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Examiners' Report
June 2025

Int Advanced Level Chemistry WCH13 01

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June 2025

Publications Code WCH13_01_2506_ER

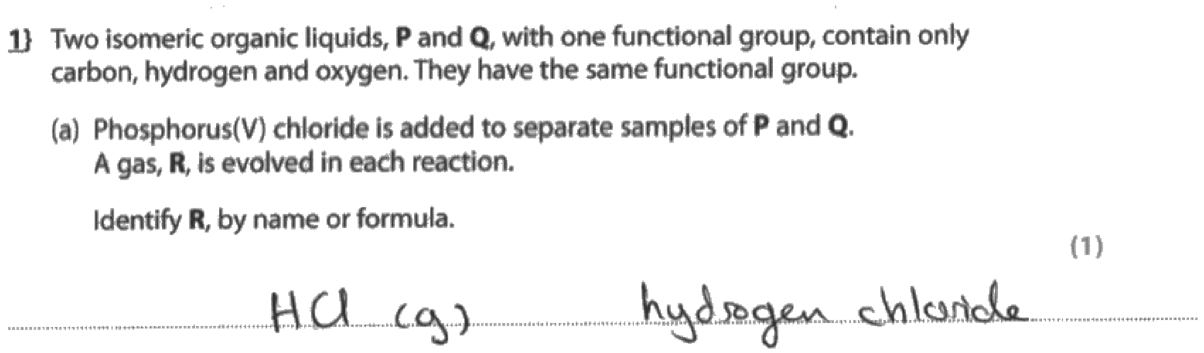
Introduction

The paper was accessible to most candidates, probably more so than previous series due to several marks being available from GCSE topics. Nevertheless, there were some quite challenging questions and the paper provided the full range of marks. Some candidates scored very highly and were fully prepared for the examination, demonstrating the excellent teaching and learning that has taken place. Many candidates showed a sound knowledge of the specification and could demonstrate this in the quality of their responses. However, a small minority of candidates found some of the questions more challenging and needed to express their understanding of chemistry more clearly. For most candidates, the calculations were very well attempted with a significant number scoring full marks. For those candidates who did not do so well with calculations, one of the main errors was in early or incorrect rounding of both intermediate and final answers. It is good practise, unless instructed otherwise by the paper, to use a minimum of three significant figures throughout. The mean mark for the paper was 58%.

Question 1(a)

75% of candidates scored this mark, showing that the PCl5 test for alcohols was well known. Some of those who did not score gave "misty fumes" which is the correct observation for this test but clearly, although they were familiar with the test, these candidates did not read the question properly, which asked for the **identity** of the gas. Other candidates that were unfamiliar with the test gave a wide range of incorrect compounds.

This is the perfect answer.



1) Two isomeric organic liquids, **P** and **Q**, with one functional group, contain only carbon, hydrogen and oxygen. They have the same functional group.

(a) Phosphorus(V) chloride is added to separate samples of **P** and **Q**.
A gas, **R**, is evolved in each reaction.

Identify **R**, by name or formula.

(1)

HCl (g) hydrogen chloride

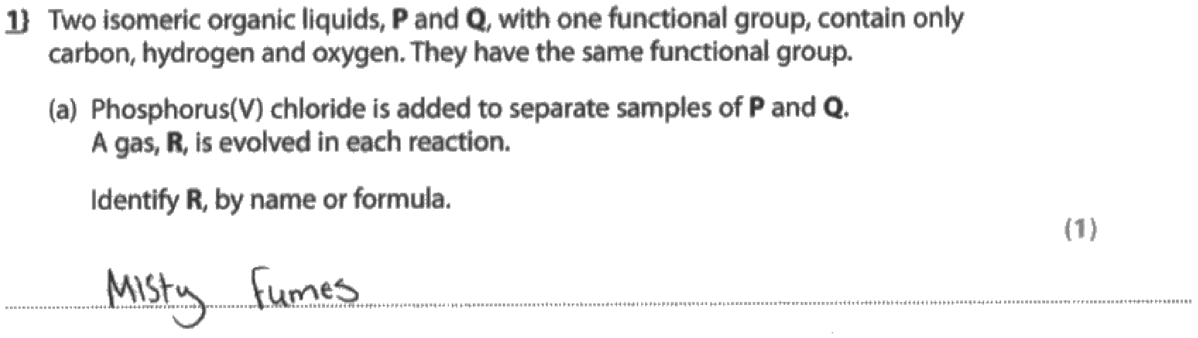
ResultsPlus
Examiner Comments

Although it was not required to give both formula and name, this candidate has done so. You have to be careful when doing this as, if the formula is correct and the name is wrong, the mark is not scored. Also, the state symbol is not required but this candidate has clearly read the question, noted that it was a gas evolved and gave the correct state symbol for gas. Note that HCl on its own would have scored but "hydrochloric acid" would not since it is a solution, not a gas.

ResultsPlus
Examiner Tip

It is not good practise to give two answers when only one is needed as there is a risk that the mark could be lost, even if one of the answers is correct.

Here, the candidate was clearly familiar with the test for the alcohol group but did not read the question properly.



1) Two isomeric organic liquids, **P** and **Q**, with one functional group, contain only carbon, hydrogen and oxygen. They have the same functional group.

(a) Phosphorus(V) chloride is added to separate samples of **P** and **Q**. A gas, **R**, is evolved in each reaction.

Identify **R**, by name or formula.

(1)

Misty fumes

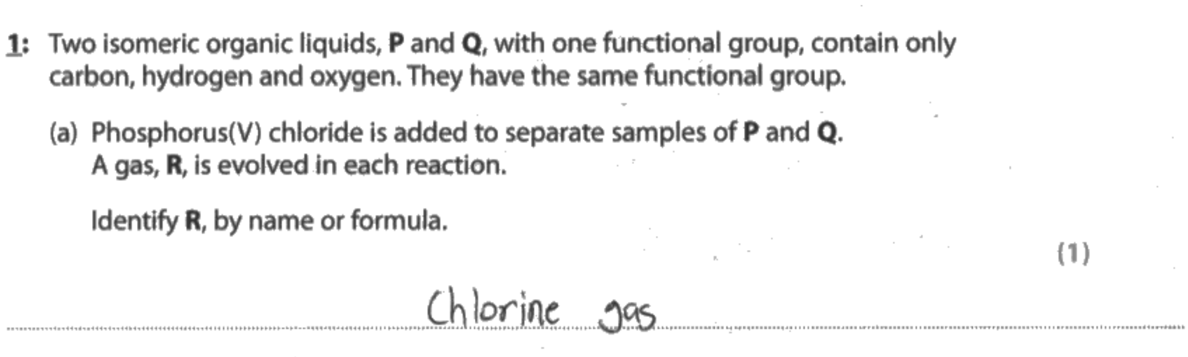
ResultsPlus
Examiner Comments

Misty fumes is the correct observation for the PCl5 test for alcohols but is not what the question asked for. It asked for the identity of the gas, not the observation.

ResultsPlus
Examiner Tip

Make sure you read the question properly, taking note of any relevant key words. Also, make sure you are familiar with the command words at the start of the question stem. The two most important words in this question were gas and the command word identify.

An example of an incorrect answer.



1 Two isomeric organic liquids, **P** and **Q**, with one functional group, contain only carbon, hydrogen and oxygen. They have the same functional group.

(a) Phosphorus(V) chloride is added to separate samples of **P** and **Q**. A gas, **R**, is evolved in each reaction.

Identify **R**, by name or formula.

(1)

Chlorine gas

ResultsPlus
Examiner Comments

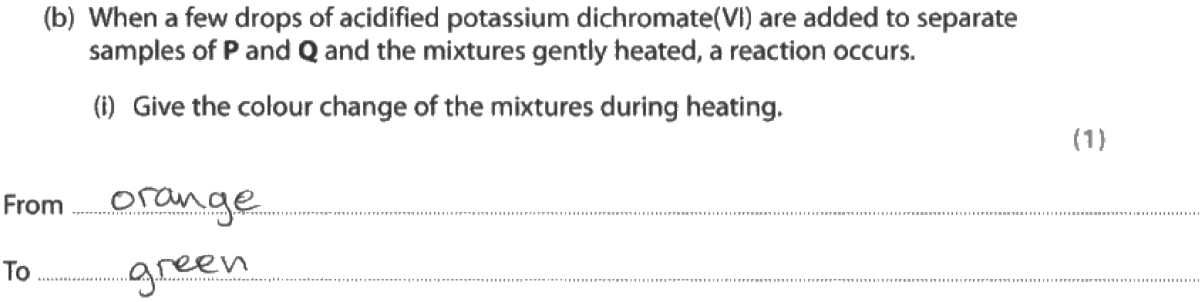
Chlorine is close but not the correct answer.

ResultsPlus
Examiner Tip

Make sure you are familiar with all the chemical tests in the specification. A good idea, when revising, is to make a set of flash cards on the chemical tests and get friends or family to test you on them.

Question 1(b)i

A correct response.



(b) When a few drops of acidified potassium dichromate(VI) are added to separate samples of **P** and **Q** and the mixtures gently heated, a reaction occurs.

(i) Give the colour change of the mixtures during heating.

(1)

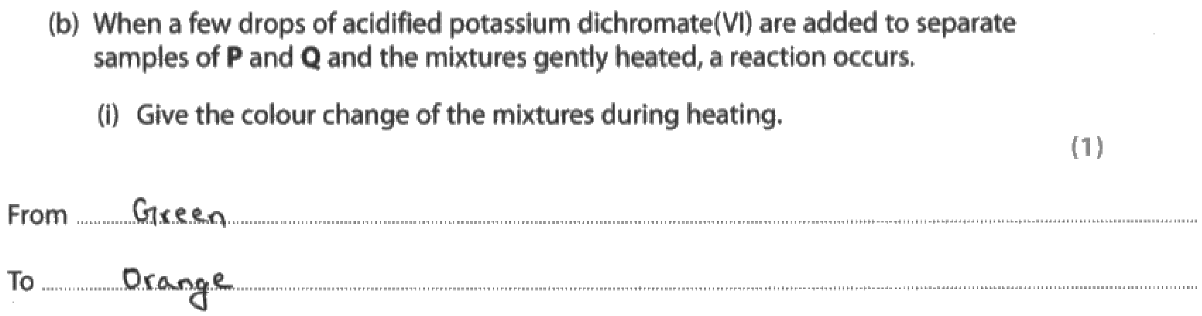
From orange

To green

ResultsPlus
Examiner Comments

This candidate clearly knew the colour change and scored the mark.

An incorrect response.



(b) When a few drops of acidified potassium dichromate(VI) are added to separate samples of **P** and **Q** and the mixtures gently heated, a reaction occurs.

(i) Give the colour change of the mixtures during heating.

(1)

From Green

To Orange

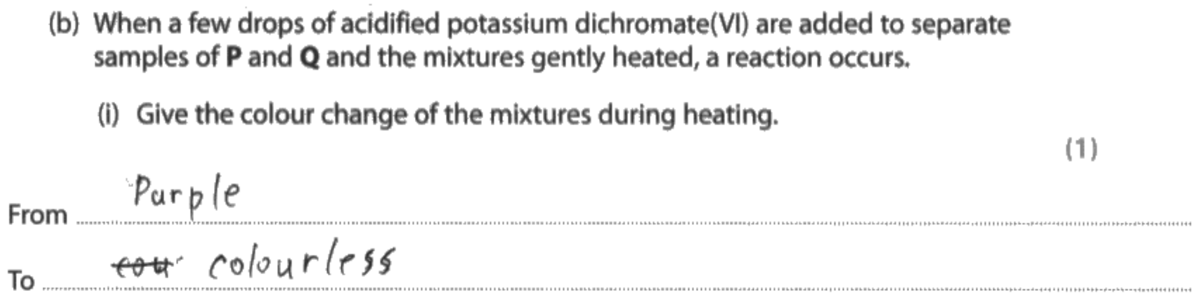
ResultsPlus
Examiner Comments

This candidate clearly knows the colour change but unfortunately got it the wrong way round.

ResultsPlus
Examiner Tip

When learning the chemical tests for the different ions and functional groups, you should also learn the observation that is associated with it.

An example of an incorrect response.



(b) When a few drops of acidified potassium dichromate(VI) are added to separate samples of **P** and **Q** and the mixtures gently heated, a reaction occurs.

(i) Give the colour change of the mixtures during heating.

(1)

From Purple

To ~~cou~~ colourless

ResultsPlus
Examiner Comments

It appears that this candidate got confused between two different tests for oxidation of alcohols and gave the correct colour change for when potassium manganate(VII) is used.

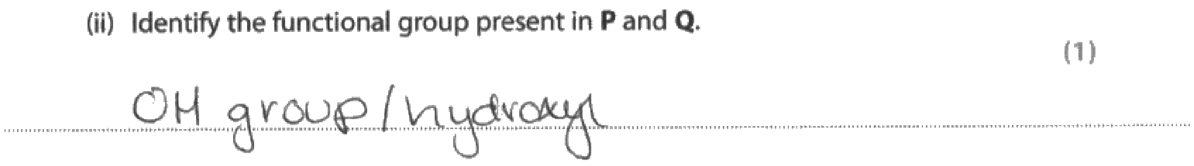
ResultsPlus
Examiner Tip

Always make sure you learn the observations associated with the chemical tests described in the specification.

Question 1(b)ii

This question required use of the previous two to identify the alcohol functional group. 86% of all candidates scored this mark.

An example of a good answer.



(ii) Identify the functional group present in **P** and **Q**.

(1)

OH group / hydroxyl

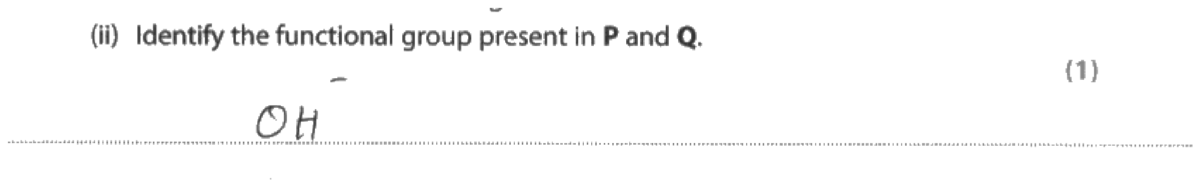
ResultsPlus
Examiner Comments

This candidate was one of many who was able to deduce the correct functional group from the observations in the two tests carried out.

ResultsPlus
Examiner Tip

It is not good practise to give two responses when only one is required, just in case one is not correct.

This was a common error among the 16% that didn't score.



(ii) Identify the functional group present in **P** and **Q**.

(1)

OH^-

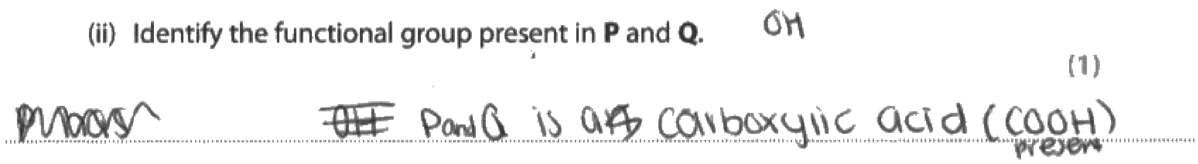
ResultsPlus
Examiner Comments

Unfortunately, adding a minus sign to the OH group negates the mark. This makes it a hydroxide ion which is clearly incorrect.

ResultsPlus
Examiner Tip

Be careful when adding signs to formulae. Are they needed and are they correct. Note that OH on its own without the minus sign would have scored the mark.

An example of an incorrect functional group.



(ii) Identify the functional group present in **P** and **Q**. OH

(1)

P and Q is a carboxylic acid ($COOH$) present

ResultsPlus
Examiner Comments

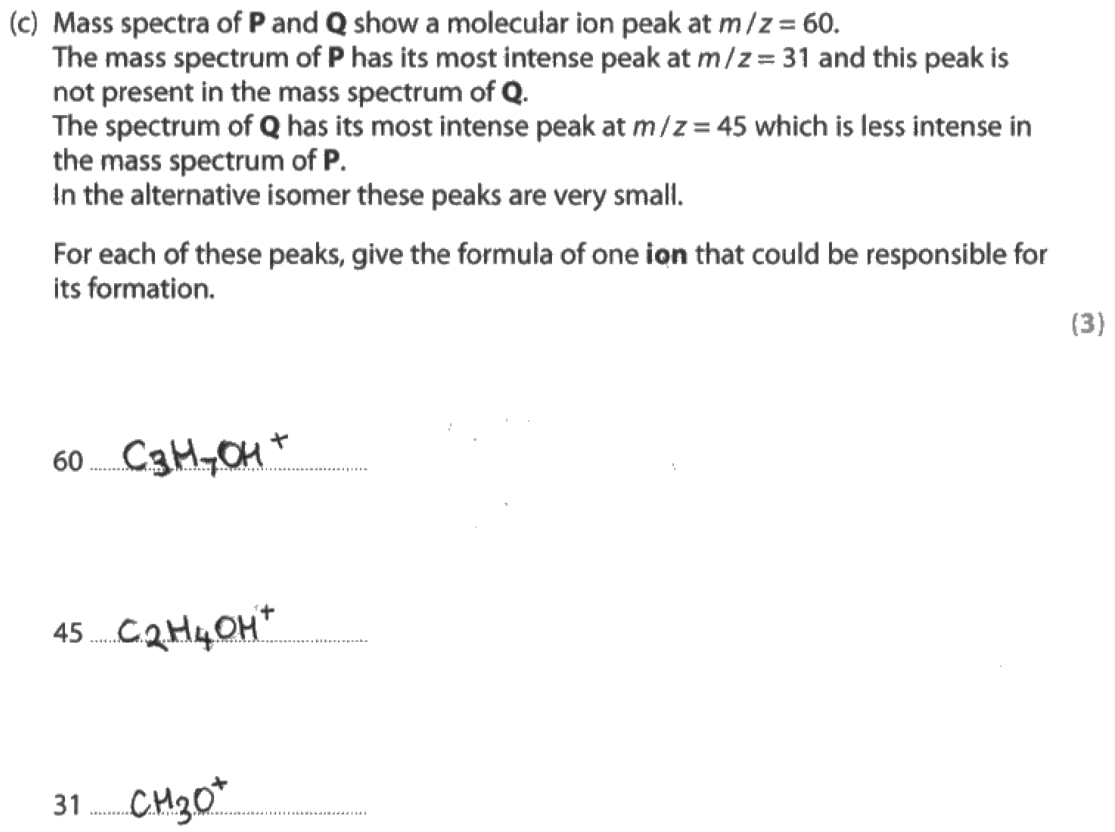
From the rough working above, it is obvious that the candidate knew there was an OH group involved. However, although the carboxylic acid contains an OH, it is a very different functional group overall and would not give the test results described in the previous two questions.

ResultsPlus
Examiner Tip

Make sure you learn the organic functional groups and the chemical tests associated with them contained in the specification.

Question 1(c)

An example of a 100% correct response.



(c) Mass spectra of **P** and **Q** show a molecular ion peak at $m/z = 60$.
The mass spectrum of **P** has its most intense peak at $m/z = 31$ and this peak is not present in the mass spectrum of **Q**.
The spectrum of **Q** has its most intense peak at $m/z = 45$ which is less intense in the mass spectrum of **P**.
In the alternative isomer these peaks are very small.

For each of these peaks, give the formula of one **ion** that could be responsible for its formation.

(3)

60 $C_3H_7OH^+$

45 $C_2H_4OH^+$

31 CH_3O^+

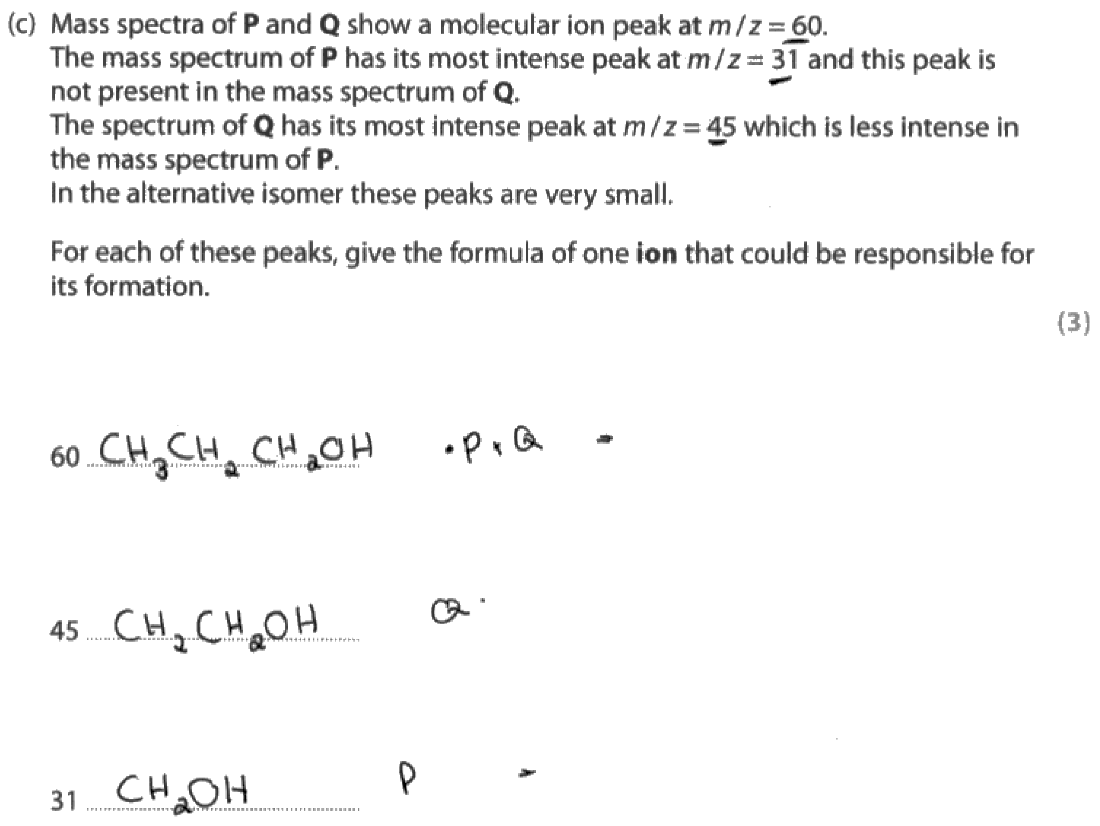
ResultsPlus
Examiner Comments

This candidate clearly knew how to interpret a mass spectrum and give correct formulae for the species involved. Note that if the ions had been written as molecular formulae, this would also have been accepted, eg C 3 H 8 O + for the molecular ion peak.

ResultsPlus
Examiner Tip

Make sure you understand that organic molecules break up into fragments that can be used to identify the parent molecule.

An example of a partially correct answer.



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In the alternative isomer these peaks are very small.

For each of these peaks, give the formula of one **ion** that could be responsible for its formation.

(3)

60 $CH_3CH_2CH_2OH$ · P , Q

45 CH_2CH_2OH Q

31 CH_2OH P

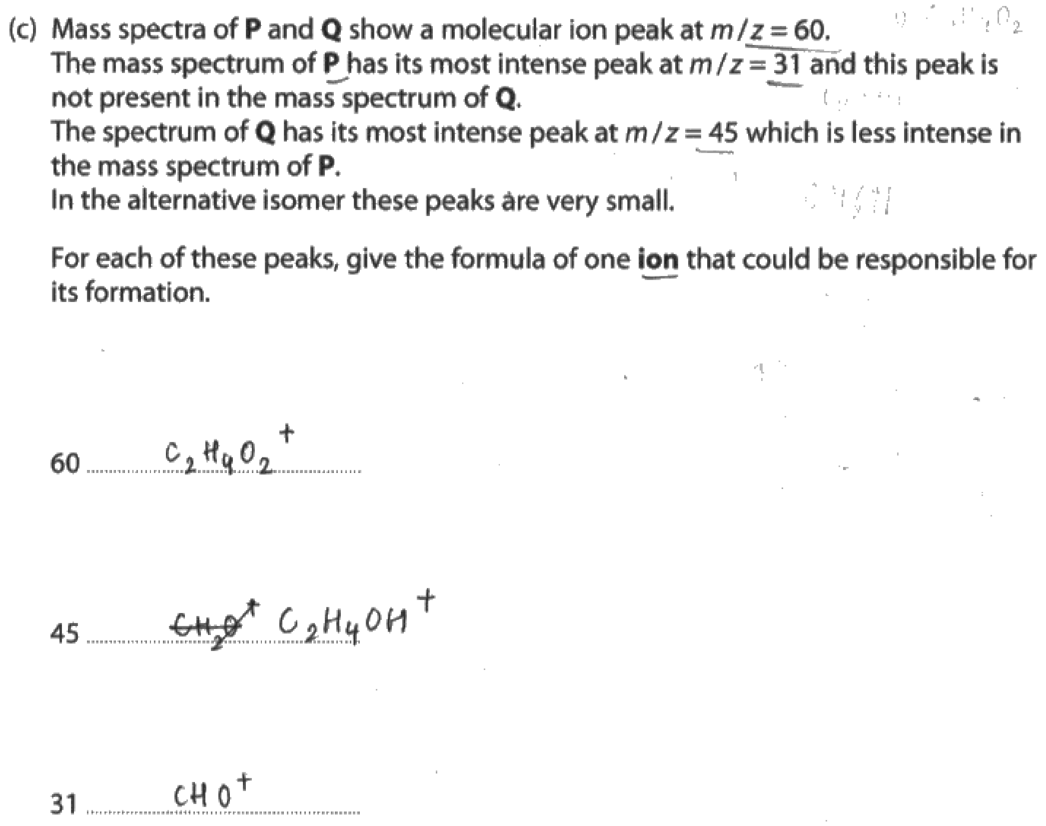
ResultsPlus
Examiner Comments

Although all of the formulae are correct (they can be written as structural or molecular formulae) they are all missing the "+" charge.

ResultsPlus
Examiner Tip

Make sure to add a "+" charge to all ions detected in a mass spectrometer. Without the charge, they would not move and therefore, would not be detected.

Another partially correct answer.



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In the alternative isomer these peaks are very small.

For each of these peaks, give the formula of one **ion** that could be responsible for its formation.

(3)

60 $C_2H_4O_2^+$

45 ~~CHO_2^+~~ $C_2H_4OH^+$

31 CHO^+

ResultsPlus
Examiner Comments

Only one of the formulae is correct, that for the peak at m/z 45. The others have the wrong relative formula mass.

ResultsPlus
Examiner Tip

Make sure that when writing the formula of fragments (or molecular ions) that you check that the sum of the relative atomic masses adds up to the m/z value.

Question 1(d)

Following on from identification of the fragments, the candidates now had to use this information to identify the structures of the two alcohol isomers of C3H8OH. 61% of all candidates were able to do this.

Candidates could, of course, deduce the structures of the two isomers from the m/z of the molecular ion without using the fragment ions, but this often led to an incorrect answer, giving the structures the wrong way round.

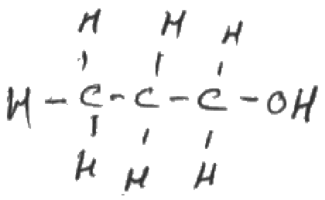
A large proportion of those candidates not scoring were because the formulae of the two structures did not have a formula mass of 60 and/or they were not isomers of each other.

This is an example of a correct answer with two correct structures.

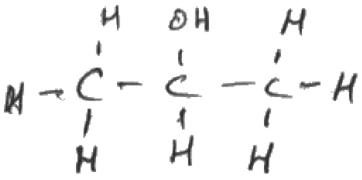
(d) Deduce the structural formulae of **P** and **Q**.

(2)

P



Q



(Total for Question 1 = 8 marks)

ResultsPlus
Examiner Comments

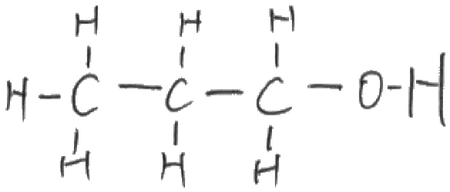
Note that the type of structure was not demanded in the question. This candidate gave fully displayed structures but simple structural formulae and skeletal structures were also accepted.

A partially correct answer.

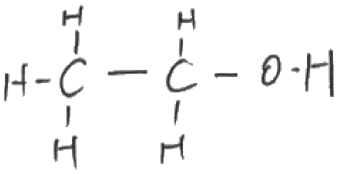
(d) Deduce the structural formulae of **P** and **Q**.

(2)

P



Q



(Total for Question 1 = 8 marks)

ResultsPlus Examiner Comments

The structure for P is fully correct but Q, although it is an alcohol is not an isomer of P.

ResultsPlus Examiner Tip

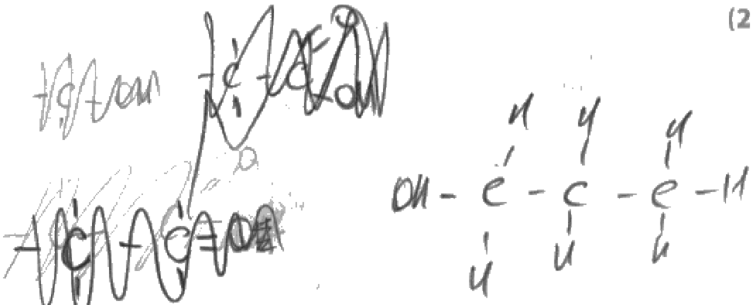
Make sure that, if you are asked for isomers, that they have the same molecular formulae, and that this matches the m/z value for the molecular ion, in this case 60.

This is an example of a poor response that scored nothing.

(d) Deduce the structural formulae of **P** and **Q**.

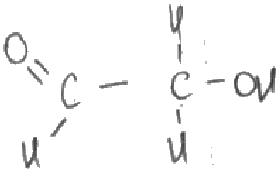
(2)

P



$(OH)(CH_2)(CH_2)(CH_3)$

Q



(Total for Question 1 = 8 marks)

ResultsPlus
Examiner Comments

Although the formula for P is correct, and the structure is almost correct, the mark is negated because of the incorrect connectivity of the OH group. The H of the hydroxyl group should not be connected to a carbon atom. The structure of Q has the wrong formula and the wrong functional group.

ResultsPlus
Examiner Tip

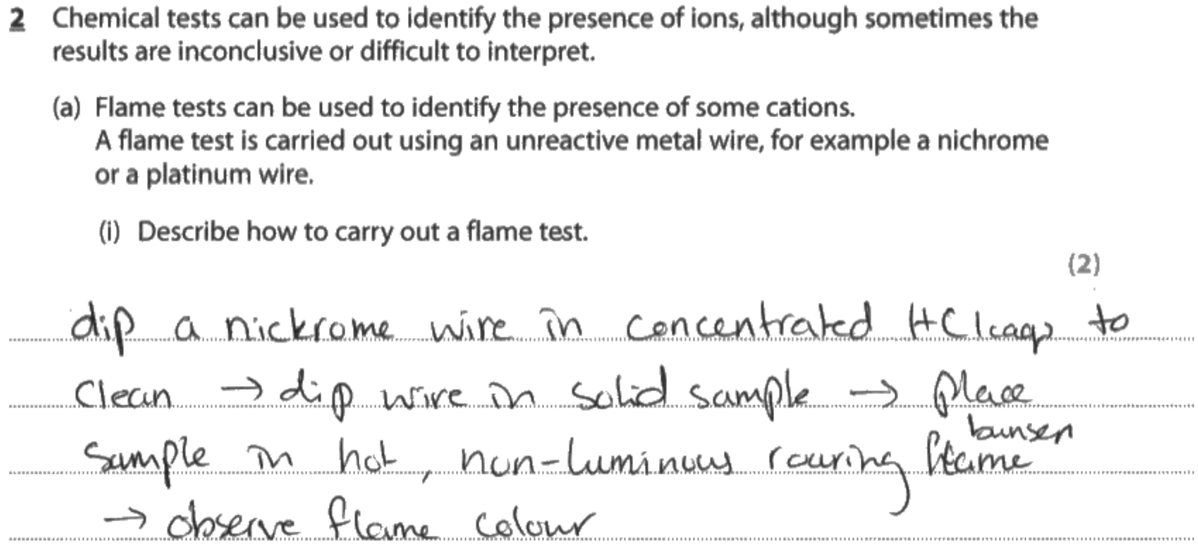
When drawing structures, always make sure the atoms are connected in the right way and with the right number of bonds. Use the HONC rule. In the vast majority* of organic structures, H always has 1 bond, O almost always has 2 bonds, N usually has 3 bonds and C always has 4 (* there are a very few exceptions for oxygen and nitrogen but these are not encountered in the AS specification).

Question 2(a)i

This ought to have been a very accessible question because it was about the flame test procedure which candidates ought to have encountered at GCSE if not before. However, only 72% got it fully correct.

Marks were lost through lack of detail, mostly the type / colour of the flame used.

This is an example of a perfect answer.



2 Chemical tests can be used to identify the presence of ions, although sometimes the results are inconclusive or difficult to interpret.

(a) Flame tests can be used to identify the presence of some cations.
A flame test is carried out using an unreactive metal wire, for example a nichrome or a platinum wire.

(i) Describe how to carry out a flame test.

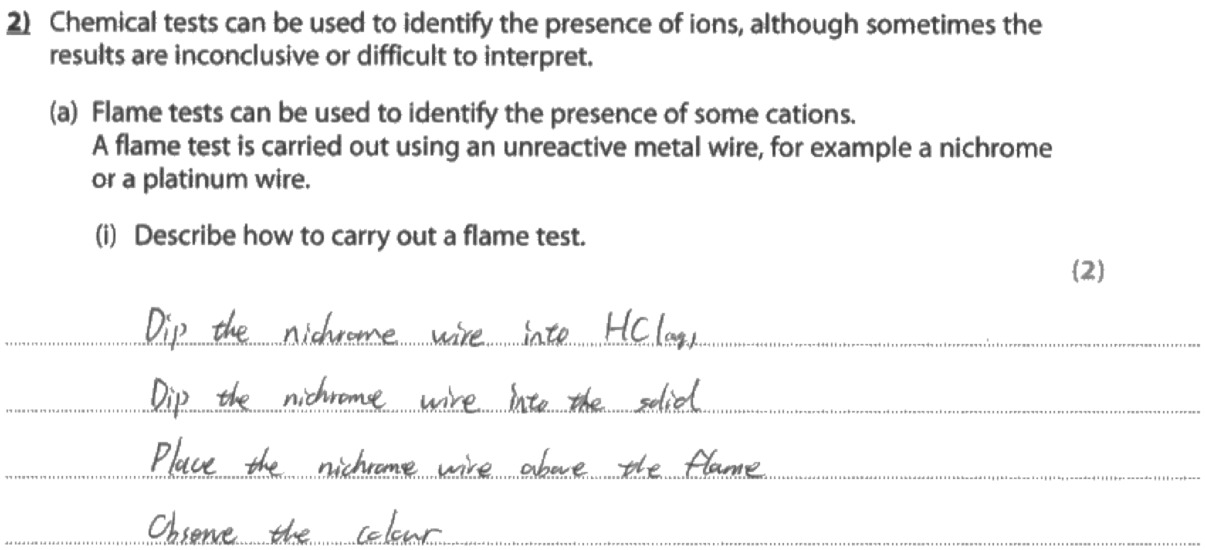
(2)

dip a nickrome wire in concentrated $HCl(aq)$ to clean → dip wire in solid sample → place sample in hot, non-luminous roaring bunsen flame → observe flame colour

ResultsPlus
Examiner Comments

All the detail necessary to score both marks: a suitable use of hydrochloric acid; and the correct Bunsen flame colour.

An example of an almost perfect answer, just missing one small detail.



2 Chemical tests can be used to identify the presence of ions, although sometimes the results are inconclusive or difficult to interpret.

(a) Flame tests can be used to identify the presence of some cations.
A flame test is carried out using an unreactive metal wire, for example a nichrome or a platinum wire.

(i) Describe how to carry out a flame test.

(2)

Dip the nichrome wire into $HCl_{(aq)}$

Dip the nichrome wire into the solid

Place the nichrome wire above the flame

Observe the colour

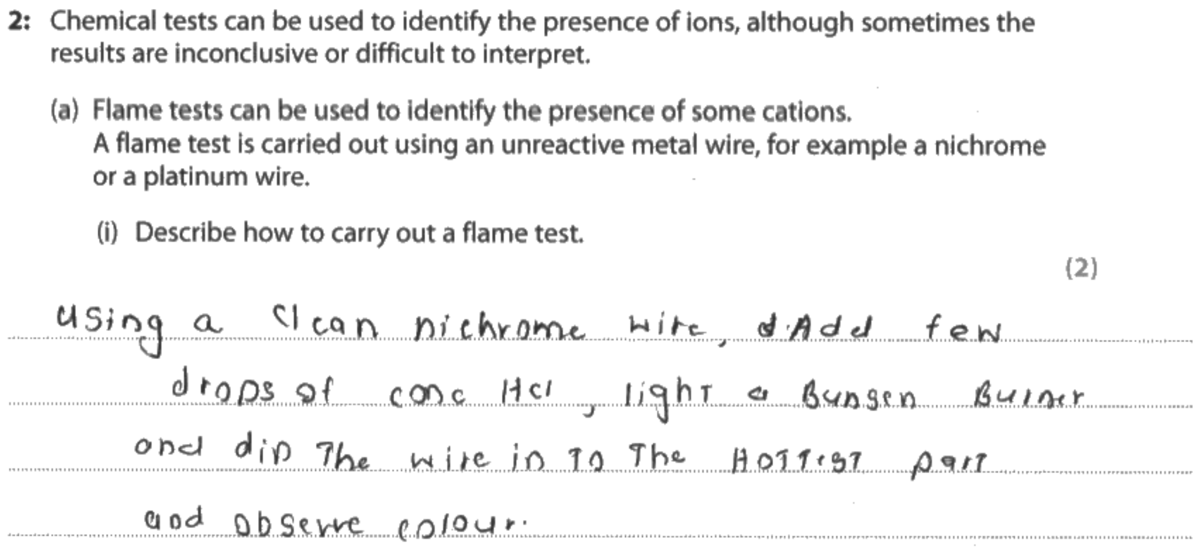
ResultsPlus
Examiner Comments

The response has the correct use of hydrochloric acid but is missing the colour of the flame.

ResultsPlus
Examiner Tip

Make sure to add relevant detail, no matter how trivial you think it is.

This is an example of a poor answer, lacking all the necessary detail.



2: Chemical tests can be used to identify the presence of ions, although sometimes the results are inconclusive or difficult to interpret.

(a) Flame tests can be used to identify the presence of some cations.
A flame test is carried out using an unreactive metal wire, for example a nichrome or a platinum wire.

(i) Describe how to carry out a flame test.

(2)

using a clean nichrome wire, Add few drops of conc Hcl, light a Bunsen Burner and dip The wire in To The Hottest part and observe colour.

ResultsPlus
Examiner Comments

They haven’t told us what they are doing with the hydrochloric acid and the type of Bunsen flame is also missing.

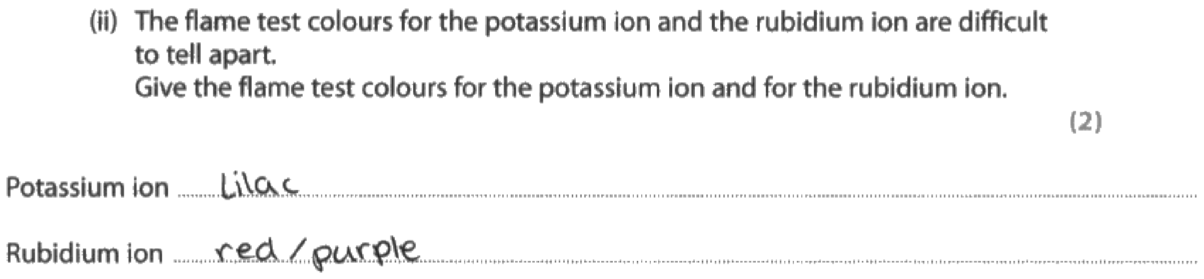
ResultsPlus
Examiner Tip

Lack of detail in an answer is a very common source of lost marks in examinations. You may well know the detail but unless you write it down, the examiner does not know what you are thinking.

Question 2(a)ii

Flame test colours are generally very well-known and candidates found the question very accessible. Incorrect answers for potassium were very rare but as the colour for rubidium is less well known, incorrect answers were a little more common.

A perfect textbook answer.



(ii) The flame test colours for the potassium ion and the rubidium ion are difficult to tell apart.
Give the flame test colours for the potassium ion and for the rubidium ion.
(2)

Potassium ion Lilac

Rubidium ion red / purple

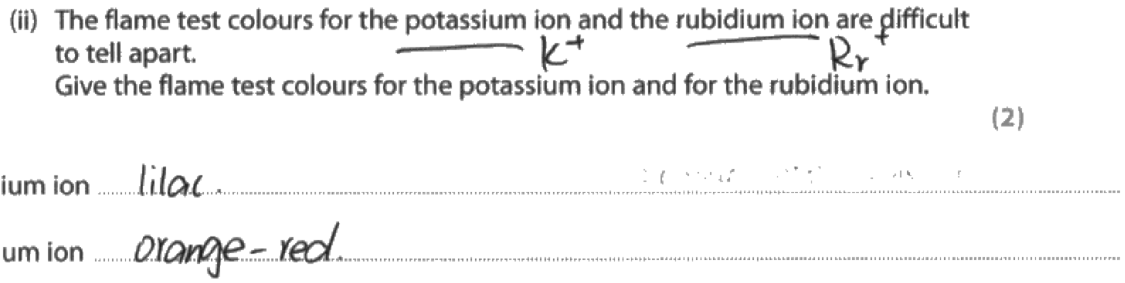
ResultsPlus
Examiner Comments

Correct textbook colours for both metal ions.

ResultsPlus
Examiner Tip

Make sure you know the flame test colours found in this specification.

Correct for potassium but incorrect for rubidium.



(ii) The flame test colours for the potassium ion and the rubidium ion are difficult to tell apart. K^+ Rr^+
Give the flame test colours for the potassium ion and for the rubidium ion.

(2)

Potassium ion lilac.

Rubidium ion orange-red.

ResultsPlus
Examiner Comments

This was one of the more common incorrect colours given for rubidium. Almost any shade of red or purple was allowed for rubidium but not orange / brick red since this is the flame test colour for calcium.

ResultsPlus
Examiner Tip

Make sure you know your flame test colours.

Question 2(a)iii

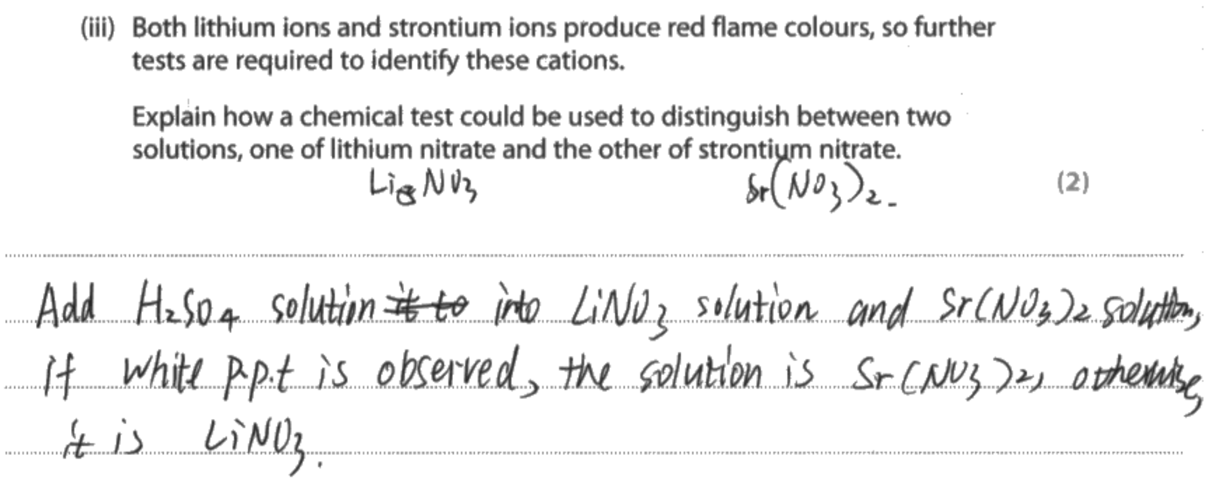
Most candidates found this question very challenging with only 21% scoring full marks.

The context was unusual; candidates had to draw on information and understanding from a number of sources to formulate a correct solution to the problem.

Only the more able candidates, who knew their solubility rules and could apply them, realised that this was just the test for sulfate ions in disguise.

This was a fully correct answer.

The candidate was clearly able to use the solubility rules and trends in solubility down Group 2 to work out that lithium sulfate is soluble and strontium sulfate is insoluble so would give a precipitate with sulfate ions.



(iii) Both lithium ions and strontium ions produce red flame colours, so further tests are required to identify these cations.

Explain how a chemical test could be used to distinguish between two solutions, one of lithium nitrate and the other of strontium nitrate.

$LiNO_3$ $Sr(NO_3)_2$ **(2)**

Add H_2SO_4 solution ~~it to~~ into $LiNO_3$ solution and $Sr(NO_3)_2$ solution, if white p.p.t is observed, the solution is $Sr(NO_3)_2$, otherwise it is $LiNO_3$.

ResultsPlus
Examiner Comments

In this case, the candidate chose sulfuric acid as a source of sulfate ions but any soluble sulfate, eg sodium sulfate, would also have worked.

ResultsPlus
Examiner Tip

Note that some candidates who clearly understood the chemistry involved still lost a mark by not stating that lithium sulfate gave no visible change / no ppt. If the question is about telling the difference between two compounds or species, make sure you write about both of them.

This is an example of a response where the candidate had the right idea relating to precipitates forming but chose the wrong reagent.

(iii) Both lithium ions and strontium ions produce red flame colours, so further tests are required to identify these cations.

Explain how a chemical test could be used to distinguish between two solutions, one of lithium nitrate and the other of strontium nitrate.

(2)

aqueous ~~sulfate~~ hydroxide

Sodium ~~hydroxide~~ ~~the~~ solution should be added to each solution. There will be no change in the solution of Lithium nitrate, and a pale white precipitate will form in the solution of strontium nitrate.

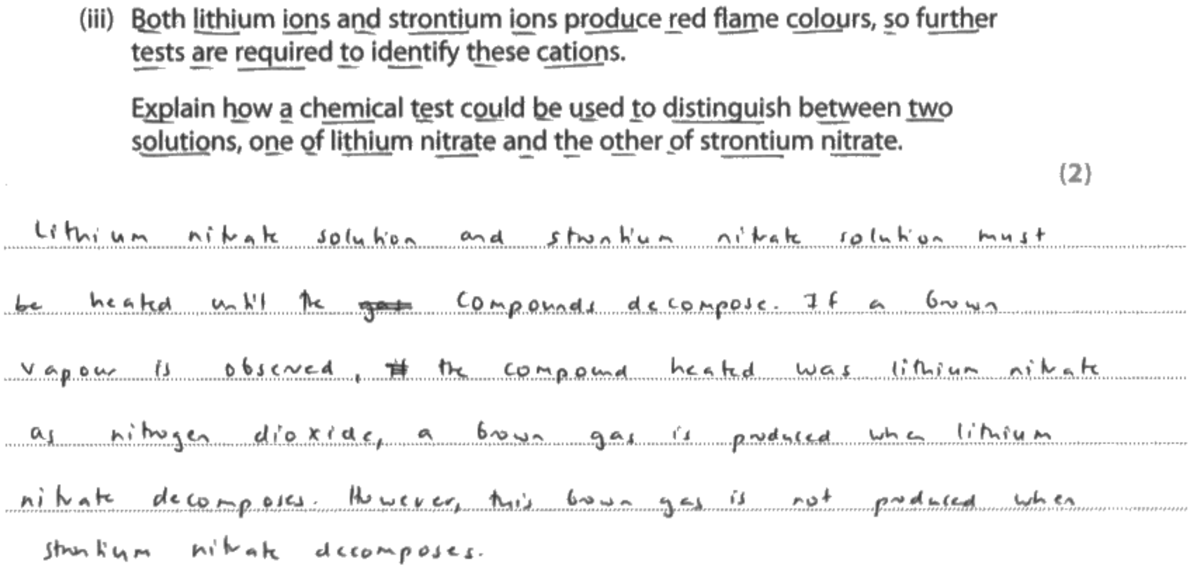
ResultsPlus
Examiner Comments

Both lithium and strontium hydroxides are soluble. Solubility of hydroxides increases as you go down Group 2 – this is the piece of understanding that this candidate was lacking here.

ResultsPlus
Examiner Tip

Make sure you know your solubility rules and can apply them. They can come up in lots of different contexts.

This was the most common incorrect answer given – significantly more common than the correct answer.



(iii) Both lithium ions and strontium ions produce red flame colours, so further tests are required to identify these cations.

Explain how a chemical test could be used to distinguish between two solutions, one of lithium nitrate and the other of strontium nitrate.

(2)

Lithium nitrate solution and strontium nitrate solution must be heated until the ~~gas~~ compounds decompose. If a brown vapour is observed, ~~#~~ the compound heated was lithium nitrate as nitrogen dioxide, a brown gas is produced when lithium nitrate decomposes. However, this brown gas is not produced when strontium nitrate decomposes.

ResultsPlus
Examiner Comments

It is commendable that a very large proportion of candidates know the trends in thermal decomposition of nitrates. Unfortunately, it does not work in this case because it was solutions of the ions being distinguished, not the solids.

ResultsPlus
Examiner Tip

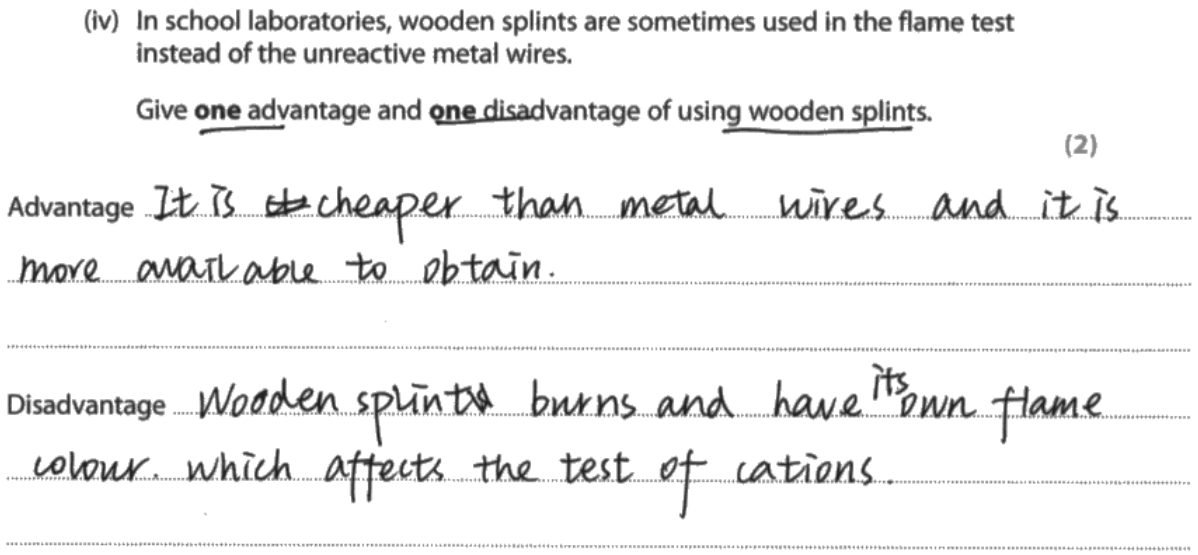
Make sure you read and understand the question correctly, taking note of key words (in this case solutions) so that you can apply the chemistry correctly.

Question 2(a)iv

This question proved more challenging than expected with only half of all candidates scoring both marks.

The most commonly lost mark was, once again, through lack of detail, mostly when describing the disadvantage.

A very good answer with correct and appropriate detail, scoring both marks with ease.



(iv) In school laboratories, wooden splints are sometimes used in the flame test instead of the unreactive metal wires.

Give **one** advantage and **one** disadvantage of using wooden splints.

(2)

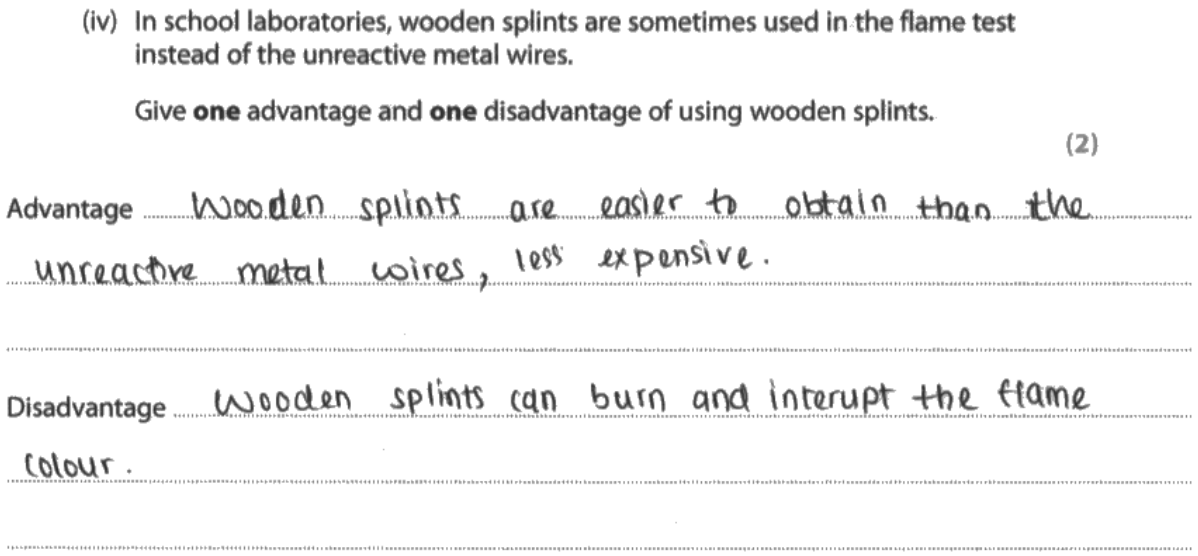
Advantage It is ~~ob~~ cheaper than metal wires and it is more available to obtain.

Disadvantage Wooden splint~~s~~ burns and have its own flame colour. which affects the test of cations.

ResultsPlus
Examiner Comments

Cheaper, more available and easy to obtain were the three most common answers for the advantage. To score the disadvantage mark, there had to be some form of justification as to why the burning splint would interfere with the flame test.

An answer with the right idea but again, lacking in detail.



(iv) In school laboratories, wooden splints are sometimes used in the flame test instead of the unreactive metal wires.

Give **one** advantage and **one** disadvantage of using wooden splints.

(2)

Advantage Wooden splints are easier to obtain than the unreactive metal wires, less expensive.

Disadvantage Wooden splints can burn and interupt the flame colour.

ResultsPlus
Examiner Comments

The advantage mark was scored but the disadvantage mark was not. "Wooden splints burn and interrupt the flame colour" is insufficient because it doesn’t say why or how it interrupts the flame colour. If they had said "Wooden splints burn with a yellow colour so it interrupts the flame colour", that would have been a much better explanation. Smoke from a splint interferes is a weaker but still acceptable justification.

ResultsPlus
Examiner Tip

Remember to add relevant detail in order to fully explain your answer.

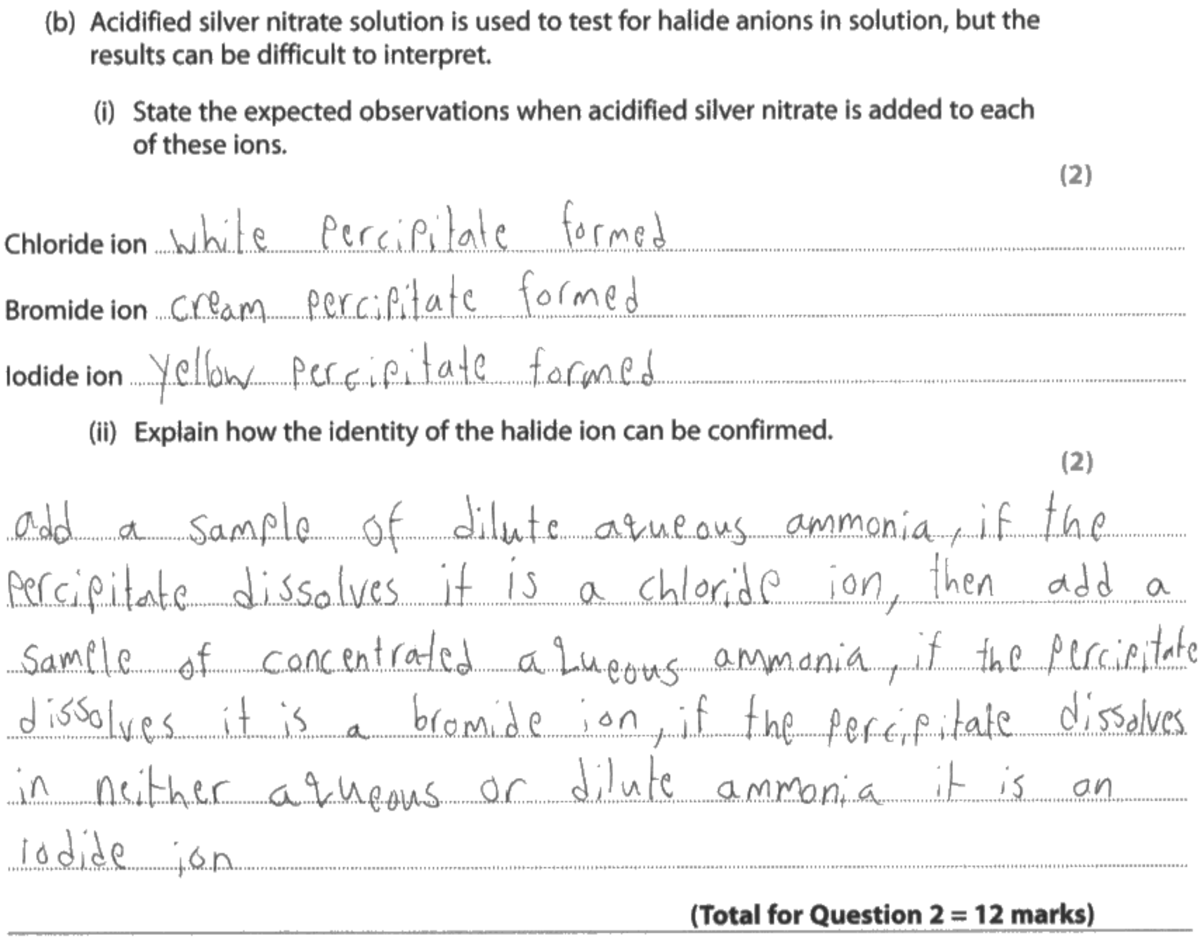
Question 2(b)

Hardly any candidates gave incorrect colours for the silver halide precipitates. A few cited bromide as giving a pale-yellow colour, which was not accepted, but this was rare.

77% of all candidates scored full marks here and most marks were lost on the confirmation test using ammonia.

A few marks were lost through incomplete explanations but more commonly through the use of an inappropriate reagent.

An answer, although not perfect, but was sufficient to score full marks.



(b) Acidified silver nitrate solution is used to test for halide anions in solution, but the results can be difficult to interpret.

(i) State the expected observations when acidified silver nitrate is added to each of these ions.

(2)

Chloride ion white percipitate formed

Bromide ion cream percipitate formed

Iodide ion yellow percipitate formed

(ii) Explain how the identity of the halide ion can be confirmed.

(2)

add a sample of dilute aqueous ammonia, if the percipitate dissolves it is a chloride ion, then add a sample of concentrated aqueous ammonia, if the percipitate dissolves it is a bromide ion, if the percipitate dissolves in neither aqueous or dilute ammonia it is an iodide ion

(Total for Question 2 = 12 marks)

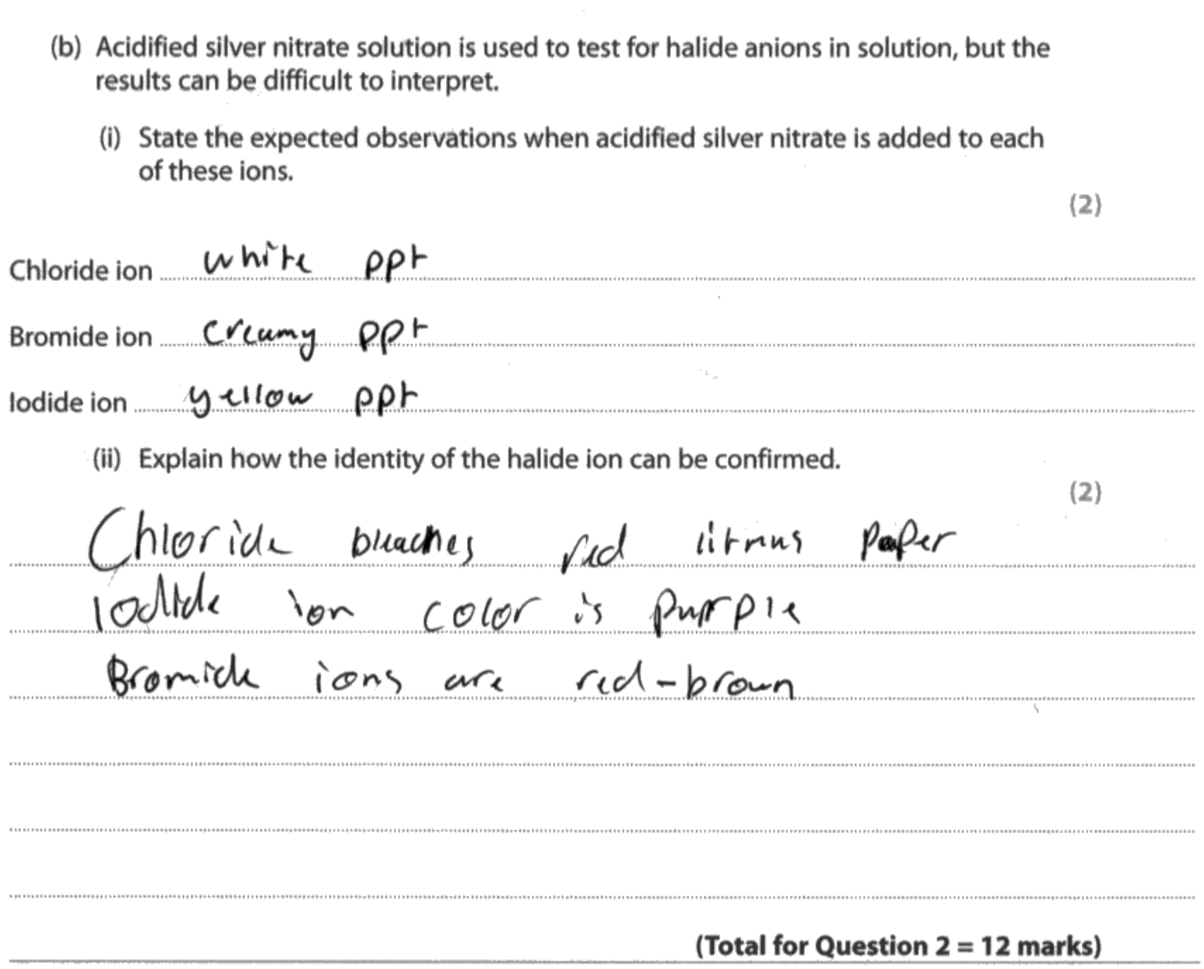
ResultsPlus
Examiner Comments

Part (i) for the colours of the precipitates was fully correct. Even though precipitates was spelled incorrectly but that was not penalised here. Use of ppt as an abbreviation is perfectly acceptable. The answer to part (ii) could have added that the chloride ppt is also soluble in concentrated ammonia for the purpose of clarity but the answer was sufficient to score both marks.

ResultsPlus
Examiner Tip

Make sure your answers have no gaps and fully explain the chemistry.

A correct answer for part (i) but very poor for part (ii).



(b) Acidified silver nitrate solution is used to test for halide anions in solution, but the results can be difficult to interpret.

(i) State the expected observations when acidified silver nitrate is added to each of these ions.

(2)

Chloride ion white ppt

Bromide ion Creamy ppt

Iodide ion yellow ppt

(ii) Explain how the identity of the halide ion can be confirmed.

(2)

Chloride bleaches red litmus Paper
iodide ion color is Purple
Bromide ions are red-brown

(Total for Question 2 = 12 marks)

ResultsPlus
Examiner Comments

This candidate clearly did not understand how to differentiate between the halides using ammonia and gave a completely inappropriate response that did not address the question.

ResultsPlus
Examiner Tip

Make sure you know and understand your chemical tests inside out as it is 100% certain that they will come up – most likely more than once in a question paper. 20% of the marks on this paper are related to chemical tests.

Question 3(a)

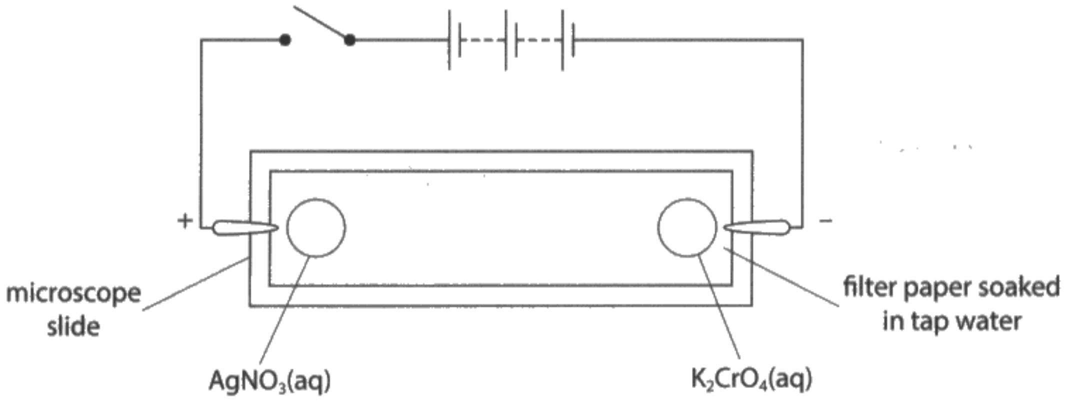
Candidates found this question quite challenging with just over 30% scoring all the available marks.

Only the strongest candidates were able to relate the observations in the experiment to the structure and bonding in the compounds concerned.

More candidates were able to construct an equation, however a good number of these were unbalanced.

This is a very good example where the candidate has linked observations to chemical structure and also given a correctly balanced equation.

3) An experiment was set up as shown.



Several drops of aqueous silver nitrate and aqueous potassium chromate(VI), both of concentration 1.0 mol dm^{-3}, were placed on the filter paper and the switch closed. After a short while, a red precipitate formed in the centre of the filter paper.

(a) Explain what the experiment tells us about the structure of silver nitrate and potassium chromate(VI), including an equation for the reaction which occurs. State symbols are not required.

(3)

The expirement suggests that Both silver nitrate and potassium chromate ~~are~~ have an ionic structure. Chromate ions are negatively charged and are attracted to the left side By current. Ag^+ ions are attracted to the right. They react in the middle

$$2Ag^+ + CrO_4^{2-} \rightarrow Ag_2CrO_4$$

ResultsPlus
Examiner Comments

To score full marks, candidates had to:

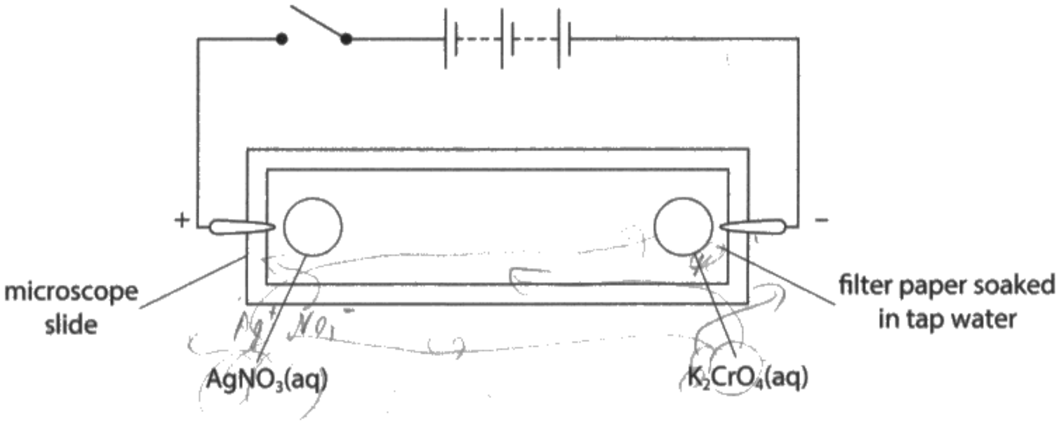
1. give a correctly balanced equation for the formation of the precipitate.
2. explain how the ions moved to meet in the middle.
3. link the observations to the ionic structure of silver nitrate and potassium chromate(VI). This candidate did all three very succinctly.

ResultsPlus
Examiner Tip

Don't add more than is necessary, make your answers short and to the point. Adding unnecessary detail only serves to cloud you answer and sometimes contradicts what you have previously written. For this type of question, try answering in bullet points.

Despite the scruffy writing and crossings out, this is a relatively good answer that comes very close to scoring all three marks.

3; An experiment was set up as shown.



Several drops of aqueous silver nitrate and aqueous potassium chromate(VI), both of concentration 1.0 mol dm^{-3}, were placed on the filter paper and the switch closed. After a short while, a red precipitate formed in the centre of the filter paper.

(a) Explain what the experiment tells us about the structure of silver nitrate and potassium chromate(VI), including an equation for the reaction which occurs. State symbols are not required.

(3)

~~$2AgNO_3 + K_2CrO_4 \rightarrow Ag_2CrO_4 + 2KNO_3$~~

$2Ag^+_{(aq)} + CrO^{-2}_{4(aq)} \rightarrow Ag_2CrO_{4(s)}$

- ~~Here, silver nitrate moves towards the~~
- Here, Ag^+ ions move ~~towards the~~ right (allong with K^+ ions) due to then having a posiitive charge.
- (NO_3^- ~~&~~) CrO_4^{-2} ions move to left due to then having a negative charge.
- The silver ions and Chromate (VI) ions intercept each other at the center, forming the insoluable red ppt. at the center. (when travelling from one end to another)
- Hence suggesting ~~the Ag~~ ~~sit~~ that $AgNO_3$ has ions Ag^+ & NO_3^- & K_2CrO_4 having $2K^-$ & CrO_4^{-2} ions.

ResultsPlus
Examiner Comments

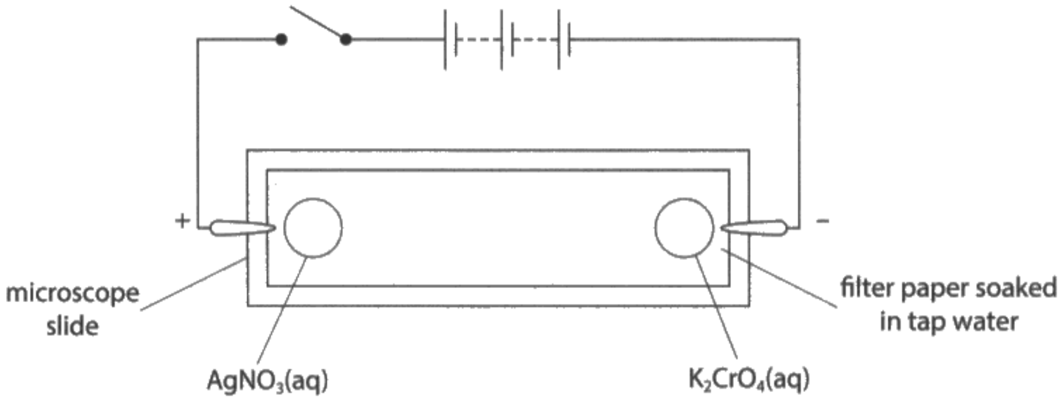
There is a correctly balanced equation at the top for the first mark. The second mark is also scored for the correct movement of the ions. Mark three is missing because it is not sufficient just to talk about ions, this has to be related to the structure so the word ionic is needed.

ResultsPlus
Examiner Tip

Make sure you read and understand the question fully and take note of key words in it. They are there for a reason, to guide you towards a fuller explanation.

On the face of it, this looks like a good answer but it only scores 1 mark.

3: An experiment was set up as shown.



Several drops of aqueous silver nitrate and aqueous potassium chromate(VI), both of concentration 1.0 mol dm^{-3}, were placed on the filter paper and the switch closed. After a short while, a red precipitate formed in the centre of the filter paper.

(a) Explain what the experiment tells us about the structure of silver nitrate and potassium chromate(VI), including an equation for the reaction which occurs. State symbols are not required.

(3)

$AgNO_3 + K_2CrO_4 \rightarrow Ag_2CrO_4 + KNO_3$.

This experiment tells us that $AgNO_3$ and K_2CrO_4 are ionic compounds, ~~Fern~~ and that they can split up into ions and travel along the filter paper when a ~~potential d~~ potential difference is applied. And the red precipitate formed ~~is~~ Ag_2CrO_4, which shows that $AgNO_3$ and K_2CrO_4 can split up into ions and react.

ResultsPlus
Examiner Comments

The first mark is lost because the equation does not balance in terms of silver and potassium ions. The candidates scores the second mark for the ions moving but, although there is a relatively strong implication that the compounds are ionic, it is not stated explicitly. We needed to see the word ionic to score.

ResultsPlus
Examiner Tip

Make sure that any equations you write are balanced in terms of atoms and charges. There is one thing for certain in a chemistry exam and that is that unbalanced equations do not score any marks.

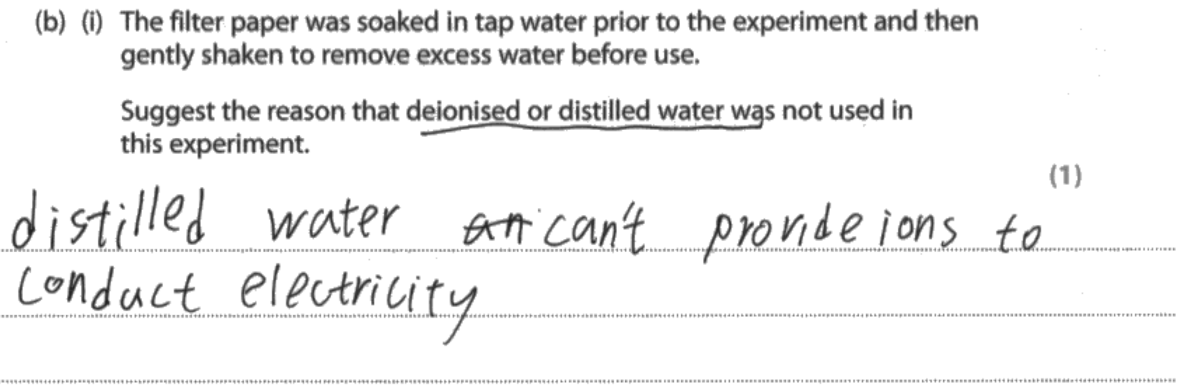
Question 3(b)i

This should have been a relatively easy question for candidates to access but proved more challenging than expected, probably due to the unfamiliar context of the whole experiment.

All that was required was the understanding that the filter paper needed to conduct electricity and that tap water contains the ions necessary for it to do that.

Only 42% of candidates scored.

A fully correct answer linking the presence of ions to electrical conductivity.



(b) (i) The filter paper was soaked in tap water prior to the experiment and then gently shaken to remove excess water before use.

Suggest the reason that deionised or distilled water was not used in this experiment.

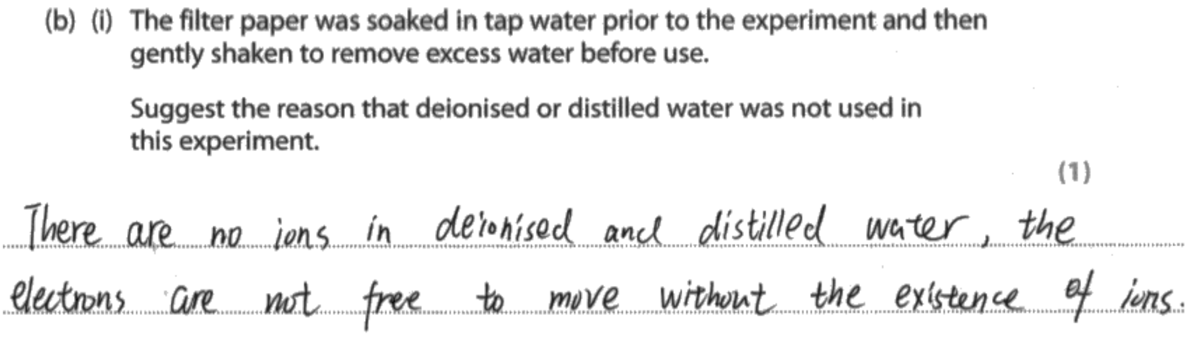
(1)

distilled water ~~an~~ can't provide ions to conduct electricity

ResultsPlus
Examiner Comments

The answer was given from the reverse point of view but explains the need for ions to be present.

A seemingly good response but not thought through.



(b) (i) The filter paper was soaked in tap water prior to the experiment and then gently shaken to remove excess water before use.

Suggest the reason that deionised or distilled water was not used in this experiment.

(1)

There are no ions in deionised and distilled water, the electrons are not free to move without the existence of ions.

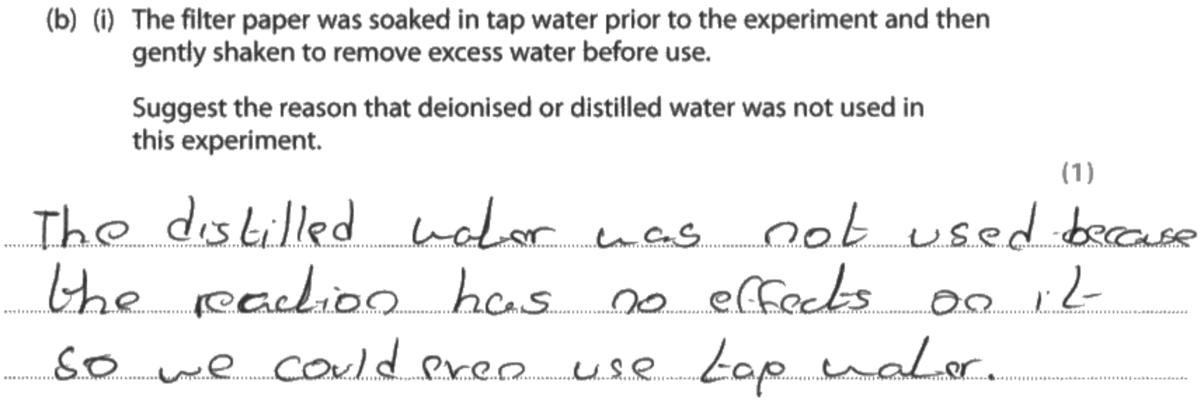
ResultsPlus
Examiner Comments

The candidate scores the mark perfectly succinctly but then negates it by talking about the movement of electrons.

ResultsPlus
Examiner Tip

Remember that when solutions conduct electricity, it is due to the movement of ions, and when metals (or graphite) conduct electricity it is due to the movement of electrons. It can never be both in the same place.

A poor answer that does not attempt to link conduction with the presence (or absence) of ions.



(b) (i) The filter paper was soaked in tap water prior to the experiment and then gently shaken to remove excess water before use.

Suggest the reason that deionised or distilled water was not used in this experiment.

(1)

The distilled water was not used because the reaction has no effects on it so we could even use tap water.

ResultsPlus
Examiner Comments

The candidate did not consider the context of this question, the fact that it is part of an experiment that requires the movement of ions.

ResultsPlus
Examiner Tip

Make sure that any answers you give address the question, thinking about the context of the whole experiment.

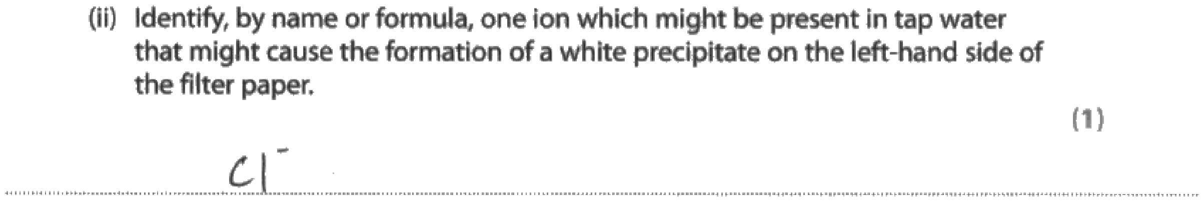
Question 3(b)ii

This question proved less challenging than the previous one but once again, it scored lower than expected.

Candidates simply had to identify an ion present in tap water but 39% failed to do this, with the most popular wrong answer being hydroxide ions.

Surprisingly, some candidates suggested species that were not even ions.

The most common, and most expected correct answer.



(ii) Identify, by name or formula, one ion which might be present in tap water that might cause the formation of a white precipitate on the left-hand side of the filter paper.

(1)

Cl^-

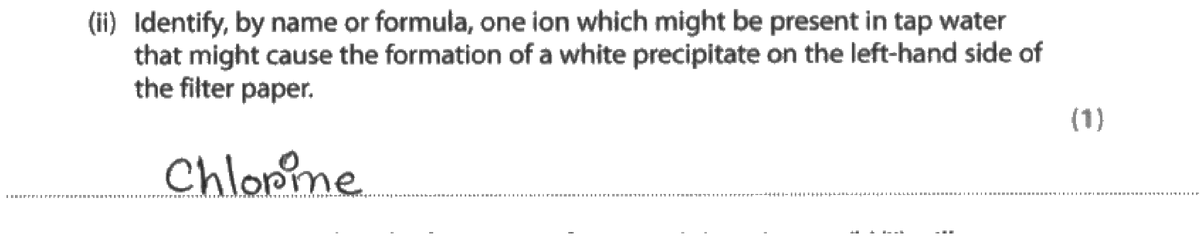
ResultsPlus
Examiner Comments

The candidate has a good understanding that chloride ions are present in tap water.

ResultsPlus
Examiner Tip

Knowledge of the common ions found in water is an essential part of this specification.

An example of an incorrect response that is not an ion.



(ii) Identify, by name or formula, one ion which might be present in tap water that might cause the formation of a white precipitate on the left-hand side of the filter paper.

(1)

Chlorine

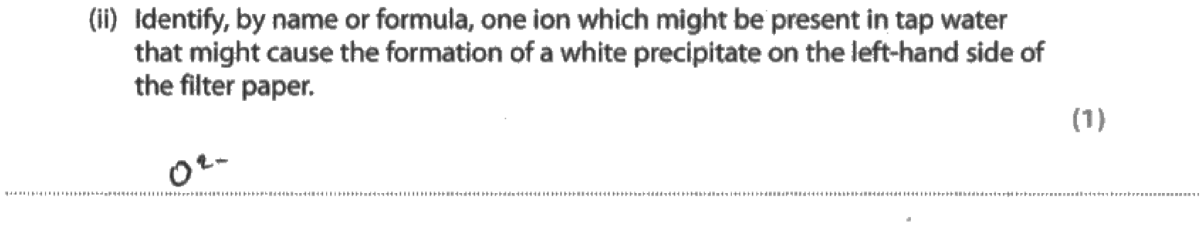
ResultsPlus
Examiner Comments

The candidate clearly understands that chlorine is present in water but did not read the question properly, in particular, the key word ion.

ResultsPlus
Examiner Tip

Make sure you read the question properly, taking note of important key words.

An example with an incorrect, and impossible ion.



(ii) Identify, by name or formula, one ion which might be present in tap water that might cause the formation of a white precipitate on the left-hand side of the filter paper.

(1)

O^{2-}

ResultsPlus
Examiner Comments

This candidate picked up on the fact they needed to give an ion in their answer but the choice of ion implies some misunderstanding of chemistry. Oxide ions do not exist in aqueous solution as there are no soluble ionic oxides. Any ionic oxides that interact with water do so by a hydrolysis reaction, creating hydroxide ions.

ResultsPlus
Examiner Tip

Expect to have to think about other areas of the specification that may be relevant rather than just the close confines of the question before writing down an answer that is impossible.

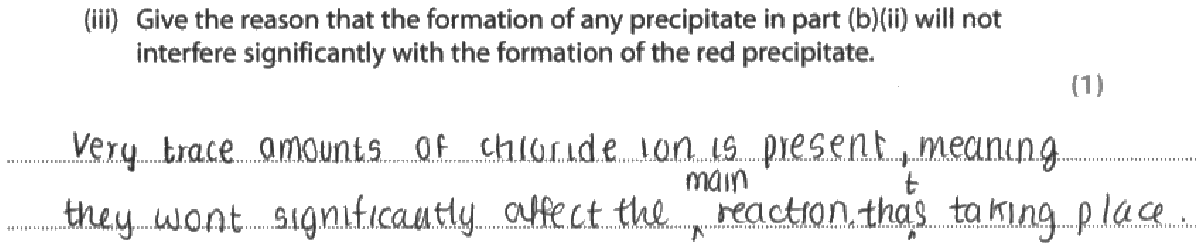
Question 3(b)iii

Perhaps because of the wider context of the whole question, most candidates found this question very challenging with only the top 27% scoring.

Many candidates did not seem to understand what the question was really asking and the range of incorrect responses was very broad.

The expected response was that the concentration of ions in tap water is very low and / or that very little precipitate would be made as a result.

This is one of the better responses that clearly explained the reason.



(iii) Give the reason that the formation of any precipitate in part (b)(ii) will not interfere significantly with the formation of the red precipitate.

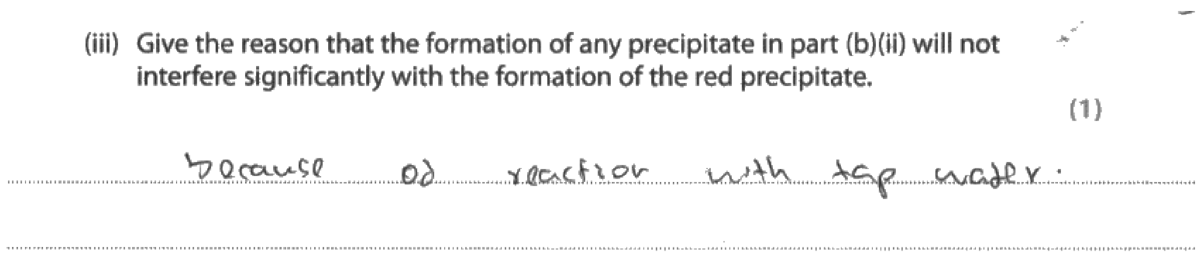
(1)

Very trace amounts of chloride ion is present, meaning they wont significantly affect the main reaction thats taking place.

ResultsPlus
Examiner Comments

The candidate clearly understood the link between the concentration of ions in tap water and the potential effect on the experiment.

This is typical of a poorer response that does not address the question.



(iii) Give the reason that the formation of any precipitate in part (b)(ii) will not interfere significantly with the formation of the red precipitate.

(1)

because of reaction with tap water.

ResultsPlus
Examiner Comments

This candidate clearly understood that it was something to do with tap water but the answer does not contain any detail as to how and is far too general.

ResultsPlus
Examiner Tip

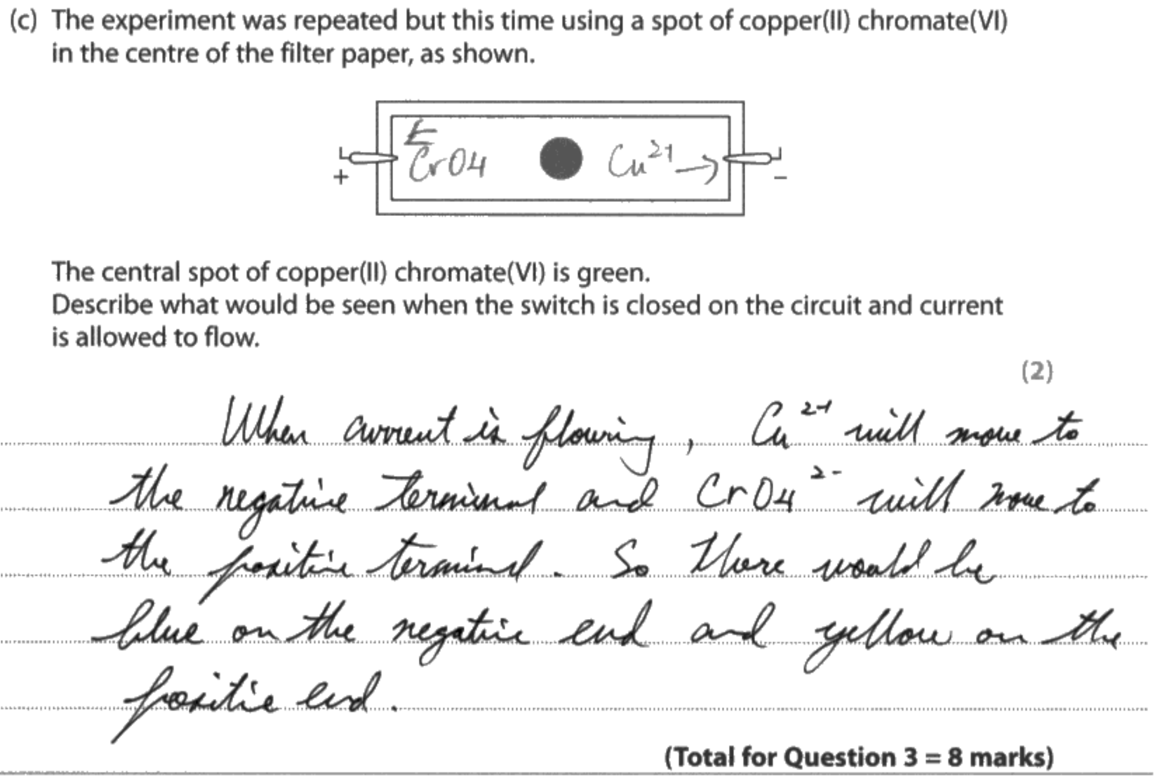
Make sure your answers address specific points in the question rather than writing very general remarks.

Question 3(c)

Candidates found this a little easier than the previous question but still quite difficult with only 42% scoring both marks.

Many appeared to understand the underlying chemistry but did not pick up on the key phrase "what would be seen" in the question so often good chemistry was seen but marks were lost because candidates did not relate the chemistry to the observations.

This is an example of an excellent response that links the chemistry with the expected observations.



(c) The experiment was repeated but this time using a spot of copper(II) chromate(VI) in the centre of the filter paper, as shown.

The central spot of copper(II) chromate(VI) is green.
Describe what would be seen when the switch is closed on the circuit and current is allowed to flow.

(2)

When current is flowing, Cu^{2+} will move to the negative terminal and CrO_4^{2-} will move to the positive terminal. So there would be blue on the negative end and yellow on the positive end.

(Total for Question 3 = 8 marks)

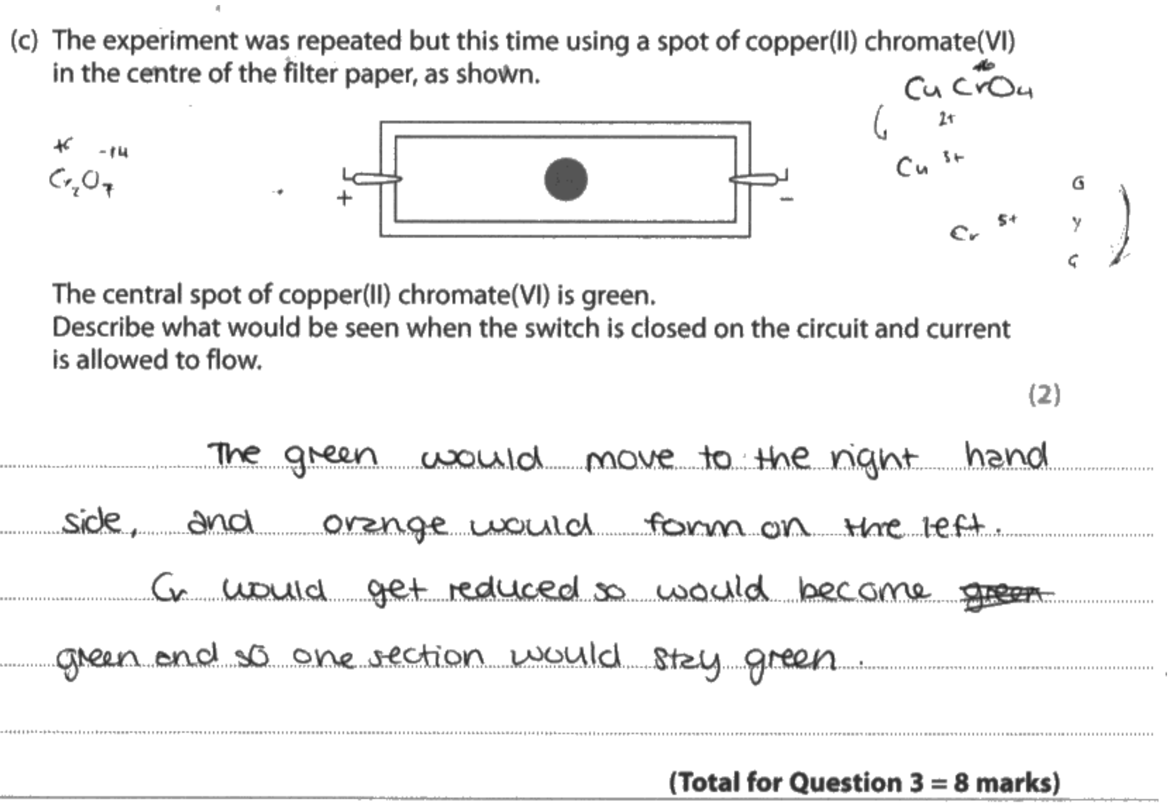
ResultsPlus
Examiner Comments

The candidate has even annotated the diagram to show movement of the ions. If they had added the correct colour to the diagram as well, it would have scored both marks without any of the writing below.

ResultsPlus
Examiner Tip

Think about alternative ways of answering questions. Often, a well annotated diagram can score marks more easily than prolonged prose. They can also demonstrate your understanding to the examiner in a clearer way.

An example of a confused answer.



(c) The experiment was repeated but this time using a spot of copper(II) chromate(VI) in the centre of the filter paper, as shown.

$CuCrO_4$

Cu^{2+}

Cu^{3+}

Cr^{5+}

Cr_2O_7

The central spot of copper(II) chromate(VI) is green.
Describe what would be seen when the switch is closed on the circuit and current is allowed to flow.

(2)

The green would move to the right hand side, and orange would form on the left.
Cr would get reduced so would become ~~green~~ green and so one section would stay green.

(Total for Question 3 = 8 marks)

ResultsPlus
Examiner Comments

This candidate has picked up on the "seen" key word in the question and understands they need to give observations but the answer indicates some misunderstanding and confusion of the chemistry involved. Firstly, they seem to think that the whole green spot moves as one entity without splitting into ions. Next, they have stated that "orange moves to the left", but orange is the colour of the dichromate(VI) ion, not the chromate(VI) ion. If they had stated "yellow moves to the left", they would have scored a mark despite the apparent confusion. They have also recognised that green is the colour of the chromium(III) ion when it is reduced from chromate(VI) but that is not applicable here as there is no redox happening.

ResultsPlus
Examiner Tip

Make sure you understand the context of the question, try to work out what is happening in the experiment and make your answers relevant to that process.

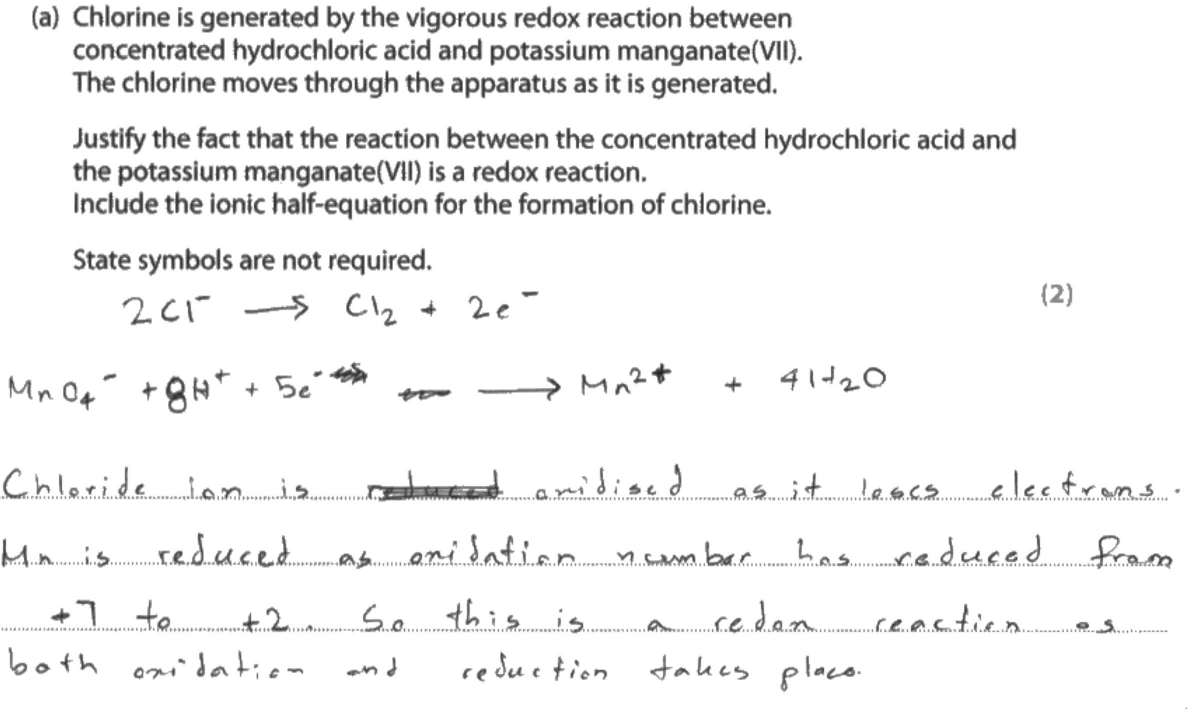
Question 4(a)

The whole of question 4, with the exception of Q04(e)(i) proved very challenging for the majority of candidates. Although the chemistry itself ought to be familiar, most candidates will not have seen this complex apparatus before which took the application of knowledge and understanding to a different level.

The first part, Q04(a), is a question that has been repeated in many previous series, but this time an equation for the reaction was not given. Instead, candidates had to give their own equation for the oxidation of chloride ions to chlorine and state why the reaction was redox in terms of either electron transfer of change in oxidation number.

Despite the mark scheme being fairly generous in that specific oxidation numbers or number of electrons transferred was not required, only 29% of candidates scored both marks.

This is a very good example of a full and comprehensive answer that scores both marks.



(a) **Chlorine is generated by the vigorous redox reaction between concentrated hydrochloric acid and potassium manganate(VII). The chlorine moves through the apparatus as it is generated.**

Justify the fact that the reaction between the concentrated hydrochloric acid and the potassium manganate(VII) is a redox reaction. Include the ionic half-equation for the formation of chlorine.

State symbols are not required.

(2)

$2Cl^- \longrightarrow Cl_2 + 2e^-$

$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$

Chloride ion is ~~reduced~~ oxidised as it loses electrons. Mn is reduced as oxidation number has reduced from +7 to +2. So this is a redox reaction as both oxidation and reduction takes place.

ResultsPlus
Examiner Comments

This candidate clearly understands the chemistry involved, has given a correct equation for the oxidation of chloride ion and has also given a correct equation for the reduction of manganate(VII) ions, which was not required. The second mark is scored by saying that chloride ions lose electrons so are oxidised and that the manganese changes oxidation state from +7 to +2 so is reduced.

ResultsPlus
Examiner Tip

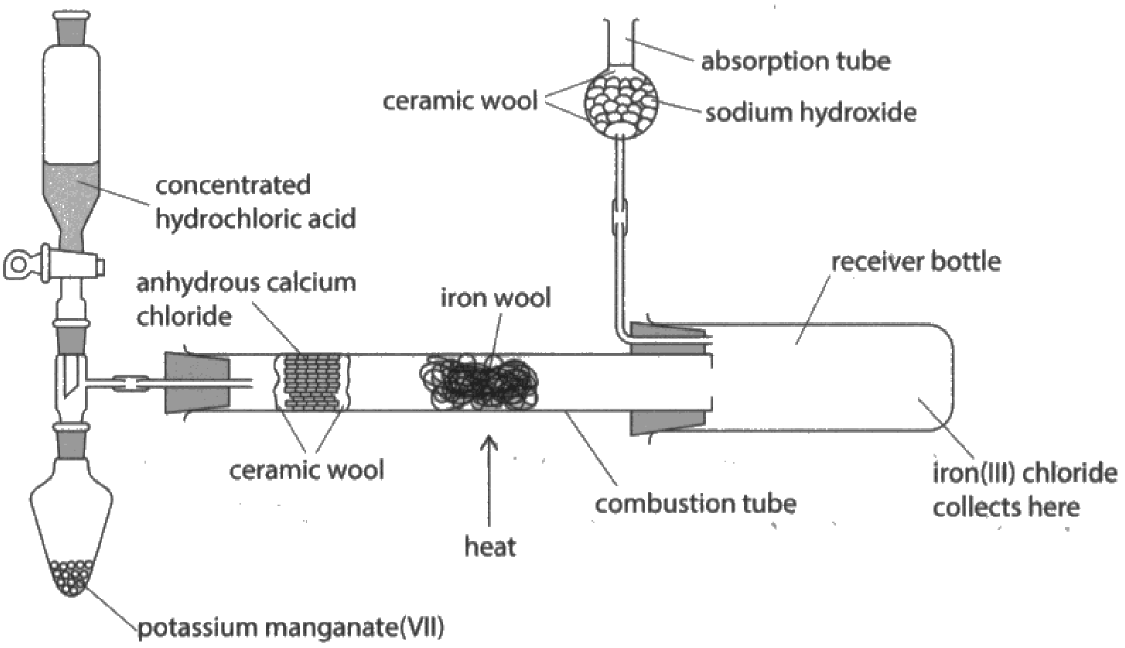
This type of question is very common and marks are mostly lost because change in oxidation number is not linked to oxidation and reduction.

This is quite a good response that almost scores both marks.

4. Anhydrous iron(III) chloride can be synthesised by the direct reaction of iron metal with chlorine. It reacts vigorously with water to produce hydrates.
The apparatus shown can be used for this synthesis.
The equation for the formation of iron(III) chloride is

$$2Fe(s) + 3Cl_2(g) \rightarrow 2FeCl_3(s)$$

The iron(III) chloride that is formed sublimes and is collected in the receiver bottle.
The product is rapidly transferred to a weighing bottle, then sealed with a lid.



(a) Chlorine is generated by the vigorous redox reaction between concentrated hydrochloric acid and potassium manganate(VII).
The chlorine moves through the apparatus as it is generated.

Justify the fact that the reaction between the concentrated hydrochloric acid and the potassium manganate(VII) is a redox reaction.
Include the ionic half-equation for the formation of chlorine.

State symbols are not required.

(2)

$2Cl^- \cancel{+} \rightarrow Cl_2 + 2e^-$

Chlorine oxidises from -1 to 0 and form Cl_2. Hydrogen is reduced. So, this is a redox reaction

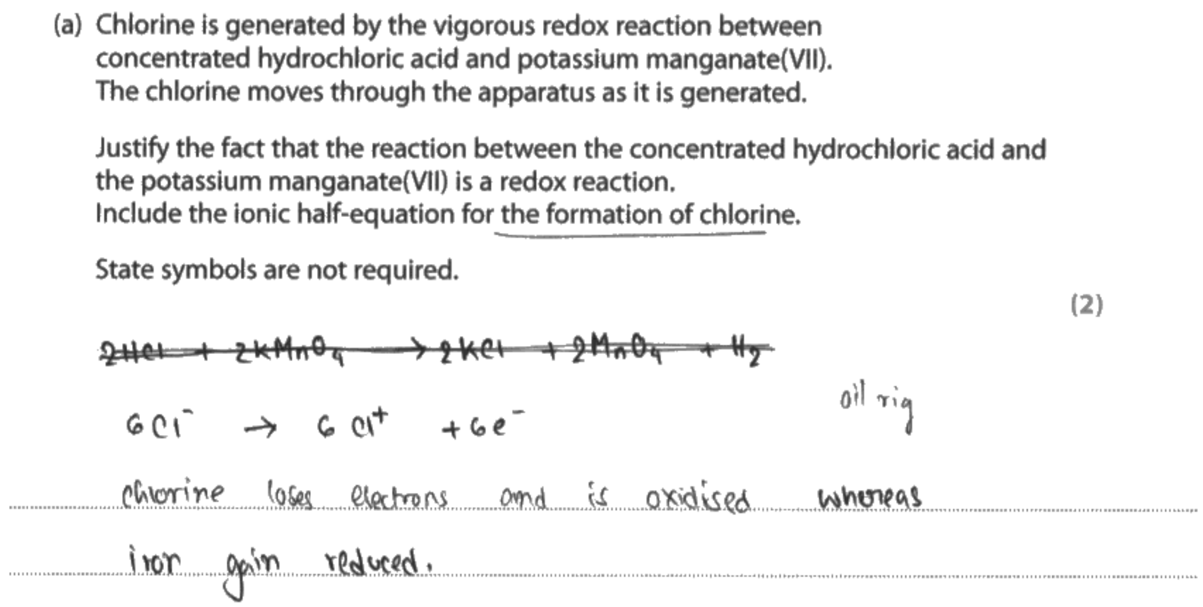
ResultsPlus
Examiner Comments

The equation for the oxidation of chloride ions is correct so the first mark is scored. Then there is a correct statement that the oxidation number of chlorine changes from -1 to 0 linked to oxidation. Unfortunately, the candidate then chooses the wrong element that is reduced: hydrogen does not change oxidation number in this process, it is +1 throughout.

ResultsPlus
Examiner Tip

Make sure you double check the oxidation numbers of each element, that they have actually changed before committing pen to paper.

A poor example.



(a) Chlorine is generated by the vigorous redox reaction between concentrated hydrochloric acid and potassium manganate(VII). The chlorine moves through the apparatus as it is generated.

Justify the fact that the reaction between the concentrated hydrochloric acid and the potassium manganate(VII) is a redox reaction.
Include the ionic half-equation for the formation of chlorine.

State symbols are not required.

(2)

~~$2HCl + 2KMnO_4 \rightarrow 2KCl + 2MnO_4 + H_2$~~

$6Cl^- \rightarrow 6\ Cl^+ + 6e^-$ oil rig

chlorine loses electrons and is oxidised whereas iron gain reduced.

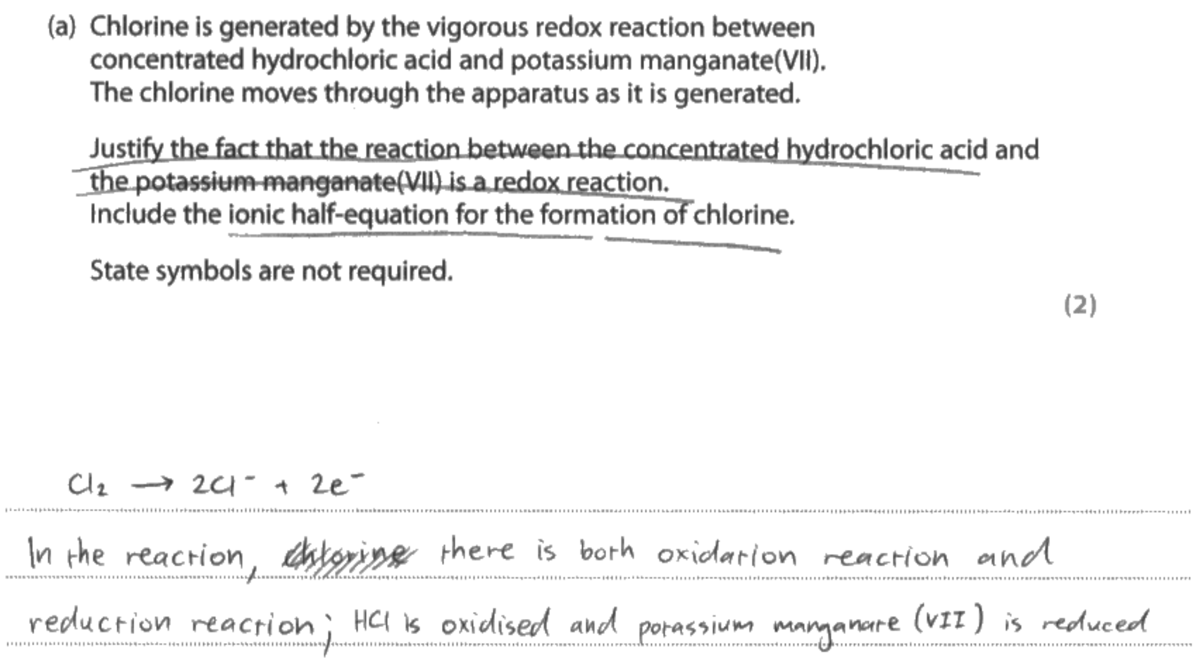
ResultsPlus
Examiner Comments

"Chlorine loses electrons and is oxidised" is the first half of the first mark but this candidate appears confused about which reaction to talk about. They appear to be talking about the reaction in the combustion tube between chlorine and iron rather than the one in the pear-shaped flask, which the question directs them to. The equation is totally wrong, containing the wrong species and it does not balance.

ResultsPlus
Examiner Tip

Make sure you read the question carefully so that you understand which reaction to discuss in your answer, make sure any equations you give are about the right species and that they balance.

An example of a response that contains some relevant chemistry but fails to score.



(a) Chlorine is generated by the vigorous redox reaction between concentrated hydrochloric acid and potassium manganate(VII). The chlorine moves through the apparatus as it is generated.

Justify the fact that the reaction between the concentrated hydrochloric acid and the potassium manganate(VII) is a redox reaction.
Include the ionic half-equation for the formation of chlorine.

State symbols are not required.

(2)

$Cl_2 \rightarrow 2Cl^- + 2e^-$

In the reaction, ~~chlorine~~ there is both oxidation reaction and reduction reaction; HCl is oxidised and potassium manganate (VII) is reduced

ResultsPlus
Examiner Comments

The equation for chlorine is incorrect for two reasons: it has chlorine being converted into chloride ions so the wrong way round; and the electrons are on the wrong side for the given equation, meaning the equation is not balanced for charges. Then there is a general statement about oxidation and reduction but this is incorrectly inked to compounds rather than elements within compounds.

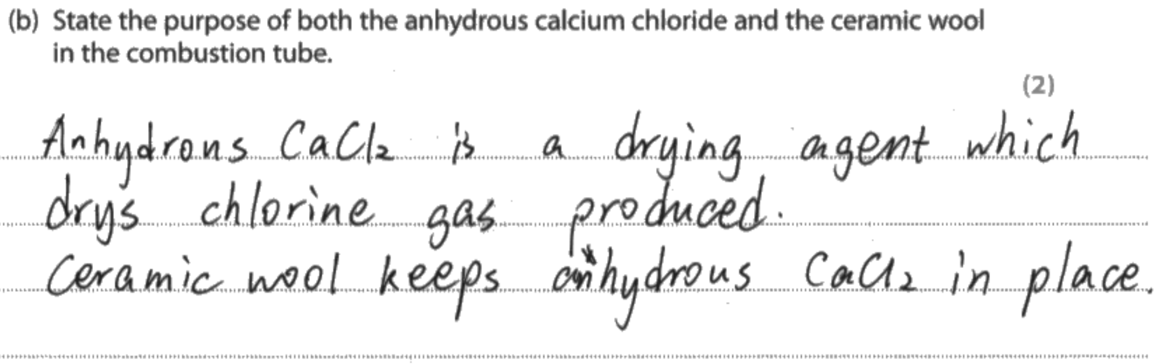
ResultsPlus
Examiner Tip

Make sure that any equations you give are balanced for charges as well as atoms. Make sure you understand that in a redox reaction, it is an element within a compound that gets oxidised or reduced, not the whole compound. There are three elements in potassium manganate(VII) – KMnO4 – and a statement that says it is reduced does not tell us what happens to each of the elements. In this case it is only the manganese that is reduced, the oxidation numbers for potassium and oxygen do not change.

Question 4(b)

Most candidates were familiar with the use of anhydrous calcium chloride as a drying agent and most got the mark for this, but some candidates lost it because they did not grasp the subtle difference between a drying agent and a dehydrating agent. Very few candidates correctly deduced the role of the ceramic wool which was simply to keep the calcium chloride and / or sodium hydroxide in place.

A fully correct response.



(b) State the purpose of both the anhydrous calcium chloride and the ceramic wool in the combustion tube.

(2)

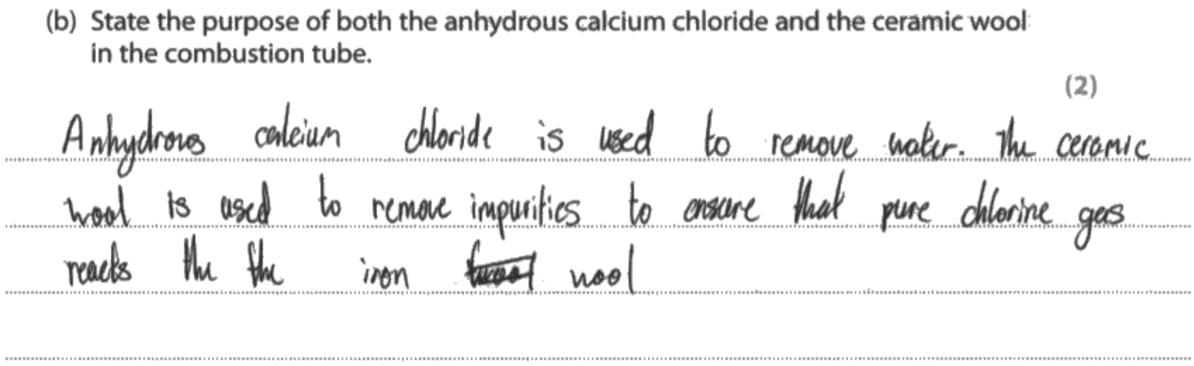
Anhydrons $CaCl_2$ is a drying agent which drys chlorine gas produced.

Ceramic wool keeps anhydrous $CaCl_2$ in place.

ResultsPlus
Examiner Comments

An example of a well thought through and well-structured answer.

A partly correct answer.



(b) State the purpose of both the anhydrous calcium chloride and the ceramic wool in the combustion tube.

(2)

Anhydrous calcium chloride is used to remove water. the ceramic wool is used to remove impurities to ensure that pure chlorine gas reaches the the iron ~~[illegible]~~ wool

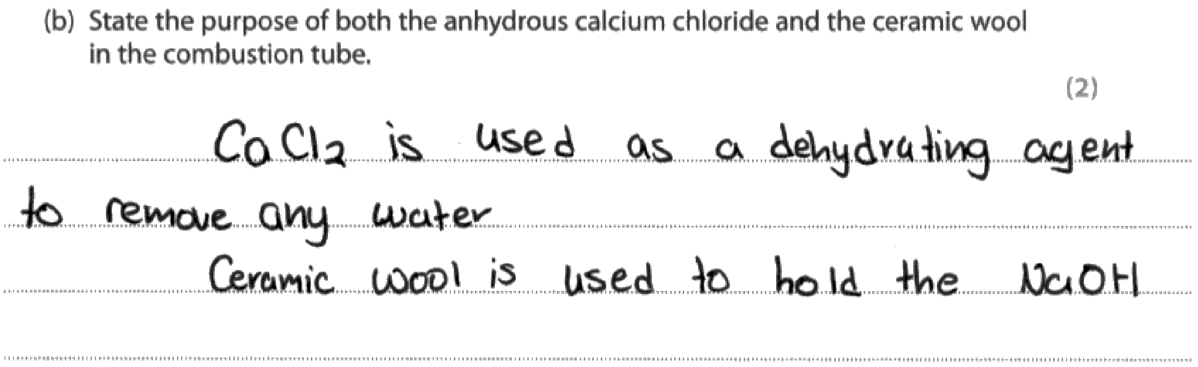
ResultsPlus
Examiner Comments

Correct use of calcium chloride but not ceramic wool. Ceramic wool is inert and would therefore not have the ability to remove impurities.

ResultsPlus
Examiner Tip

Don’t write general comments such as remove impurities. Firstly, there are no impurities present – the reaction just generates chlorine and if there were, ceramic wool would not be a good choice.

Another partially correct answer.



(b) State the purpose of both the anhydrous calcium chloride and the ceramic wool in the combustion tube.

(2)

$CaCl_2$ is used as a dehydrating agent to remove any water

Ceramic wool is used to hold the NaOH

ResultsPlus
Examiner Comments

Holds the sodium hydroxide in place is an alternative correct response for the second mark. The first mark is not scored as the chlorine is dried, not dehydrated.

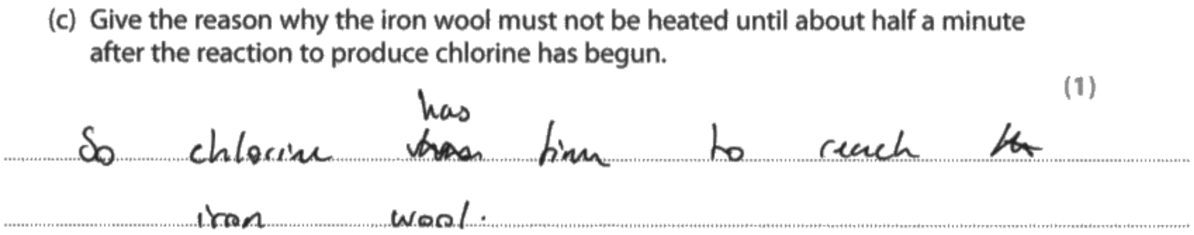
ResultsPlus
Examiner Tip

Make sure you understand the difference between a dehydrating agent and a drying agent. Drying is a physical process for removing water whereas dehydration involves a chemical reaction to remove water.

Question 4(c)

This question required candidates to appreciate that it takes time for the chlorine to reach and fill the combustion tube. Only 48% of candidates correctly deduced this.

This is one way of scoring the mark.



(c) Give the reason why the iron wool must not be heated until about half a minute after the reaction to produce chlorine has begun.

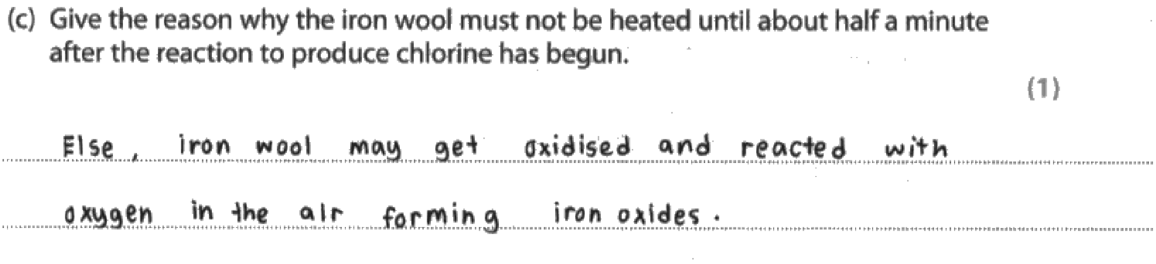
(1)

So chlorine has time to reach the iron wool.

ResultsPlus
Examiner Comments

This scores from the point of view of a time lag for chlorine to reach the iron wool.

This is the alternative way of scoring the mark.



(c) Give the reason why the iron wool must not be heated until about half a minute after the reaction to produce chlorine has begun.

(1)

Else, iron wool may get oxidised and reacted with oxygen in the air forming iron oxides.

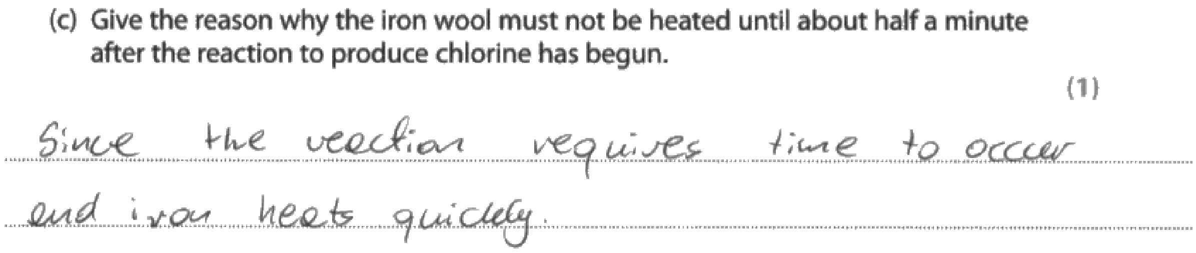
ResultsPlus
Examiner Comments

This candidate shows an appreciation that if heating starts before the chlorine has reached the iron wool, that it will react with the oxygen present in the tube.

ResultsPlus
Examiner Tip

Have an appreciation that there is often more than one way to demonstrate your understanding of a chemical process or practical procedure to an examiner.

A much weaker answer that does not score.



(c) Give the reason why the iron wool must not be heated until about half a minute after the reaction to produce chlorine has begun.

(1)

Since the reaction requires time to occur and iron heats quickly.

ResultsPlus
Examiner Comments

This candidate seems to have an appreciation of a time delay but the answer is too loose and lacks any detail as to the effect of a time delay.

ResultsPlus
Examiner Tip

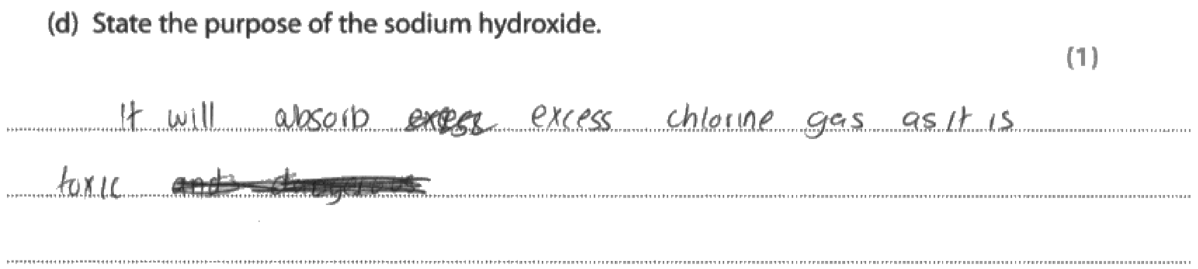
Think about what reactions may or may not be happening and add the necessary detail that directly addresses the question.

Question 4(d)

To answer this question, candidates needed to think through the whole process and think through what chemicals may have gone right through the apparatus.

The substance can only be a gas and the question tells them that the iron(III) chloride formed is collected in the receiver bottle, which leaves chlorine as the only choice. The top 38% of candidates made a correct deduction with the rest giving a wide range of impossible answers.

A fully correct answer.



(d) State the purpose of the sodium hydroxide.

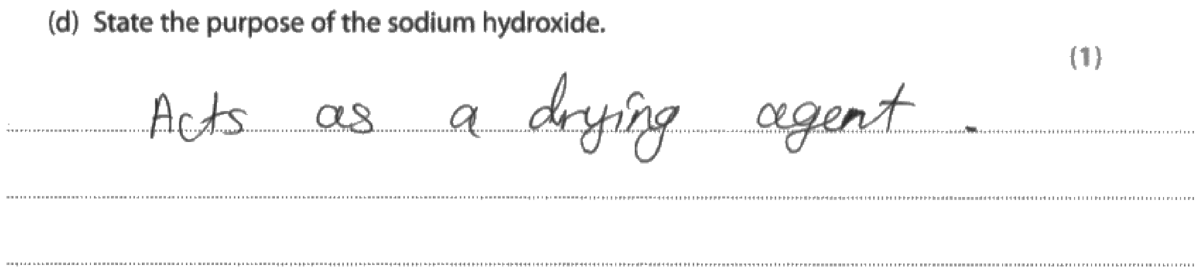
(1)

It will absorb ~~excess~~ excess chlorine gas as it is toxic ~~and dangerous~~

ResultsPlus
Examiner Comments

This candidate clearly thought through the process and deduced that the only possible substance that could get through was chlorine. They have also justified their answer by saying it is toxic.

An incorrect response that wasn't thought through.



(d) State the purpose of the sodium hydroxide.

(1)

Acts as a drying agent.

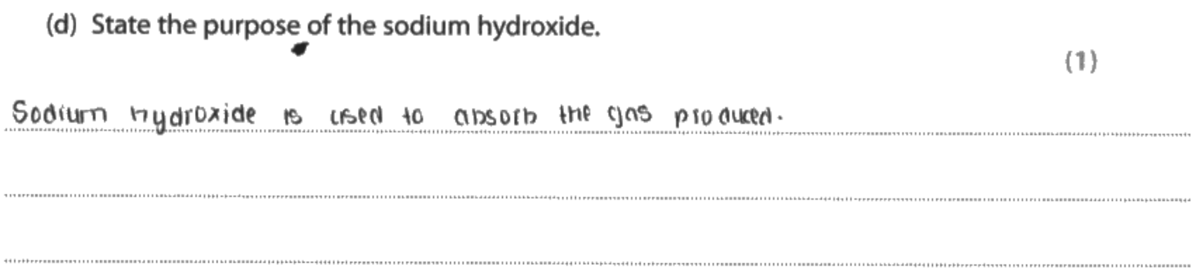
ResultsPlus
Examiner Comments

Sodium hydroxide will absorb a certain amount of water but this candidate has not thought their answer through. Firstly, there is little or no water present as this was removed by the anhydrous calcium chloride. Secondly, it would not matter if a little water vapour escaped into the atmosphere as it is harmless.

ResultsPlus
Examiner Tip

Try to think about a process such as this as a whole, what substances will be present at the different positions along the pathway, what are the physical states of the substance in those places and what might you not want escaping into the atmosphere.

An answer that was thought through but lacks detail.



(d) State the purpose of the sodium hydroxide.

(1)

Sodium hydroxide is used to absorb the gas produced.

ResultsPlus
Examiner Comments

This candidate has clearly appreciated that a gas needs to be absorbed but has not said that the gas is chlorine.

ResultsPlus
Examiner Tip

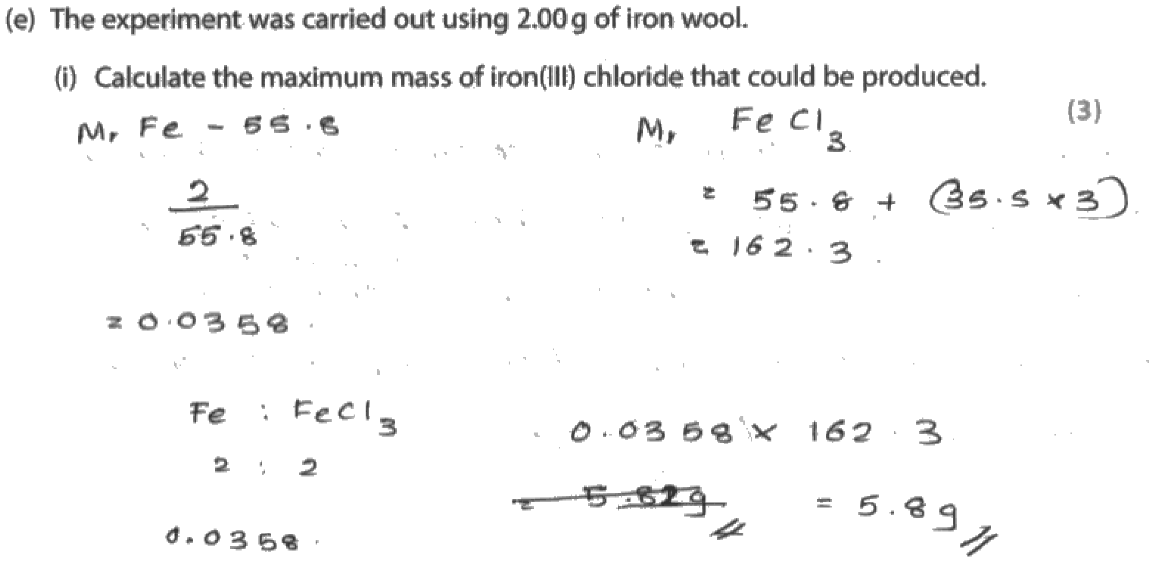
Don’t write nonspecific statements such as "to absorb a gas". The examiner will inevitably need to know what the gas is. If in doubt, it is better to make an educated guess yourself than to leave the examiner guessing.

Question 4(e)i

This question proved to be very accessible with 85% of all candidates being able to correctly solve a simple reacting masses calculation, scoring all three marks.

Scores below 2 were rare, with the average score being 2.56.

This example was fully correct.



(e) The experiment was carried out using 2.00 g of iron wool.

(i) Calculate the maximum mass of iron(III) chloride that could be produced.

(3)

M_r Fe - 55.8

$\frac{2}{55.8}$

= 0.0358

M_r $FeCl_3$

= 55.8 + (35.5 × 3)

= 162.3

Fe : $FeCl_3$

2 : 2

0.0358

0.0358 × 162.3

~~= 5.82g~~

= 5.8g

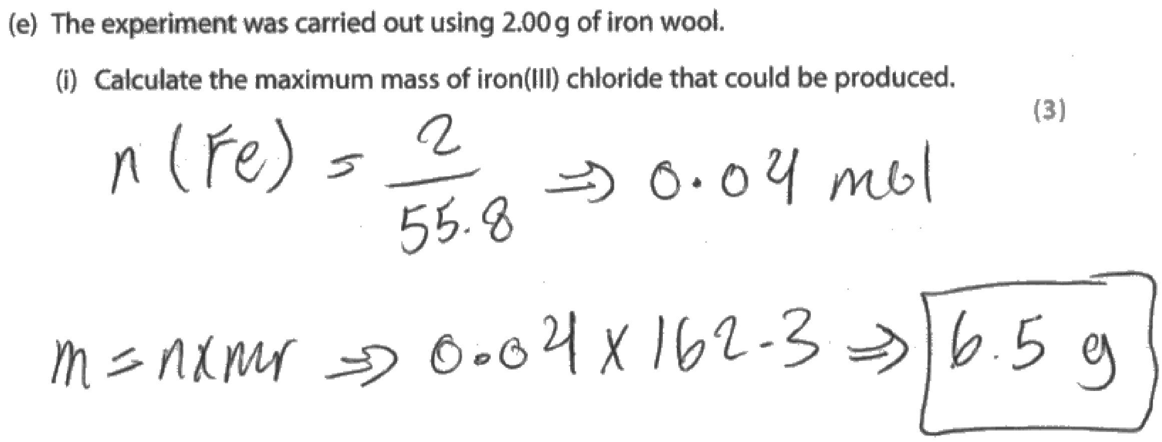
ResultsPlus
Examiner Comments

Although the layout could have been better, this candidate showed all their working for the three different steps, making it very easy for the examiner to award all three marks.

ResultsPlus
Examiner Tip

Note that the final answer was given to 2 significant figures and this is the lowest that is acceptable for the vast majority of calculations in this specification.

Three steps carried out correctly but an incorrect final answer.



(e) The experiment was carried out using 2.00 g of iron wool.

(i) Calculate the maximum mass of iron(III) chloride that could be produced.

(3)

$n(Fe) = \frac{2}{55.8} \Rightarrow 0.04$ mol

$m = n \times mr \Rightarrow 0.04 \times 162.3 \Rightarrow \boxed{6.5\text{ g}}$

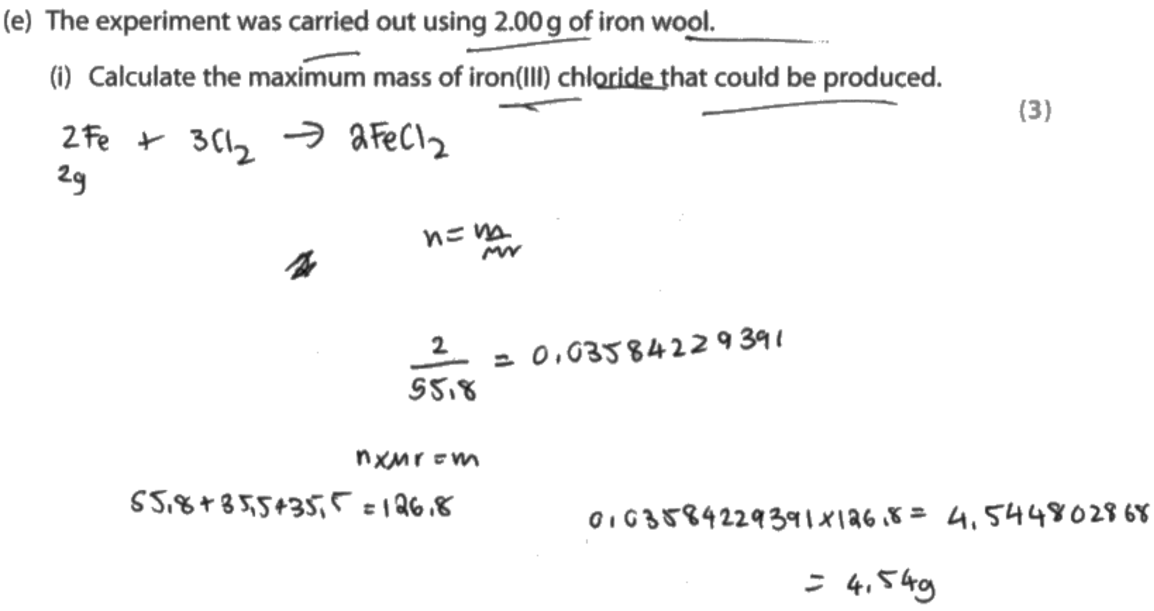
ResultsPlus
Examiner Comments

This candidate lost a mark because of over rounding to one significant figure in the first step. Although the steps were carried out correctly, the over rounding led to an inaccurate final answer.

ResultsPlus
Examiner Tip

The minimum number of significant figures for calculations in this specification is usually two. This includes intermediate steps as well as the final answer. It is wise, when doing multi-step calculations, to use at least three significant figures throughout, or even better, use the full calculator value held in its memory, unless the wording in the question tells you otherwise.

Another example with one small error.



(e) The experiment was carried out using 2.00 g of iron wool.

(i) Calculate the maximum mass of iron(III) chloride that could be produced.

(3)

$2Fe + 3Cl_2 \rightarrow 2FeCl_2$

2g

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

$\frac{2}{55,8} = 0,03584229391$

nxMr = m

55,8+35,5+35,5 = 126,8

0,03584229391x126,8 = 4,544802868

= 4,54g

ResultsPlus
Examiner Comments

This candidate correctly calculated the moles of iron in the first step but then calculated the relative formula mass of iron(II) chloride instead of iron(III) chloride. The final step was done correctly, however, so this mark was awarded as error carried forward because the candidate showed their working.

ResultsPlus
Examiner Tip

Make sure you use the correct formula when calculating a formula mass. Note that this candidate only scored two out of the three available marks because they showed their working. If they had just given a final answer of 4.54g, they would have scored zero because the examiner would have no clue as to how they got there.

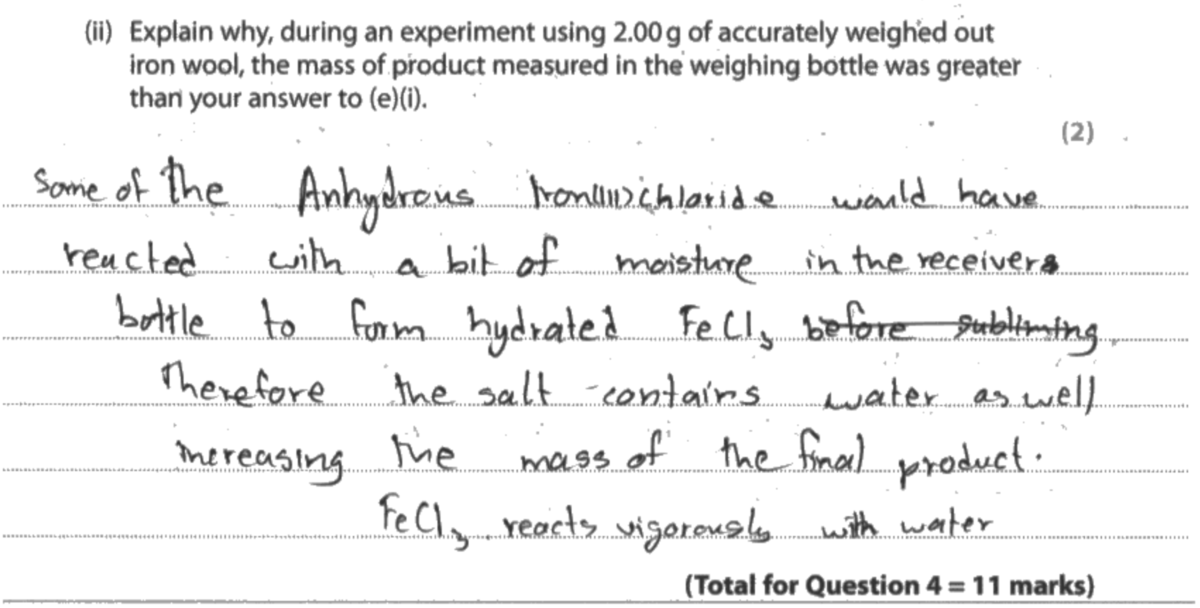
Question 4(e)ii

This question proved to be the most difficult on the paper with only the top 8% of candidates giving a fully correct answer.

There were a multitude of different wrong answer that highlighted two things: firstly, that candidates found it difficult to follow the process through and understand what was present and / or what reactions were happening at different stages of the process. Secondly that there were a number of misconceptions concerning the chemistry involved.

Some candidates stated that the iron reacted with oxygen before the chlorine had time to reach it, but what these candidates failed to take into account is the fact that the percentage by mass of oxygen on iron(III) oxide is much lower than the percentage by mass of chlorine in iron(III) chloride so this would actually cause a lower mass to be obtained. Other candidates stated that there was excess chlorine present so more iron(III) chloride was made. These candidates failed to appreciate that there was a finite amount of iron which was the limiting reagent so you can't make more moles of iron(III) chloride than you have moles of iron.

This is a fully correct answer which gives all the necessary detail.



(ii) Explain why, during an experiment using 2.00 g of accurately weighed out iron wool, the mass of product measured in the weighing bottle was greater than your answer to (e)(i).

(2)

Some of the Anhydrous Iron(III) chloride would have reacted with a bit of moisture in the receivers bottle to form hydrated $FeCl_3$ ~~before subliming~~ Therefore the salt contains water as well increasing the mass of the final product. $FeCl_3$ reacts vigorously with water

(Total for Question 4 = 11 marks)

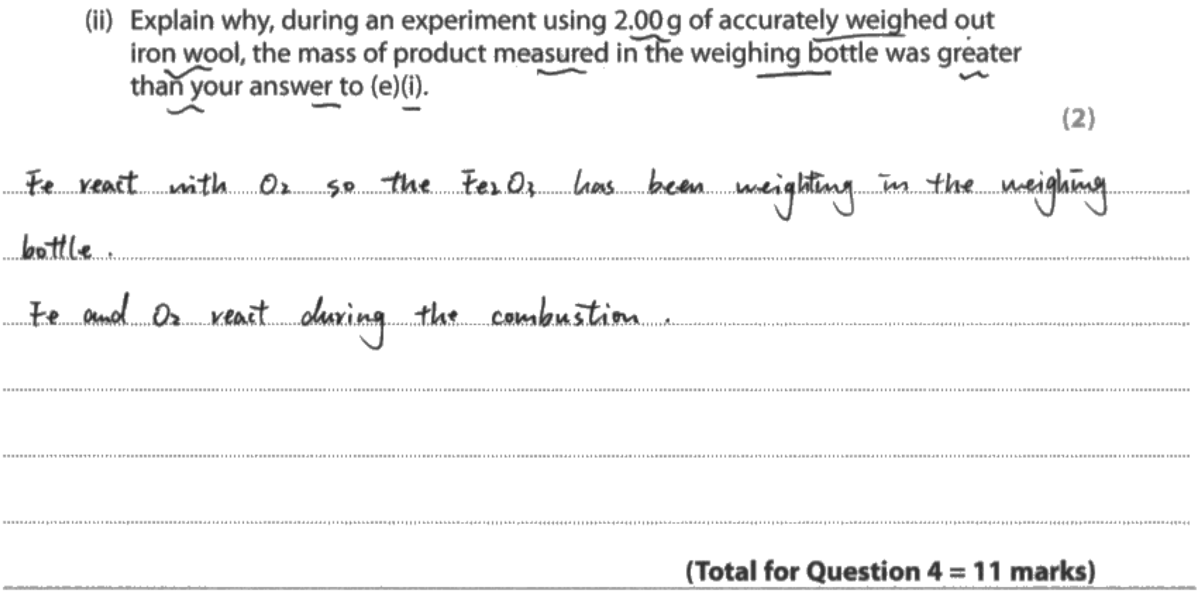
ResultsPlus
Examiner Comments

This candidate clearly realised that the only possible source of extra mass must be water, as it cannot be chlorine, iron or oxygen. It could be that trace amounts were not absorbed by the calcium chloride or that water vapour may have entered the receiver between disconnecting it from the apparatus and putting the stopper in. The source is not important, what is important is that the iron(III) chloride became hydrated as a result and it is the mass of the extra water that caused the increase.

ResultsPlus
Examiner Tip

When faced with a complex, multi-step process such as this, it is worth taking some time out to think about what is happening and what is present at each stage. This will put you in a better position to eliminate possible wrong explanations and arrive at the correct one.

An incorrect explanation.



(ii) Explain why, during an experiment using 2.00 g of accurately weighed out iron wool, the mass of product measured in the weighing bottle was greater than your answer to (e)(i).

(2)

Fe react with O_2 so the Fe_2O_3 has been weighting in the weighing bottle.

Fe and O_2 react during the combustion .

(Total for Question 4 = 11 marks)

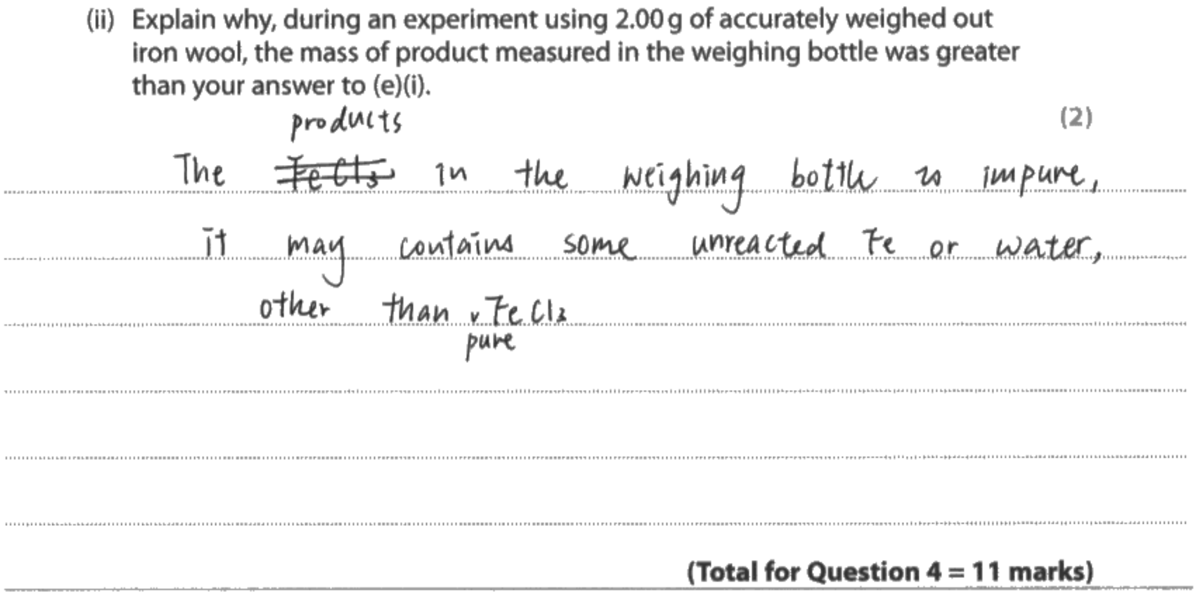
ResultsPlus
Examiner Comments

This is an example where the candidate thought that some of the iron reacting with oxygen caused the increase in mass.

ResultsPlus
Examiner Tip

Take time to consider all the information available, such as the fact that chlorine atoms are more than twice as heavy as oxygen atoms and therefore that this would cause a decrease in mass, not an increase.

A poor answer that it too vague to score.



(ii) Explain why, during an experiment using 2.00 g of accurately weighed out iron wool, the mass of product measured in the weighing bottle was greater than your answer to (e)(i).

(2)

The ~~$FeCl_3$~~ products in the weighing bottle is impure, it may contains some unreacted Fe or water, other than pure $FeCl_3$

(Total for Question 4 = 11 marks)

ResultsPlus
Examiner Comments

There is a misconception in this candidate’s understanding. Unreacted iron would cause the mass to be lower, not higher. There is also a statement about water being present but it is far too vague to be creditworthy.

ResultsPlus
Examiner Tip

There is no point in making vague and general comments such as water being present in this response. You need to demonstrate deeper understanding to the examiner, in this case that the water reacts with / hydrates the iron(III) chloride so the resulting compound has a higher mass.

Question 5(a)(b)

This two-part calculation, comprising a total of six marks proved to be the most accessible on the paper with 88% of candidates scoring full marks. Errors were rare in part (a), where candidates simply had to calculate the moles of the two reactants and state which was in excess. More errors were observed in part (b) but these were mostly related to omission of the last step to calculate **Δ H** or use the wrong moles to calculate **Δ H**. A few candidates seemed to think that temperatures needed to be converted to Kelvin, whilst others used the mass of magnesium (2.2g) or the mass of magnesium plus water (52.2g) to do the $Q = m \times c \times \Delta T$ calculation, rather than just the mass of water (50.0g). A small minority of candidates lost a mark by getting themselves confused over units.

This is an example of an almost fully correct answer with one small omission.

5) A student planned an experiment to determine the enthalpy change of reaction for the displacement of zinc from zinc sulfate solution by magnesium metal.

$$Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$$

Procedure

Step **1** Transfer 50.0 cm^3 of a 1.00 mol dm^{-3} aqueous solution of zinc sulfate into a glass beaker using a measuring cylinder.

Step **2** Put a thermometer in the beaker and leave it to stand for 5 minutes and then record the temperature.

Step **3** Add 2.20 g of magnesium metal powder to the beaker.

Step **4** Stir the mixture and record the maximum temperature reached.

(a) Show, by calculation, that magnesium was in excess.

(2)

mol of zinc : $\left(\frac{50}{1000}\right) \times 1 = 0.05$ mol

mol of mg = $\frac{2.20}{24.3} = 0.0905$ 1 : 1

0.05 : 0.0905

(b) The student carried out the reaction.
The starting temperature recorded was 19.4°C.
The maximum temperature recorded was 55.2°C.

Calculate the value for the enthalpy change of reaction.
Include a sign and unit in your answer.

[Assume: mass of solution = 50.0 g
specific heat capacity = 4.18 J g^{-1} °C^{-1}]

(4)

Temperature change = 35.8

mcΔT → $50 \times 35.8 \times 4.18 = 7482.2$

$\frac{7482.2}{0.05} = 149644$

$\hookrightarrow \div 1000$

149.644

$\boxed{149.64 \text{ KJmol}^{-1}}$

ResultsPlus Examiner Comments

This is a response from a good candidate who clearly understands their chemistry in this topic. They score both marks in part (a). Although they did not make an explicit statement about magnesium being in excess, the fact that they used the moles of zinc for the final calculation was enough to demonstrate to the examiner that they appreciate that zinc was the limiting reagent. Unfortunately, they lost the final mark by not including the correct sign in their final answer.

ResultsPlus Examiner Tip

Remember that, if there is a temperature increase in a reaction that the reaction must be exothermic so the sign for Δ H must be negative.

This is another good answer that only loses one mark.

5; A student planned an experiment to determine the enthalpy change of reaction for the displacement of zinc from zinc sulfate solution by magnesium metal.

$$Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$$

Procedure

Step 1 Transfer 50.0 cm³ of a 1.00 mol dm⁻³ aqueous solution of zinc sulfate into a glass beaker using a measuring cylinder.

Step 2 Put a thermometer in the beaker and leave it to stand for 5 minutes and then record the temperature.

Step 3 Add 2.20 g of magnesium metal powder to the beaker.

Step 4 Stir the mixture and record the maximum temperature reached.

(a) Show, by calculation, that magnesium was in excess.

(2)

$50\ cm^3 = 5.0 \times 10^{-2} dm^3$

moles of zinc sulfate = $1 \times 5 \times 10^{-2} = 0.05$

moles of Mg needed = 0.05

mass of Mg needed = $0.05 \times 24.3 = 1.215$ g.

2.20g > 1.215g ∴ Mg is in excess

(b) The student carried out the reaction.
The starting temperature recorded was 19.4°C.
The maximum temperature recorded was 55.2°C.

Calculate the value for the enthalpy change of reaction.
Include a sign and unit in your answer.

[Assume: mass of solution = 50.0 g
specific heat capacity = 4.18 J g⁻¹ °C⁻¹]

(4)

$\Delta T = 55.2 - 19.4 = 35.8°C$

$q = 50 \times 4.18 \times 35.8 = 7482.2\ J = -7.4822\ kJ$

$\simeq -7.48\ kJ$

ResultsPlus
Examiner Comments

The first two marks are scored via the alternative method but this is just as valid. The only mark lost is by not performing the last step of the calculation ie dividing the energy change by the moles of limiting reagent.

ResultsPlus
Examiner Tip

Remember that when the question asks for an enthalpy change this means per mole so you have to divide the energy change by the number of moles reacting.

A less well thought out answer.

5) A student planned an experiment to determine the enthalpy change of reaction for the displacement of zinc from zinc sulfate solution by magnesium metal.

$$Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$$

Procedure

Step 1 Transfer 50.0 cm^3 of a 1.00 mol dm^{-3} aqueous solution of zinc sulfate into a glass beaker using a measuring cylinder.

Step 2 Put a thermometer in the beaker and leave it to stand for 5 minutes and then record the temperature.

Step 3 Add 2.20 g of magnesium metal powder to the beaker.

Step 4 Stir the mixture and record the maximum temperature reached.

(a) Show, by calculation, that magnesium was in excess.

(2)

$\frac{2.2}{24.3}$ = ~~$\frac{24.3}{2.2}$ = 11.045~~

0.0905

(b) The student carried out the reaction.
The starting temperature recorded was 19.4°C.
The maximum temperature recorded was 55.2°C.

Calculate the value for the enthalpy change of reaction.
Include a sign and unit in your answer.

[Assume: mass of solution = 50.0 g
specific heat capacity = 4.18 J g^{-1} °C^{-1}]

(4)

$Q = m\Delta tc$ 55.2 − 19.4 = 35.8 °C

35.8 × 50 × 4.18 = 7482.2

$\frac{65.4}{50}$ = 1.308 $\frac{7482.2}{1.308}$

= 5720.34

ResultsPlus
Examiner Comments

Only one mark is scored in part (a) because only the moles of magnesium are calculated. In part (b) the layout is poor which makes it difficult for the examiner to follow. Nevertheless, three marks are scored for the $Q = m \times c \times \Delta T$ calculation to give the correct energy change. The candidate then realises they need to divide by moles but this is calculated wrongly, using the relative atomic mass of zinc when it should have been calculated from the volume and concentration of the zinc sulfate solution.

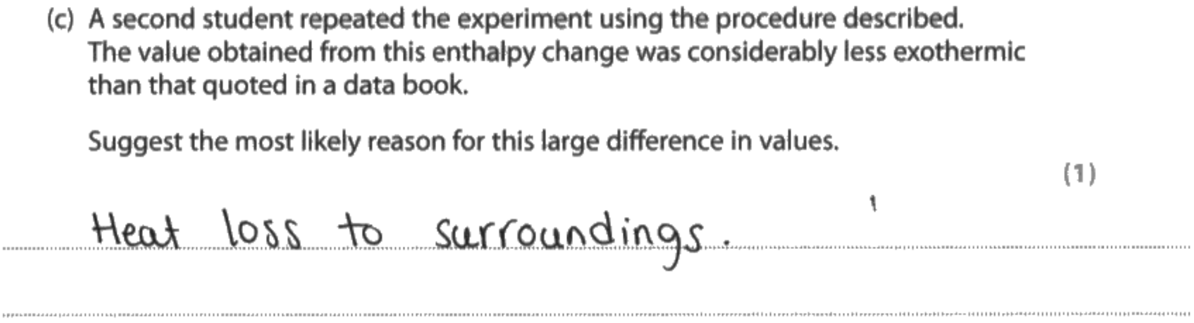
ResultsPlus
Examiner Tip

If you are asked to show that a reagent is in excess, it automatically implies that you have to calculate the moles of two substances (and often apply the relevant stoichiometry). Also, make sure you calculate the amount of substance correctly from the information given.

Question 5(c)

Most candidates were able to access this familiar question but with one slight difference: that they were asked to give the **most likely reason**, which a good number of candidates missed the significance of and gave reasons that would have had much less impact than heat loss (to the surroundings).

The correct answer.



(c) A second student repeated the experiment using the procedure described.
The value obtained from this enthalpy change was considerably less exothermic than that quoted in a data book.

Suggest the most likely reason for this large difference in values.

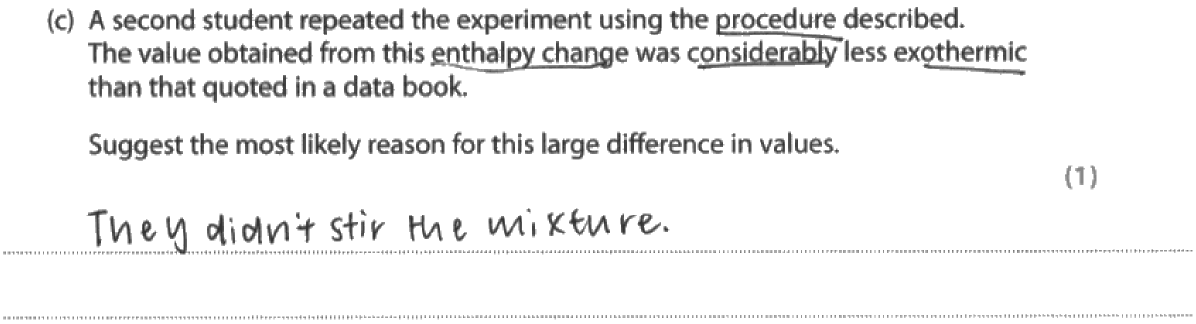
(1)

Heat loss to surroundings.

ResultsPlus
Examiner Comments

In this case, just "heat loss" would have been enough but the candidate was wise to be specific and add "to the surroundings" as this is often required.

An incorrect example.



(c) A second student repeated the experiment using the procedure described. The value obtained from this enthalpy change was considerably less exothermic than that quoted in a data book.

Suggest the most likely reason for this large difference in values.

(1)

They didn't stir the mixture.

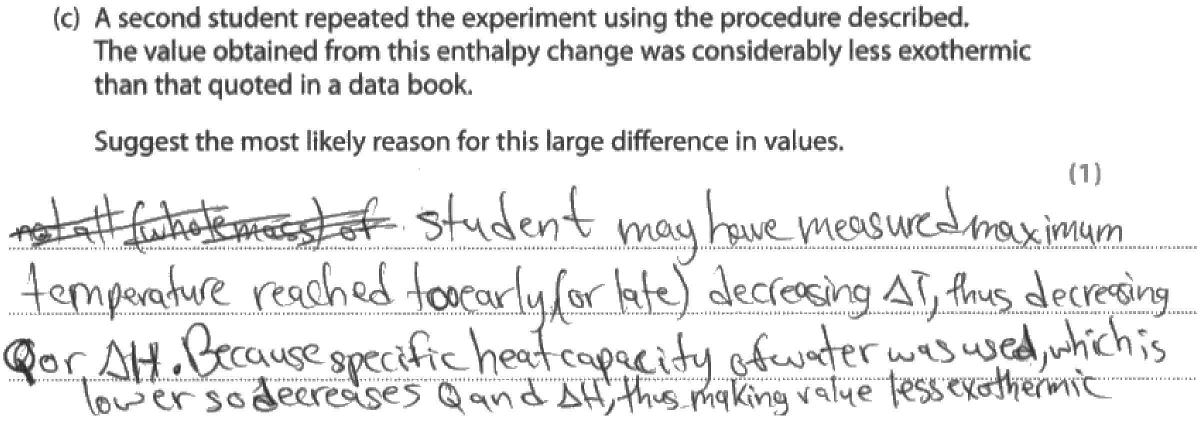
ResultsPlus
Examiner Comments

Not stirring the mixture may have a slight effect but is insignificant when compared to the heat lost to the surroundings.

ResultsPlus
Examiner Tip

Remember that heat lost (to the surroundings) is always the main source of error in this type of calorimetry experiment when comparing experimental values to databook values.

A very garbled and confused answer.



(c) A second student repeated the experiment using the procedure described. The value obtained from this enthalpy change was considerably less exothermic than that quoted in a data book.

Suggest the most likely reason for this large difference in values.

(1)

~~not all (whole mass) of~~ student may have measured maximum temperature reached too early (or late) decreasing ΔT, thus decreasing Q or ΔH. Because specific heat capacity of water was used, which is lower so decreases Q and ΔH, thus making value less exothermic

ResultsPlus
Examiner Comments

This candidate made two mistakes here. Other than not giving the correct answer, there are two answers here when the question only asks for one (the most likely one). One of these, using an inaccurate specific heat capacity, will make a slight difference but certainly not the biggest difference. The other answer talks about the student recording the temperature wrongly, which implies human error.

ResultsPlus
Examiner Tip

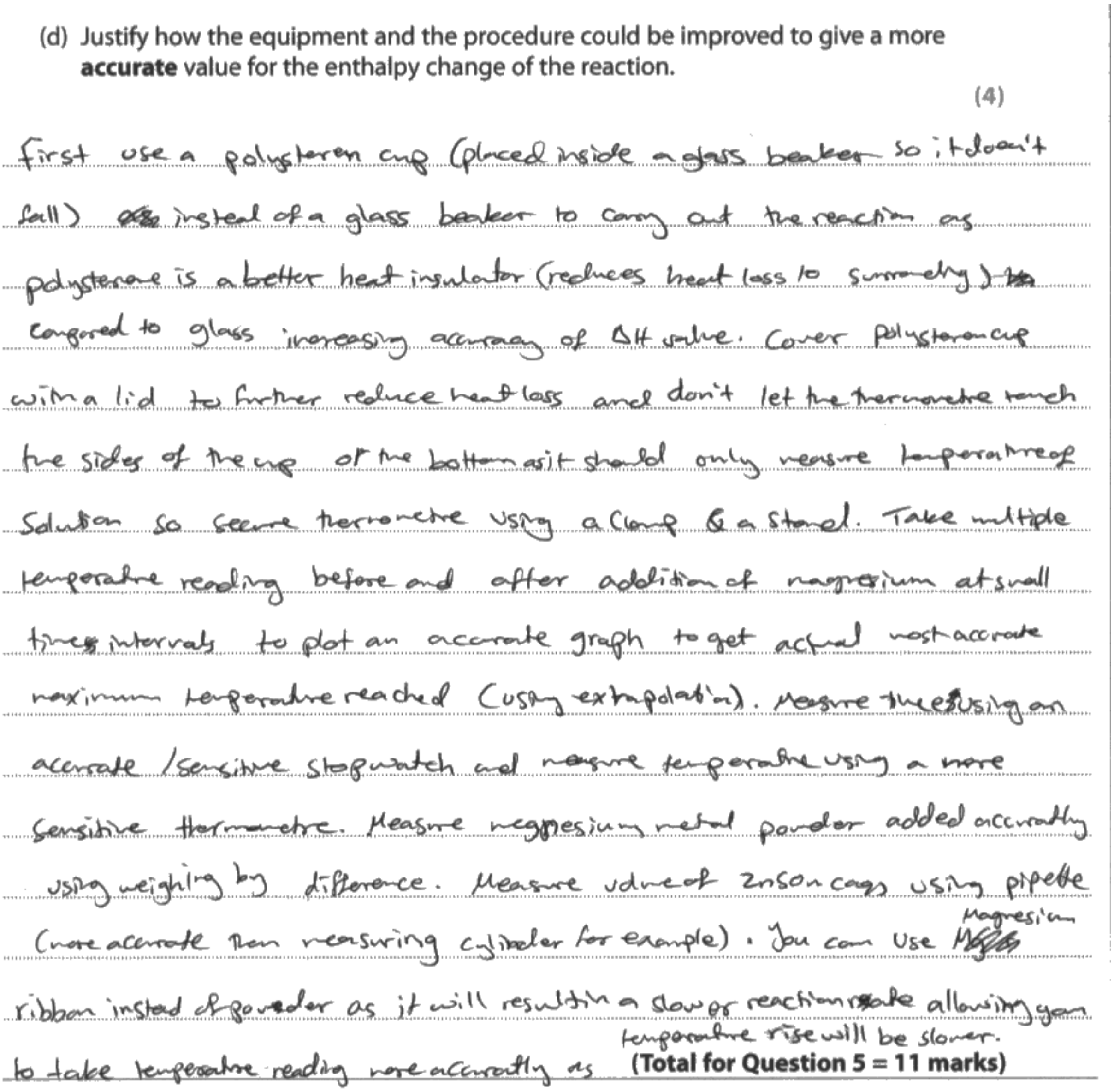
Answers which imply human error in an experimental procedure should be avoided as they don’t usually address the specific issue being asked about. If the student had recorded the temperatures perfectly, there would still be a large difference between the experimental and databook values.

Question 5(d)

Even though there are a large number of factors that candidates could have chosen, this question proved less accessible than expected.

The most popular choice by far was to use a polystyrene cup, with the second most popular being use of a lid, but very few candidates went on to give a third correct reason.

This is an example of an excellent and well-structured answer.



(d) Justify how the equipment and the procedure could be improved to give a more **accurate** value for the enthalpy change of the reaction.

(4)

first use a polysteren cup (placed inside a glass beaker so it doesn't fall) instead of a glass beaker to carry out the reaction as polysterene is a better heat insulator (reduces heat loss to surrounding) ~~to~~ compared to glass increasing accuracy of ΔH value. Cover polysteren cup with a lid to further reduce heat loss and don't let the thermometre touch the sides of the cup or the bottom as it should only measure temperature of solution so secure thermometre using a clamp & a stand. Take multiple temperature reading before and after addition of magnesium at small time~~s~~ intervals to plot an accurate graph to get actual most accurate maximum temperature reached (using extrapolation). Measure time using an accurate /sensitive stopwatch and measure temperature using a more sensitive thermometre. Measure megnesium metal powder added accurately using weighing by difference. Measure volume of $ZnSO_4(aq)$ using pipette (more accurate than measuring cylinder for example). You can use ~~Mg~~ Magnesium ribbon instead of powder as it will result in a slower reaction rate allowing you to take temperature reading more accurately as temperature rise will be slower.

(Total for Question 5 = 11 marks)

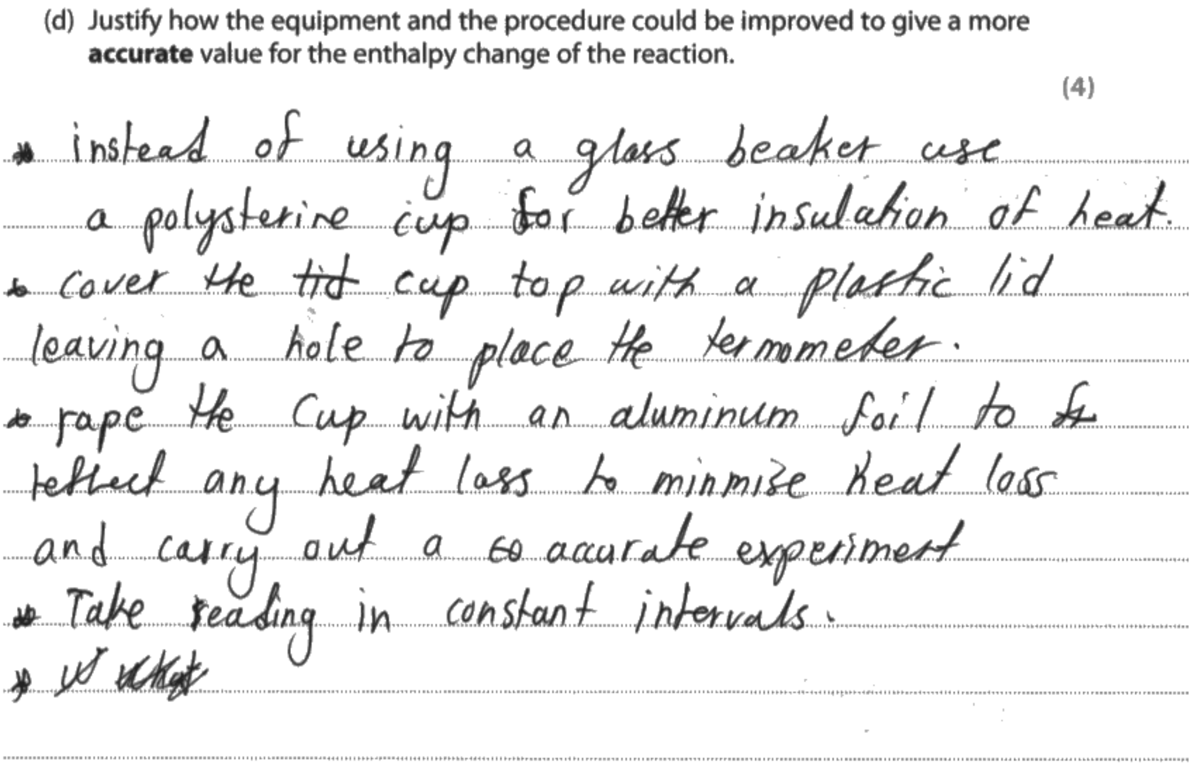
ResultsPlus
Examiner Comments

This candidate not only gives three correct responses but also justifies their reasons for suggesting them. They actually give more than three reasons. If anything, the response is a little too long and at the end, they make a suggestion that would not improve the outcome, but there are no penalties for that here.

ResultsPlus
Examiner Tip

When faced with a question that asks you to make a number of suggestions, such as this one, the best way to respond is usually to use bullet points. This makes it easier for the examiner to follow your reasoning and therefore award the marks.

A response that scores the two most popular points but nothing else.



(d) Justify how the equipment and the procedure could be improved to give a more **accurate** value for the enthalpy change of the reaction.

(4)

- instead of using a glass beaker use a polysterine cup for better insulation of heat.
- cover the ~~lid~~ cup top with a plastic lid leaving a hole to place the termometer.
- tape the Cup with an aluminum foil to ~~fe~~ reflect any heat loss to minmize heat loss and carry out a ~~so~~ accurate experiment
- Take reading in constant intervals.
- ~~W what~~

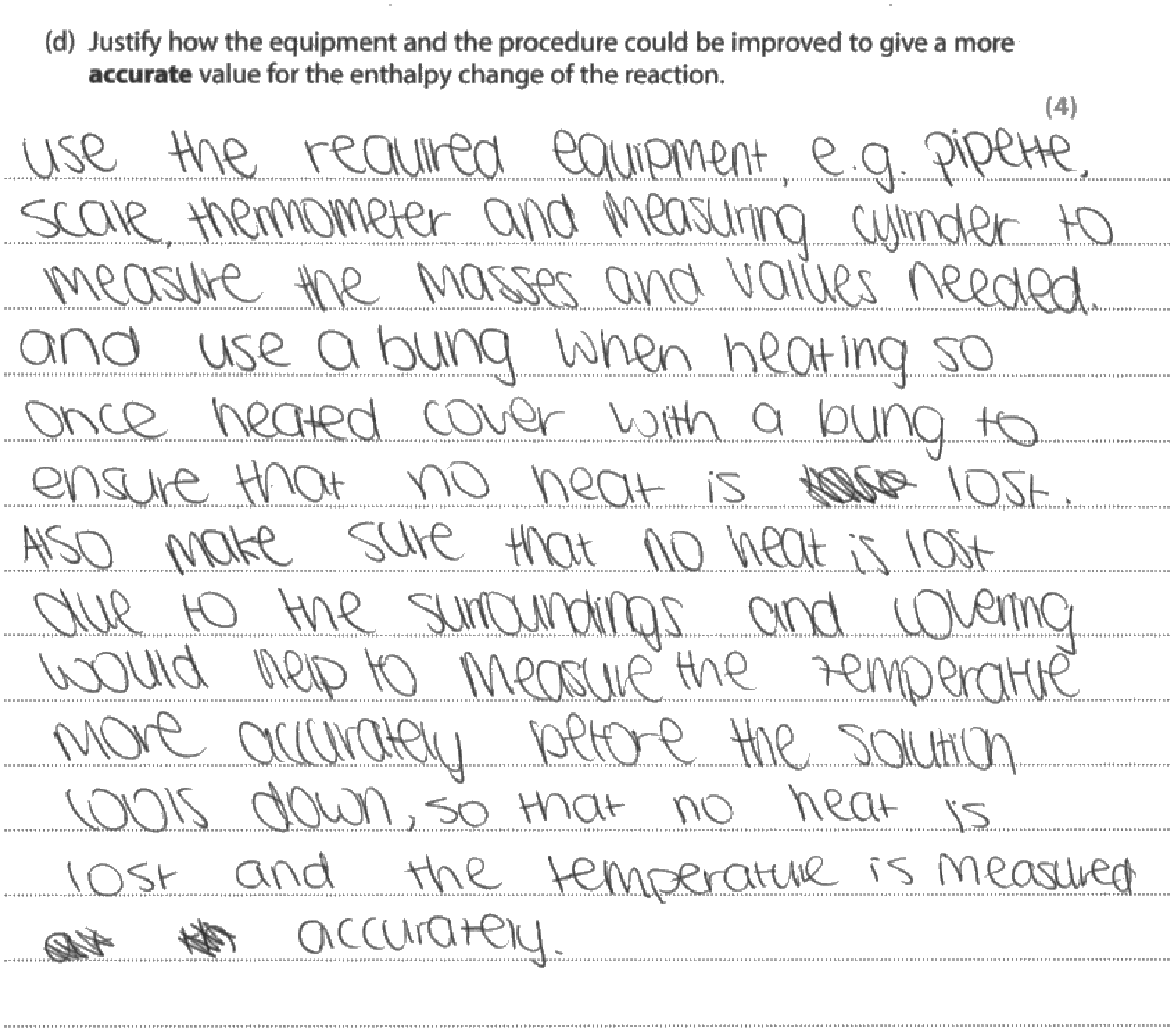
ResultsPlus
Examiner Comments

This scores two marks for use of a polystyrene cup and a lid. Adding aluminium foil as extra insulation scores the same mark as using a polystyrene cup so no extra mark. "Taking readings at constant intervals" does not score as it is not specific, whereas "taking readings every 30 seconds" is specific and would have scored.

ResultsPlus
Examiner Tip

Avoid generalisations in your answers, always being more specific wherever possible.

A poor response that scores 0 marks as it fails to mention any valid improvements.



(d) Justify how the equipment and the procedure could be improved to give a more **accurate** value for the enthalpy change of the reaction.

(4)

use the required equipment, e.g. pipette, scale, thermometer and measuring cylinder to measure the masses and values needed. and use a bung when heating so once heated cover with a bung to ensure that no heat is lost. Also make sure that no heat is lost due to the surroundings and covering would help to measure the temperature more accurately before the solution cools down, so that no heat is lost and the temperature is measured accurately.

ResultsPlus
Examiner Comments

This response comes close but is far too vague with no real explanation. There is more than one mention of preventing heat loss but no attempt to explain how. "Covering" and "bung" are attempts at suggestions but a bung is inappropriate for a beaker and covering is too vague.

ResultsPlus
Examiner Tip

A much better way to answer this question would be to:

Structure your answer using bullet points.

Make sure that your suggestions / equipment are appropriate.

Make sure your suggestions are specific.

Make sure your focus is on the key word, "accurate" in the question – will your suggestions make the experimental outcome more accurate.

Paper Summary

Candidates gained most marks on this paper where the context was familiar and on simple calculations. Most marks were lost on questions where the context was unfamiliar and / or practical based. Questions three and four on this paper were particularly prone to this as most candidates would have been unfamiliar with the experimental procedures concerned. As WCH13 is a practical based paper, it is to be expected that complex practical procedures such as those in questions three and four will be an ongoing and perfectly reasonable feature of the paper. As answering this type of question is a clearly acknowledged weakness of most candidates, they can only be expected to improve by being exposed to a diverse range of practical experience, including but certainly not limited to practising past paper questions of a similar complex nature.

Based on their performance on this paper, candidates are offered the following advice:

- Be encouraged to read the questions carefully to ensure they have not missed any important points.
- Recognise and use the command words in the question to guide their answers.
- Practise how to improve the structure of their answers (for questions of 3 or more marks), avoiding repetition, irrelevancy and contradiction. Use of bullet points is often a better way of communicating ideas.
- Learn how to structure calculations better, showing all working so that examiners can more easily follow them and apply T.E. if appropriate.
- Do not round too early in a calculation – marks can often be lost through use of 1 sig fig. so stick to the 3 sig fig min rule.
- Don’t use generalisations or vaguery in answers. Always follow up an idea with relevant detail.

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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