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June 2024

IAL Chemistry WCH13 01R

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June 2024

Publications Code WCH13_01R_2406_ER

Introduction

The paper was accessible to most candidates and provided the full range of marks. Some candidates scored very high marks and were well prepared for the examination, showing excellent learning and teaching has taken place. Many had a sound knowledge of the specification and could demonstrate this in their explanations and descriptions. However, a small minority of candidates found the questions challenging and need to express their understanding of chemistry more clearly. The calculations were generally well attempted with the main errors being in the choice of data being substituted into formulae. There were no reports of candidates running out of time and the majority of candidates provided responses to the last question, indicating that the paper was not unduly long. The mean mark for the paper was 25.

Question 1 (a)

Over 60% of candidates did not achieve this mark, despite the equipment being very familiar from GCSE. Common errors included omission of the plunger or the gradations and some candidates did not attempt this answer at all. Many candidates drew apparatus for collecting the gas over a liquid, sometimes labelling the liquid with names other than water, though as sulfur dioxide is also soluble in alcohols and other organic liquids none of these were accepted. Some candidates attached a measuring cylinder or conical flask to the collecting tube which is concerning.

This example shows an excellent candidate diagram.

1 Sodium sulfite reacts with dilute sulfuric acid, as shown.

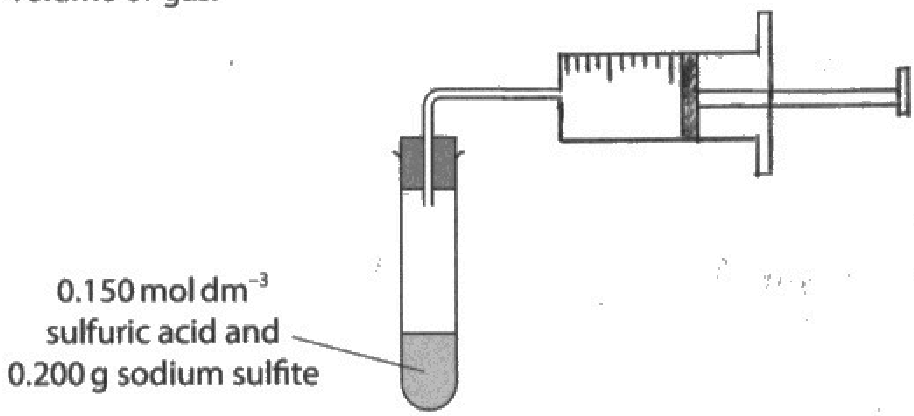
$$Na_2SO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + SO_2$$

A student carried out an experiment to measure the molar volume of sulfur dioxide. 0.200 g of sodium sulfite was added to 0.150 mol dm^{-3} sulfuric acid in a boiling tube and the volume of gas given off was measured.

Sulfur dioxide is soluble in water, so collecting the gas over water **cannot** be used.

(a) Complete the diagram to show the apparatus that could be used to measure the volume of gas.

(1)



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Examiner Comments

Though use of a ruler is not required, the neat lines on this diagram make it very clear that the candidate understands all parts of the piece of equipment. The graduations are clearly visible and the tube is properly connected to the syringe. The plunger is also visible inside the barrel.

ResultsPlus
Examiner Tip

Make sure that diagrams show all parts of the equipment required and tubes are linked with solid lines.

Question 1 (b-di)

Most candidates gained 4 of the 5 marks for this question. The mark that was least frequently awarded was the calculation of the gas volume in part (c), often because candidates used the equation upside down. Where candidates worked out the M_r of the sulphate instead of the sulfite, they could gain the later marks by transferred error (TE).

This candidate scores all the available marks.

(b) Calculate the number of moles of sodium sulfite in 0.200 g.

(2)

$M_r = 23 \times 2 + 32.1 + 16 \times 3 = 126.1$

$n = \frac{m}{M} = \frac{0.2}{126.1} = 1.59 \times 10^{-3}$ mol

(c) The reaction produced 29.5 cm^3 of sulfur dioxide.

Calculate the molar volume of sulfur dioxide, in dm^3, from this result.

(2)

$n(SO_2) = n(Na_2SO_3) = 1.59 \times 10^{-3}$ mol.

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

$V_m = \frac{V}{n} = \frac{29.5 \times 10^{-3}\ dm^3}{1.59 \times 10^{-3}\ mol} = 18.55\ dm^3$.

(d) The molar volume calculated was less than expected so after checking for leaks, the student repeated the experiment. The volume produced was still less than expected, so the student decided the acid might not be in excess.

(i) Calculate the minimum volume of 0.150 mol dm^{-3} acid that should be present in the boiling tube to fully react with 0.200 g of sodium sulfite. Use your answer to (b).

You should include units in your answer.

(1)

$n(H_2SO_4) = n(Na_2SO_3) = 1.59 \times 10^{-3}$ mol.

$n = cV$

$V = \frac{n}{c} = \frac{1.59 \times 10^{-3}}{0.15} =$ ~~0.0106 dm^{-3}~~ 0.0106 dm^3.

ResultsPlus Examiner Comments

The candidate clearly shows their working, including the rearrangement of equations and has included correct units throughout. The answers are given to at least 3 significant figures, so there is no loss of precision for subsequent steps. Where the candidate has changed their mind on an answer, they have clearly crossed it out with horizontal lines.

ResultsPlus Examiner Tip

Show all your workings so that you can gain transferred error marks if something goes awry.

Question 1 (d)(ii)

Only a quarter of candidates gained a mark for this question, with many giving imprecise answers that did not score. Candidates should aim for more detail in their answers, ensuring they have read the question for responses that won't score – some candidates wrote that sulfur dioxide will dissolve in water or gas leaking out of the apparatus when both had already been given in the question.

An example of an answer that scored the mark.

(ii) Suggest another reason for the molar volume being lower than expected.

(1)

the ~~press~~ temperature of the experiment may be lower than room temperature.

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Examiner Comments

Room temperature here is being taken as equivalent to standard conditions.

An example of a common answer that did not score.

(ii) Suggest another reason for the molar volume being lower than expected.

(1)

Some gas will be lost when moving the bung.

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Examiner Comments

This answer is too vague. If the candidate had written "replacing" the bung, they would have gained credit.

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Examiner Tip

Use scientific vocabulary when answering questions. Review the core practical instructions sheets before your practical exams so you can revise key terms and equipment.

Question 1 (e)

This question was not well answered. Candidates often failed to use scientific terminology and/or specify which compound the hazard related to.

An example of a very good answer.

(e) State why the experiment should be carried out in a fume cupboard.

(1)

because SO_2 gas is toxic and has choking smell.

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Examiner Comments

This candidate has included the scientific vocabulary and also a description.

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Examiner Tip

Make sure you explain which compound or species the scientific terms relate to so you can score all the marks.

An example of a poor answer.

(e) State why the experiment should be carried out in a fume cupboard.

(1)

Because SO_2 is harmful to the environment.

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Examiner Comments

This answer did not score. Though the correct compound is chosen, "harmful" is not sufficient for the mark and it is not the environment that we are concerned about when doing experiments in the fume cupboard.

Question 2 (a)(i)

This question was very poorly answered. Over 60% of candidates failed to score any marks which is concerning. Though this is not a core practical on the specification, the reactions are and all candidates should be familiar with the experiments from GCSE. Some candidates even stated that lithium is more reactive than potassium so were unable to access the rescue mark relating to reactivity down the group. A minority of candidates tried to explain the change in reactivity down the group instead of answering the question in terms of observations. The first mark was most frequently awarded for lithium fizzing or moving on the water, though even this was sometimes negated by candidates stating that lithium would form a precipitate or produce oxygen gas. Some candidates also wrote about the solution changing colour, often as though Universal Indicator had been added, but answering as though the hydroxide solutions themselves were coloured. Some candidates wrote about the flame test colours for the Group 1 metals, instead of the reaction with water and these answers did not score any marks.

A rare 3 mark answer.

2 This question is about reactive metals and their compounds.

(a) Lithium, sodium and potassium all react with water.

(i) Describe the differences you would see when this experiment is carried out with the three metals.

(3)

Lithium : slow reaction , doesnt melt, fizzing can be seen and heard.
Sodium : sodium melt, the ball of sodium dash across the surface
Potassium : melts and floats and self-ignites. results in sparks and a lilac flame.

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Examiner Comments

There are three metals in the stem of the question and 3 marks available for the question, so this should help candidates structure their answers. As differences need to described, it is easiest to describe the first and then explain how the other two are different.

ResultsPlus
Examiner Tip

Use the question and the marks available to structure your answers, along with the command words.

Question 2 (a)(ii)

The average mark here was one of the two available, often because candidates gave too many answers in their response so lost marks due to extra incorrect precautions. Many candidates included gloves as protection from the exothermic reaction, which could not score. Some candidates also referred to protection from explosions which does not answer the question, as we want to prevent an explosion from happening. A great variety of safety clothing and equipment was seen though candidates are only expected to wear a laboratory coat, safety glasses/goggles and gloves at A-Level.

This candidate scored both marks.

(ii) State **two** precautions, other than wearing safety goggles, that should be taken during the experiment.

(2)

Wear gloves and lab coat, and use a fume
Use cupboard.

ResultsPlus
Examiner Comments

Any two of these three answers would have scored a mark, though they are all "allow"s on the mark scheme. This means there are potentially better answers that are specific to this experiment, but the answers given here are still worthy of credit.

ResultsPlus
Examiner Tip

Try to make sure your answers are specific to the experiment.

An example of a candidate who gave too many answers.

(ii) State **two** precautions, other than wearing safety goggles, that should be taken during the experiment.

(2)

wear gloves

prevent oxidising agent

stay away from flammable substance

prepare fireplug

ResultsPlus
Examiner Comments

No credit was given here as the number of incorrect statements exceed the correct answers.

Wearing gloves would otherwise have scored.

ResultsPlus
Examiner Tip

Do not give more answers than are required by the question, as incorrect statements can cancel out correct responses.

Question 2 (b)(i)

Over half of candidates gained this mark; this is better than ionic equations in previous years. The most common reason for losing the mark was failing to balance the hydroxide ions, other candidates omitted the state symbols or gave the state symbols incorrectly. Other incorrect responses included spectator ions or compounds that would not form.

An example of a correct answer.

(b) Group 2 metals all have soluble chloride salts.

(i) Write an **ionic** equation for the reaction of magnesium chloride solution with aqueous sodium hydroxide.

$MgCl_2 + NaOH$

Include state symbols in your answer.

(1)

$$Mg^{2+}(aq) + 2OH^{-} aq \rightarrow Mg(OH)_2 (s)$$

ResultsPlus
Examiner Comments

The candidate has not put the aq for the hydroxide ions in brackets, but this answer scores the mark.

ResultsPlus
Examiner Tip

Ensure your writing of equations is legible. In relation to state symbols, the g and s need to be distinguishable.

An example of a common error.

(b) Group 2 metals all have soluble chloride salts. Cl^-

(i) Write an **ionic** equation for the reaction of magnesium chloride solution with aqueous sodium hydroxide. $MgCl_2$.

$NaOH$

Include state symbols in your answer.

(1)

$$Mg^{2+}_{(aq)} + OH^-_{(aq)} \longrightarrow Mg(OH)_{2\,(s)}$$

ResultsPlus
Examiner Comments

This was the most common reason for loss of the mark – the hydroxide ions have not been balanced.

ResultsPlus
Examiner Tip

Always check your equations are balanced.

Question 2 (b)(ii)

Two thirds of candidates gained this mark. Common errors included omission of the colour, but exothermic reaction and effervescence were also seen regularly.

A correct answer.

(ii) State what would be observed during this reaction.

White precipitate formed

ResultsPlus
Examiner Comments

This candidate scored the mark.

ResultsPlus
Examiner Tip

Always give the colour with your observation.

Question 2 (b)(iii)

Over half of candidates gained both marks here. Where only one mark was awarded, this was often due to omission of the observation or use of an incorrect formula for a reagent. Many answers were seen that included hydrochloric acid with the sulfuric acid – presumably to react with any carbonate ions that may give a false positive – but as this would react with the sulfuric acid anyway, it was unexpected to see this addition so frequently. Another error seen was to add sodium hydroxide or silver nitrate showing a lack of understanding as the chloride was present in both solutions.

A frequently seen response.

(iii) It is suspected that a bottle of magnesium chloride solution has been contaminated with barium chloride.

Describe a test and its result, other than a flame test, which could be used to confirm that the bottle contains traces of barium chloride.

(2)

Add H_2SO_4 and HCl.

There is white precipitate ($BaSO_4$) remained.

ResultsPlus Examiner Comments

This response was seen regularly, where candidates added both sulfuric acid and unnecessary hydrochloric acid. The test would still give the required observation though, and this is correctly stated so the candidate scores both marks.

ResultsPlus Examiner Tip

Learn the inorganic tests for the different ions.

An accepted answer.

(iii) It is suspected that a bottle of magnesium chloride solution has been contaminated with barium chloride. Na_2SO_4

Describe a test and its result, other than a flame test, which could be used to confirm that the bottle contains traces of barium chloride.

(2)

Add Na_2SO_4 solution into ~~bottot~~ bottle. ~~to~~

White ppt forms. ($BaSO_4$). So the bottle contains $BaCl_2$.

ResultsPlus
Examiner Comments

Any soluble compound containing sulfate ions was accepted here. The candidate has not included acid in their test to remove any carbonate ions that may give a false positive, but this was beyond the scope of the question in this case.

ResultsPlus
Examiner Tip

When giving formulae for reagents they must be correct, $NaSO_4$ would not have scored M1 here.

Question 2 (b)(iv)

M2 was awarded for the majority of candidates here, but more errors were seen on M1. Though most candidates could state the colour of the flame for barium, incorrect answers included a whole range of colours. The incorrect answers for magnesium were usually "white" as seen for the burning metal rather than the lack of colour for the magnesium ion.

A fully correct response.

(iv) State the colours produced by the magnesium ions and barium ions in a flame test.

(2)

Magnesium

no color

Barium

pale green

ResultsPlus Examiner Comments

This is an example of a fully correct answer. The shade of green was not required and all were accepted except "blue-green" (as this is the description of the copper flame colour).

ResultsPlus Examiner Tip

Practise writing out the flame colours of the various ions required on the specification.

A common mistake.

(iv) State the colours produced by the magnesium ions and barium ions in a flame test.

(2)

Magnesium

white

Barium

pale green

ResultsPlus
Examiner Comments

Where two marks were not awarded, this was the most common response. It gains one mark for the barium colour.

ResultsPlus
Examiner Tip

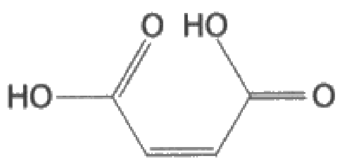
Don't confuse the colour of burning magnesium with the ion flame colour.

Question 3 (a)

The aim of this question was to test knowledge of the colour change as well as the understanding of which solution is in the conical flask and which is being titrated from the burette. Just under two thirds of candidates gained both marks, with one mark being achieved by candidates who recalled the correct colours but put them in the wrong order. A minority of candidates gave colours relating to methyl-orange, but some used inappropriate colours to describe the final colour of the phenolphthalein. Purple and red were not accepted as final colours. Shades of pink were ignored, as some candidates described the pale colour at the actual end point and others the striking hue of an overshoot.

A fully correct answer.

3 Maleic acid is a solid acid that can be used as a standard for titration.



maleic acid

A 5.00 g sample of maleic acid was dissolved in deionised water and made up to 250 cm^3 of solution. A 20.0 cm^3 portion of this solution was titrated against sodium hydroxide solution, producing the results shown.

Titration	Rough	1	2	3
Final reading / cm^3	22.45	43.55	21.45	42.60
Initial reading / cm^3	0.00	22.45	0.05	21.45
Titre / cm^3	22.45	21.10	21.40	21.15

(a) Phenolphthalein indicator was used in the experiment.

State the colour change seen at the end-point.

(2)

colorless to pink

ResultsPlus
Examiner Comments

The candidate has correctly recalled the colours and worked out the order using the information given in the question.

ResultsPlus
Examiner Tip

Learn the colours of the indicators in the specification in both acid and alkali.

Question 3 (b)-(d)

The mean mark for this question was 4. The majority of candidates scored the first mark, using the concordant results to find the mean titre. Where candidates did lose this mark – and some did average 3 or 4 titres – they could get a transferred error (TE) on part (b) to part (d) when they need to use the value. In part (c), the vast majority of candidates could calculate the concentration and scored two of the two available marks. Part (d) was less successfully completed by candidates; some used the volumes the wrong way around and some omitted the ratio.

An example of a fully correct response.

(b) Calculate the mean titre of sodium hydroxide solution using the concordant results.

(1)

mean titre = (21.10 + 21.15) ÷ 2 = 21.125 cm^3

(c) Calculate the concentration of the maleic acid solution in mol dm^{-3}.

[M_r maleic acid = 116]

(2)

$\frac{1}{2} = \frac{n_{acid}}{n_{OH^-}}$ => $2n_{acid} = n_{OH^-}$

$n_{acid} = \frac{m}{M} = \frac{5.0}{116} = 0.0431$ mol

$c = \frac{n}{V} = \frac{0.0431 \text{ mol}}{250 \times 10^{-3} \text{ dm}^3} = 0.1724$ mol/dm^3

≈ 0.172 mol/dm^3

(d) Use your answers to (b) and (c) to calculate the concentration of the sodium hydroxide solution in mol dm^{-3}.

(3)

$2n_{H^+} = n_{OH^-}$ $\quad$ $n_{H^+} = CV = 0.172 \times 20\times10^{-3} = 3.44\times10^{-3}$ mol

$\Rightarrow n_{OH^-} = 2\times3.44\times10^{-3}$ mol

$= 6.88\times10^{-3}$ mol

$C = \frac{n_{OH^-}}{V} = \frac{6.88\times10^{-3} \text{ mol}}{21.125\times10^{-3} \text{ dm}^3} = 0.32568$ mol/dm^3

≈ 0.326 mol/dm^3

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Examiner Comments

This candidate scores all the marks available, though the presentation of their answers could be improved.

For part (c), the mole calculation is on the right and the subsequent concentration calculation is on the left. The final answer is correct to 3SF, however and the candidate has given units – though the preferred format would be mol dm^{-3}.

In part (d), the candidate correctly used the pipette volume and the mean titre, along with the stoichiometric ratio.

ResultsPlus
Examiner Tip

Writing out the units throughout your calculations will help you rearrange formulae correctly.

An example of a common incorrect response.

(b) Calculate the mean titre of sodium hydroxide solution using the concordant results.

(1)

$\frac{21.10 + 21.15}{2} = 21.125$ cm^3

(c) Calculate the concentration of the maleic acid solution in mol dm^{-3}.

[M_r maleic acid = 116]

(2)

$n = \frac{5}{116} = 0.043$

$n = cV$

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

$c = 2.04$ mol/dm^3

(d) Use your answers to (b) and (c) to calculate the concentration of the sodium hydroxide solution in mol dm^{-3}.

(3)

$\frac{0.043}{20 \times 10^{-3}} = 2.16$ mol/dm^3

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Examiner Comments

The candidate scores the mark for (b) and M1 on (c). They then do not calculate the concentration correctly as they have divided by the mean titre (converted to dm^3).

No credit is given for part (d) as the candidate attempts to use the moles calculated from part (c) along with the pipette value, instead of the concentration they calculated in (c). If they had used their previous answer correctly, they could have gained marks by TE.

ResultsPlus
Examiner Tip

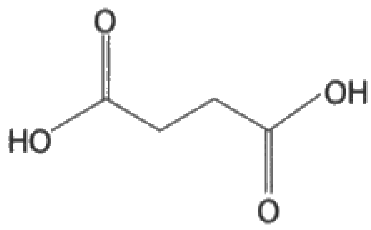
Practise titration calculations using different stoichiometries.

Question 3 (e)(i)

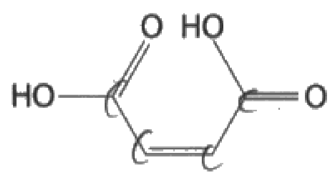
This question was not well answered with only 45% of candidates gaining both marks. Many candidates gave the correct test and result for maleic acid but failed to state the result for succinic acid so could not be awarded the second mark. If candidates are asked to distinguish between substances with a chemical test, they need to give both results to gain all the marks available. The majority of candidates did use bromine or bromine water to test for the double bond, and a tiny percentage of the cohort used acidified manganate(VII). Incorrect substances used were usually carbonate and hydrogencarbonate (solid and solutions were seen) to test for the acid group, often with a correct observation – though this would not distinguish between the two acids as asked for in the question.

A fully correct answer.

(e) Succinic acid is another solid acid.



succinic acid



maleic acid

(i) Describe a laboratory test that could be used to distinguish between solutions of these acids.

(2)

Add bromine water ~~~~ with two acids. The colour for succinic acid with bromine water will stay orange brown. The colour for maleic acid will turn from orange brown to colourless with the presence of alkene group.

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Examiner Comments

This candidate scores both marks. They have stated the test and the result for each acid.

ResultsPlus
Examiner Tip

If asked to distinguish between two substances, make sure you give the chemical test result for each.

Question 3 (e)(ii)

Fewer than 2% of candidates scored this mark. The compound given was quite difficult, combining different parts of the specification and candidates struggled with this. The most common error was to ignore the Z/cis, but many also ignored the two acid groups. Candidates should spend more time practising naming compounds with multiple functional groups in class.

An example of an answer that did not score.

(ii) State the IUPAC name for maleic acid.

(1)

~~cis buta~~ cis-but-2-ene-1,4-dionic acid.

ResultsPlus
Examiner Comments

This answer is very close to the correct answer but is not the IUPAC name due to the "dionic" acid. The extra – 1,4 – would have been ignored.

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Examiner Tip

Revise naming of all types of compound on the specification.

Question 4 (a)

Over 50% of candidates did not gain either mark here. Many suggested temperatures that were too high or too low and some left the question blank. It was possible for candidates to gain the justification mark without a suitable temperature, but some responses were seen where the candidates wrote comments such as "room temperature as the timings are suitable" showing they had not read the information given earlier in the question. Other answers related to the boiling or evaporation of water, showing candidates were not aware of the lower boiling points of the organic compounds. A minority of candidates warned about the rate being too fast at high temperatures and this did not gain credit.

There were multiple answers that could score for this part, relating both to safety and practical considerations so it is disappointing that some candidates did not attempt it.

An example of a good answer.

4 An experiment was carried out to compare the rates of hydrolysis of different halogenoalkanes. The method and results are shown.

Step 1 Set up a water bath using a 250 cm^3 beaker.

Step 2 Add 5 cm^3 of ethanol to a test tube.

Step 3 Add four drops of 1-iodobutane to the test tube.

Step 4 Loosely place a bung in the test tube and place it in the water bath.

Step 5 Pour 5 cm^3 of silver nitrate solution into a clean test tube and place it in the water bath.

Step 6 When the solutions have reached the temperature of the water bath, add the silver nitrate solution to the 1-iodobutane in ethanol solution. Replace the bung and shake. Start the timer as you do so.

Step 7 As soon as the solution becomes cloudy, stop the timer.

Step 8 Repeat steps 2 to 7 using a bromoalkane and a chloroalkane instead of 1-iodobutane.

Halogen element in halogenoalkane	Time taken for precipitate to form / s
Iodine	51
Bromine	85
Chlorine	594

(a) Justify an appropriate temperature for the water bath.

(2)

~~60°C~~ 45°C

Increase the rate of the reaction and 45°C is lower than the boiling point of the halogenoalkane.

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Examiner Comments

This candidate gives an answer in the allowed range and then gives two reasons for their choice. Both reasons given are related to the practicality of the method.

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Examiner Tip

Ensure you give a complete answer, here 2 marks shows that you will need to give a reason for your first answer to gain full marks.

Question 4 (b)

Just over half of candidates gained any credit for this question. Many got the idea of the same structure with bromo – and chloro – groups, but failed to correctly identify the alkane structure or just named the molecules as bromoalkane and chloroalkane. Molecular formulae were not accepted, but structural formulae and diagrams were. Occasionally, candidates used the wrong alkane name, with bromopentane, etc., seen.

An example of a very good response.

(b) Suggest, by name or formula, a bromoalkane and a chloroalkane suitable for this experiment, justifying your answers.

(2)

1- bromobutane and 1-chlorobutane is suitable. As there should be no difference in branching or length of hydrocarbon chain comparing to the 1-iodobutane, otherwise rate of hydrolysis is affected by factors other than the ~~[illegible]~~ halogen group.

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Examiner Comments

This candidate correctly names both compounds and gives multiple justifications for their choices.

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Examiner Tip

Fully explain your reasoning when you have to justify an answer.

A response that does not gain M2.

1-bromobutane and 1-chlorobutane.
Primary, secondary, tertiary, and lenght of carbon chain will effect react of reaction.

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Examiner Comments

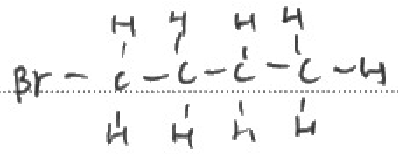
This candidate gains the first mark but is not awarded M2. The candidate states the factors that affect the rate of reaction but has not said that these will be the same in the halogenoalkanes they have chosen, so they do not get the second mark.

ResultsPlus
Examiner Tip

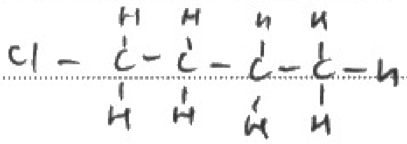
Link justifications to your choices to ensure you get the marks available.

An answer only scoring M1.

(2)



form AgBr



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ResultsPlus Examiner Comments

Candidates could gain M1 by name or formula, though molecular formulae were not accepted as they could be primary or secondary. This candidate draws fully displayed structures for M1 but makes no attempt to justify their answer.

ResultsPlus Examiner Tip

Re-read each question to ensure you give all the necessary information.

Question 4 (c)

Over 80% of candidates did not gain this mark, that was supposed to simply recall a specification statement. All candidates should have experience of similar reactions and approximations of rate from GCSE experiments, so it is surprising that they did so poorly on this response. The majority of candidates had the right idea, either stating that rate was inversely proportional to time or some measured variable such as concentration/volume/mass or even height of precipitate divided by time would give the rate. Perhaps the lack of correct/incomplete answers highlights the fact that many candidates had not done this experiment. A significant number of candidates showed that they did not understand the concept of rate by giving answer just about time – e.g. “measure the time taken for the precipitate to form”. Another, smaller, group of candidates misunderstood the question altogether and talked about how or why the rate varied from chlorine to iodine.

An answer given as an equation.

(c) State how the results of this experiment could be converted into a value that can be used as a measure of rate.

(1)

$$\text{Rate} = \frac{1}{\text{time taken}}$$

ResultsPlus Examiner Comments

This candidate gains the mark. Communicating through equations is effective and efficient.

ResultsPlus Examiner Tip

Don't be afraid to use equations in your answers.

An example of an answer given in prose.

I divided by time.

ResultsPlus
Examiner Comments

This candidate explains the mathematical operation in a sentence.

Question 4 (d)

Only 15% of candidates scored on this part. Many answers related to the times being different, and this is not sufficient as a reason not to repeat the experiment. All answers relating to the trend of results were given credit. Answers that discussed the percentage difference between the times or the experimental uncertainty could score the mark, but only a minority of candidates thought about the reasons for repeating or not repeating in sufficient detail to gain credit. There were quite a few answers that mentioned the differences being significant but as no statistical test had been performed there was no credit for this type of answer.

An example of a correct response.

(d) State why it is not necessary to repeat these experiments for each halogenoalkane.

(1)

The steps are correct and the trend for time taken for precipitate to form Is accurate, so no need to repeat

ResultsPlus
Examiner Comments

This candidate is commenting on the method which was not necessary, but gains the mark for the trend. The word "accurate" is not necessarily appropriate here but the response clearly shows the candidates understanding that the expected trend can be seen.

ResultsPlus
Examiner Tip

Draw on your own practical experience when asked about experiments.

Question 4 (e)

Both name and formula of ammonia were accepted here but many candidates went further, some giving experimental details as they discussed dilute and concentrated ammonia and the results of the test. This was not necessary and candidates need to appreciate that for one mark that level of detail will not be required. Approximately half of candidates gained the mark here.

This candidate gave more detail than required.

(e) Under these conditions, all the silver halide precipitates can appear to be white.

Identify, by name or formula, a compound, the solutions of which can be used to distinguish between the silver halide precipitates.

(1)

conc. Ammonia solution and dilute ammonia solution.

ResultsPlus
Examiner Comments

The mark is awarded here, but the candidate gives more detail than the question requires.

If asked for a name or formula, the concentration is not needed for 1 mark.

ResultsPlus
Examiner Tip

Read the question carefully, underlining key phrases so you can give the information required.

Question 5 (a)

Fewer than half of candidates scored a mark here, with very few gaining two. This is disappointing, as the experiment is Core Practical 6 and all candidates should have experience of the techniques required in the process. The most common response that scored had B and F switched around the wrong way.

An example of a response that scored 1 mark.

5 The alcohol, 2-methylpropan-2-ol can be converted into 2-chloro-2-methylpropane using concentrated hydrochloric acid.

The individual steps of the method are listed.

A	The alcohol and concentrated hydrochloric acid are mixed. The flask is sealed and swirled for 20 minutes, with the bung removed occasionally.
B	Sodium hydrogencarbonate solution is added. The mixture is swirled and any pressure released.
C	The organic liquid is distilled and a fraction between 50 °C and 52 °C is collected.
D	The aqueous layer is run off and discarded. The organic layer is run into a small conical flask and shaken with anhydrous sodium sulfate.
E	When the solution is clear, the organic liquid is decanted into a round-bottomed flask.
F	Anhydrous calcium chloride is added to the flask and swirled until dissolved. The mixture is poured into a separating funnel and the lower layer is discarded.

(a) Complete the list to show the correct order of the steps.

(2)

A D B F E C

ResultsPlus
Examiner Comments

Candidates could gain one of the two marks for any two letters in the correct place. This answer actually has three of the five correct. The candidate has used the letters on the method as a way of working out which letters they have already used and it is clear they have worked from the end to the beginning, a perfectly acceptable method.

ResultsPlus
Examiner Tip

Crossing off information in the question to help you complete your response is an excellent technique.

Question 5 (b)(i)

This question was well answered with nearly half of candidates gaining both marks. M2 was dependent on M1 and candidates who gave an incorrect equation scored zero, with the exception of those who gave a correct equation for sodium carbonate – these could gain M2 for the state symbols. Most equations that scored zero involved an organic acid being neutralised, or some candidates tried a reaction involving the alcohol or the halogenoalkane. A minority of candidates attempted the ionic equation and these were likely to gain both marks.

An example of a correct response.

(b) (i) Write an equation to show the reaction taking place in Step **B**.

Include state symbols in your answer.

(2)

$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2\,(g)$

(aq) (aq) (aq) (l)

ResultsPlus
Examiner Comments

This answer gained 2 marks, one for the balanced equation and the second for state symbols.

Though the state symbols should be after each substance on the equation, this candidate has not left enough space. The state symbols underneath are in the correct order and are given the mark.

ResultsPlus
Examiner Tip

Re-read the question after making your response to see if you have any more to add.

Question 5 (b)(ii)

Although there was a wide scope of possible acceptable answers to this question, only the best candidates scored with 30% gaining the mark. The most common answer was "to remove the water" which is insufficient on its own as it could relate to running off the aqueous layer, therefore being ambiguous. If they qualified this by adding "from the organic layer", this is unambiguous and was a popular correct response. Another common inadequate response was simply to state "to turn the (organic layer) from cloudy to clear". Whilst often being true, this possibly demonstrates that they had seen/done this procedure but not fully appreciated what was going on and why the appearance was changing.

An example of a correct answer.

(ii) State the purpose of adding anhydrous sodium sulfate in Step **D**.

(1)

to dry the organic liquid.

ResultsPlus
Examiner Comments

This candidate has clearly explained the purpose of the reagent.

ResultsPlus
Examiner Tip

Add as much detail to your answer as possible.

An example of an allowed answer.

To absorb water.

ResultsPlus
Examiner Comments

This answer gains the mark, but the response doesn't fully answer the question. Ideally the candidate should state why the water is absorbed (or where it is absorbed from).

ResultsPlus
Examiner Tip

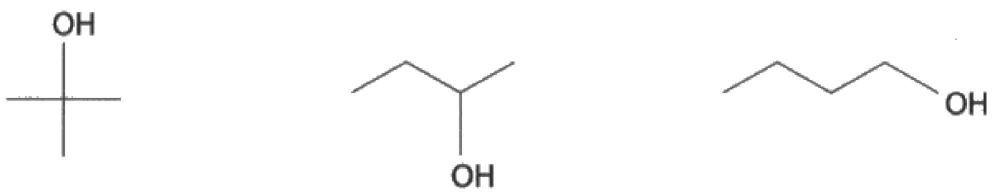
Try to avoid vague answers. Include reasons or locations for full clarity.

Question 5 (c)(i)

This was designed to be a more challenging question near the end of the paper, but marks were accessible to many candidates. The mean score for this question was 1.5, but the whole range of marks were seen. Some candidates only got as far as selecting the fastest reacting compound – so could only score one mark – and a minority left the answer space blank, while others got the order of stability for the carbocations the wrong way around so could not gain any credit. Where candidates chose an incorrect alcohol is was always Z. Some candidate discussed the stability of the alcohols rather than the carbocations so could not score M3.

A fully correct response.

(c) The experiment was repeated using three different alcohols, **X**, **Y** and **Z**.



X **Y** **Z**

(i) The C–O bond is broken in the mechanism.

Using your knowledge of carbocations, explain which alcohol may react fastest in the experiment.

(3)

X alcohol.
X alcohol can form tertiary carbocations, which is the most stable, compared to the second carbocation in Y, and primary carbocation in Z. Because alkyl groups are electron donating groups. So X has the fastest reaction rate.

ResultsPlus
Examiner Comments

This is an excellent answer and gives more detail than was required for all 3 marks.

Though the English isn't perfect, the meaning of the candidate is clear and even gives the marking points in the same order as the mark scheme.

A succinct answer scoring all the marks.

X is tertiary alcohol, Y is secondary, Z is primary.

X alcohol reacts fastest because ~~##~~ tertiary carbocation is the most stable,

ResultsPlus
Examiner Comments

This candidate gains full credit, despite their short answer.

In fact, the second sentence alone could have scored 3 marks as they have identified the alcohol, its structure and the reason it reacts fastest.

ResultsPlus
Examiner Tip

Don't always use the lines as a guide for how much you should write. The marks and structure of the question indicate how much detail is needed.

Question 5 (c)(ii)

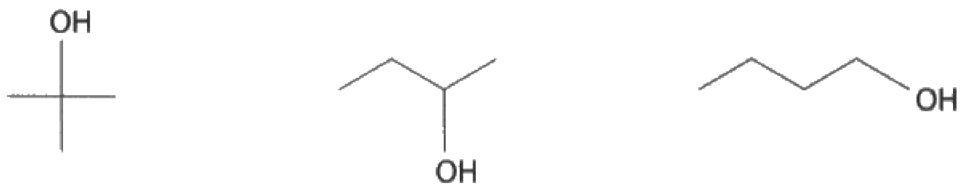
A third of candidates failed to gain any credit here, which is disappointing considering the familiarity of the material. Occasionally, candidates confused the direction of the colour change, which is surprising as they only ever see a reaction go from orange to green for dichromate. Candidates were given the benefit of the doubt when they were describing the products after oxidation, as some referred to these as X, Y and Z instead of the reaction products. The most frequently awarded marks were M4 and M5, when candidates used either Benedict's or Tollens' to identify Z as an aldehyde (along with the correct observation). The least frequently awarded mark was M3 for distillation, with many candidates seemingly carrying out their tests on the dichromate reaction mixture. Where candidates did score, they often gained three marks, for M4 and M5 along with M2, the dichromate colour change.

An example of a response scoring all 5 marks.

(ii) Describe how a solution of acidified potassium dichromate(VI) and subsequent chemical tests could be used to distinguish between alcohols **X**, **Y** and **Z**.

You may assume that the usual laboratory glassware and chemicals are available.

Include the colour change(s) seen.



X **Y** **Z**

(5)

X: Tertiary alcohol can not be oxidised so no observation formed.
Y: Secondary alcohol can be oxidised and form ketone.
Colour change from orange to green. orange
Ketone can be distinguished by adding 2,4-DNP, ~~red~~ precipitate formed ~~from blue solution~~.
Z: Primary alcohol ① when oxidised under reflux, carboxylic acid is formed. Colour from orange to green.
Carboxylic acid can be detected by adding $NaHCO_3$ and ~~bu~~ bubbles formed which can turn lime water milky
② when oxidised under distillation, aldehyde is formed. Colour from orange to green.
Aldehyde can be detected by adding Tollen's colourless to silver mirror.

ResultsPlus
Examiner Comments

This candidate has structured and presented their answer very clearly. All five marks can be awarded and the candidate gives even more detail than required with the 2,4-dinitrophenylhydrazine test for the ketone and both the test for the acid product and the aldehyde. The candidate also doesn't waste time repeating information given in the question. This is unnecessary and never scores marks.

ResultsPlus
Examiner Tip

Where there are several parts to a longer response, feel free to use bullet points or numbers to help you structure your answer.

An example of an atypical response.

add acidified potassium dichromate separatly to flask containing those alcohol ~~do~~ and heat under reflux

for X no reaction occur the solution remain orange for both Y and Z solution turn from orange to green.

and to be able to distinguish between Y and Z add ethanol to both product solution Z would give fruity smell Y will not. due to Z product containing ~~carbox~~ carboxylic acid so ester form when ethanol added Y only produce ketone so ~~ke no kee~~ no reaction occur.

ResultsPlus
Examiner Comments

This candidate scores 2 from the 5 marks available. This response scores M1 and M2, whereas most answers gaining two marks scored M4 and M5.

The reason for highlighting this answer is that M4 and M5 could have been awarded here if a concentrated acid was also added with the ethanol, without suitable reagents the result given for M5 is not awarded. The omission of the acid catalyst in the formation of esters is often seen in candidates' responses and it would be required for the test to work – especially when the acid could be produced in small quantities.

ResultsPlus
Examiner Tip

Include all reagents and conditions when describing reactions.

Paper Summary

Candidates lost marks on both core practicals and parts of the specification that are almost identical to GCSE content (e.g. reactions of Group 1 metals), showing that more practical experience may be required in lessons for this cohort. Where candidates could show they had practical knowledge this did not always translate into being able to explain the reasons the techniques are performed (e.g. adding anhydrous salts to organic liquids) so further explanation from teachers may be required to ensure full understanding.

Candidates also need to:

- practise drawing apparatus, in this case a gas syringe, with sufficient detail for it to be recognised
- ensure they use scientific vocabulary when describing hazards and precautions
- read questions carefully so they do not give answers that have already been excluded
- use the command words as prompts to structure their answers
- use the marks available as a prompt on the level of detail required.

Grade boundaries

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