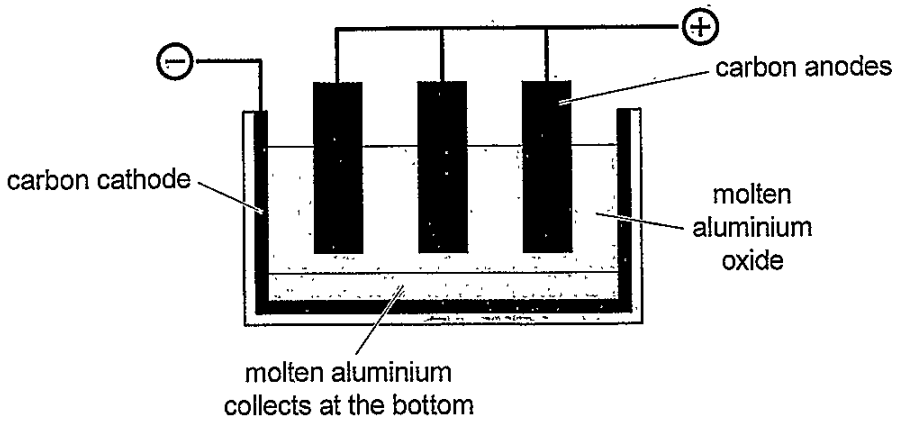
Use these words to label the reaction profile.

hydrogen **oxygen** **water** **activation energy**



[3]

11 Aluminium is made by the electrolysis of molten aluminium oxide.



(a) The ions present in molten aluminium oxide are Al^{3+} and O^{2-}.

Write **half-equations** for the formation of aluminium and oxygen in the electrolysis cell.

Formation of aluminium $Al^{3+} + 2e^-$

Formation of oxygen $O^{2-} - 2e^-$

[2]

(b) Aluminium oxide does not conduct electricity when it is solid.

It conducts electricity when it is molten.

Explain why.

In a solid the ions are not free to move whereas when it is molten they can. So it can conduct electricity. **[3]**

(c) This is an equation for the overall reaction in the electrolysis cell.

$2Al_2O_3 \rightarrow 4Al + 3O_2$

1.0 kg of aluminium is made in the cell.

1000g

Calculate the volume of oxygen (in dm^3 at room temperature and pressure) that is made.

Assume one mole of gas has a volume of 24 dm^3 at room temperature and pressure.

4 : 3

$2Al_2O_3 \rightarrow 4Al + 3O_2$

mass 1000g

rfm 108 96

mo 9.259 6.94

÷4 ×3

vol. 6.94 × 24

= 166.6

= 167 dm^3

vol. = mo × 24

mo = $\frac{ma}{rfm}$

Volume = 167 ..... dm^3 **[4]**

12 Sulfuric acid is used in car batteries.

Mia has a sample of car battery acid that is diluted to $\frac{1}{100}$ of its original concentration.

She measures the concentration of this acid by titration.

(a) This equation shows what happens when pure sulfuric acid is mixed with water.

$H_2SO_4(l) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$

Explain how this equation shows that sulfuric acid is a **strong** acid.

~~It is not a reversible reaction.~~ It still reacts even though it has been diluted. [1]

(b) Mia does a titration.

She puts the sulfuric acid in a burette.

She measures out 25.0 cm^3 of 0.100 mol/dm^3 NaOH.

(i) She wants to measure the 25.0 cm^3 of NaOH as accurately as possible.

Which piece of apparatus should Mia use?

Put a (ring) around the correct answer.

conical flask **(100 cm^3 measuring cylinder)** **volumetric pipette** **volumetric flask** [1]

(ii) Calculate the number of moles in 25.0 cm^3 of 0.100 mol/dm^3 NaOH.

Use the equation: concentration (mol/dm^3) = number of moles of solute ÷ volume (dm^3)

NaOH

vol. $25 \div 1000 = 0.025$

conc. 0.100

mol.

$conc = \frac{mol.}{vol.}$

$mol. = conc \times vol.$

$= 0.100 \times 0.025$

$= 2.5 \times 10^{-3}$

Number of moles = 2.5×10^{-3} mol **[3]**

(iii) This is an equation for sulfuric acid reacting with NaOH.

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

Mia finds that 24.5 cm^3 of H_2SO_4 reacts exactly with the NaOH.

Calculate the concentration of the sulfuric acid in the burette in mol/dm^3.

Use the equation: concentration (mol/dm^3) = number of moles of solute ÷ volume (dm^3)

2 : 1

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

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

vol. $0.0245 dm^3$

conc.

mol. 2.5×10^{-3} 1.25×10^{-3}

$\div 2$

$conc = \frac{mol.}{vol.}$

$= \frac{1.25 \times 10^{-3}}{0.0245}$

$= 0.05102...$

$= 0.051$

Concentration = 0.051 mol/dm^3 **[3]**

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).