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Examiners' Report
June 2023

Int GCSE Chemistry 4CH1 2C

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Introduction

This paper discriminated well giving a range of marks for all grades. The paper was well balanced with some accessible marks on all questions. There were a few unfamiliar questions, namely Q4(g) and Q6(b), which proved difficult for the majority of candidates. On the whole, the calculations performed better than expected and candidates often picked up error carried forward marks on the Q3 and Q4 mark calculations. Completing and balancing equations proved difficult for some candidates. Explanations and descriptions gave some good answers, but many candidates lost marks as their answers were too vague. There was some confusion as to which catalysts were required and the conditions needed in the reactions and colour changes and observations were not always well known.

Question 1 (a)(i)

A large majority of candidates gave the correct answer of silicon. A small minority confused relative atomic mass with atomic number and wrote nitrogen, even though the key on the Periodic Table showed where the atomic number was.

Question 1 (a)(ii)

Many candidates gave the incorrect answer as calcium, as they thought calcium was in period 3. The correct answer was magnesium which is in group 2 and period 3.

Question 1 (a)(iii)

Most candidates gave the correct answer for bromine. Mercury was also seen and was an acceptable answer. A small minority gave an incorrect answer such as chlorine or iodine.

Question 1 (a)(iv)

A large majority of candidates gave the correct answer of 2,8,5. Very few gave an incorrect answer of 2,5 or 2,8,8,5.

Question 1 (a)(v)

Only around 50% of candidates gave the correct formula for sodium sulfide. Common mistakes were NaS, NaS_2 $NaSO_4$ or Na_2SO_4. Note that a compound ending in – ide does not contain oxygen.

Question 1 (b)

A large majority of candidates gained the first marking point, but many lost the second mark for not being specific enough. Some just mentioned either not gaining or losing electrons but not both, so they lost the second mark.

(b) Explain, in terms of electron configuration, why neon is unreactive.

(2)

Neon is in group 0 which is noble gases therefore it is unreactive.

ResultsPlus
Examiner Comments

No marks can be awarded here as there is no mention of a full outer shell or any loss or gain of electrons.

ResultsPlus
Examiner Tip

Just stating that it is 'unreactive' is in the stem of the question, so is not creditworthy. The question asks for an explanation involving electrons, so electrons must be referred to in order to gain the marks.

(b) Explain, in terms of electron configuration, why neon is unreactive.

(2)

* Neon is unreactive as it has the electronic configeration of 2,8 meaning that it has a full outter most-shell therefore it does not gain or lose any electrons making it unreactive.

ResultsPlus
Examiner Comments

This is a complete answer which gives the correct electron configuration and states that it does not gain or lose any electrons, so both marks are awarded.

ResultsPlus
Examiner Tip

Make sure you answer the question in terms of electron configuration or mention a full outer shell.

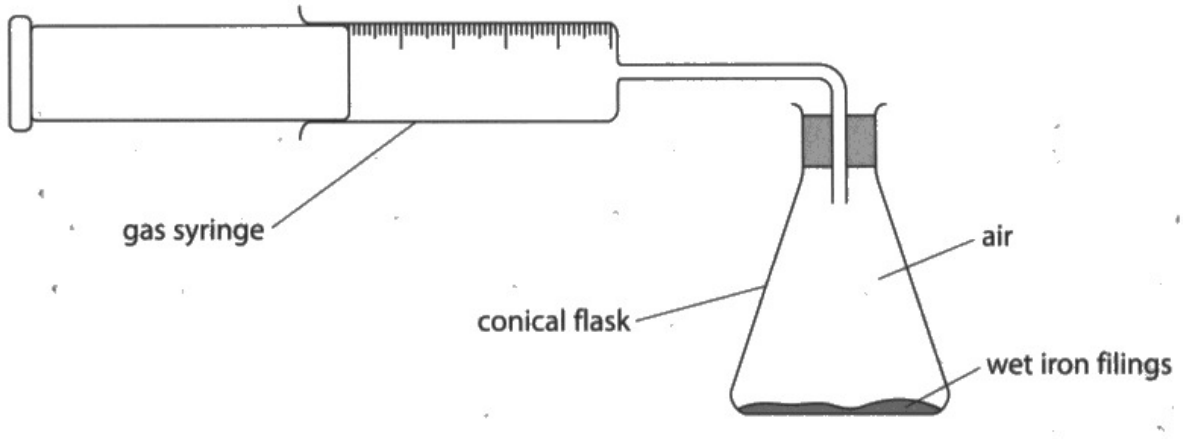
Question 2 (b)(iii)

Around 50% of the candidates wrote the correct equation. Common errors included adding oxygen to the left-hand side of the equation or giving the incorrect formula of copper(II) carbonate or copper(II) oxide. At the beginning of the question this stated that copper(II) carbonate formed copper(II) oxide and carbon dioxide, so oxygen or any other species should not have been included in the equation.

Question 2 (c)

This question gave a range of marks with most scoring either 3 or 4 marks.

(c) A student uses this apparatus to find the percentage of oxygen in a sample of air.



The student leaves the apparatus until there is no further change in volume of gas in the syringe.

These are the student's results.

volume of gas in flask and connecting tube in cm^3	280
volume of gas in syringe at start in cm^3	100
volume of gas in syringe at end in cm^3	27

Calculate the percentage of oxygen in the sample of air.

Give your answer to two significant figures.

(4)

total volume = 280 + 100 = 380 cm^3

amount lost = 100 − 27 = 73 cm^3

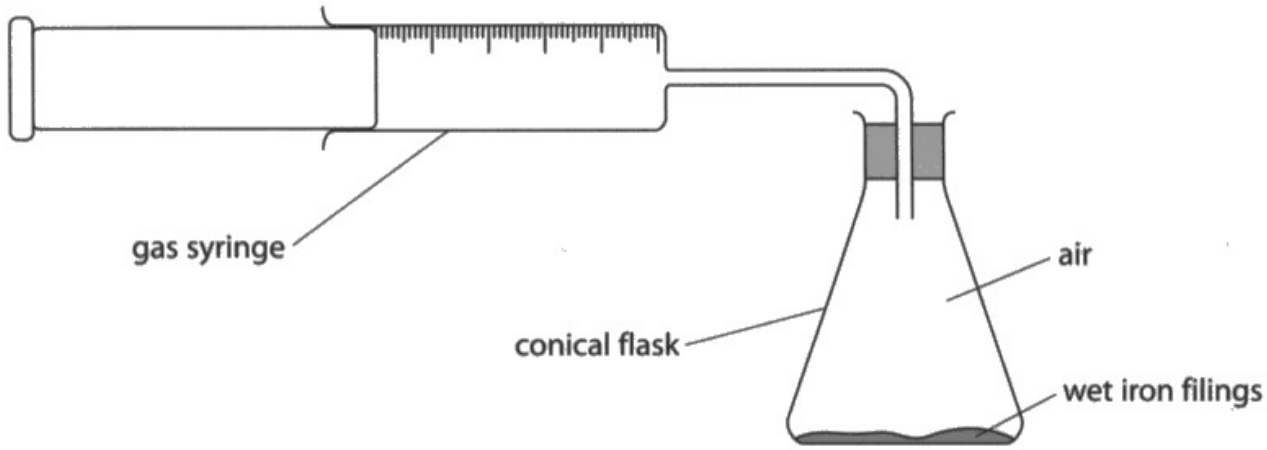
$\frac{73}{380} \times 100 = 19.2 = 19$

percentage of oxygen = 19 %

This was a clear 4 mark answer showing all the steps of the calculation.

Always show your working as if you make a mistake, you are likely to pick up error carried forward marks.

(c) A student uses this apparatus to find the percentage of oxygen in a sample of air.



The student leaves the apparatus until there is no further change in volume of gas in the syringe.

These are the student's results.

volume of gas in flask and connecting tube in cm^3	280
volume of gas in syringe at start in cm^3	100
volume of gas in syringe at end in cm^3	27

Calculate the percentage of oxygen in the sample of air.

Give your answer to two significant figures.

(4)

$100 - 27 = \frac{73}{280} \times 100$

$= 26.07$

$= 26.1$

percentage of oxygen = 26.1 %

ResultsPlus
Examiner Comments

This answer scored 2 marks. The volume of oxygen was found which scored the first marking point.

The candidate failed to add the 100 to the 280 but the error was carried forward as they knew how to find a percentage, so the third marking point was awarded.

The fourth marking point was not awarded as they did not give the answer to two significant figures.

ResultsPlus
Examiner Tip

Make sure you read the question carefully as unnecessary marks can be lost by not giving the answer to two significant figures.

Question 2 (d)

The majority of candidates scored both marks. A few did not mention the greenhouse effect, but most mentioned global warming or climate change. A small number lost a mark by referring to the ozone layer.

(d) Explain why an increasing amount of carbon dioxide in the atmosphere is likely to cause a problem for the environment.

(2)

Because it is a greenhouse gas and so it causes global warming which can lead to polar ice caps melting.

ResultsPlus
Examiner Comments

This is a clear answer which scored both marks.

ResultsPlus
Examiner Tip

It is not necessary to go into a lot of detail, just mentioning the greenhouse gas and global warming is sufficient for both marks.

(d) Explain why an increasing amount of carbon dioxide in the atmosphere is likely to cause a problem for the environment.

(2)

It does not make easy for people to breath too much of carbon dioxide might be harmful to environment because we need a lot of oxygen not carbon dioxide.

ResultsPlus
Examiner Comments

An increase in carbon dioxide would not affect a person's breathing difficulties. There is still plenty of oxygen available and the percentage of carbon dioxide is still low. There is nothing creditworthy here.

ResultsPlus
Examiner Tip

The explanation should be a problem for the environment, not for the health of humans.

Question 3 (a)

Most scored either 2 marks or zero, with a small number scoring 1 mark.

3 This question is about alcohols.

Ethanol can be manufactured using two different methods.

- hydration of ethene
- fermentation of glucose

This is the equation for hydration.

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

(a) Complete the equation for fermentation.

(2)

$C_6H_{12}O_6 \rightarrow$ C_2H_5OH + H_2O

ResultsPlus
Examiner Comments

Unfortunately, this did not score as they thought water was produced rather than carbon dioxide.

ResultsPlus
Examiner Tip

It would not be possible to balance this equation if water was one of the products.

3 This question is about alcohols.

Ethanol can be manufactured using two different methods.

- hydration of ethene
- fermentation of glucose

This is the equation for hydration.

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

(a) Complete the equation for fermentation.

(2)

glucose ethanol carbon dioxide.

$C_6H_{12}O_6 \rightarrow$ C_2H_5OH + CO_2

ResultsPlus
Examiner Comments

The products were correct, but the second mark was lost, as they failed to balance the equation.

ResultsPlus
Examiner Tip

When writing a chemical equation, it must be balanced.

3 This question is about alcohols.

Ethanol can be manufactured using two different methods.

- hydration of ethene
- fermentation of glucose

This is the equation for hydration.

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

(a) Complete the equation for fermentation.

(2)

$C_6H_{12}O_6 \rightarrow$ $2C_2H_5OH$ + $2CO_2$

ResultsPlus
Examiner Comments

A fully correct answer scoring both marks.

ResultsPlus
Examiner Tip

The formula for ethanol is given in the equation for hydration, so all you need to remember to add is the carbon dioxide and to balance the equation.

Question 3 (b)(i)

This question gave a good range of marks, with almost half the candidates scoring all 3 marks.

(b) The table gives some information about the two methods.

	Hydration	Fermentation
Reagents	ethene and steam	aqueous glucose
Catalyst	phosphoric acid	enzymes in yeast
Temperature in °C	300	30
Pressure in atmospheres	60 – 70	1
Rate of process	fast	slow
Purity of product	pure	impure

(i) Complete the table by giving the missing information.

(3)

ResultsPlus
Examiner Comments

A mark scheme answer scoring all 3 marks.

ResultsPlus
Examiner Tip

Learn the conditions stated in the specification, as they are often asked for.

(b) The table gives some information about the two methods.

	Hydration	Fermentation
Reagents	ethene and steam	aqueous glucose
Catalyst	silica	enzymes in yeast
Temperature in °C	300	35
Pressure in atmospheres	60 - 70	1
Rate of process	fast	slow
Purity of product	pure	impure

(i) Complete the table by giving the missing information.

(3)

ResultsPlus
Examiner Comments

35 ^{o}C is an acceptable temperature and the range of pressure is correct, so 2 marks can be awarded.

ResultsPlus
Examiner Tip

A common mistake was to give an incorrect catalyst. Silica and alumina were often seen as there was confusion with cracking. Another common mistake was to refer to potassium dichromate, which is not a catalyst. It is an oxidising agent.

Question 3 (b)(ii)

This question discriminated well giving a good range of marks, with most scoring 2 or 3 marks.

(ii) Explain one advantage and one disadvantage of using fermentation rather than hydration to produce ethanol.

You should use information from the table to help your answer.

(4)

advantage

fermentation can be done in much lower temperature than hydration

disadvantage

fermentation is a slow process and ~~can~~ forms impure ethanol.

ResultsPlus
Examiner Comments

This candidate stated that it was done at a lower temperature, which scored the first marking point and that it was a slow process, which scored the third marking point. However, no explanation of either an advantage or disadvantage was given which limited them to 2 marks.

ResultsPlus
Examiner Tip

When an explanation is required, they need to give a reason why there is an advantage and a disadvantage.

(ii) Explain one advantage and one disadvantage of using fermentation rather than hydration to produce ethanol.

You should use information from the table to help your answer.

(4)

advantage

It requires less energy as not high temperature and pressure is requireed.

disadvantage

The purity of ethanol produced is impure, which means it needs further processing, taking more time.

ResultsPlus
Examiner Comments

The candidate stated that less energy was required as high temperature and pressure was not required, and the ethanol was impure as it needed further processing. This was a clear concise answer which scored all 4 marks.

ResultsPlus
Examiner Tip

Make sure you state an advantage and a disadvantage, then explain why there is an advantage and a disadvantage. As stated, use information from the table to help your answer.

Question 3 (c)

This question discriminated well and gave a range of marks. Stating that anaerobic conditions were needed to produce ethanol was the more popular alternative to answer the question.

(c) Explain why fermentation needs to occur in the absence of air.

(2)

If any air is present, the ethanol produced reacts with oxygen to form ethanoic acid. Yeast cannot produce ethanol in presence of oxygen.

ResultsPlus
Examiner Comments

This is the first alternative on the mark scheme and is a clear answer which gains both marks.

ResultsPlus
Examiner Tip

Make sure you explain why fermentation needs to occur in the absence of air.

(c) Explain why fermentation needs to occur in the absence of air.

(2)

Oxygen from air will react with alcohol and form carboxylic acid or other oxides.

ResultsPlus
Examiner Comments

The first mark is allowed for oxygen from air will react with alcohol. However, the second mark is not awarded as stating carboxylic acid is formed is too vague. It needs to be ethanoic acid or vinegar.

ResultsPlus
Examiner Tip

A carboxylic acid could be any acid and only ethanoic acid can form when oxygen reacts with ethanol.

(c) Explain why fermentation needs to occur in the absence of air.

(2)

fermentation needs to happen in anaerobic condition because if it was produced in aerobic conditions ethanol would not be formed, instead CO_2 and H_2O would be formed because glucose would react with oxygen

ResultsPlus
Examiner Comments

This is a clear explanation as to why fermentation needs to occur in the absence of air, and both marks can be awarded.

ResultsPlus
Examiner Tip

As there are two alternatives, choose the one you are most familiar with.

Question 3 (d)(i)

This question was well answered with most candidates scoring all 3 marks.

(d) Propanol has this percentage composition by mass.

C = 60.0% H = 13.3% O = 26.7%

(i) Show by calculation that the empirical formula of propanol is C_3H_8O. (3)

Element	C	H	O	
Mass	60	13·3	26·7	
Ar	12	1	16	
Moles	$\frac{60}{12}$	$\frac{13·3}{1}$	$\frac{26·7}{16}$	
	= 5	13·3	1·66875	
Mole ratio	$\frac{5}{1·66875}$	$\frac{13·3}{1·66875}$	$\frac{1·66875}{1·66875}$	C_3H_8O
	= 2·99 ≈ 3	7·9 ≈ 8	1	
			1	

ResultsPlus Examiner Comments

This was a very well-constructed answer showing all the steps in the calculation and 3 marks were awarded.

ResultsPlus Examiner Tip

Making a table like this is a good way to show all the steps in the calculation.

(d) Propanol has this percentage composition by mass.

C = 60.0% H = 13.3% O = 26.7%

(i) Show by calculation that the empirical formula of propanol is C_3H_8O. (3)

= C = 60.0 / 12 H = 13.3 / 1 O = 26.7 / 16

= C = 5 / 1.6 = 3.125 H = 13.3 / 1.6 = 8.3125 O = 1.6 / 1.6 = 1

= C_3H_8O

ResultsPlus
Examiner Comments

This answer scored 2 marks. A mark was lost due to incorrect rounding.

ResultsPlus
Examiner Tip

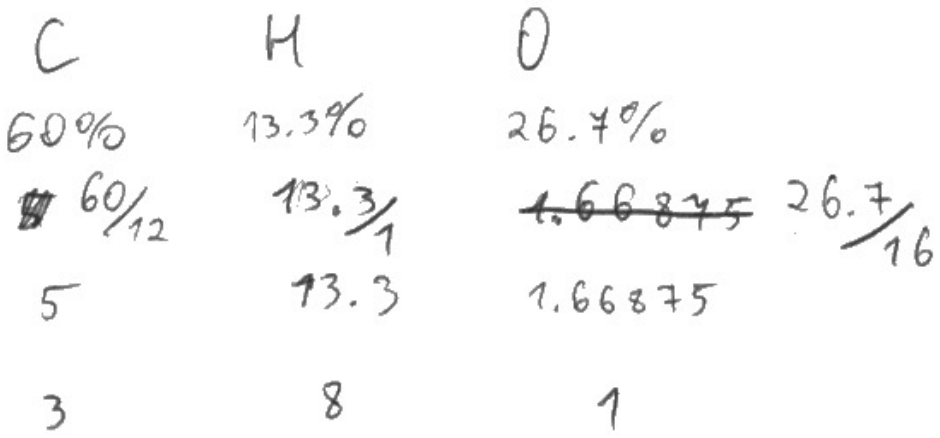
If you round your answer, make sure you round it correctly. 1.67 or 1.7 would be acceptable answers, but not 1.6 or 1.66.

(d) Propanol has this percentage composition by mass.

C = 60.0% H = 13.3% O = 26.7%

(i) Show by calculation that the empirical formula of propanol is C_3H_8O.

(3)



ResultsPlus
Examiner Comments

This candidate scored the first 2 marks, but did not divide by the smallest number, so lost the third marking point.

ResultsPlus
Examiner Tip

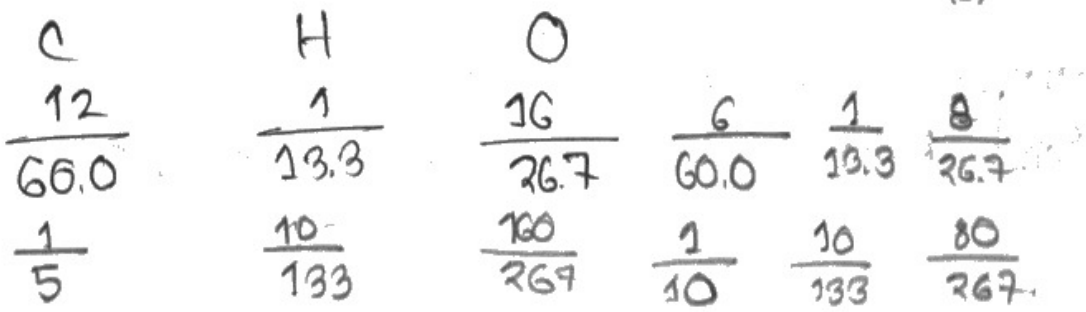
As this is a 'show by calculation', **all** steps must be shown to gain all 3 marks.

(d) Propanol has this percentage composition by mass.

C = 60.0% H = 13.3% O = 26.7%

(i) Show by calculation that the empirical formula of propanol is C_3H_8O.

(3)



ResultsPlus
Examiner Comments

This is a very confused answer. An upside-down calculation automatically scores zero. The candidate also did another upside-down calculation using atomic numbers as well. Even if this was correct, it would be a contradiction as it would be the list principle.

ResultsPlus
Examiner Tip

Always remember to find a moles ratio by dividing the percentages by the relative atomic masses.

Question 3 (d)(ii)

This was well answered by the majority. Some lost a mark by not showing the bond between the O and the H. Note that if a displayed formula is required, make sure you show **all** the bonds.

Question 4 (a)

The majority of candidates gave the correct answer of pipette. The other common incorrect answer was measuring cylinder, which is not accurate enough for a titration.

Question 4 (b)

Many candidates gained either 1 or 2 marks. Most knew the acid was red and pink was also allowed, but fewer knew yellow. A common error was to mention orange. This is the colour at the end point and alkali is definitely yellow and acid red, not orange. A few confused phenolphthalein with methyl orange and stated pink and colourless. Some thought the alkali was blue or purple with confusion with universal indicator or litmus.

Question 4 (c)

The majority gave the correct mark scheme answer. However, there was some confusion about marking a cross on the tile and waiting for it to disappear. Some didn't mention the colour at all and thought the tile was there to protect the bench if acid or alkali was spilled.

Question 4 (d)

The majority gave the correct answer that was to mix the solutions with a few also stating that it was to speed up the reaction, which was also an allowable answer. Some referred to ensuring the reaction was complete or referred to the colour at the end point, which was not creditworthy.

Question 4 (e)

This was not particularly well answered with the majority not being specific enough. Many just said that the results were close together, but did not give a quantitative value. Those who gave the correct answer stated that they were 0.2 cm^3 apart. A fewer said they were 0.1 cm^3 apart, which was an allowable answer. Those who stated an incorrect value were out of range, 0.5 was too far out and 0.01 could not be measured to that accuracy, so these answers were not creditworthy.

Question 4 (f)

This question was surprisingly well answered with the majority gaining all 3 marks.

(f) The student finds that 15.00 cm^3 of sulfuric acid of concentration 0.180 mol/dm^3 neutralises 25.0 cm^3 of potassium hydroxide solution.

This is the equation for the reaction.

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

Calculate the concentration of the potassium hydroxide solution. (3)

$n = c \times v$

$15 \times \frac{0.180}{100}$

$= 0.027$

0.027×25

$= 0.675$

concentration = 0.675 mol/dm^3

ResultsPlus Examiner Comments

This candidate multiplied 15 by 0.180, but unfortunately divided by 100 instead of 1000. They did not take into account the mole ratio and then multiplied their first marking point by 25 instead of dividing by 0.025, so no marks could be awarded.

ResultsPlus Examiner Tip

Always remember to convert cm^3 to dm^3 by dividing both volumes by 1000.

(f) The student finds that 15.00 cm^3 of sulfuric acid of concentration 0.180 mol/dm^3 neutralises 25.0 cm^3 of potassium hydroxide solution.

This is the equation for the reaction.

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

Calculate the concentration of the potassium hydroxide solution.

(3)

mols = mr x ml

$0.015 \times 0.180 = 0.0027$ mol

$\frac{0.0027}{0.025} = 0.108$

concentration = 0.108 mol/dm^3

ResultsPlus
Examiner Comments

This candidate found the moles of sulfuric acid, but unfortunately ignored the equation and forgot to multiply the moles by 2. However, they did divide their first marking point by 0.025 so the third marking point was an error carried forward mark and could be awarded.

ResultsPlus
Examiner Tip

Always remember to use the numbers in front of the formulae in the equation and, in this example, multiply the moles by 2 to get the moles of KOH.

(f) The student finds that 15.00 cm^3 of sulfuric acid of concentration 0.180 mol/dm^3 neutralises 25.0 cm^3 of potassium hydroxide solution.

This is the equation for the reaction.

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

Calculate the concentration of the potassium hydroxide solution.

(3)

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

$25cm^3$ $15cm^3$ $0.180 mol/dm^3$

mols in H_2SO_4 → 0.015×0.180

$= 2.7 \times 10^{-3}$

∴ KOH mols = 5.4×10^{-3}

conc → $\frac{5.4 \times 10^{-3}}{0.025} = 0.216$

concentration = 0.216 mol/dm^3

ResultsPlus
Examiner Comments

This is a fully correct answer scoring all 3 marks.

ResultsPlus
Examiner Tip

Writing the volumes and concentration under the equation is a good way of ensuring that you use the correct data in the calculation. Always show your working, as if you make a mistake error carried forward marks can still be awarded.

Question 4 (g)

The majority of candidates found this question very difficult, with only a small minority scoring 1 or 2 marks.

(g) This is the ionic equation for the reaction between an acid and an alkali.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

Explain why the OH^- ion is a proton acceptor in this reaction.

(2)

OH^-

~~It~~ is a negatively charged ion which ~~accept~~ reacts with H^+ ion to form H_2O. H^+ ion is a single proton which OH^- accepts. so it is a proton acceptor.

ResultsPlus Examiner Comments

This is a clear answer which scores both marks. They state that an H^+ ion is a single proton and that OH^- reacts with H^+ to form water, which are mark scheme answers.

ResultsPlus Examiner Tip

You need to explain why the H^+ ion is a proton and that it reacts with the OH^- ion to gain the marks.

(g) This is the ionic equation for the reaction between an acid and an alkali.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

Explain why the OH^- ion is a proton acceptor in this reaction.

(2)

OH^- is an alkali so it accepts protons to be able to form it

ResultsPlus
Examiner Comments

There is no mention of an H^+ ion being a proton and just stating that OH^- accepts protons is too close to the stem, which states it is a proton acceptor, so no marks can be awarded.

ResultsPlus
Examiner Tip

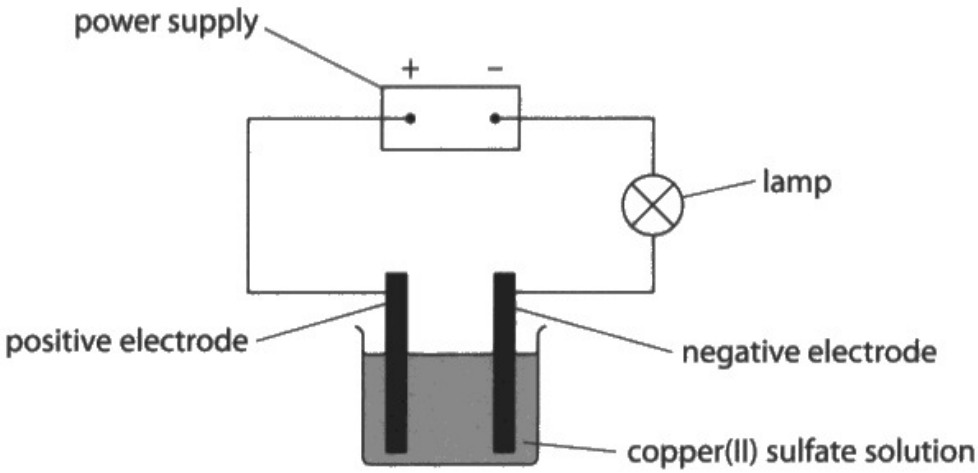
Marks cannot be awarded for more or less repeating what is in the stem of the question.

Question 5 (a)

The majority gained 1 or 2 marks. Some seemed to misunderstand the question and as the diagram was shown they discussed electrolysis rather than giving a test for copper(II) ions. Others added an incorrect reagent.

5 When copper(II) sulfate solution is electrolysed, copper forms at the negative electrode.

A student uses this apparatus to investigate the electrolysis of copper(II) sulfate solution.



(a) Describe how the student could test a sample of copper(II) sulfate solution to show that it contains copper(II) ions. Cu^{2+}

(2)

The student could use a flame and test for copper(II) ions are present, the flame will turn blue / green.

ResultsPlus
Examiner Comments

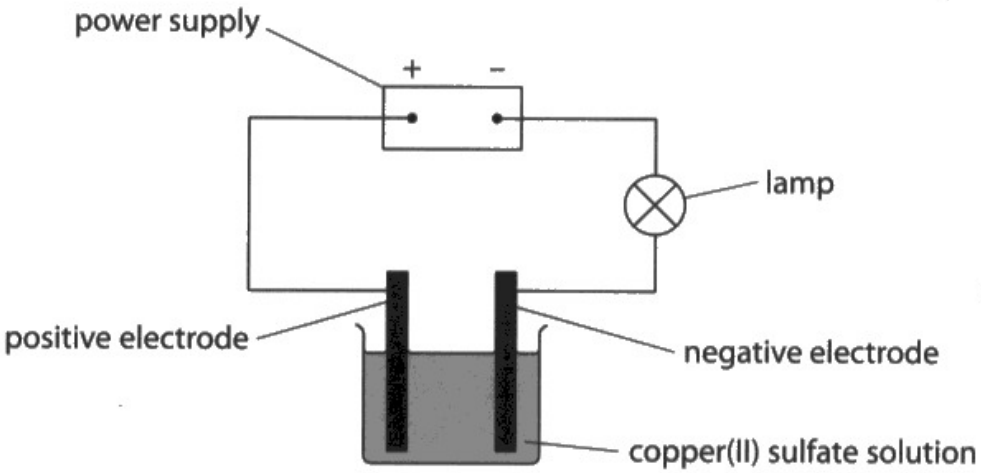
This candidate correctly described a flame test and gained both marks.

ResultsPlus
Examiner Tip

Just stating use a flame test and giving the result is sufficient for the marks. It is not necessary to discuss how to carry out a flame test.

5 When copper(II) sulfate solution is electrolysed, copper forms at the negative electrode.

A student uses this apparatus to investigate the electrolysis of copper(II) sulfate solution.



(a) Describe how the student could test a sample of copper(II) sulfate solution to show that it contains copper(II) ions.

(2)

They could add sodium hydroxide and the solution would go blue if copper ions present

ResultsPlus
Examiner Comments

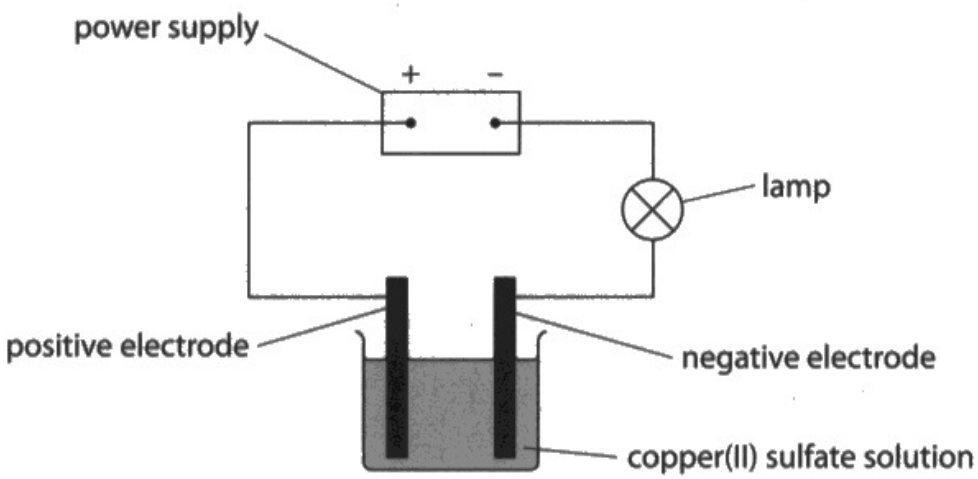
This candidate correctly added sodium hydroxide, but they just stated that the solution would go blue. This is not enough for the second mark as the solution is already blue. They must state that a blue precipitate was formed.

ResultsPlus
Examiner Tip

When describing a test for ions and adding a suitable reagent, make sure that you state that a precipitate is formed. Just giving the colour is not enough for the mark.

5 When copper(II) sulfate solution is electrolysed, copper forms at the negative electrode.

A student uses this apparatus to investigate the electrolysis of copper(II) sulfate solution.



(a) Describe how the student could test a sample of copper(II) sulfate solution to show that it contains copper(II) ions.

(2)

Add water or H_2O

Result → it turns white to blue

ResultsPlus
Examiner Comments

No correct reagent was added, so no marks could be awarded. This candidate confused a test to show that water was present, by adding anhydrous copper(II) sulfate.

ResultsPlus
Examiner Tip

There was no point adding water to a solution of copper(II) sulfate as the solution was already blue. Make sure you read the question carefully as it was clear that the copper(II) sulfate was already in solution and not an anhydrous white powder.

Question 5 (b)

This question discriminated well giving a full range of marks with the majority scoring 2 or 3 marks.

(b) Describe how copper metal forms at the negative electrode.

(3)

The positive copper ions are attracted to the negative electrode where they receive electrons that complete the outer shell of the copper atom.

ResultsPlus
Examiner Comments

This is a very clear concise answer which gained all 3 marks.

ResultsPlus
Examiner Tip

There was no need to mention any other ions present in the solution as you just needed to describe how the copper metal forms.

(b) Describe how copper metal forms at the negative electrode.

(3)

Cu^{2+} has a positive charge so it attract to the negative electrode (cathode) and it is lese reactive.

ResultsPlus
Examiner Comments

This candidate gained the first 2 marks by stating that Cu^{2+} was attracted to the negative electrode, but failed to mention how it gained electrons and formed copper atoms, so neither of the third and fourth marking points could be awarded.

ResultsPlus
Examiner Tip

This question is a 3-mark answer, so three points must be mentioned to gain the marks. You must state how the copper metal forms at the negative electrode.

(b) Describe how copper metal forms at the negative electrode.

(3)

Copper ion go to the cathode along with hydrogen ion. because copper is more reactive than copper it is discharged at the cathode.

ResultsPlus
Examiner Comments

The second marking point was awarded for the copper ion going to the cathode. The first marking point was not awarded as it did not state that the copper ion was positive and there was no mention of gaining electrons or becoming a copper atom.

ResultsPlus
Examiner Tip

There is no need to refer to hydrogen ions or to the reactivity of copper as this is not relevant to the question.

Question 5 (c)

This question was poorly answered. Many candidates gave a correct colour, but failed to state that it was a solid, coating, deposit or metal. Some thought it was blue, confusing it with copper(II) sulfate or copper(II) hydroxide.

Question 5 (d)(i)

The majority described the correct test for oxygen. A few lost a mark for referring to a lit splint, rather than a glowing splint and a small number of candidates gave a test for hydrogen.

Question 5 (d)(ii)

This question was poorly answered with only a small minority gaining both marks.

(ii) Complete the half-equation for the formation of oxygen at the positive electrode.

(2)

$2H_2O \rightarrow$ O_2 + $2H_2$ + $4e^-$

ResultsPlus
Examiner Comments

This question gained 1 mark for showing that oxygen and electrons were formed, but the other product should be $4H^+$ not $2H_2$.

ResultsPlus
Examiner Tip

Although the formulae were balanced, the charges were not. A half equation cannot have 4 minuses on the right-hand side and no charge on the left-hand side. The $4H^+$ would cancel out the $4e^-$ and on both sides the charges would be balanced.

(ii) Complete the half-equation for the formation of oxygen at the positive electrode.

(2)

$2H_2O \rightarrow$ H 2 + O + 2 e⁻

ResultsPlus
Examiner Comments

This question gained 0 marks as an oxygen atom is incorrect and the equation was not balanced.

ResultsPlus
Examiner Tip

Oxygen is always diatomic and a free oxygen atom does not exist.

Question 5 (d)(iii)

More than half the candidates lost a mark here. All that was needed was to state that electrons are lost. Many contradicted themselves by stating that oxygen or oxide ions lost electrons, which was not the case, as water does not contain oxide ions. It is safer when answering this type of question to just state that electrons are lost, as candidates often refer to the wrong species which loses them the mark.

Question 6 (a)(i)

Less than half of the candidates gave a correct answer. Those who gave the correct answer usually stated sulfuric acid, rather than any other allowable answer. Common incorrect answers included silica or alumina confusing it with cracking or potassium dichromate, which is an oxidising agent, not a catalyst.

Question 6 (a)(ii)

Around half the candidates knew that it was a sweet, fruity or distinctive smell. Some gave too vague answers such as pleasant smell, nice smell or strong smell. Very few mentioned an oily layer. A significant minority stated that water was formed, which could not be detected so could not be classified as an observation or distinctive smell.

Question 6 (a)(iii)

The majority gave the correct answer as methyl ethanoate, although a few lost marks for incorrect spelling. A common incorrect answer was ethyl methanoate.

Question 6 (b)

Most candidates found this question very difficult with only a small minority gaining all 3 marks. Many thought the C-H bond was broken or some just only wrote one bond down even though the question clearly stated that two bonds were broken.

(b) The table shows the number of bonds in the reactants and the number of bonds in the products.

Bond	C—H	C—C	C—O	C═O	O—H
Number of bonds in reactants	6	1	2	1	2
Number of bonds in products	6	1	2	1	2

(i) State which two bonds need to be broken in the reactants.

(1)

(O–H) (C–O)

(ii) Explain why the enthalpy change in this reaction is approximately 0 kJ / mol.

(2)

number of bonds broken is equal to the number of bonds formed

ResultsPlus
Examiner Comments

This candidate gave the correct two bonds so gained 1 mark, but stating that the number of bonds broken equals the number of bonds formed is not specific enough as it has to be the **same** bonds.

ResultsPlus
Examiner Tip

An explanation in (ii) is needed for 2 marks. Even if they just stated that the same bonds were broken and formed, only 1 mark can be awarded as there is no mention of the energy involved.

(b) The table shows the number of bonds in the reactants and the number of bonds in the products.

Bond	C—H	C—C	C—O	C═O	O—H
Number of bonds in reactants	6	1	2	1	2
Number of bonds in products	6	1	2	1	2

(i) State which two bonds need to be broken in the reactants.

(1)

C – O & O – H

(ii) Explain why the enthalpy change in this reaction is approximately 0 kJ / mol.

(2)

because the total energy needed to break the bonds is equal to the total energy needed to create the bonds.

ResultsPlus
Examiner Comments

1 mark was awarded for the correct bonds, but the statement relating to energy is incorrect and there is no mention of the bonds being broken and formed, so no more marks can be awarded.

ResultsPlus
Examiner Tip

Energy is needed to break the bonds, but it is not needed to create the bonds as energy is released when bonds are formed.

(b) The table shows the number of bonds in the reactants and the number of bonds in the products.

Bond	C—H	C—C	C—O	C=O	O—H
Number of bonds in reactants	6	1	2	1	2
Number of bonds in products	6	1	2	1	2

(i) State which two bonds need to be broken in the reactants.

(1)

C–O and O–H

(ii) Explain why the enthalpy change in this reaction is approximately 0 kJ / mol.

(2)

Because the same bonds that are being broken in the reactants are being ~~made~~ formed to make the Products. Therefore, the energy taken in to break the bonds is equal to the energy released when making bonds to form the products. So the enthalpy change is 0.

(Total for Question 6 = 6 marks)

ResultsPlus
Examiner Comments

This is a very clear answer and all 3 marks can be awarded.

ResultsPlus
Examiner Tip

Make sure you state that the same bonds are broken and formed and that energy to break bonds equals energy released when bonds are formed.

Question 7 (a)

The majority of candidates scored the mark here, with many mentioning carbon monoxide binding with haemoglobin.

7 Methane reacts with steam to form carbon monoxide and hydrogen.

This is the equation for the reaction.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H = +206\ kJ/mol$$

(a) State why carbon monoxide is poisonous to humans.

(1)

It prevent oxyen ~~fro~~ to flow through the body.

ResultsPlus
Examiner Comments

This answer was too vague and did not score the mark.

ResultsPlus
Examiner Tip

There must be some reference to reducing the capacity to carry oxygen in the blood or reference to carbon monoxide binding with haemoglobin to score the mark.

7 Methane reacts with steam to form carbon monoxide and hydrogen.

This is the equation for the reaction.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H = +206\ kJ/mol$$

(a) State why carbon monoxide is poisonous to humans.

(1)

Reduces the ability of ~~t~~ blood to transport oxygen around the body.

ResultsPlus
Examiner Comments

This was the preferred mark scheme answer which scored the mark.

ResultsPlus
Examiner Tip

This answer is stated in the specification, which is a good idea to learn this response.

Question 7 (b)

The majority of candidates gained the first marking point as they knew that the catalyst did not affect the yield, but only the minority explained adequately why the yield was not affected. A few thought that as the reaction speeded up that the yield would increase.

(b) Explain the effect, if any, on the yield of hydrogen at equilibrium when a nickel catalyst is used.

(2)

A catalyst has no effect on the position of equilibrium. It increases the rate of reaction in both directions at an equal rate. Thus yield of hydrogen will be unchanged.

ResultsPlus
Examiner Comments

This is a clear answer which gains both marks.

ResultsPlus
Examiner Tip

It is important to mention that the rates of forward and backward reactions are increased **equally** in order to gain the second marking point.

(b) Explain the effect, if any, on the yield of hydrogen at equilibrium when a nickel catalyst is used.

(2)

No effect on the yield as catalyst only increases the rate of reaction by lowering activation energy.

ResultsPlus
Examiner Comments

This has gained the first marking point for stating that there is no effect on the yield. There is a mention of increasing the rate by lowering the activation energy, but there is no reference to the forward and backward reactions being equal so the second marking point cannot be awarded.

ResultsPlus
Examiner Tip

Stating that a catalyst increases the rate by lowering the activation energy does not explain the effect of the yield.

(b) Explain the effect, if any, on the yield of hydrogen at equilibrium when a nickel catalyst is used.

(2)

The reation speeds up and it forms a product in short period of time

ResultsPlus
Examiner Comments

This question refers to the idea of a catalyst speeding up the reaction, but there is no reference to the yield or the equilibrium, so no marks can be awarded.

ResultsPlus
Examiner Tip

Just referring to the rate of reaction is not creditworthy. The effect of the yield needs to be explained to gain the marks.

Question 7 (c)(i)

This question gave a range of marks with most scoring at least 1 mark for knowing that the yield decreases.

(c) The reaction conditions for this reaction are a temperature of 700 °C and a pressure of 5 atmospheres.

(i) The temperature of the reaction mixture is reduced to 600 °C but the pressure is kept at 5 atmospheres.

Explain the effect on the yield of hydrogen at equilibrium.

(2)

the yield of hydrogen decreases, as the reaction is endothermic, the equilibrium shifts to the left side

ResultsPlus
Examiner Comments

This is a clear concise answer which gains both marks.

ResultsPlus
Examiner Tip

A detailed explanation is not required. Just stating that the yield decreases as the reaction is endothermic is enough for both marks.

(c) The reaction conditions for this reaction are a temperature of 700 °C and a pressure of 5 atmospheres.

(i) The temperature of the reaction mixture is reduced to 600 °C, but the pressure is kept at 5 atmospheres.

Explain the effect on the yield of hydrogen at equilibrium.

(2)

Decreasing the temperature will decrease the ~~yei~~ yield of hydrogen at equilibrium as the position will shift from ~~left~~ right to left.

ResultsPlus
Examiner Comments

This candidate gained 1 mark for stating that the yield decreases, but there is no mention of the reaction being endothermic so the second marking point cannot be awarded.

ResultsPlus
Examiner Tip

You need to discuss whether a reaction is endothermic or exothermic to explain why the yield decreases. Note that the equation shows that the reaction is endothermic, so use this data when answering the question.

(c) The reaction conditions for this reaction are a temperature of 700 °C and a pressure of 5 atmospheres.

(i) The temperature of the reaction mixture is reduced to 600 °C, but the pressure is kept at 5 atmospheres.

Explain the effect on the yield of hydrogen at equilibrium.

(2)

If you decrease the temperature, the equilibrium will shift to the ~~right~~ endothermic direction, in this case, the right. So the yield of hydrogen would increase.

ResultsPlus
Examiner Comments

Unfortunately, the candidate knew that the forward reaction was endothermic but they thought that the yield would increase, so no marks could be awarded.

ResultsPlus
Examiner Tip

If the temperature is reduced the equilibrium would shift to the exothermic reaction, which is the backwards reaction and in this case the equilibrium would move to the left and decrease the yield.

Question 7 (c)(ii)

The majority scored at least 1 mark for stating that the yield increased, although many did not refer to the numbers of moles so did not gain the second marking point.

(ii) The pressure of the reaction mixture is reduced to 4 atmospheres, but the temperature is kept at 700 °C.

Explain the effect on the yield of hydrogen at equilibrium.

(2)

The reaction will be slower but the hydrogen yield will stay the same.

ResultsPlus
Examiner Comments

Unfortunately, this candidate thought that the yield stayed the same and so no marks were awarded.

ResultsPlus
Examiner Tip

The question needed to explain the effect on the yield at equilibrium and although the reaction would be slower, this is not about the rate of the reaction.

(ii) The pressure of the reaction mixture is reduced to 4 atmospheres, but the temperature is kept at 700 °C.

Explain the effect on the yield of hydrogen at equilibrium.

(2)

When the pressure decreases then it favors forward reaction and the yield of hydrogen at equilibrium will increase

ResultsPlus
Examiner Comments

This candidate gained 1 mark for stating that the yield increases, but there was no reference to the moles on each side of the equation so the second marking point was not awarded.

ResultsPlus
Examiner Tip

Reference to favouring the forward reaction is ignored. Stating that there are more moles on the right-hand side is needed to explain why the yield increases.

(ii) The pressure of the reaction mixture is reduced to 4 atmospheres, but the temperature is kept at 700 °C.

Explain the effect on the yield of hydrogen at equilibrium.

(2)

When pressure is decreased equilibrium will shift to the side with more molecules, which is the right side, ✗ so hydrogen yield will increase.

ResultsPlus
Examiner Comments

This is a clear answer which gains both marks.

ResultsPlus
Examiner Tip

Make sure you state which side has the most moles or molecules.

Question 7 (d)

This question discriminated very well with an even range of all the five marks.

(d) Calculate the volume, in dm^3, of methane gas at rtp needed to produce 6.6 tonnes of hydrogen gas.

[at rtp, molar volume = $24\,dm^3$ 1 tonne = 10^6 g]

Give your answer in standard form.

(4)

vol = mol × 24 dm^3

H_2 mol = $\frac{\text{mass}}{\text{Mr}} = \frac{6.6 \times 10^6}{2} = 3300000$ mol

ratio 1 : 3 3300000 ÷ 3 = 1100000 mol CH_4

vol = mol × 24

= 1100000 × 24 = 26400000

volume of methane = 2.64×10^7 dm^3

ResultsPlus Examiner Comments

This candidate showed their clear working and gave the correct answer scoring all 4 marks.

ResultsPlus Examiner Tip

Show each step clearly, so if you make a mistake error can be carried forward.

(d) Calculate the volume, in dm^3, of methane gas at rtp needed to produce 6.6 tonnes of hydrogen gas.

[at rtp, molar volume = 24 dm^3 1 tonne = 10^6 g]

Give your answer in standard form.

(4)

$n(H) = \frac{6.6 \times 10^6}{1} = 6.6 \times 10^6$

$H_2 : CH_4$

3 : 1

$\therefore \frac{6.6 \times 10^6}{3} = 2.2 \times 10^6$

$n = \frac{V}{MV}$

$2.2 \times 10^6 = \frac{V}{24}$

$V = 52.8 \times 10^6$

volume of methane = 52.8×10^6 dm^3

ResultsPlus
Examiner Comments

This candidate did not gain the first marking point as there was no division by 2, but gained the second marking point for dividing the 6.6 tonnes by 3 and the third marking point by multiplying their answer by 24. Unfortunately, they did not give the answer in the correct standard form so the fourth mark was not awarded.

ResultsPlus
Examiner Tip

Hydrogen, H_2 is diatomic so to find the moles, 6.6 tonnes needs to be divided by 2. When writing your answer in standard form, there should just be one number before the decimal point.

(d) Calculate the volume, in dm^3, of methane gas at rtp needed to produce 6.6 tonnes of hydrogen gas.

[at rtp, molar volume = $24\,dm^3$ 1 tonne = 10^6 g]

Give your answer in standard form.

(4)

1 mol = $24\,dm^3$

412500 mol = x

=> $412500 \times 24 = 9900000$

CH_4

Mr 16

mass $10^6 \times 6.6$

mol

=> mol = mass / Mr

=> mol = 412500

$9,900,000\,dm^3$

9.9×10^6

volume of methane = 9.9×10^6 dm^3

ResultsPlus
Examiner Comments

This was quite a common answer. They divided the 6.6 tonnes by 16, which was the relative molecular mass of methane, instead of dividing by 2 and dividing by 3. They did, however, multiply their answer by 24 and gave their answer in standard form so two error carried forward marks could be awarded.

ResultsPlus
Examiner Tip

Note that there were 6.6 tonnes of hydrogen gas, so you need to find the moles of hydrogen and divide by 3 to find the moles of methane and then multiply by 24 to find the volume.

Paper Summary

Based on their performance on this paper, candidates should:

- Learn descriptions of chemical tests and conditions in the familiar reactions.
- Practise writing and balancing equations and, when writing half equations, make sure the charges are balanced.
- Always show your working clearly in calculations as you will often be able to pick up error carried forward marks.
- Use the data provided in the questions to help your answers.
- Read the questions carefully so as not to miss important points that will help you answer the questions.
- Do not waste time by repeating what is in the stem of the question as this will not be creditworthy.

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