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Examiners' Report
June 2024

Int GCSE Chemistry 4CH1 2CR

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Introduction

In general, candidates performed well on this paper, with candidates proving successful in questions spread across the paper, suggesting a good overall knowledge.

Calculation questions were well attempted, but frequently the stoichiometric ratio was neglected, and candidates were then unable to score full marks. Question 05(c) was particularly well answered, with many candidates carrying out correct methods to calculate x; this success was possibly due to the familiarity based on previous hydrated salts questions.

Questions on practical chemistry were variable, with candidates achieving greater success in Q05 about titration compared to Q06, which focused on electrolysis. Many candidates found it difficult to apply their knowledge, write half-equations or even recall simple chemical tests.

Energetics questions were generally well managed in terms of manipulating values or drawing diagrams, but qualitative answers about what happens in terms of bonds breaking and forming were extremely poorly executed. This demonstrates that many candidates still don't really understand what is happening on a submicroscopic level. Only the top candidates successfully achieved marks across the full range of Q07(b).

Question 1 (b)(i)

In this question, answers linked to the rate of reaction were common, with fewer candidates giving an answer linked to activation energy. A significant number of candidates talked about melting the reactants and the impact of their melting point. Many responses did not reference energy at all. Common errors also included references to making bonds rather than breaking bonds and simple references to heat. Most candidates were unable to express and organise their thoughts well. There was also a higher-than-average number of candidates who did not attempt this question.

(b) When a mixture of sulfur and zinc is heated to a high temperature a reaction occurs, forming the compound zinc sulfide, ZnS

(i) Give a reason why the mixture of sulfur and zinc needs heating before a reaction occurs.

(1)

To increase activation energy.

ResultsPlus
Examiner Comments

This is an example of a response which suggests the candidate doesn't fully understand the term 'activation energy'. Whilst they recognised this is what the question might be looking for, the actual reason given is incorrect.

(b) When a mixture of sulfur and zinc is heated to a high temperature a reaction occurs, forming the compound zinc sulfide, ZnS

(i) Give a reason why the mixture of sulfur and zinc needs heating before a reaction occurs.

(1)

Because they are solids, to make a mixture need to make them molten.

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Examiner Comments

This was a common answer which scored 0 marks. Many candidates focused on the reactants being solids and the need to melt them rather than on the high activation energy associated with the chemical reaction.

Question 1 (b)(ii)

Candidates performed well in this question and the vast majority were able to perform this simple task. The small number of errors that were observed included incorrect addition with correct numbers and multiplication/division of the correct numbers.

(ii) **Calculate the relative formula mass (M_r) of zinc sulfide.**

[for Zn, $A_r = 65$ for S, $A_r = 32$]

(1)

$n = \frac{m}{Mr}$, $Mr = m \times n$

$= 65 \times 32$

$= 2080$

$M_r = $ 2080

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Examiner Comments

There is some confusion for the candidate who incorrectly used the values in a rearranged moles equation (moles = mass/Mr) giving 2080.

(ii) Calculate the relative formula mass (M_r) of zinc sulfide.

[for Zn, A_r = 65 for S, A_r = 32]

(1)

65 + 32 x 2

M_r = 129

(Total for Question 1 = 4 marks)

2.8.8.8.4

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Examiner Comments

The candidate correctly adds the values but then carries out an incorrect additional step of multiplying the Ar of S by 2. The correct formula for zinc sulfide was given in the stem of the question.

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Examiner Tip

Encourage candidates to look for information in the stem of the question, particularly formulae or ratios for equations, when carrying out calculations.

Question 2 (b)(i)

Candidates performed well and the majority gained both marks for this question. The most common incorrect answer mentioned atomic number and mass number having failed to note the reference to sub-atomic particles in the question.

(b) These are the symbols for the two isotopes of lithium.

$^{6}_{3}\mathrm{Li}$ $^{7}_{3}\mathrm{Li}$

(i) In terms of sub-atomic particles, give one similarity and one difference between the two isotopes.

(2)

similarity

Both of them have the same amount of proton and electron

difference

^{6}Li has 3 neutron and ^{7}Li ~~which~~ has 4 neutron

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Examiner Comments

This response scored 2 marks, the addition of electrons did not impact the answer as this was allowed as a potential answer.

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Examiner Tip

Candidates should be careful that when giving additional (unnecessary) information that it is correct and doesn't contradict the rest of their answer. In this response the number of neutrons in the two isotopes was not required but the values given are correct and so full marks are awarded.

(b) These are the symbols for the two isotopes of lithium.

$^{6}_{3}Li$ $^{7}_{3}Li$

(i) In terms of sub-atomic particles, give one similarity and one difference between the two isotopes.

(2)

similarity

same atomic number

difference

~~Same~~ different mass number

ResultsPlus
Examiner Comments

This was the most common incorrect answer given by candidates as they had not responded 'in terms of sub-atomic particles'.

ResultsPlus
Examiner Tip

Underlining key words when reading the question can help candidates ensure that they are following the exact instructions.

Question 2 (b)(ii)

Candidates performed well, with most scoring both marks.

Most candidates were able to use the data provided and correctly calculate the relative formula mass. Responses that did not score were often as a result of multiplying both abundances by 7. There were also one or two rounding errors, but generally, if there was a calculation, it was correct. Some responses incorrectly added the atomic number to the mass to get 9.925. Other less common errors included rounding up to 7 and not dividing by 100.

(ii) A sample of lithium contains 7.5% of $^{6}_{3}Li$ and 92.5% of $^{7}_{3}Li$

Calculate the relative atomic mass (A_r) of this sample of lithium.

(2)

$(7.5 \times 6) + (92.5 \times 7)$

$45 + 647.5 = 692.5$

$A_r =$ 692.5

ResultsPlus
Examiner Comments

This style of question can be seen in a range of past papers and differs in the marks available depending on the complexity of the question and the requirements. In this instance, only two isotopes are involved with relatively simple numbers and no specific requirement to answer to a certain number of decimal places or significant figures. In this example, the candidate has forgotten to divide by 100 giving an unrealistic answer of 692.5 meaning the response scores 0 marks.

ResultsPlus
Examiner Tip

Candidates should consider whether values they determine from a calculation make sense in the context of the question. If lithium has either a mass number of 6 or 7 then the relative atomic mass will not be nearly 700.

(ii) A sample of lithium contains 7.5% of ${}^{6}_{3}Li$ and 92.5% of ${}^{7}_{3}Li$

Calculate the relative atomic mass (A_r) of this sample of lithium.

(2)

$(7.5 \times 7) + (92.5 \times 7) = 700$

$\frac{700}{100} = 7$

A_r = ...7........

(Total for Question 2 = 6 marks)

ResultsPlus
Examiner Comments

This response scored 0 marks. Whilst on the face of it the method looks correct, the candidate has multiplied both numbers by 7. If the method had been correct and the candidate had then rounded their response to 7 then they could have scored 1 mark but in this instance neither the method mark nor the maths skills mark was achieved.

Question 3 (a)(i)

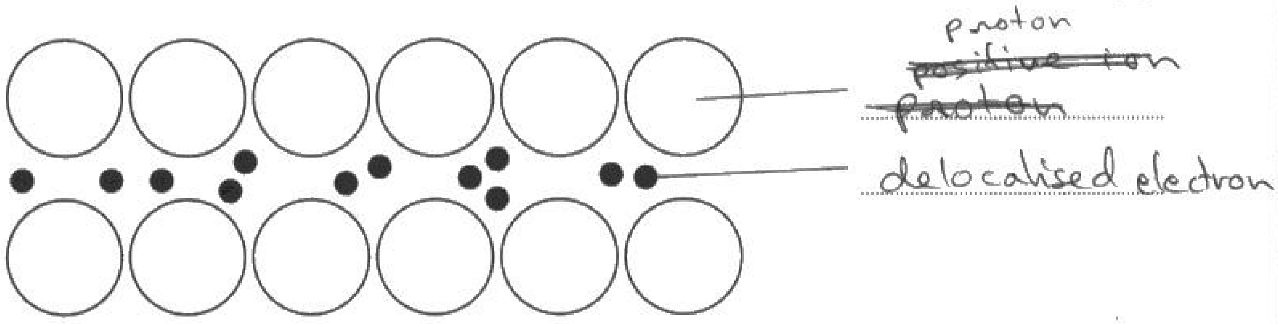
Candidates performed well, with most scoring at least one mark. Common errors included confusing nuclei, positive and negative ions, and protons for M1. A small number of candidates also mixed up the order and couldn't tell that the smaller dots represented electrons. On the whole, candidates understood the structure of metals and metallic bonding.

3 This question is about magnesium metal and its compounds.

(a) (i) The diagram represents the structure of magnesium.

Complete the diagram by adding the labels.

(2)



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Examiner Comments

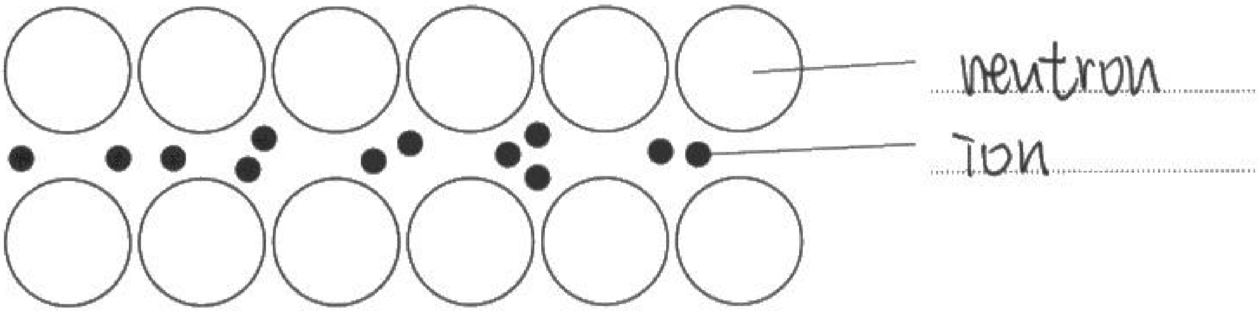
This response scored 1 mark for (delocalised) electron. Protons, Nuclei and just 'magnesium' were often errors encountered when marking. This candidate had clearly had some debate between the answer of proton and positive ion but unfortunately finished on the incorrect answer.

3 This question is about magnesium metal and its compounds.

(a) (i) The diagram represents the structure of magnesium.

Complete the diagram by adding the labels.

(2)



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Examiner Comments

Candidates should be encouraged to consider the relative sizes of different atoms, ions, sub-atomic particles, molecules and compounds which will help them when answering questions like these.

Question 3 (a)(ii)

Candidates performed well, with most scoring both marks. There were some excellent answers, with references to the regular size of the atoms. Common errors included candidates talking about electrons sliding instead of ions and incorrectly linking weak intermolecular forces to their explanations.

(ii) Explain why magnesium is malleable.

(2)

weak bonds between the ~~layers of~~ magnesium molecules.

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Examiner Comments

This response scored 0 marks as there are two issues with the response and nothing creditworthy. This includes the incorrect use of the term 'molecule' for magnesium and the suggestion that bonds are weak. Many of the responses to this question were excellent but occasionally there were answers where candidates guessed, using terminology that looks familiar.

Question 3 (b)(i)

The majority of candidates performed well. Marks lost were usually due to incorrect state symbols rather than the balancing of the equation. The most common incorrect state symbol was for MgO, which was often given as (aq) or (l).

(b) Magnesium burns in oxygen gas to form solid magnesium oxide.

(i) Complete the chemical equation for the reaction by balancing the equation and adding the state symbols.

(2)

$$4\,Mg(s) + O_2(2) \rightarrow 4\,MgO(4)$$

ResultsPlus
Examiner Comments

Responses like these are rare but they do occur. If the candidate had squeezed a '2' in front of the O_2 then they could have gained a mark but this isn't recommended as there is a risk that the number will be unreadable.

ResultsPlus
Examiner Tip

Candidates who have struggled with the course and have done limited revision should be practising these skills to help them access additional marks.

(b) Magnesium burns in oxygen gas to form solid magnesium oxide.

(i) Complete the chemical equation for the reaction by balancing the equation and adding the state symbols.

(2)

$$2\,Mg(s) + O_2(g) \rightarrow 2\,MgO(aq)$$

ResultsPlus
Examiner Comments

This response scored 1 mark for the correct balancing of the equation. The state symbol for oxygen is correct but unfortunately the state symbol for magnesium oxide is given as aqueous. This is an example of one of the more common errors seen for this question.

Question 3 (b)(ii)

Oxidation as the gain of oxygen or loss of electrons was well known. Weaker candidates referred to the magnesium reacting with oxygen as their answer, which was insufficient. A small number of candidates incorrectly stated that the magnesium gains electrons. Overall, candidates performed well in this question and demonstrated a good understanding of oxidation.

(ii) Give a reason why magnesium is oxidised in this reaction.

(1)

Racted with oxygen in the air.

ResultsPlus Examiner Comments

Question 3(b)(i) states that there is a reaction occurring before asking candidates to balance the chemical equation. Therefore, for question 3(b)(ii), this response scored 0 marks as it is a repetition of the earlier information and doesn't really address what 'oxidation' means.

(ii) Give a reason why magnesium is oxidised in this reaction.

(1)

It gains electrons.

ResultsPlus Examiner Comments

As an examiner we have to keep an eye out for responses like this as they are easy to miss. 'Gains electrons' is incorrect as they should be saying 'gains oxygen' or 'loses electrons'. This response scored 0 marks.

Question 3 (c)(i)

Most candidates were able to identify that the surface area had increased, but a significant number did not link this to causing the rate of reaction to increase, and therefore, they were not awarded the mark. Candidates should ensure they fully answer the question, which in this context means considering why increasing the surface area would be beneficial.

(c) A student uses this method to make a solution of magnesium chloride.

Step 1 measure $25\,cm^3$ of dilute hydrochloric acid into a beaker

Step 2 add magnesium powder a little at a time

Step 3 keep adding magnesium powder until it is in excess

Step 4 remove the excess magnesium powder by filtration

This is the equation for the reaction.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

(i) Give a reason why the student uses magnesium powder rather than magnesium ribbon.

(1)

→ To increase surface area so that rate of reaction also increases.

ResultsPlus
Examiner Comments

This is an example of a response that achieved 1 mark by elaborating on why they increased the surface area.

Question 3 (c)(ii)

Most candidates were able to indicate that the reason for using excess magnesium was to ensure that all of the acid reacted, but some candidates incorrectly stated that it was to make sure all the magnesium was used up. There were also many references to ensuring a saturated solution was formed.

Question 3 (c)(iii)

This question was well attempted by the majority of candidates, with most scoring at least two marks. A significant number of candidates were able to determine the moles of HCl (M1) and then use this value to calculate the mass of magnesium (M3), but they forgot to apply the 2:1 ratio (M2), resulting in an answer of 1.2g. This is a good example of where candidates should always follow through with their workings until the end, as they can score error carried forward (ecf) marks.

(iii) Calculate the minimum mass of magnesium needed to react with 25.0 cm^3 of 2.00 mol / dm^3 hydrochloric acid.

[for Mg, A_r = 24]

(3)

$25 cm^3 = \cancel{25000 dm^3}$ $0.025 dm^3$

mol = $2 \times 0.025 = 0.05$

mass = 24×0.05
= 1.2

mass = 1.2 g

(Total for Question 3 = 12 marks)

ResultsPlus
Examiner Comments

An example of a response scoring 2 marks where M2 was lost due to the 2:1 ratio not being taken into account.

(iii) Calculate the minimum mass of magnesium needed to react with $25.0\,cm^3$ of $2.00\,mol/dm^3$ hydrochloric acid.

[for Mg, $A_r = 24$]

(3)

mol of HCl = 2.00 x 0.025 = 0.05 mol

mol of magnesium = $\frac{0.05}{2}$ = 0.025

$0.025 = \frac{mass}{24}$ mass = 0.025 x 24

= 0.6

mass = 0.6 g

(Total for Question 3 = 12 marks)

ResultsPlus
Examiner Comments

This response scored 3 marks but what is notable is how well the answer is set out and how clear their method is.

ResultsPlus
Examiner Tip

Well set out responses which show the thought process of the candidate allow examiners to ensure ecf marks are awarded when appropriate, even when there are mistakes.

(iii) Calculate the minimum mass of magnesium needed to react with $25.0\,cm^3$ of $2.00\,mol/dm^3$ hydrochloric acid.

[for Mg, $A_r = 24$]

(3)

$n = c \times v = 2.00 \times 0.025$

$HCl\ n = 0.05$

$0.05 \times 2 = 0.1$

$m = mr \times n = 0.1 \times 24 = 2.4g$

mass = 2.4 g

(Total for Question 3 = 12 marks)

ResultsPlus
Examiner Comments

This response scored 2 marks as the candidate incorrectly multiplied the moles by 2 rather than dividing, resulting in an answer of 2.4g.

Question 4 (a)

There was some confusion between the industrial production of ethanol and fermentation, leading to many candidates scoring zero for quoting the conditions used in industrial production. Common errors also included using the general term 'optimum temperature' and referencing incorrect ranges of temperature and pressure. Additionally, there were instances where information from the question was repeated, suggesting that candidates did not fully read the question before answering.

4 This question is about the manufacture of ethanol by the fermentation of glucose.

(a) Fermentation needs to be done in the absence of air.

Give **two** other conditions needed for fermentation.

(2)

1 300 °C temperature

2 70 ~~Atm~~ atmospheric pressure

ResultsPlus
Examiner Comments

This response gives the conditions for the industrial production of ethanol scoring 0 marks. There were plenty of examples of responses which included one or both of these conditions.

4 This question is about the manufacture of ethanol by the fermentation of glucose.

(a) Fermentation needs to be done in the absence of air.

Give **two** other conditions needed for fermentation.

(2)

1 60-70 atmosphere

2 ~~300~~ 25°C temperature

ResultsPlus
Examiner Comments

This response also scored 0 marks as whilst the temperature is closer to the correct value it is still outside the acceptable range of 30-40 °C.

Question 4 (b)

Candidates are reminded to read questions carefully and ensure they do not merely restate provided information; this issue was frequently observed in answers to question 4(b) and did not receive credit. The most common response that earned 2 marks stated that ethanol could be oxidised to ethanoic acid. Some answers focused on discussing the biological aspects of the reaction, addressing aerobic or anaerobic respiration, rather than considering the chemistry of the reaction. In the context of this question, candidates should avoid stating that oxygen reacts with ethanol to produce water and carbon dioxide. Some candidates also hold misconceptions about the oxidation of glucose to ethanoic acid.

(b) Explain why fermentation needs to be done in the absence of air.

(2)

So yeast can anaerobically respire to break down sugar into alcohol.

ResultsPlus
Examiner Comments

Candidates are not credited for using the terms anaerobic/aerobic. Question 4(c)(i) also shows the equation of glucose breaking down into ethanol, so stating this information also did not gain any marks. The response doesn't explore why the absence of air is important in terms of the potential chemical reactions with oxygen.

Question 4 (c)(i)

The formula for carbon dioxide was frequently provided, and errors typically arose from incorrectly determining the remaining atoms that needed to be accounted for. It was positive to observe that candidates who couldn't recall the answer from memory made efforts to determine the product using this method.

(c) (i) Complete the equation for fermentation.

(1)

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2\ CHO_2$$

ResultsPlus
Examiner Comments

Evidence of candidates attempting to determine the missing product when they couldn't give the answer through recall alone was a welcome observation. Unfortunately, this candidate miscalculated the number of hydrogens, which emphasises the importance of reviewing their work once they have completed the paper.

Question 4 (c)(ii)

Most candidates were able to score at least one mark in this question by using the mass of ethanol and converting this into moles. However, some candidates were unable to link the calculated value to subsequently answer the question. A good number of candidates scored two marks by providing an answer of 25%. There were still issues with candidates securing M2 as they did not consider the 2:1 ratio, similar to the issue in question 3(c)(iii). Additionally, a small number of candidates used novel (and acceptable) methods to calculate the answer.

(ii) A mixture containing 500 mol of glucose is fermented.

A mass of 5750 g of ethanol is obtained.

Calculate the percentage yield.

[for ethanol, M_r = 46]

(3)

$500 \times 46 = 23000\text{g}$

$\frac{5750}{23000} \times 100$

percentage yield = 25 %

ResultsPlus Examiner Comments

This was a common response which scored 2 marks, where the ratio of 2:1 was not taken into account.

(ii) A mixture containing 500 mol of glucose is fermented.

A mass of 5750 g of ethanol is obtained.

Calculate the percentage yield.

[for ethanol, M_r = 46]

$\frac{500}{2}$ = 250 mol

(3)

250 x 46 = 11500

$\frac{5750}{11500}$ x 100 = 50%

percentage yield = ...50........ %

ResultsPlus
Examiner Comments

Overall, this response scored 2 marks. The candidate incorrectly divided the moles of glucose by 2, giving 250 moles of ethanol; they should have multiplied by 2 for M1. They then scored M2 (ecf) for using the correct method to determine the mass of ethanol by multiplying by the Mr. They also scored M3 (ecf) for using the correct method to determine the % yield using their figures.

Question 5 (a)(i)

Candidates performed well and the majority gave the answer pipette. Common incorrect answers were beaker or measuring cylinder. Throughout question 5, there seemed to be a good awareness of the type of equipment required for carrying out a titration.

Question 5 (a)(ii)

Most candidates were able to score up to 4 marks, with only the best candidates securing all 5 marks. Few candidates scored M4 (adding the sodium hydrogen sulphate dropwise near the end point), and only the most meticulous candidates were able to include all the main points clearly. The very best candidates also provided valid details that were not specifically assessed, such as the use of a white tile, procedures for taking readings, and the correct colour change for a named indicator.

Common errors included using a pipette instead of a burette, adding the solution dropwise from the start instead of near the end point, and forgetting to swirl. Colours of indicators were often incorrect and unnecessary, though not penalised in this question. A few candidates mistakenly put the acid in the conical flask despite the provided information. Additionally, some candidates' phrasing suggested they did not fully grasp the meaning of 'concordant results'.

(ii) **Describe the method the student should use to find the accurate volume of sodium hydrogensulfate solution needed to neutralise the 25.0 cm^3 of sodium hydroxide solution.**

(5)

Place a white tile under the clonical flask. Using a pipette, add 25 cm^3 of sodium hydroxide solution into the clonical flask, ~~Add the so~~ and add two drops of indicator. Add the sodium hydrogen sulfate ~~into~~ solution into a burette and record the starting volume. Slowly add the acid into the clonical flask while continuously swirling and mixing the solution in the clonical flask. Once the ~~that~~ solution has changed to its appropriate colour, ~~see~~ stop adding the acid and record the final volume of acid left in the burette. ~~Take away the final volume from the sta~~ Repeat these steps until you obtain concordant results. Calculate the mean from your concordant results. ~~Take away~~

ResultsPlus
Examiner Comments

This response scored 4 marks and is well written. There is no mention of adding the sodium hydrogen sulfate dropwise near the end point, which is where 1 mark was lost. 'Clonical flask' is not unusual, with 'conical flask' being one of the most commonly misspelt pieces of apparatus, along with the commonly used 'chronical flask'.

(ii) Describe the method the student should use to find the accurate volume of sodium hydrogensulfate solution needed to neutralise the 25.0 cm^3 of sodium hydroxide solution.

(5)

Rinse a burette with sodium hydrogensulfate solution, and add sodium hydrogen sulfate solution to the burette, add~~e~~ ~~[illegible]~~ the sodium hydrogen sulfate solution to the flask, and swirl continuously. Add the solution dropwise near the end, until the indicator changes color, measure the initial and final reading of the burette and find the difference. Repeat this until ~~t~~ you obtain concordant result and calculate an average using these concordant results.

ResultsPlus
Examiner Comments

This is an example of a high-quality response that meets all the points and scores 5 marks. The candidate is concise and meets all the criteria for the essential stages of titration.

(ii) Describe the method the student should use to find the accurate volume of sodium hydrogensulfate solution needed to neutralise the 25.0 cm^3 of sodium hydroxide solution.

(5)

① use a pipette transfer the ~~25.0cm³ of~~ sodium hydrogensulfate in the conical flack and add ~~3~~2 drops of ~~indicator~~ methyl orange and then put a white tile under the conical flask.

② fill the burette of 25.0cm³ of sodium hydroxide solution. and record the initial reading.

③ open the tap and add ~~NaHSO4~~ NaOH (aq) by dropwise and swirling the conical flask. at the same time

④ until the solution from red to yellow then record the final reading.

⑤ get the concordant result by ± 0.20cm³

ResultsPlus
Examiner Comments

This response scored 3 marks. By setting out the answer using numbers (or bullet points) this often reduces the chance of repetition or contradiction and it is far easier for candidates to review their own work at the end. Marks have been lost as the wrong reagent has been placed in the burette (M1) and the solution is being added dropwise from the start rather than near the end point (M4). Whilst theoretically the method will still work, adding the reagent dropwise at the start is not realistic for the values given.

Question 5 (b)

Most candidates were able to identify the need to heat the solution, allow time for crystallisation, and provide a drying method. However, some candidates did not specify when to stop heating the solution, and very few suggested heating to dryness. Those candidates who summarised their answer in bullet points often provided clearer answers compared to those who attempted paragraphs, which sometimes strayed off topic. Common errors included starting with the titration method, filtering before heating, and retaining the residue. A number of candidates confused this question with the procedure for obtaining an insoluble salt and began by filtering the solution without mentioning the need for heating.

(b) The student repeats the titration without the indicator and forms a solution of sodium sulfate.

Describe how the student can obtain pure, dry crystals of hydrated sodium sulfate from the solution.

(4)

Pour the sodium sulfate through a filtration funnel and collect the residue of the filtration process. Either store the residue on a evaporating dish and leave it somewhere sunny to dry or heat it up with a microwave.

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Examiner Comments

This response scored 0 marks as the candidate was under the wrong impression that a sodium sulfate residue would form.

ResultsPlus
Examiner Tip

Salt preparation methods is a good opportunity to review the solubility of salts rules; candidates should be encouraged to review their answer with these in mind.

(b) The student repeats the titration without the indicator and forms a solution of sodium sulfate.

Describe how the student can obtain pure, dry crystals of hydrated sodium sulfate from the solution.

(4)

you heat the solution until it saturates, you can see if it saturated from a glass rod, by dipping it and seeing if crystals are formed. if so. let it cool and after sometime dry ~~these~~ the crystals by filter paper gently pressing them for excess ~~it~~ solution to be absorbed by paper. and then your hydrated crystals of sodium sulfate are ready.

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Examiner Comments

This response is relatively well written but misses M3 for pouring off the excess liquid/filtering. Filter paper is mentioned but only to dry the crystals scoring M4.

(b) The student repeats the titration without the indicator and forms a solution of sodium sulfate.

Describe how the student can obtain pure, dry crystals of hydrated sodium sulfate from the solution.

(4)

After the titration, take the solution and filter it to get precipitate of sodium sulfate. wash / rinse the residue with water to remove any excess impurities. ~~leave the preci residue~~ Heat the precipitate in evaporating dish on bunsen burner. to get sodium sulfate crystals and leave it to cool to form more crystals.

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Examiner Comments

This response uses nearly all of the correct terms from the mark scheme but the order of the method does not make sense and would not successfully produce hydrated crystals. As a result this scored 0 marks.

Question 5 (c)

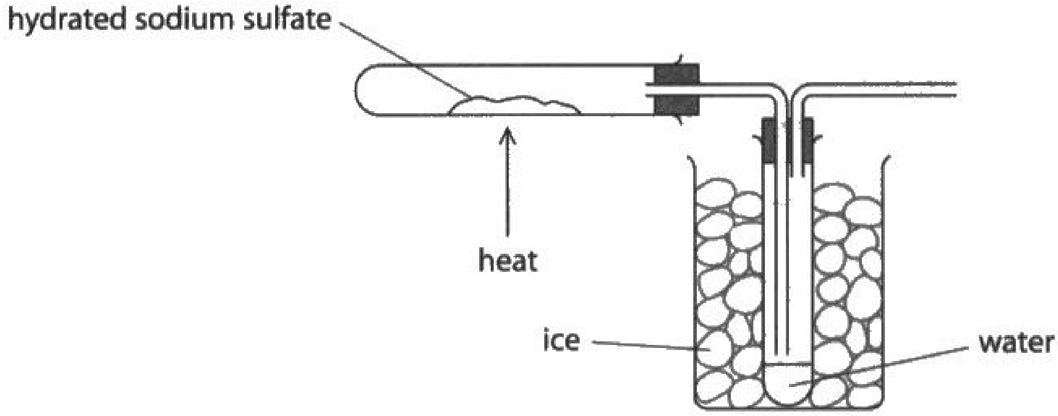
Candidates performed very well in this question with many scoring all four marks. Most candidates were able to score the first two marks via either mark scheme route, so the numbers 2.84, 3.6 and 6.44 were seen but then incorrectly processed. Many candidates also went on to calculate the moles but a small number were unable to score the final mark as they did not know what the next step was once they had calculated the moles. It was good to see that those candidates who had made an error often recognised that a whole number was required on the answer line and so were able to gain M4.

(c) Crystals of hydrated sodium sulfate decompose when heated.

This is the equation for the decomposition.

$$Na_2SO_4.xH_2O \rightarrow Na_2SO_4 + xH_2O$$

A student uses this apparatus to find the value of x.



The student heats the crystals until the decomposition is complete.

The table shows the student's results.

mass of empty test tube in g	25.12
mass of test tube and $Na_2SO_4.xH_2O$ in g	31.56
mass of test tube and Na_2SO_4 in g	27.96

Use the results to calculate the value of x.

[for Na_2SO_4, M_r = 142 for H_2O, M_r = 18]

(4)

$Mass_{Na_2SO_4} = 27.96 - 25.12$

$= 2.84g$

$Mol_{Na_2SO_4} = \frac{2.84}{142}$

$= 0.02 mol$

~~Mat S·~~ $mass_{H_2O} = 31.56 - 27.96$

$= 3.6g$

$mol = \frac{3.6}{18}$

$= 0.2$

x : 0.2

1 : 1

x = 0.2

value of x = 0.2

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Examiner Comments

The value of x should be a whole number so this answer is incorrect. The candidate has managed to score M1, M2 and M3 but the final step of working out x using the data was unsuccessful.

Question 6 (a)(ii)

The test for oxygen gas is commonly examined, yet many candidates still fail to provide both a method and a result. Some candidates only mentioned 'the glowing splint test' but omitted the result. Common errors included confusing it with the test for hydrogen and incorrectly using terms like 'burnt splint' or 'blown-out splint'.

(ii) Give a test to show that the gas produced at the positive electrode is oxygen.

(1)

Expose the gas to a burning splint if it relights, Oxygen is present.

ResultsPlus
Examiner Comments

A small number of candidates did not gain a mark for a test they were clearly familiar with. Use of the correct language is important in this instance.

Question 6 (a)(iii)

Candidates generally performed well on this commonly examined question, with most able to access the marks. However, common errors included confusion between the test for oxygen and using 'squeaky pop test' without providing details linked to the method.

(iii) Give a test to show that the gas produced at the negative electrode is hydrogen.

(1)

Pop test

ResultsPlus
Examiner Comments

The 'squeaky pop test' is a response that many previous examiner reports have highlighted as insufficient, so it was interesting to find a number of small samples that had reduced this incorrect answer even further. Method and result are important to achieve marks for chemical tests.

Question 6 (a)(iv)

Constructing a half-equation proved challenging for many candidates, who produced an interesting range of incorrect answers. Common errors included using H-, placing electrons on the wrong side of the arrow, omitting charges, or assigning incorrect charges to species. This suggests that candidates often approached this as a recall question rather than ensuring that their equations were balanced. Overall, the responses indicate a general lack of understanding of half-equations.

(iv) Give an ionic half-equation for the formation of hydrogen at the negative electrode.

(1)

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

ResultsPlus
Examiner Comments

Question 6(a)(iv) requires a half-equation for the **formation** of hydrogen, which means this response scored 0 marks. The candidate clearly has an awareness of what is required for a half-equation but sadly has not answered the question.

(iv) Give an ionic half-equation for the formation of hydrogen at the negative electrode.

(1)

$2H^{-1} - 2e^{-1} \rightarrow H_2$

ResultsPlus
Examiner Comments

This response scored 0 marks as they have given a hydride ion rather than a hydrogen ion. They have clearly edited the addition of electrons and turned this into a subtraction which has then helped them balance the (incorrect) equation. The standard notation expected in this course is for the addition of electrons on the correct side of the half-equation in order to be creditworthy.

Question 6 (a)(v)

Candidates performed well overall, and many correctly carried out this calculation. The most common error was using 16 instead of 32 for the Mr of oxygen, resulting in an answer of 0.0119g. Candidates also frequently forgot to round their answer to three significant figures after completing the calculation, leading to a loss of marks for M3. Weaker candidates were confused about how to incorporate the 24000 cm^3 and whether it should be divided or multiplied in the calculation.

(v) The oxygen gas in the tube has a volume of 17.8 cm^3 at rtp.

Calculate the mass, in grams, of oxygen gas in the tube.

Give your answer to 3 significant figures.

[for O_2 at rtp, molar volume = 24 000 cm^3]

mole = mass/mr

mole = volume/molar vol

mole = volume × concentration

(3)

mole = $\frac{\text{volume}}{\text{molar volume}}$

mole = $\frac{17.8}{24000}$ = 7.416×10^{-4}

mass = mole × mr

mass = $7.416 \times 10^{-4} \times 32$

= 0.023

= 0.024

mass of oxygen = 0.024 g

ResultsPlus
Examiner Comments

A clearly set out response that uses all the data correctly but unfortunately has not given the answer to 3 significant figures so only scores 2 marks. This could either be a lack of understanding of significant figures (by including any number after the decimal point) or not recalling that this is what the question required.

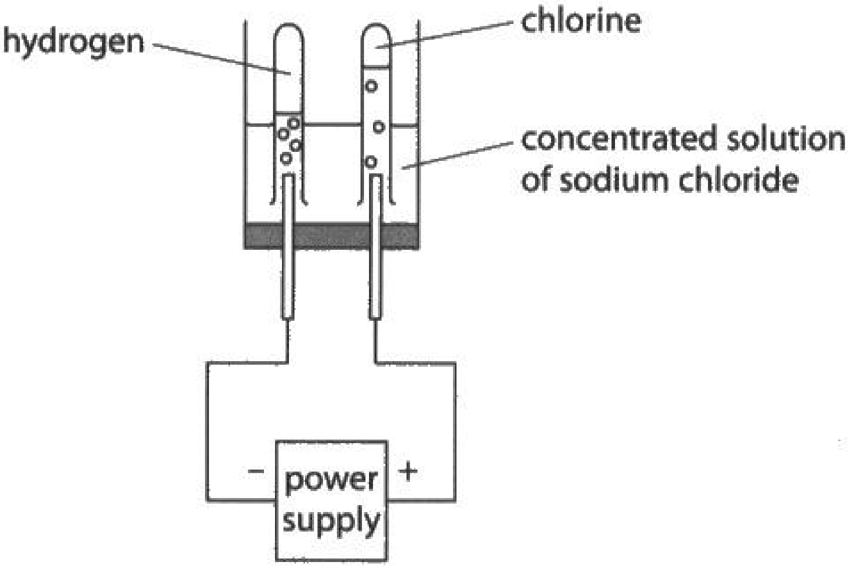
ResultsPlus
Examiner Tip

When reading the question the candidates could add (3sf) to the answer line ready to remind them what they need to do when they get to the final step.

Question 6 (b)(i)

Most candidates were able to identify ions as the charge carriers and that they could move. Weaker answers focused on electrons not ions and others lost a mark for mentioning both electrons and ions in their answer. Some candidates simply made reference to 'charged particles' moving rather than being specific.

(b) This apparatus is used to electrolyse a concentrated solution of sodium chloride.



(i) Give a reason why sodium chloride solution conducts electricity.

(1)

Its ions are free to ~~ca~~ carry charge.

ResultsPlus
Examiner Comments

There is no mention of movement, only 'free to carry charge', resulting in 0 marks.

Question 6 (b)(ii)

The majority of candidates correctly referenced the relative reactivities of hydrogen and sodium. Marks could also be gained by accurately comparing the relative reactivity of their ions, but many candidates did not succeed in this aspect. Other candidates stated that H^+ would be attracted to the negative electrode (possibly from a previous question), forgetting that Na^+ ions are also positive. A small number of top candidates were able to answer this question by using the concept of oxidising power, such as recognising that hydrogen ions have a stronger oxidising power than sodium ions.

Question 6 (b)(iii)

Candidates performed poorly in this question. While most candidates were able to gain one mark by providing the correct colour of the indicator, few understood the underlying process or explained their answer effectively. Common errors included stating that H^+ ions remained, therefore the solution was acidic, and attributing the colour to Na^+ ions because sodium is an alkali metal. A minority of candidates incorrectly suggested that the colour would disappear due to being "bleached" by chlorine.

(iii) A sample of the solution is taken from near the negative electrode.
The sample is tested with universal indicator.

Explain the final colour of the universal indicator.

(2)

The universal indicator would be red, as H is acidic because of the H^+ ions.

ResultsPlus
Examiner Comments

This was a common incorrect response, likely due to question 6(b)(ii) (above) stating that H^+ ions are in the solution. Candidates didn't link this to the context of the overall experiment covered in question 6. For example, in question 6(a)(iv), they had been asked to show the formation of hydrogen using a half-equation, demonstrating that the H^+ ions had been used up.

Question 7 (a)(i)

Candidates performed as expected, with only the more able candidates securing both marks through clear explanations. Most candidates demonstrated understanding of the concept of the shift towards the side with the most moles of gas. However, few candidates provided a complete answer by failing to mention the shift in equilibrium to the left or omitted to state that the yield of ethanol would decrease. A common error was also answering as if the pressure had been increased. Additionally, some candidates lost marks due to the poor clarity of their responses, and a few candidates incorrectly used particle theory as their explanation.

7 Gaseous ethanol is manufactured by reacting ethene gas with steam.

This is the equation for the reaction.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

(a) (i) The pressure on an equilibrium mixture of the three gases is decreased. All the other conditions are kept the same.

Predict the effect of this change on the yield of ethanol at equilibrium, giving a reason for your answer.

(2)

Yield decreases. There are more ~~number~~ ~~number~~ number of moles in the reactant side.

ResultsPlus
Examiner Comments

This response only scored 1 mark for stating that there are more moles on the reactant side. While the candidate correctly identified that the yield of ethanol decreases, more information was required. Specifically, they needed to mention that the equilibrium "shifts to the left-hand side" to achieve M1 and avoid responses being credited due to a 50:50 guess.

7 Gaseous ethanol is manufactured by reacting ethene gas with steam.

This is the equation for the reaction.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

(a) (i) The pressure on an equilibrium mixture of the three gases is decreased. All the other conditions are kept the same.

Predict the effect of this change on the yield of ethanol at equilibrium, giving a reason for your answer.

(2)

As pressure decreases, temperature also decreases. So the rate of reaction decreases and there are smaller yield of ethanol

ResultsPlus
Examiner Comments

This response scored 0 marks and clearly lacks understanding. This clip highlights the importance of not just stating "yield decreases" for M1.

Question 7 (a)(ii)

Question 7(a)(ii) was poorly answered, with candidates finding this part even more challenging than question 7(a)(i). A good number of candidates could identify that there was no change in yield. However, many candidates did not score M2 because they failed to state that the increase in rate was equal for both the forward and backward reactions, or they simply made a vague reference to 'both sides' of the equation. Some responses incorrectly stated that the forward reaction rate would increase, leading to an increase in yield. Additionally, many candidates provided unnecessary detail about how a catalyst works, which could not be credited.

(ii) Predict the effect of adding a catalyst on the yield of ethanol at equilibrium, giving a reason for your answer.

(2)

→The catalyst will increase the yeild.
because catalyst inerese the rate of reaction.

ResultsPlus
Examiner Comments

This was a common error, as candidates had not considered the impact of the catalyst on a reversible reaction but instead focused only on the forward reaction.

(ii) Predict the effect of adding a catalyst on the yield of ethanol at equilibrium, giving a reason for your answer.

(2)

The yeild will not change.

Because catalyst doesn't effect the mass of product. It's only effect the rate of reaction.

Catalyst effected the rate of reaction by providing alternative ~~one~~ reaction pathway with lower activation energy.

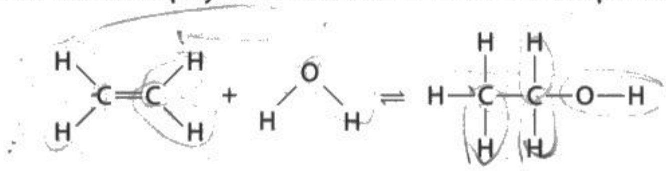
ResultsPlus
Examiner Comments

This response provides plenty of detail about how a catalyst works but only scores 1 mark for 'yield will not change' as there is nothing related to why this would be the case.

Question 7 (b)(i)

Candidates performed very well in this question, benefiting from the approximate value provided. Most candidates accurately calculated the sum of bond energies in both the reactants and products. Common errors included subtracting the values in the wrong order (resulting in a loss of M3) and then adjusting the sign to match the negative sign given in the question (eg 3237 – 3196 = –41). Generally, candidates were familiar with this type of question, and mistakes often stemmed from calculator-related errors.

(b) The equation shows the displayed formulae for the reactants and products.



The table gives the bond energies.

Bond	Bond energy in kJ / mol
4 C—H	414
1 C=C	614
1 O—H	463
C—C	346
C—O	358

endo ~~bond~~ break

(i) Using the data in the table and the equation, show that the enthalpy change, ΔH, is approximately –40 kJ / mol.

(3)

(4×414) + 614 + (2×463) → (5×414) + 463 + 358 + 346

~~3196~~ 3196 3196 → 3237

3237 − 3196 = 41

ΔH = −41

ResultsPlus Examiner Comments

An easy error to miss but this response scores only 2 marks as the candidate has written – 41 kJmol^{-1} but they have added in the minus sign afterwards. The values used to calculate enthalpy are the wrong way around and so lose M3.

Question 7 (b)(ii)

Question 7(b)(ii) was very poorly answered and proved quite challenging for many candidates, mainly due to the high level of accuracy and coherence required. Responses often contained contradictions, leading to a score of zero with candidates either scoring both available marks or none at all. It was common for candidates to make a simple mistake by suggesting that energy was needed for both bond breaking and bond making, resulting in no marks being awarded. Some misconceptions were also evident, with answers focusing solely on the number rather than the type of bonds. Additionally, there were instances where candidates seemed to have been extensively coached in answering this style of question, with answers showing almost identical phrasing to previous mark schemes.

endo exo

(ii) Explain, in terms of bonds broken and bonds made, why this reaction is exothermic.

(2)

there are more bonds made than broken, more energy is released as bond making is a exothermic process.

ResultsPlus
Examiner Comments

This response scored 0 marks but could have scored 1 mark had they elaborated further and stated that bond breaking is an endothermic process. It also focuses on the number of bonds rather than the type.

(ii) Explain, in terms of bonds broken and bonds made, why this reaction is exothermic.

(2)

the amount of energy needed to break the bonds is less than the energy needed to make the bonds, hence thermal energy is released to the environment so that the reaction is exothermic

ResultsPlus
Examiner Comments

This was a common error that resulted in a mark of 0, as it suggests that both breaking bonds and making bonds require energy. The mark scheme’s additional information states: "If the response states or implies that energy is required to make bonds, it scores 0."

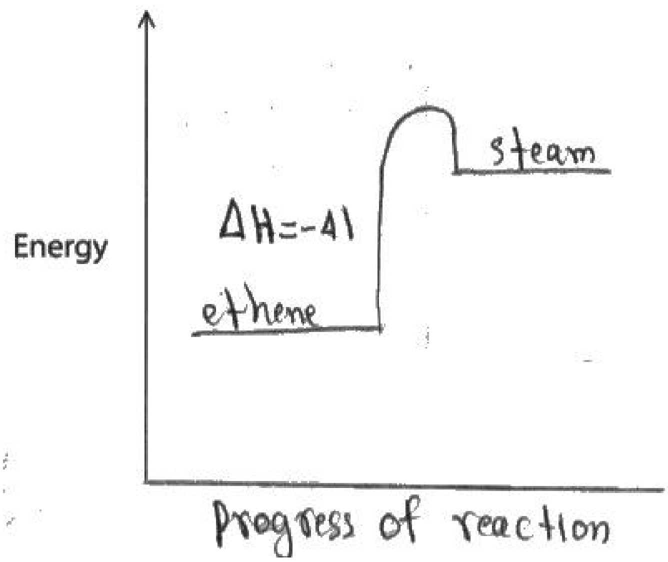
Question 7 (b)(iii)

When drawing the energy level diagram, most responses positioned the products lower than the reactants. Some diagrams included generic labels like 'reactants' and 'products' instead of specific details of the reaction. Candidates also showed confusion between enthalpy change and activation energy when labelling these on their diagrams. While not penalised unless obviously incorrect, many arrows were too small or lacked direction, demonstrating little understanding of what they were representing.

(iii) Draw an energy level diagram for the reaction between ethene and steam.

Label the enthalpy change, ΔH.

(3)



ResultsPlus
Examiner Comments

This energy level diagram has the x-axis added and labelled, showing awareness of the material. However, each key creditworthy area contains errors. This response scored 0 marks, with M3 being lost as enthalpy seems to be confused with activation energy.

ResultsPlus
Examiner Tip

Make sure enthalpy change labels are drawn facing the correct direction and are the correct length (from reactants to products).

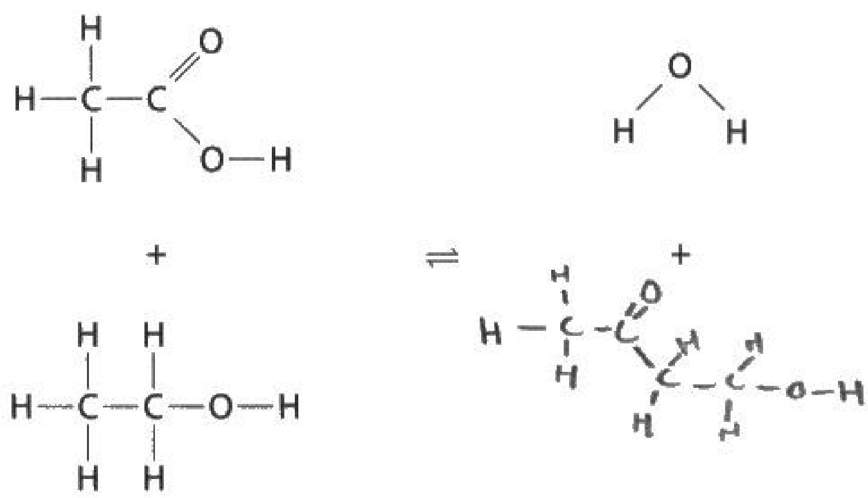
Question 7 (c)(i)

Candidates performed poorly, with many questions left unanswered. Common errors included OH groups, ester groups bonded to hydrogen on the single bond side, carbons with more than 4 bonds, or carbonyls with the linking oxygen missing and found as an OH on the end. Candidates typically either scored both marks or none at all.

(c) Ethanoic acid reacts with ethanol to form ester A and water.

(i) Complete the equation by adding the displayed formula of ester A.

(2)



ester A

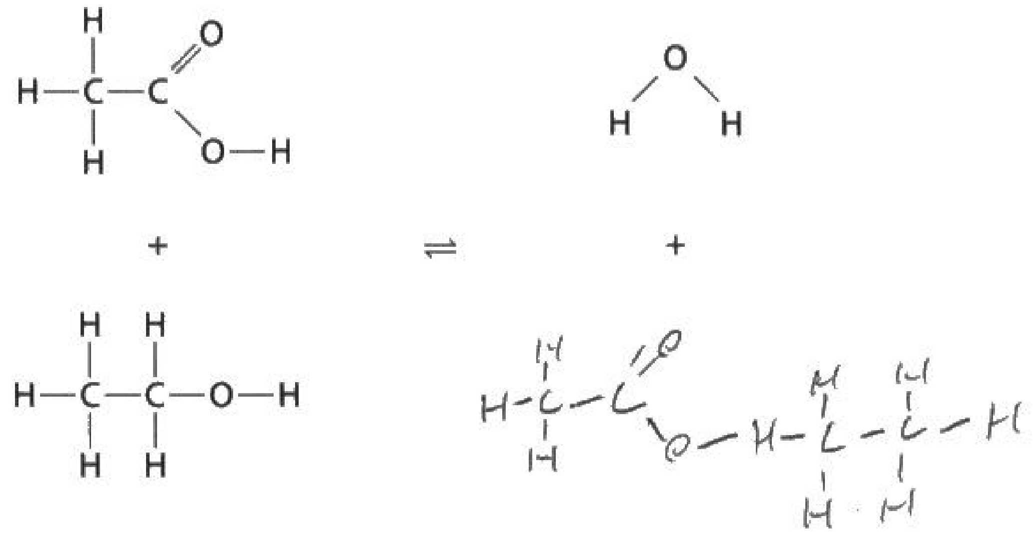
ResultsPlus
Examiner Comments

A common incorrect answer: no ester bond is given, so no M1. The rest of the molecule is not correct, so no M2.

(c) Ethanoic acid reacts with ethanol to form ester A and water.

(i) Complete the equation by adding the displayed formula of ester A.

(2)



ester A

ResultsPlus
Examiner Comments

This response scored 0 marks as even though they have the – COO bonds, the oxygen is then linked to a H which is not consistent with an ester group.

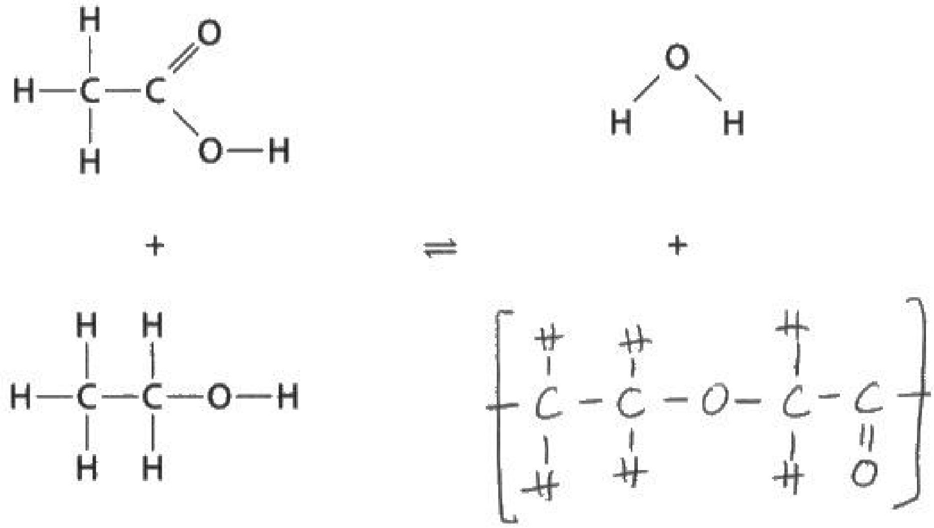
ResultsPlus
Examiner Tip

Candidates should be encouraged to review their structures by checking how many bonds each atom has been given to identify potential errors.

(c) Ethanoic acid reacts with ethanol to form ester A and water.

(i) Complete the equation by adding the displayed formula of ester A.

(2)



ester A

ResultsPlus
Examiner Comments

Many responses included trailing bonds with brackets, indicating that candidates were eager to provide a repeating unit when this wasn't required. Candidates who have completed a large number of past papers as part of their revision can sometimes start to assume what is being asked rather than taking the time to read the question carefully.

Question 7 (c)(ii)

Identifying the ester as ethyl ethanoate was successfully completed by most candidates, despite not all of these candidates achieving marks in question 7(c)(i).

Paper Summary

Based on their performance in this paper, candidates should:

- Take care when selecting terminology when explaining why a substance conducts electricity.
- Consider more carefully the stoichiometric ratios that need to be taken into account when carrying out multi-step calculations.
- Familiarise themselves with the investigations included in the specification in order to write clearer and more concise methods.
- Practise drawing the products for organic reactions relevant to this course.
- Consider how activation energy and enthalpy change differ in order to assist in the correct labelling of energy level diagrams.