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Examiners' Report
June 2025

Int GCSE Chemistry 4CH1 1C

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June 2025

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Introduction

In general, candidates performed well on this paper and demonstrated good knowledge, particularly across the first half.

Long-response questions proved challenging for those candidates who lacked a firm grasp of key terminology (eg incorrect use of intermolecular forces) and clarity in their written responses (eg confusion between ene and ane in Q09(c)).

Questions on practical chemistry showed the greatest variation in performance. Responses to Q07(b), Q07(e), and Q10(a) often lacked specific detail or failed to consider the direction of error. While mathematical skills relating to these practical questions were generally strong, such as plotting graphs and interpreting data, candidates tended to perform less well in qualitative responses. This highlights qualitative analysis as a key area for improvement within AO3, including proposing methodological improvements to increase accuracy and identifying appropriate control variables.

Overall, mathematical skills in mole calculations were well demonstrated, with many candidates benefiting from the application of error carried forward.

Question 1(a)

Question 1(a) was well answered, with the majority of candidates scoring full marks. Where errors occurred, these were typically due to the proton and neutron labels being switched, which still resulted in 2 out of 3 marks being awarded. It is worth noting that the spelling of the subatomic particles was often poor.

Question 1(b)

The majority of candidates responded well to Q01(b), with most achieving at least 2 marks and many securing the full 4 marks available. The mass number and electron configuration were most frequently identified correctly, as these could be directly inferred from the diagram. In contrast, errors were most commonly associated with the identification of the correct group or period number, with some candidates demonstrating a lack of understanding that the number of electron shells corresponds to the period.

Question 1(c)

Candidates generally performed well on this question. However, marks were occasionally lost due to the word *'boron'* not being fully formed. While benefit of doubt was applied where appropriate, it is important to remind candidates of the need to write clearly and complete words fully. In other questions, such as Q09(c), illegible responses had a more significant implication for the awarding of marks.

(c) Give the name of this element.

Boron

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Examiner Comments

This response scored 1 mark as boron is the only valid answer, with no other elements bearing a similar name. However, in this example the answer was written as 'Boror' due to incomplete letter formation. Candidates should be encouraged to take care when forming words, particularly when responses may be linked to chemical equations, where clarity is essential.

Question 2(a)

Question 2(a) is a familiar and well-established question. Most candidates picked up at least one mark, usually for stating that the substance got smaller or dissolved. Some candidates gave answers linked to other Group 1 elements such as the appearance of a flame or the substance turning into a ball. Candidates should be encouraged to provide the requested number of observations asked for in the question rather than potentially losing marks based on giving a list of answers with incorrect responses.

2 A small piece of lithium is added to a trough of water.

(a) State two observations made when lithium reacts with water.

1 it dissolves

2 it forms lithium hydroxide

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Examiner Comments

The first observation scored but the second answer is not an observation so does not score the second mark. Candidates cannot see the lithium hydroxide forming.

Question 2(c)

For Question 2(c)(i), most candidates attempted the question; however, many did not provide a complete answer, often omitting either a pH value or range, or failing to explain that the solution was alkaline. Some candidates incorrectly described the solution as acidic or focused on lithium being an alkali metal rather than discussing the nature of the solution itself. For Question 2(c)(ii), the most common incorrect response was Li^+.

(c) After the reaction is complete, a few drops of universal indicator are added to the solution in the trough.

(i) Explain the colour and pH of the solution in the trough.

(3)

When the ~~reactio~~ universal indicator are added the Solution changes colour to blue, which increases the PH of the solution in the trough

(ii) Give the formula of the ion responsible for this pH.

(1)

Li^+

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For Q02(c)(i) this response scored M1 for 'changes colour to blue'. No specific pH is given resulting in no M2 being awarded and no explanation provided resulting in no M3. In Q02(c)(ii) the incorrect ion is given, this was a common response from candidates.

(c) After the reaction is complete, a few drops of universal indicator are added to the solution in the trough.

(i) Explain the colour and pH of the solution in the trough.

(3)

universal indicator will turn blue since the solution is alkaline and the pH will be between 8 and 14 since it is alkaline

(ii) Give the formula of the ion responsible for this pH.

(1)

OH^-

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Examiner Comments

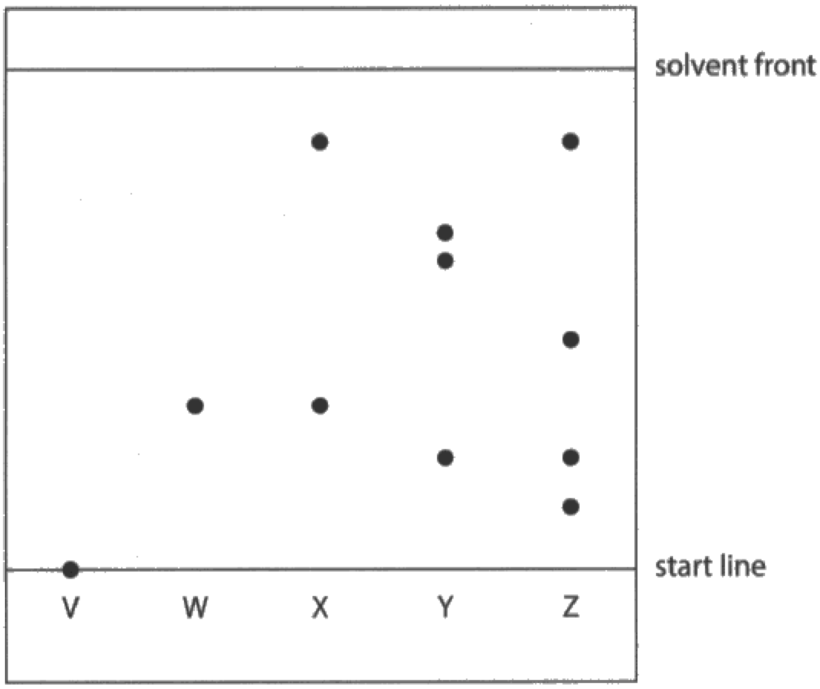
For Q02(c)(i), this response scores M1 for "turn blue" and M3 for "alkaline." No M2 mark is awarded because the pH given is outside the acceptable range for a strong alkali; a range of 10-14 was accepted. For Q02(c)(ii), this response scored 1 mark for providing the correct formula. The position of the minus charge was not taken into account.

Question 3(a)

Most candidates were able to score M1 in Q03(a), as they correctly commented on the solubility of ink in water or the insolubility of pencil. Fewer candidates secured M2, which required a full explanation of the impact of ink solubility. Most referred to the ink moving or its effect on visibility, but very few candidates coherently linked these ideas to give a complete response. There was also an issue with responses using the term 'inks' and 'dyes' incorrectly.

3 A student uses paper chromatography to investigate the dyes in five different inks, V, W, X, Y and Z.

The chromatogram shows the results of the investigation.



(a) Explain why the start line on the paper is drawn in pencil rather than in ink.

(2)

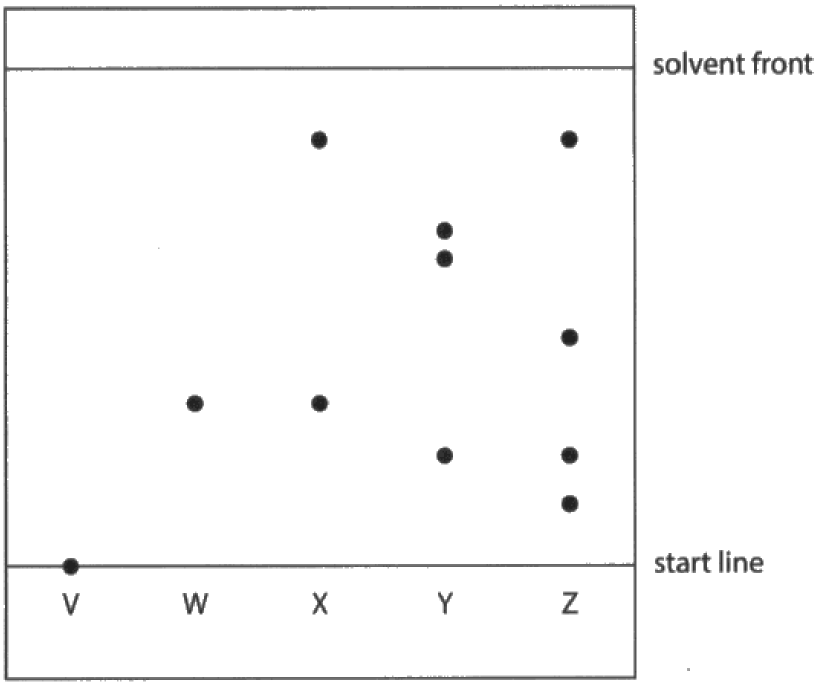
if it's drawn with ink, it can dissolve into the solvent and as well rise up through the cromatography paper, ~~mari~~ so the results will not be clear.

ResultsPlus Examiner Comments

This is an example of a response which scored 2 marks. M1 was scored for 'ink, it can dissolve into the solvent'. M2 was scored for 'rise up through the chromatography paper' along with 'the results will not be clear'. Both of these comments are needed to score M2.

3 A student uses paper chromatography to investigate the dyes in five different inks, V, W, X, Y and Z.

The chromatogram shows the results of the investigation.



(a) Explain why the start line on the paper is drawn in pencil rather than in ink.

(2)

Pencil is insoluble. ink will be mix with solvent so they used pencil.

ResultsPlus
Examiner Comments

This is an example of a response where 1 mark is scored. They have secured M1 for 'pencil is insoluble' but M2 is incomplete with 'mix with solvent' so not fully explained.

Question 3(b)

Q03(b) was generally very well answered, with only a small number of candidates incorrectly linking the most soluble dye to the number of spots rather than identifying the one that had travelled the furthest. Where no marks were awarded, this was usually due to an error in M1, which prevented M2 from being achieved.

(b) Explain which two inks contain the dye that is most soluble in the solvent.

x and z as they have highest amount of ink in the dye

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Examiner Comments

This response scored 1 mark with the explanation linked to 'amount of ink in the dye' rather than the distance travelled by the most soluble dye.

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Examiner Tip

When terms such as dye and ink cause confusion, candidates should be encouraged to use the wording from the question stem to help structure their response – for example: "the two inks which contain the dye that is the most soluble are...".

they have travelled.

(b) Explain which two inks contain the dye that is most soluble in the solvent.

(2)

X and Z as they travelled the furthest on chromatography paper.

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Examiner Comments

An example of a response which scores both marks, there is no mention of dyes and inks which is not essential in this response. Often when the use of dyes and inks were included, they were used incorrectly.

Question 3(c)

Candidates demonstrated good knowledge of chromatography in their answers to this question. However, marks were lost for M1 because many candidates simply repeated the question stem by stating that W contains only one dye, rather than using appropriate terms such as *spot* or *mark*. Since the phrase *"one dye"* appeared in the question, it could not be credited as part of their explanation.

(c) Explain how the chromatogram shows that

- W contains only one dye
- V may contain more than one dye

(3)

W has one spot of dye that has travelled, and nothing lys on the start line, meaning there is one dye. V hasn't moved, meaning the ink is insoluble. However, there could be several insoluble dyes in V, meaning it could contain more than just 1 insoluble dye

This is an example of an excellent response. M1 was scored for linking W to 'one spot of dye'. M2 was scored for the 'the ink is insoluble' which they then go on to link to the insolubility of several dyes in V – one of the very few responses where dyes/ink were used correctly. M3 was awarded for 'V hasn't moved'.

Question 3(d)

Q03(d) was generally well answered, with few errors overall. Marks were most commonly lost when candidates gave the solvent front measurement as 7 cm or did not express their final answer to two significant figures. The incorrect multiplication of the fraction by 100 was seen less frequently than in the previous year.

(d) Calculate the R_f value for the dye in W.

Give your answer to two significant figures.

(4)

$\frac{2.3}{7} = 0.3285714$

$= 0.33$

R_f value = 0.33

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Examiner Comments

M1, M3 and M4 were scored. M2 was lost for the measurement from the baseline to the solvent front.

(d) Calculate the R_f value for the dye in W.

Give your answer to two significant figures.

(4)

$$\frac{2.3}{6.9} = 0.3$$

R_f value = 0.3

ResultsPlus
Examiner Comments

M1, M2 and M3 were scored for this response but M4 was lost for not giving an answer to two significant figures.

Question 4(b)

Most candidates demonstrated an understanding of the principle for calculating relative formula mass and recognised what was being asked. Some, however, used atomic numbers instead of relative atomic masses in Q04(b)(i), or calculated an incorrect formula mass by including too many or too few oxygen atoms. Occasionally, phosphorus (P) was mistaken for potassium (K), which affected the final answer. Many candidates benefited from error carried forward in Q04(b)(ii), as examiners were able to view both parts of the question together.

(b) (i) Calculate the relative formula mass (M_r) of $Ca_3(PO_4)_2$

(2)

$40 \times 3 = 120$ $\quad$ $120 + 62 + 96$

$31 \times 2 = 62$

$16 \times 6 = 96$

M_r of $Ca_3(PO_4)_2$ = 278

(ii) Calculate the percentage by mass of calcium in calcium phosphate.

(2)

$\frac{120}{278} \times 100$

percentage = 43.2 %

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Examiner Comments

This response used the correct values to determine the relative formula mass but contained a minor error in calculating the number of oxygen atoms in the formula. As a result, it was awarded only M1 in Q04(b)(i). However, the candidate went on to gain both M1 and M2 in Q04(b)(ii) by correctly calculating the percentage by mass using their own value from part (b)(i).

Question 4(c)

This was a challenging equation to balance and many candidates required several attempts to reach an answer. Those candidates who were unsuccessful often did not attempt the question or showed some working but left the answer lines blank.

(c) Calcium hydroxide can react with phosphoric acid to form calcium phosphate.

Complete the equation for this reaction.

(1)

[illegible] $Ca(OH)_2$ + [illegible] H_3PO_4 → [illegible] $Ca_3(PO_4)_2$ + [illegible] H_2O

ResultsPlus
Examiner Comments

This response was difficult to read due to multiple attempts and numerous crossings-out.

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Examiner Tip

Candidates may work out their answer below the answer line; once they have determined the correct coefficients, they should neatly cross out any working and clearly write their final answer in the equation.

Question 5(a)

The greatest challenge candidates faced in Q05(a) was providing a complete answer that addressed both terms included in the question. Many candidates focused on only one term, and even when all three terms were mentioned, responses often lacked the specificity required for full marks.

5 Butane (C_4H_{10}) is an alkane.

(a) Explain why butane is a saturated hydrocarbon.

(3)

it has ~~cm~~ carbon and hydrogen atoms only

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Examiner Comments

Incomplete answers that addressed only the term hydrocarbon and not saturated were common scoring 2 out of 3 marks.

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Examiner Tip

Candidates should use the total number of marks allocated to a question as a guide for how many key points their response should include.

5 Butane (C_4H_{10}) is an alkane.

(a) Explain why butane is a saturated hydrocarbon.

(3)

It has carbon – carbon single bonds and it contains carbon and hydrogen only.

ResultsPlus
Examiner Comments

This response scored 2 marks overall. At first glance, it appears that all areas are addressed; however, the explanation of saturated is insufficient. Candidates needed to clearly state that the molecule either contains only single bonds or does not contain any double/multiple bonds.

Question 5(b)i

As always, there was a range of candidates using O instead of O_2 which unfortunately resulted in a loss of both marks. There were also plenty of examples of Co_2 rather than CO_2 which, despite giving the benefit of the doubt where possible, did unfortunately look like a diatomic cobalt formula. There was no preference regarding the use of fractional or whole-number coefficients; a range of correctly balanced equations were accepted.

(b) (i) When butane burns completely in oxygen, carbon dioxide and water are produced.

Give a chemical equation for this combustion reaction.

$C_4H_{10} + \frac{9}{2}O_2 \longrightarrow 2CO_2 + 5H_2O$

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Examiner Comments

This response scored M1 for the correct formulae within the equation. M2 was lost due to the incorrect balancing of the equation.

ResultsPlus
Examiner Tip

Candidates should be encouraged to always check their chemical equations once they have finished the exam paper.

Question 5(b)ii

The most common correct answers were **water** and **soot**. Common incorrect responses included **carbon dioxide** (incorrect) and **carbon monoxide** (already provided in the question), with **sulfur dioxide** also occasionally given. Some candidates lost marks due to the **list principle**, where providing more than one answer, one of which was incorrect, meant the mark could not be awarded.

Question 5(b)iii

Most candidates were able to link the limitation of oxygen to carbon monoxide binding with haemoglobin. The most common issue was a lack of clarity in responses from candidates who did not score, with many using confusing terminology or providing incomplete answers focused on haemoglobin.

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

(1)

Because it kills the oxygen in ~~and~~ our body. And it slowly stops us from breathing.

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Examiner Comments

There were many examples of candidates focusing on breathing in their answers, including this response which scored 0 marks. This examination does not require knowledge from the Biology curriculum, and full marks can be awarded as long as the 4CH1 specification has been covered.

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

(1)

carbon monoxide reduces the ability of blood to carry oxygen around the body

ResultsPlus
Examiner Comments

A good answer for 1 mark and one of the few examples that did not specifically reference haemoglobin.

Question 5(c)i

The specification contains very clear definitions, so Question 5(c)(i) required candidates to provide this definition.

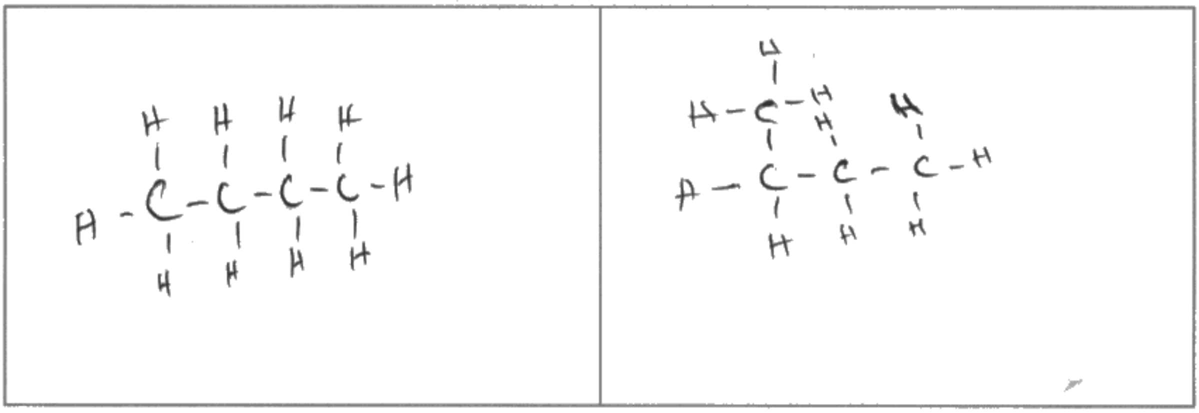
Where marks were lost it was most often due to 'molecular formula' being substituted for 'chemical', 'empirical' or even 'general', resulting in the loss of M1. There were some instances where the definition of an isotope was given mistakenly.

Question 5(c)ii

Most candidates were able to score 1 mark for correctly drawing the structure of butane. When M2 was not awarded, it was typically due to either a second butane structure being provided or a drawing of methylpropane with a $–CH_3$ branch that did not show all the bonds.

(ii) Draw the displayed formula of each isomer.

(2)



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Examiner Comments

A common mistake was for candidates to rotate one or more bonds in butane for their second response scoring 0 marks.

Question 5(d)

Despite the overuse of intermolecular forces elsewhere in the paper, most candidates referenced the breaking of covalent bonds in Q05(d) when discussing the difference in the melting point of hexane and butane. This resulted in loss of M2 and no access to M3 due to the larger amount of energy being related to the wrong attractive force.

(d) Explain why hexane (C_6H_{14}) has a higher boiling point than butane (C_4H_{10}).

(3)

hexane is a longer chain molecule, hexane has a greater relative molecular mass than C_4H_{10} So in hexane the intermolecular forces of attraction are stronger therefore more energy is required to overcome the stronger intermolecular forces of attraction in hexane. in butane the intermolecular forces of attraction are weaker so less energy is required to overcome the intermolecular forces so butane has lower boiling point and ~~[illegible]~~ hexane has higher boiling point

(Total for Question 5 = 14 marks)

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In this response, M1 is awarded for the statement "hexane is a longer chain molecule", though it could also have been credited for the comment about its greater relative molecular mass. M2 is achieved for correctly identifying that the intermolecular forces are stronger in hexane, and M3 is credited for linking this to more energy being required to overcome them. The candidate goes on to provide the reverse argument for butane – this is not required for the marks and may risk introducing errors.

(d) Explain why hexane (C_6H_{14}) has a higher boiling point than butane (C_4H_{10}).

(3)

hexane has more carbon and hydrogen atoms than butane so the bond between atoms are stronger as it is a longer-chained hydrocarbon so more energy is required for the bonds to be broken down than in butane

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Examiner Comments

Hexane containing more carbon and hydrogen atoms was an accepted answer for M1 but no further marks were gained for this response as the candidate then goes on to discuss the breaking of bonds resulting in no M2 or M3.

Question 6(a)

A familiar and well answered question, the majority of candidates were able to provide the conditions for rusting. Errors that did arise included giving the answer 'hydrogen' instead of 'water' and repeating the same condition twice eg air and oxygen.

Question 6(d)

A straightforward analytical recall question for a cation, not set in context or as part of an ionic compound. It should have been relatively accessible. Candidates generally scored either 0 or 2 marks, depending on their familiarity with the test. Where only 1 mark was awarded, it was typically due to incomplete details of reagents or observations.

(d) Describe a test to show that a solution contains Fe^{3+} ions.

test

add hydroxide

result

it will turn green

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Examiner Comments

An incomplete reagent led to the loss of M1. M2 was dependent on M1, but even if it had been accessible, the response gave an incorrect colour and didn't include the key term 'precipitate'.

Question 6(e)i

There were several common issues with this question, including the incorrect assignment of oxidation and reduction, describing iron rather than iron(III) oxide as being reduced, and confusion when applying the loss/gain of electrons to carbon monoxide. Some candidates simply stated the definition of redox without linking it to the equation provided. As seen in previous years, candidates generally performed poorly on applied redox questions, and this series was no exception.

(e) A sample of iron(III) oxide reacts with excess carbon monoxide.

This is the equation for the reaction.

$$\underset{}{\overset{160}{Fe_2O_3}} + 3CO \rightarrow \underset{56}{\overset{28g}{2Fe}} + 3CO_2$$

(i) Explain why this is a redox reaction.

(2)

This is a redox reaction because the iron (III) oxide loses oxygen and the carbon monoxide gains oxygen.

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Examiner Comments

This is an example of a common response that appears to contain two key points, leading candidates to believe it is worth 2 marks. It scores M1 from the second set of points in the mark scheme but does not link the answer to redox, so M2 is not awarded.

Question 6(e)ii

Many candidates were able to successfully determine the minimum mass of iron(III) oxide required to produce a theoretical yield of 28 g of iron.

However, some candidates incorrectly applied the ratio, multiplying by 2 instead of dividing, which resulted in an answer of 80 g. Another common error was using 112 as the relative formula mass (Mr) of iron and then dividing by 2, leading to an answer of 20 g. Despite these mistakes, both approaches still allowed candidates to gain further marks through error carried forward.

a redox reaction.

(ii) Calculate the minimum mass of iron(III) oxide needed to produce a theoretical yield of 28 g of iron.

[for Fe_2O_3 $M_r = 160$]

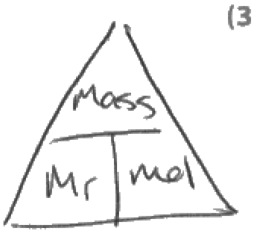
(3)

÷2

1 : 2

	Fe_2O_3	Fe
Mass	40	28
Mr	160	56
mol	0.25	0.5

÷2



minimum mass of iron(III) oxide = 40 g

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The use of the table method, formula triangle and annotations linked to the ratio allowed this candidate to clearly communicate their working and arrive at the correct answer. While there has been ongoing debate about the use of formula triangles and scaffolded table approaches, in this case, the candidate's method made their process transparent to the examiner. As a result, they successfully achieved the correct answer of 40 g and were awarded all 3 marks.

Question 6(e)iii

Although the correct values were not always used, nearly all candidates recognised that they needed to divide two numbers and multiply by 100. The most common error was the incorrect use of 40 g, carried over from their answer to Q6(e)(ii), instead of the correct value of 28 g provided in the question stem for Q6(e)(ii).

(iii) The actual yield of iron from this sample is 21 g.

Calculate the percentage yield of iron.

(2)

$$\% \text{ yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$$

$$= \frac{21}{28} \times 100 = 75\%$$

percentage yield = 75 %

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Examiner Comments

This was a well-structured response that scored 2 marks. Although the word equation was not required for credit, it served as a helpful tool to ensure the correct values from the question were used.

Question 7(a)

Completing the second half of this equation, including state symbols, proved challenging for many candidates. A common error was writing the formula of sodium sulfate as $NaSO_4$, reflecting a misunderstanding that it involves more than simply combining two ions. M2 was most frequently lost due to an incorrect state symbol being given for sodium sulfate, indicating that candidates would benefit from further practice in applying solubility rules to determine state symbols in neutralisation reactions.

7 A student does an experiment to determine the maximum temperature change when sulfuric acid reacts with sodium hydroxide.

(a) Complete the chemical equation for this neutralisation reaction.

Include the state symbols.

(2)

$2NaOH(aq) + H_2SO_4(aq) \rightarrow$ $Na_2\ SO_4$ + $2H_2O$

ResultsPlus
Examiner Comments

Correct formulae and balancing for M1 but the candidate hasn't included the state symbols resulting in a loss of M2.

7 A student does an experiment to determine the maximum temperature change when sulfuric acid reacts with sodium hydroxide.

(a) Complete the chemical equation for this neutralisation reaction.

Include the state symbols.

(2)

$2NaOH(aq) + H_2SO_4(aq) \rightarrow$ $Na_2SO_4\ (s)$ + $2\ H_2O\ (g)$

ResultsPlus
Examiner Comments

This was a common response which only scored M1 as the candidate has incorrectly assigned the state symbol for sodium sulfate resulting in the loss of M2.

Question 7(b)

The default approach by many candidates to improving an experiment was to suggest repeating and calculating a mean. While this would improve the reliability of the results, it does not improve the accuracy of the experiment. The high number of candidates scoring 0 marks suggests a clear lack of understanding between the terms reliability and accuracy.

Common valid suggestions included replacing the glass beaker with a polystyrene cup and using a burette or pipette instead of a measuring cylinder. Both of these could have scored 2 marks, but many candidates failed to explain their chosen improvement, particularly in the case of switching to a pipette or burette.

A number of responses also suggested adding the acid in smaller increments, which did not score. This approach would increase the duration of the experiment and likely lead to greater heat loss, meaning it would not necessarily improve the accuracy of the results.

(b) This is the student's method.

Step 1 add 50 cm^3 of sodium hydroxide solution to a glass beaker

Step 2 record the initial temperature of the sodium hydroxide solution

Step 3 add 5 cm^3 of dilute sulfuric acid to the beaker

Step 4 stir the mixture and record the highest temperature reached

The student repeats steps 3 and 4 until a total of 40 cm^3 of acid has been added.

Explain one way the student could improve the accuracy of the experiment.

(2)

Use a polystyrene cup as this will prevent heat from escaping as it is more insulating than a glass beaker

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Examiner Comments

This response scored 1 mark for correctly suggesting the replacement of the glass beaker with a polystyrene cup. However, the second mark was not awarded because the candidate stated that it would prevent heat loss, rather than reduce it.

Question 7(c)(d)(e)

For Q07(c), most candidates were able to plot the points correctly and identify the anomalous result. However, some lost marks due to poorly drawn lines of best fit, often caused by using a blunt pencil or not taking enough care to draw a line that closely followed the general trend of the data. A number of candidates also failed to follow the instruction to draw two straight lines, instead drawing curves or lines that intersected at the highest data point.

In Q07(d), most candidates understood what was required, but the similarity of the values led many to place correct readings in the wrong answer spaces. Candidates who had not drawn lines of best fit found this question more difficult and often resorted to quoting values directly from the table.

Overall, parts (c) and (d) were answered well and provided a relatively accessible six marks. In contrast, Q07(e) was poorly answered. Many responses were vague and focused on general human errors, such as misreading the thermometer, which was not considered a valid explanation. Few candidates correctly identified a plausible reason for the anomaly, and even fewer were able to justify it clearly. A common misconception was that an incorrect volume of acid had been used, but this would have affected subsequent data points rather than producing a single anomalous result.

(c) The table shows the student's results.

Total volume of acid in cm^3	0	5	10	15	20	25	30	35	40
Temperature of mixture in °C	21.0	22.3	23.8	24.4	26.5	28.0	28.5	28.2	27.9

(i) Plot the results on the grid.

(1)

(ii) Draw a circle around the anomalous result.

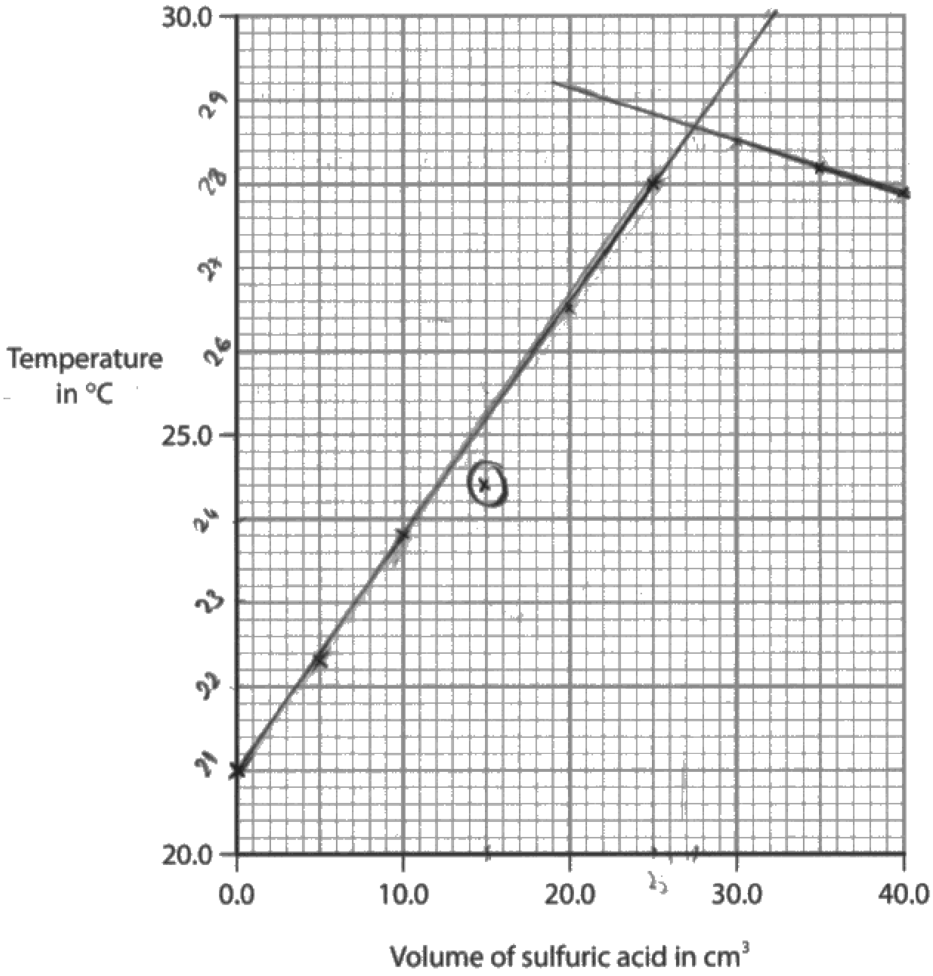
(1)

(iii) Draw a straight line of best fit through the first six points, ignoring the anomalous result.

Draw another straight line of best fit through the last three points.

Make sure that the two lines cross.

(2)



(d) The point where the lines cross shows the volume of acid needed to exactly neutralise the alkali and the maximum temperature reached.

Use your graph to determine these values.

(2)

volume of acid = 27.5 cm³

maximum temperature = 28.7 °C

(e) Explain what might have caused the anomalous result.

(2)

Took reading early, add less ~~acid to the beaker~~ dilute sulfuric acid to the beaker. so its volume is smaller than wanted result.

ResultsPlus
Examiner Comments

In Q07(c), the points have been plotted correctly, the anomalous result is correctly circled and two lines of best fit are drawn which intersect. Q07(d) scores 2 marks for the correct reading of both the temperature and the volume of acid at the point where the lines of best fit intersect. The only marks lost are in Q07(e), where the candidate begins with a suitable reason but, before fully explaining it, goes on to provide a second, incorrect reason resulting in a score of 0 marks.

(c) The table shows the student's results.

Total volume of acid in cm^3	0	5	10	15	20	25	30	35	40
Temperature of mixture in °C	21.0	22.3	23.8	24.4	26.5	28.0	28.5	28.2	27.9

(i) Plot the results on the grid.

(1)

(ii) Draw a circle around the anomalous result.

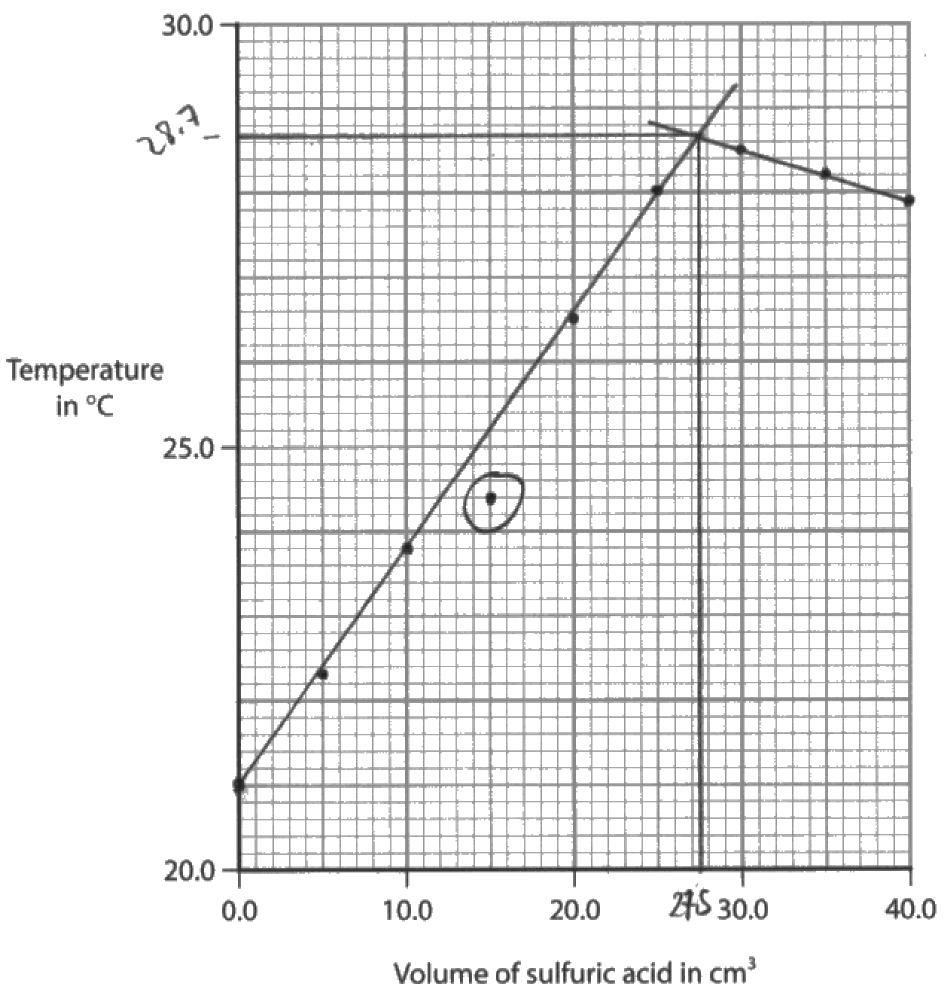
(1)

(iii) Draw a straight line of best fit through the first six points, ignoring the anomalous result.

Draw another straight line of best fit through the last three points.

Make sure that the two lines cross.

(2)



(e) Explain what might have caused the anomalous result.

(2)

~~Don't~~ Student doesn't read thermometer from eye level so there will be misreading of temperature.

ResultsPlus
Examiner Comments

For questions involving how to improve experiments or explain why an anomalous result may have occurred, candidates should avoid responses that focus on the incorrect use of apparatus or relatively minor issues such as parallax error, especially when there are usually more significant problems present within the method. This response scored 0 marks as such an error is unlikely to decrease the value by 8 degrees Celsius.

ResultsPlus
Examiner Tip

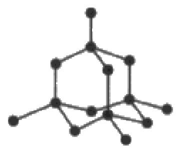
The direction of error matters; candidates should always consider whether their proposed improvement would affect the experiment in the intended direction.

Question 8(a)

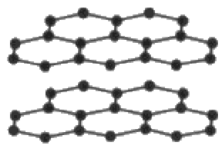
In the stem of Q08, candidates were informed that both diamond and graphite have giant covalent structures. As a result, M1 was often awarded for correctly stating that diamond contains covalent bonds. This was typically followed by a correct reference to the large amount of energy required to break the bonds, which could score M3. However, some candidates used vague or comparative terms such as "more energy," which were not credited. M2 was most commonly lost when candidates failed to mention that **many** bonds need to be broken. Additionally, 0 marks were given when candidates incorrectly referred to intermolecular forces instead of covalent bonds.

8 Diamond and graphite are two naturally-occurring forms of carbon.

They both have giant covalent structures.



diamond



graphite

(a) Explain, with reference to its bonding, why diamond has a high melting point.

(3)

Diamond has a giant covalent structure and it has strong bonds between its molecules so more energy is needed to overcome the forces so it has a high melting point.

ResultsPlus
Examiner Comments

This response scored 0 marks due to the incorrect reference to molecules. The structure of diamond is given in the question and the type of bonding in the response is not specified. There is a comment linked to energy but this is comparative although it is not clear what is being compared.

Question 8(b)

Q08(b) was a relatively straightforward extended response question taken directly from the specification. Most candidates performed well, typically scoring in the 4-6 mark range, aided by the fact that there were seven distinct, creditworthy points available.

M1 was generally well accessed, with many candidates correctly identifying the presence of covalent bonding between carbon atoms. However, a noticeable number of candidates did not refer to any bonding in their answers, despite the guidance provided in the question.

Another bonding-related mark, M5, was often lost because candidates stated that each carbon atom forms “three covalent bonds” rather than specifying that each carbon is bonded to three other carbon atoms. The former phrasing can be misinterpreted as a reference to a triple bond, which is inaccurate in the context of graphite. Surprisingly, a significant number of responses did not mention carbon at all.

M4, awarded for identifying weak forces between layers, was frequently missed due to inaccurate terminology. Many candidates referred to intermolecular forces, which incorrectly implies the presence of molecules in graphite’s structure. This consistent misuse of terminology throughout this paper suggests that candidates would benefit from a clearer understanding of what intermolecular forces are and when this term is appropriately applied.

The most common responses included the ability of layers to slide over one another and the presence of delocalised electrons that can move. While these are correct concepts, they were often not sufficiently linked to the structure or bonding of graphite, which limited candidates’ ability to access the full range of marks.

(b) Explain why graphite is soft and is a conductor of electricity.

Refer to structure and bonding in your answer.

(6)

Because:

- Graphite has layers of Carbon atoms arranged in hexagons.
- The layer are held together by weak forces so they can slide easily, making graphite soft.
- Each Carbon atom form three Strong covalent bonds with other Carbon atoms.
- The fourth electron is delocalized free to move.
- These delocalized electron can carry electrical current.
- Therefore, graphite is a good conductor of electricity and soft in texture.

ResultsPlus
Examiner Comments

This is an example of a high-quality response that includes all seven points from the mark scheme, resulting in the maximum score of six marks.

ResultsPlus
Examiner Tip

Bullet point responses are encouraged, especially if they help candidates provide clear answers that are free from repetition and include enough detail to potentially secure the highest marks.

(b) Explain why graphite is soft and is a conductor of electricity.

Refer to structure and bonding in your answer.

(6)

Graphite is a good conductor of electricity because it has free moving electrons which can move throughout its structure. Graphite is soft because of its lattice structure so its layers can slide over each other easily

ResultsPlus
Examiner Comments

The most commonly awarded marks were M2, M3, and M7, as demonstrated in this response. While the key areas are addressed, the explanations are incomplete and lack sufficient detail to score any further marks.

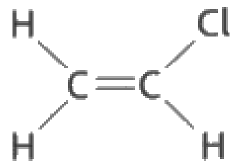
Question 9(a)i

Dot and cross diagrams were generally of a high standard, with most candidates securing both marks. Common issues included sharing too few electrons between the carbon atoms, drawing ethene instead of chloroethene, and most frequently, failing to show the non-bonding electron pairs on the chlorine atom.

9 This question is about organic compounds.

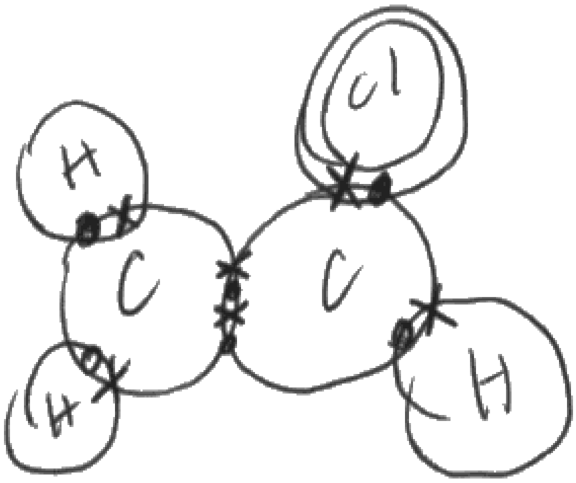
(a) Chloroethene (C_2H_3Cl) is a covalent molecule that is used to make poly(chloroethene).

This is the displayed formula of chloroethene.



(i) Draw a dot-and-cross diagram of chloroethene.

Show only the outer shell electrons.



ResultsPlus
Examiner Comments

The most common error, as seen here, is that the chlorine atom does not have a full outer shell of electrons. This mistake is understandable since all the other atoms are hydrogen, which require no additional electrons to complete their outer shells.

Question 9(a)ii

Descriptions of covalent bonding in terms of attractions often produce a variety of interesting responses, with many candidates still mentioning that it involves two non-metals bonding together. Overall, most candidates were able to secure the two marks on this question, which has become a staple due to its fundamental importance in the course.

(ii) Describe, in terms of electrostatic attraction, what is meant by a covalent bond.

(2)

• Both nucleus attracting the shared electrons

ResultsPlus
Examiner Comments

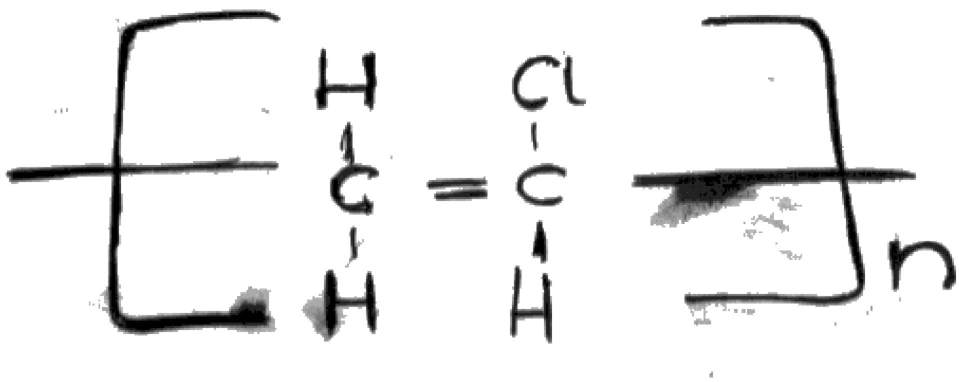
At first glance, this response appears promising; however, the use of the singular term 'nucleus' instead of 'nuclei' and the omission of the word 'pair' when referring to shared electrons meant that both M1 and M2 were not awarded. Consequently, this answer received 0 marks.

Question 9(a)iii

This question was well answered, with most candidates correctly drawing the repeating unit for chloroethene. Common errors included forgetting to remove the double bond in the repeating unit or drawing both the monomer and the repeating unit without clearly indicating which was their final answer.

(iii) Chloroethene is a monomer.

Draw the displayed formula of the repeat unit of poly(chloroethene).



ResultsPlus
Examiner Comments

Trailing bonds, square brackets, and even an 'n' were all present, showing the candidate was close to achieving the 1 mark; however, the candidate forgot to remove the double bond.

ResultsPlus
Examiner Tip

If time permits at the end of the paper, once all questions have been answered, candidates should be encouraged to check every carbon atom to ensure it has only four bonds (except in the case of graphite) to avoid losing marks.

Question 9(a)iv

Most candidates demonstrated good awareness of burning and landfill as disposal methods for poly(chloroethene). However, some marks were lost because responses described gases as merely harmful rather than toxic, or gave non-biodegradability as a reason for landfill issues, which was not credited as it was already stated in the question. Additionally, some candidates linked landfill problems to the harming of wildlife rather than focusing on the primary issues of poly(chloroethene) occupying space and being inert.

(iv) Poly(chloroethene) is non-biodegradable.

There are two main methods used to dispose of poly(chloroethene).

Describe one problem caused by each method.

(4)

1 Polymers are non-biodegradable because they are inert. Throwing polymers inside landfills is one method, but polymers stay there for thousands of years.

2 Other method is burning the polymers, this produces toxic gases which is poisonous to humans.

ResultsPlus
Examiner Comments

An example of a response that scored all 4 marks due to the use of multiple correct key terms.

Question 9(b)

Most candidates scored 3 marks and performed well overall. Some incorrectly used atomic numbers in mole calculations and made minor errors. Occasional transcription errors occurred. Additionally, several candidates attempted to calculate a relative atomic mass using the data instead of determining the empirical formula.

(b) An organic compound contains this percentage composition by mass.

C = 22.0%   H = 4.6%   Br = 73.4%

Calculate the empirical formula of this compound.

(3)

	C	H	Br
m =	$\frac{22}{12}$	$\frac{4.6}{1}$	$\frac{73.4}{80}$
n =	$\frac{1.83}{0.9175}$	$\frac{4.6}{0.9175}$	$\frac{0.9175}{0.9175}$
	1.99	5.01	1

empirical formula = CH_5Br ~~C_1H_5Br~~

ResultsPlus
Examiner Comments

This response scored only 2 marks because, although the calculations were correct, the number of carbon atoms was rounded down to 1 instead of up to 2 when giving the empirical formula on the answer line.

(b) An organic compound contains this percentage composition by mass.

C = 22.0%   H = 4.6%   Br = 73.4%
12   1   80

Calculate the empirical formula of this compound.

$\frac{22.0}{12}$ = $\frac{1.83}{0.91}$ $\frac{4.6}{1}$ = $\frac{4.6}{0.91}$ $\frac{73.4}{80}$ = $\frac{0.91}{0.91}$

= 2.0 : 5.0 : 1

empirical formula = 2 : 5 : 1

ResultsPlus
Examiner Comments

This is a further example of a response which scored only 2 marks. The final mark was lost because the ratio was not correctly applied to the formula, which was required to achieve the third mark.

Question 9(c)

Q09(c) had many potential areas for candidates to score marks if they were familiar with the details of addition and substitution reactions. However, to ensure marks were awarded across both reaction types, a maximum of 3 marks was allowed per reaction.

A number of lower-mark responses focused solely on observations involving ethene and ethane with bromine. In contrast, some high-scoring responses omitted the observations altogether. Unfortunately, in many responses it was difficult for examiners to distinguish between 'ene' and 'ane' due to the handwriting of candidates. There were numerous examples where correct equations were provided and marks were awarded accordingly, but a common error was giving the product of the addition reaction as bromoethane instead of dibromoethane.

(c) Ethane and ethene undergo different types of reaction with bromine.

Describe the differences between these two reactions.

(5)

When ethene reacts with bromine, addition reaction occurs and dibromo ethane is produced. Brown bromine turns colourless. However, Ethane can not react with bromine without uv light. When uv light is present, ethane reacts with bromine, substitution reaction occurs and bromo ethane and hydrogen bromide is produced.

ResultsPlus
Examiner Comments

In this response the M6 is scored for 'addition reaction' for ethene and M7 for bromine turning colourless. The product of the reaction isn't entirely clear as to whether it is dibromoethane or dibromoethene. M3 is scored for UV light for ethane, M1 for identifying the reaction as substitution and both M4 and M5 could be scored for the correct identification of the products. The maximum 3 marks are scored for ethane. Overall, the issue with the clarity of the name of the product for the addition reaction hasn't caused an issue for the candidate as they have given plenty of correct information to secure the maximum 5 marks.

ResultsPlus
Examiner Tip

When naming compounds, it is better to re-write the name if there is an error, rather than leaving a difficult-to-read answer that could potentially lead to the loss of a mark.

(c) Ethane and ethene undergo different types of reaction with bromine.

Describe the differences between these two reactions.

(5)

Ethane undergo substitution reaction with bromine ~~bromine~~. This reaction requires UV light. Products are bromoethane and hydrogen bromide

Ethene undergo addition reaction with bromine. This reaction don't need any condition. Products are bromoethene. This reaction has only one product

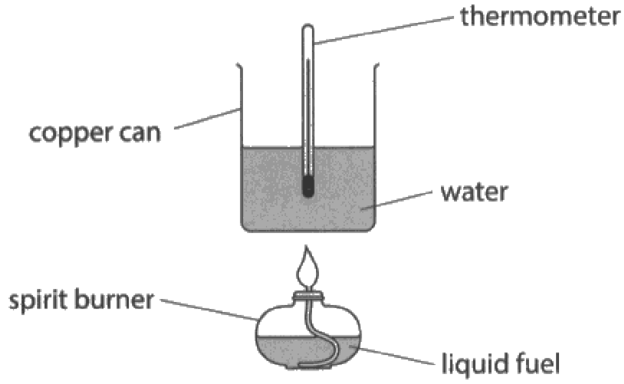
ResultsPlus
Examiner Comments

This response scores 4 marks overall. In the first paragraph about ethane, M1, M3, M4 and M5 are present, which leads to the maximum of 3 marks for this reaction. In the second paragraph about ethene, only M6 is present, scoring a further 1 mark.

Question 10(a)

The most common mark was 1, but there was a wide spread of marks achieved by candidates. The quality of responses was not as strong as in other parts of the paper, with less precise language and a lack of familiarity with determining control variables in a practical context proving to be a challenge. Many candidates explained their control variables by linking them to time, or they misunderstood the purpose of the experiment and suggested controlling the mass of the fuel instead. While most candidates recognised that the volume or mass of water should remain the same, this was often justified in terms of the time the experiment would take, rather than the energy required to cause a temperature change. Although some candidates identified the distance from the flame to the can as a variable, they rarely explained how this would affect heat loss. Candidates often failed to clearly express their reasoning and sometimes contradicted themselves. Only a comparatively small number of candidates achieved full marks with an explanation that was both clear and well-structured.

10 A student uses this apparatus to investigate the energy content of different fuels.



(a) This is the student's method.

- pour some water into the copper can
- record the mass of the spirit burner and fuel
- measure the initial temperature of the water
- place the spirit burner under the copper can and light the burner
- stop heating the water when the temperature reaches 30°C
- record the new mass of the spirit burner and fuel

The student repeats the experiment with different fuels.

Explain two variables the student should control to make this a valid test.

(4)

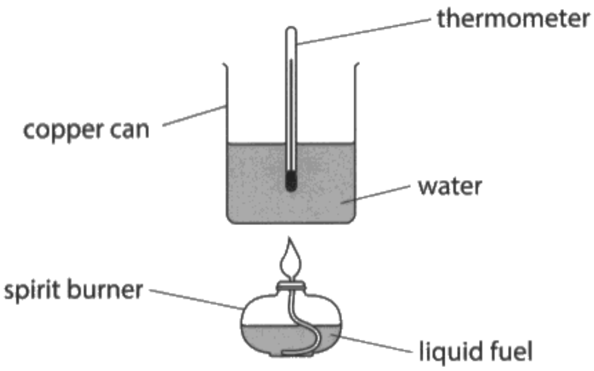
1 The volume of water needs to be the same because ~~di~~ bigger volumes need more energy to reach the same temperature.

2 The distance between the spirit burner and the copper can needs to be the same, otherwise there would be different heat losses, making readings invalid.

ResultsPlus Examiner Comments

This is an example of one of the higher-quality responses seen. It achieved 4 marks for accurately covering both Pair 1 and Pair 3 from the mark scheme.

10 A student uses this apparatus to investigate the energy content of different fuels.



(a) This is the student's method.

- pour some water into the copper can
- record the mass of the spirit burner and fuel
- measure the initial temperature of the water
- place the spirit burner under the copper can and light the burner
- stop heating the water when the temperature reaches 30°C
- record the new mass of the spirit burner and fuel

The student repeats the experiment with different fuels.

Explain two variables the student should control to make this a valid test.

(4)

1 make sure to ~~on~~ stir the water otherwise It will heat unevenly and the tenpcature shown will be in valid

2 make sure to record the mass of the spirit burner as soon as the water reaches 30 ~~m~~ °c so that no fuel ~~is~~ evaporates or continues to burn.

ResultsPlus
Examiner Comments

This response also scored 4 marks for a different pair of acceptable answers.

Question 10(b)

Candidates scored well in (b)(i), with 2 marks commonly achieved. Weaker candidates often secured 1 mark for calculating the temperature change but typically lost the second mark due to using an incorrect mass of water.

In (b)(ii), common errors included omitting the sign and failing to divide by 1,000. Some candidates were confused by the multiple masses provided in the question and were unsure where or how each should be applied.

(b) In one of the experiments, the student uses ethanol as the fuel.

These are the student's results for ethanol.

initial mass of spirit burner and ethanol in g	38.52
final mass of spirit burner and ethanol in g	38.29
volume of water in cm^3	100
initial temperature of water in °C	18
final temperature of water in °C	30

(i) Calculate the value of heat energy change (*Q*) in joules.

[for water, c = 4.2 J/g/°C 1.0 cm^3 of water has mass = 1.0 g]

(2)

$Q = \Delta T \cdot c \cdot m$

~~100·(38.52 − 38.29)~~

$(30-18) \times 4.2 \times 100 = 5040$

Q = 5040 J

(ii) Calculate the enthalpy change (ΔH) in kJ/mol.

[for ethanol, M_r = 46]

Include a sign in your answer.

(5)

$5040 \div 1000 = 5.04$

$\frac{5.04}{(0.23/46)} = 1008$

$38.52 - 38.29 = 0.23$

ΔH = 1008 kJ/mol

ResultsPlus
Examiner Comments

This response scored 2 marks for (b)(i) and 4 marks for (b)(ii). It is easy to see the candidate's method and they only lose one mark for not including the correct sign in their answer.

ResultsPlus
Examiner Tip

When reading the question, candidates could write a reminder above the answer line to include the correct sign, ensuring they don't forget it after completing multiple calculation steps.

Paper Summary

Based on their performance on this paper, candidates should:

- Take care when using the term intermolecular force and review when it is appropriate or not appropriate to use it in structure and bonding questions.
- Practise evaluating a range of experiments from the course and be able to review a method to suggest improvements specifically linked to accuracy.
- Ensure they can successfully complete, balance, and add state symbols to chemical equations.
- Consider structuring long response questions using bullet points to improve flow and avoid repetition in their answers.

Grade boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link: https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

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