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 : **73 / 90**

In the table below 'Total Mark' records the mark scored by this candidate.
'Max Mark' records the Maximum Mark available for the question.

Paper:	**J258/03**
Paper Total:	**73 / 90**

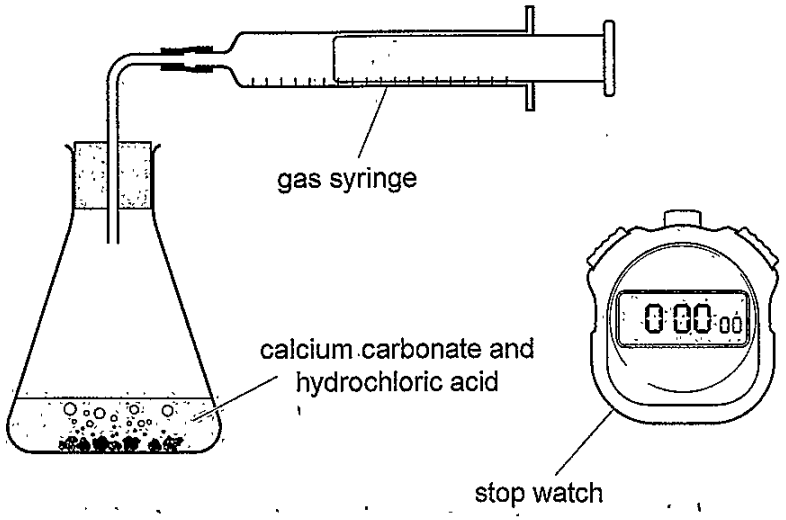
Question	Total Mark / Max Mark
1a	2 / 2
1b	2 / 2
1c	0 / 2
1d	2 / 3
2a	2 / 2
2b	4 / 4
2ci	1 / 1
2cii	1 / 1
2d	2 / 2
3a	3 / 3
3b	2 / 2
3c	1 / 1
4ai	2 / 2
4aii	0 / 1
4aiii	2 / 2
4b	1 / 1
5a	2 / 3
5b	1 / 1
6a	0 / 1
6b	3 / 3
6c	1 / 1
6d	1 / 3
7ai	1 / 1
7aii	2 / 2
7bi	0 / 1
7bii	2 / 2
7c	1 / 3
8ai	0 / 2
8aii	2 / 2
8b	3 / 3
9a	1 / 1

9bi	2 / 2
9bii	1 / 1
9ci	0 / 1
9cii	2 / 2
10a	1 / 1
10b	3 / 3
10c	2 / 3
11a	2 / 2
11b	3 / 3
11c	3 / 4
12a	1 / 1
12bi	1 / 1
12bii	3 / 3
12biii	2 / 3

Answer **all** the questions.

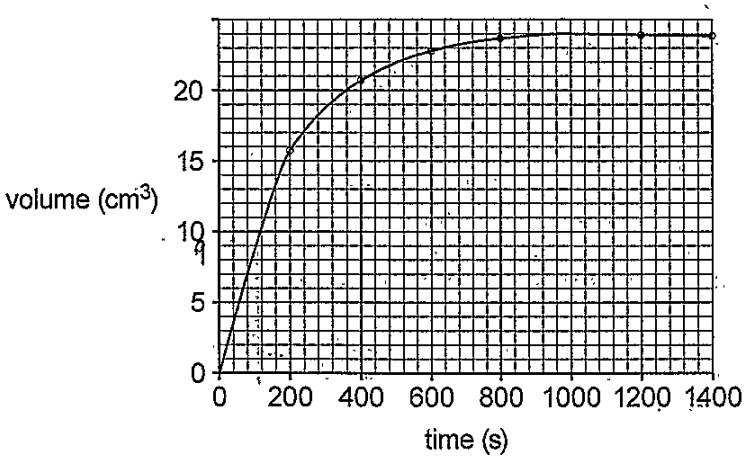
1 Calcium carbonate reacts with excess hydrochloric acid to make carbon dioxide.

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.

100 ÷ 9 = 11.1

9 ÷ 100 = 0.09

vol / time

Rate = ... 0.09 ..... 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 ~~Concentration of hydrochloric acid~~ Same temperature

2 Same ~~pressure~~ surface area of calcium carbonate

[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.

The more concentrated an acid is, the more particles there are available to react. This means that because there are more particles, more successful collisions can occur between so the rate is faster. **[2]**

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

Jack uses 0.070 g of calcium carbonate.

What volume of carbon dioxide does he make?

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

mass → mol → vol (24)

conc in mol → mol → vol

0.10 → 0.070

× 0.7 (0.070 ÷ 0.10)

24 × 0.7 = 16.8

Volume = 16.8 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**.

When the $MgCO_3$ was heated it separated the MgO and CO_2 lost into the air. Carbon dioxide is a gas so it was lost in the air so it would seem there was a loss in mass but in reality it is because the carbon dioxide gas has just dissipated to the surroundings. [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.

$MgO = 24.3 + 16 = 40.3$

$MgCO_3 = 24.3 + 12 + (16 \times 3) = 84.3$

$\frac{40.3}{84.3} \times 100 = 47.8$

$CO_2 = 32 + 12 = 44$

$MgCO_3 = 84.3$

$\frac{44}{84.3} \times 100 = 52.2$

52.2 ~~47.8~~

Atom economy = ... % **[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.

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.

$\frac{\text{actual}}{\text{theoretical}}$ $1.8 \div 2.2$

$= 0.81$

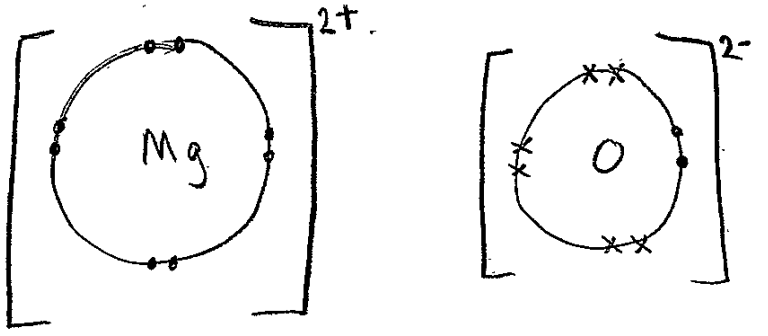
$= 82$

Percentage yield = 82 % **[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.



[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.

A could be suitable as the softening temp is very high at which is higher than water's boiling temp of 100°C 250°C and it has a very high breaking strength. But it is fairly flexible which isn't suitable for holding a liquid. B is not suitable as the softening temp of 70°C is less than the boiling temp of water, 100°C, so the cup would immediately break. (cont) [3]

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

Give a reason for your answer.

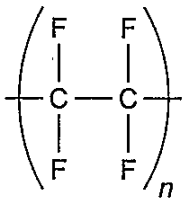
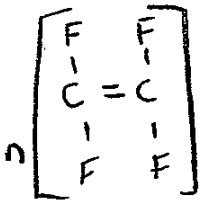
Polymer B

Reason Lowest softening temp means requires less energy to break intermolecular forces.

[2]

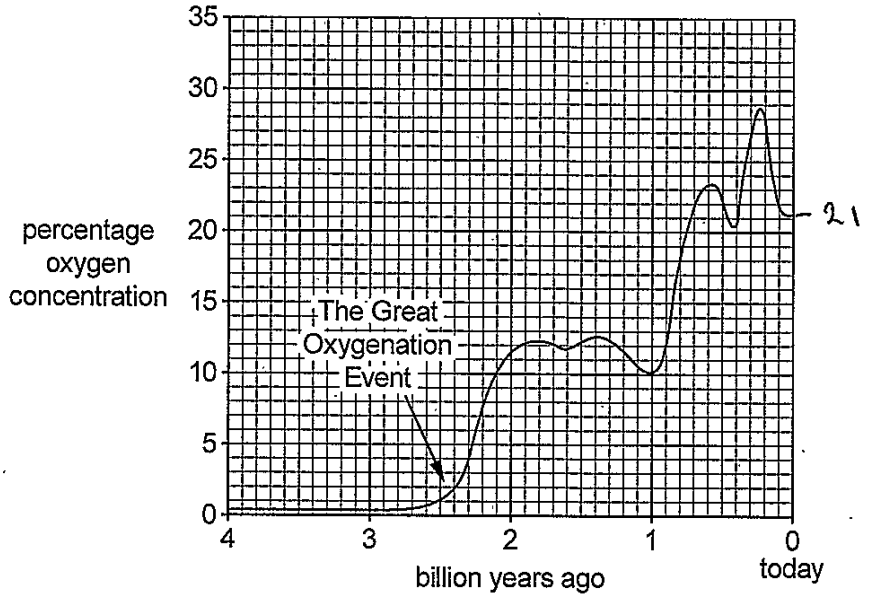
(c) Polymer **A** is an addition polymer.

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.

From 4 billion to around 2.5 billion years ago there was almost no oxygen at all until the great oxygenation event where the oxygen content has generally increased with many fluctuations. But from around a ¼ of a billion years ago it fell to 21% of today. [2]

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

By what factor has it increased?

Factor = 21 [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.

Plants developed in the oceans with the ability to photosynthesise which released oxygen as a product. The conc didn't rise because no more plants evolved so we had the same amount more than now. [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
4S

140

4S
2Fe

140

2Fe
4S
140

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.

$Cl^- + KBr \rightarrow KCl + Br^-$

Explain why.

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

$Cl^-_{(aq)} + KBr_{(aq)} \rightarrow KCl_{(aq)} + Br^-_{(aq)}$ The chlorine displaced the bromine in the potassium bromide as it is more reactive. This left the bromine ion as a solution. Bromine is a brown liquid at room temp so the solution turned brown. [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.

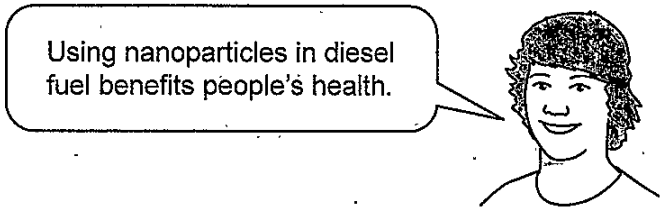
(a) Describe a property of nanoparticles that makes them good catalysts.

They have a large volume to surface area ratio.

[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.

Complete combustion is cleaner burning compared to incomplete combustion as rather than producing particulates, carbon monoxide, water and carbon dioxide it just produces the last two. This is better for our health because carbon monoxide is poisonous and particulates can worsen breathing problems such as asthma. However nanoparticles have the ability to enter the blood stream. If the nanoparticles escape into the air they could be small enough to pass into the bloodstream and get to the brain. Nanoparticles are highly reactive which makes them toxic to us, which would be very dangerous to our health.

In conclusion I think that the likelihood of the nanoparticles escaping is quite low so I think that the benefits of cleaner burning outweigh the costs. [3]

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

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

Because there are two O_2 ions there is a -4 charge which is neutralised by a +4 charge of the Ce. **[1]**

(d) A nanoparticle has a volume of 8×10^{-27} m.

A molecule has a volume of 4×10^{-30} m. smaller

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

$8 \times 10^{-27} \div 4 \times 10^{-30} = 2000$ ✓

Number of moles = 2000 mol **[3]**

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

1 mole 2 moles
$N_2 + O_2 \rightleftharpoons 2NO$

Very high temperatures are needed.

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

Because there is the ⇌ symbol which means the reaction is reversible which therefore has an equilibrium. [1]

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

The rates of the forward and reverse reactions are the same, so an equal amount of products and reactants is being produced... [2]

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

(i) Suggest a use for these compounds.

~~Ammonia~~ production of ~~ammonia~~ nitric acid (HNO_3) [1]

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

Describe and explain the effect on the equilibrium position.

There would be no change. There is an equal amount of 2 moles per on the forward and reverse reactions. Pressure only favours the reaction with the least moles but if they're equal then it would make no difference. [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 ..Produces no greenhouse gases.....

.....

Reason for ..Reactants are readily available.....

.....

Reason against ..Very high temperature is needed so lots of energy.....

.....required..... [3]

$MnO_2 + C \rightarrow MnO + CO$

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.

$MnO_{2(s)} + C_{(s)} \rightarrow MnO_{(s)} + CO_{(g)}$ [2]

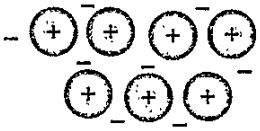
(ii) Explain why carbon can be used to extract manganese from its compounds.

Use ideas about reactivity and reduction in your answer.

Carbon is higher in the reactivity series than manganese so it is able to reduce the manganese by taking its electrons and deionising manganese ions to form plain manganese atoms [2]

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

Refer to this diagram in your answer.



In the diagram you can see a regular structure of positive metal ions. They are in a sea of delocalised electrons as all the metal atoms give up their electrons to form this sea. As a result the metals are bonded together strongly as there is a strong electrostatic attraction between the positive metal ions and the negative electrons. [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 ✓ [1]

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

(i) Describe what an emission spectrum looks like.

There are vertical coloured lines ✓ different areas on the black rectangle ✓ which correspond to the type of elements are in the compound. [2]

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

Cross reference ✓ emission spectrum against official spectrums for potassium and see if they match. [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?

~~fizzing~~ bubbling

[1]

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

$Na_2SO_4 + BaCl_2 \rightarrow 2NaCl + BaSO_4$ ✓ [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 → 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 → 2H-H + O=O

H-O = 464

464 x 2 = 928

928 x 2 = 1856

H-H = 434

434 x 2 = 868

868 x 2 = 1736

O=O = 498

868 + 498 = 1366

1856 - 1366 = 490

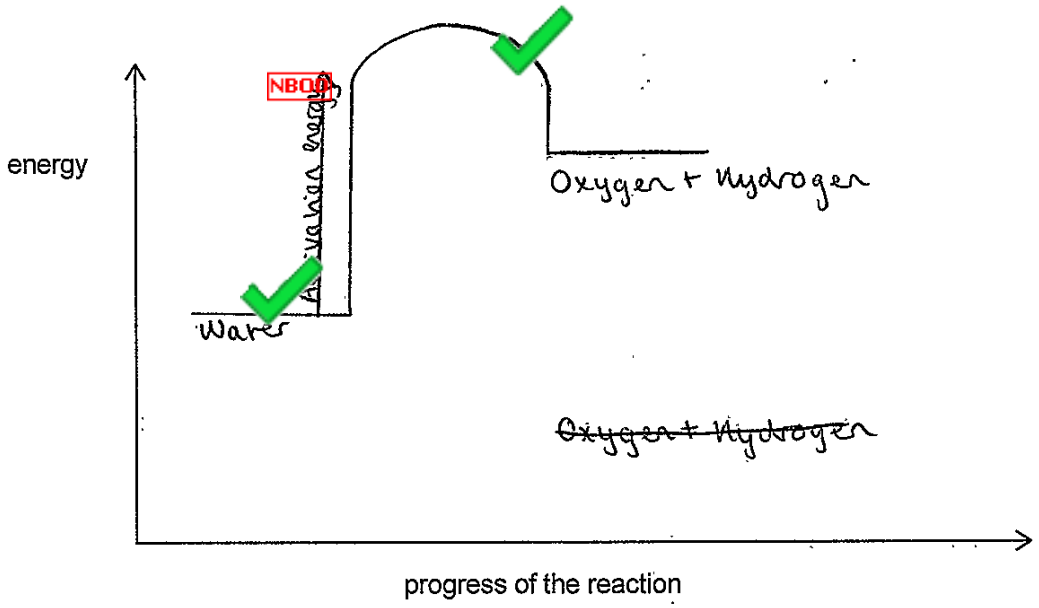
~~1856 - 2234 = -378~~

Energy change = ~~-378~~ 490 kJ/mol **[3]**

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

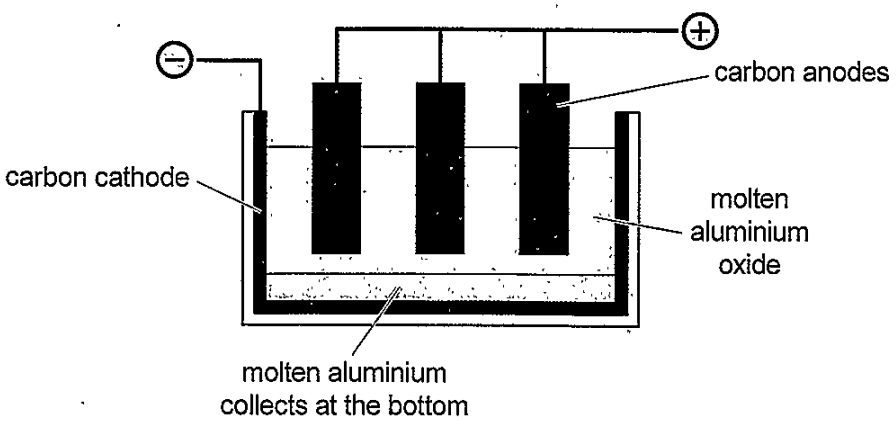
Use these words to label the reaction profile.

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 ..... $Al^{3+} + 3e^- \rightarrow Al$ .....

Formation of oxygen ..... $2O^{2-} - 4e^- \rightarrow O_2$ .....

[2]

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

It conducts electricity when it is molten.

Explain why.

As a solid, the ions are fixed in a giant ionic lattice so they cannot move. However when it is molten the ions are no longer fixed and are free to move and carry a charge which produces a current. **[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.

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.

$2Al_2O_3 \rightarrow 4Al + 3O_2$

ratio 2 : 4 : 3

mass 1kg / 1000g

rm 102 27 32

mol $\frac{1000}{27} = 37.037$ g/dm³ ÷ 1000 ÷ 1000 = 0.037 mol/dm³

$0.037 \div 4 = \frac{1}{108}$ mol/dm³ → moles of oxygen

$\frac{1}{108} \times 3 = 0.027$ mol/dm³

$0.027 \times 24 = 0.6$ dm³

vol / mol / 24

mass / mol / mr

Volume = 0.67 (2dp) dm³ **[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.

Because the H_2SO_4 has disassociated its ions completely ✓ [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)

$25 \div 1000 = 0.025\ dm^3$ ✓

moles = conc x volume

$0.100\ mol/dm^3$

$0.025 \times 0.100 = 2.5 \times 10^{-3}$ ✓

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

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

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

volume

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

$0.0245\ dm^3$

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)

0.0245

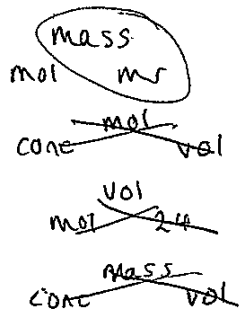
Give your answer to **2** significant figures.

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

ratio	2 : 1	
mr	40	
mass	~~80~~ 40	
mol	1	0.5

$0.5 \div 0.0245$ ✓

$= 20$



Concentration = ~~0.5~~ ~~20~~ 20 ✓ 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).

3a C seems to be most suitable as it has a high flexibility suitable to hold a liquid so it won't spill and its softening temp is over 100°C. Although the breaking strength is low cups do not go through excessive force so this is fine. ✓

SEEN

SEEN

SEEN

Off Page Comments

Item Name	Comment
11c	This candidate has the answer out by a factor of 1000.
7bi	accepted
7c	abundance of material accepted.
1c	Not enough here for either MP. Need concept of more in same volume and more frequent collisions.
6a	nearly! one to watch!
12a	accept