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Principal Examiner's Feedback

October 2016

Pearson Edexcel International Advanced Level in Chemistry (WCH02) Paper 01

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Summer 2016
Publications Code WCH02_01_1610_ER*

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WCH02_01

Paper Introduction

This is the first examination for WCH02/01 in the Pearson Edexcel International Advanced Level October examination period . It uses the same specification and examination style as the January and June Series of examinations so candidates have the opportunity to use any past papers from those examinations to practise their technique. There were some excellent answers but some candidates did not seem to have prepared sufficiently well for this paper.

The mean score for the multiple choice questions in Section A was 13.8. Questions 7 and 13 were found to be the most straightforward, whilst questions 11 and 15 were found to be the most challenging.

Successful candidates:

- read the questions carefully and answered the questions as they were set
- used correct scientific terminology in their answers
- had used a range of basic practical techniques when carrying out experiments and understood the reasons for using them
- could carry out unstructured calculations

Some answers were of a lower standard. Less successful candidates:

- did not read the questions carefully and gave answers that were related to the topic being tested but did not answer the question
- did not use correct scientific terminology, for example, they interchanged the words atoms, ions and molecules without understanding what the correct word should be
- could not carry out calculations
- could not write balanced equations
- could not draw accurate organic reaction mechanisms
- were unfamiliar with some pieces of apparatus used in a chemistry laboratory, such as a weighing bottle or a volumetric flask.

In future, candidates need to prepare more thoroughly for the examination.

WCH02_01_Q21ai

Question Introduction

The majority of candidates knew the flame colour for barium ions.

WCH02_01_Q21aii

Question Introduction

Many candidates were able to explain the origin of the flame colour in a flame test. Common errors included: not mentioning electrons, just stating that electrons are excited but not stating where they are moving to and just stating that a colour is seen instead of light or photons are emitted. A few candidates described how to carry out a flame test but that was not required here.

Item: QC0419000005763

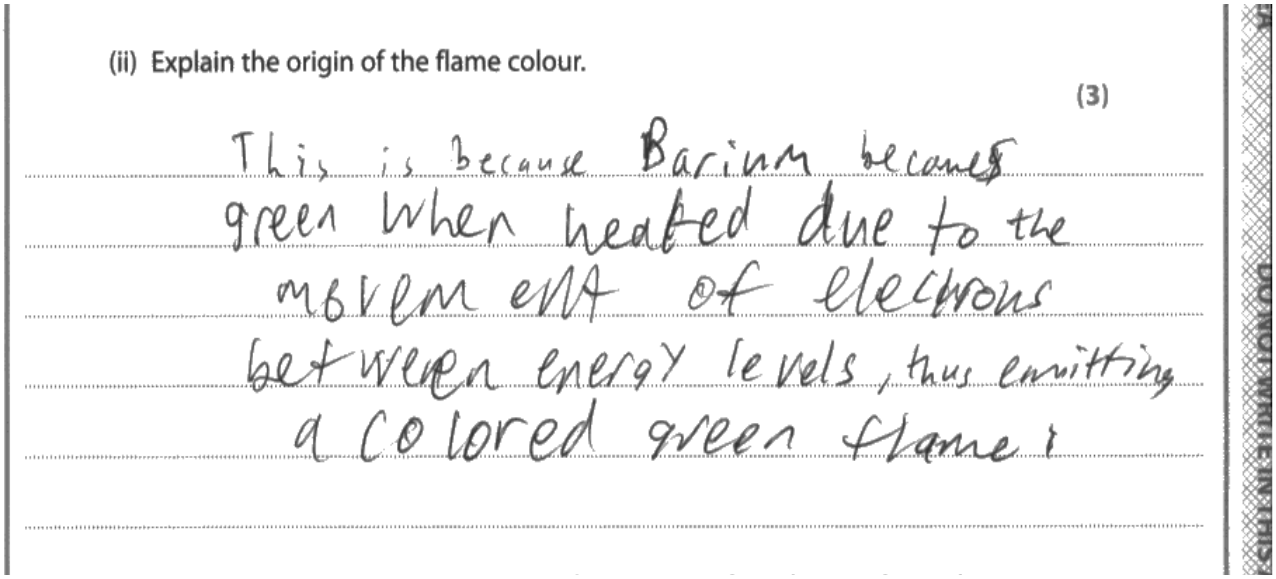
Examiner Comment

This candidate knows that the colour is caused by the movement of electrons between energy levels but no specific details of the movement are given so this answer scored zero.

Examiner Tip

Revise the details of how flame colours arise.

Learn the full explanation of the origin of the flame colour in a flame test.



(ii) Explain the origin of the flame colour.

(3)

This is because Barium becomes green when heated due to the movement of electrons between energy levels, thus emitting a colored green flame.

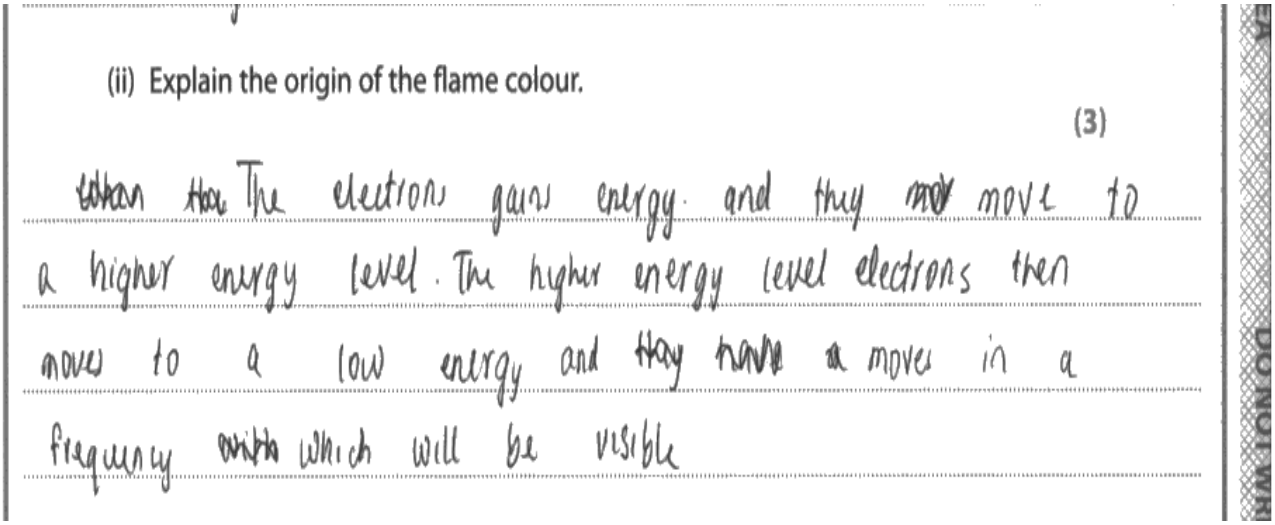
Item: QC0419000008552

Examiner Comment

This candidate has explained the movement of the electrons between energy levels but has not clearly stated that light or photons are emitted as the electrons fall back. This response scored two marks.

Examiner Tip

Learn the full explanation of the origin of the flame colour in a flame test.



(ii) Explain the origin of the flame colour.

(3)

when the The electrons gains energy and they ~~not~~ move to a higher energy level. The higher energy level electrons then moves to a low energy and they have a moves in a frequency ~~with~~ which will be visible

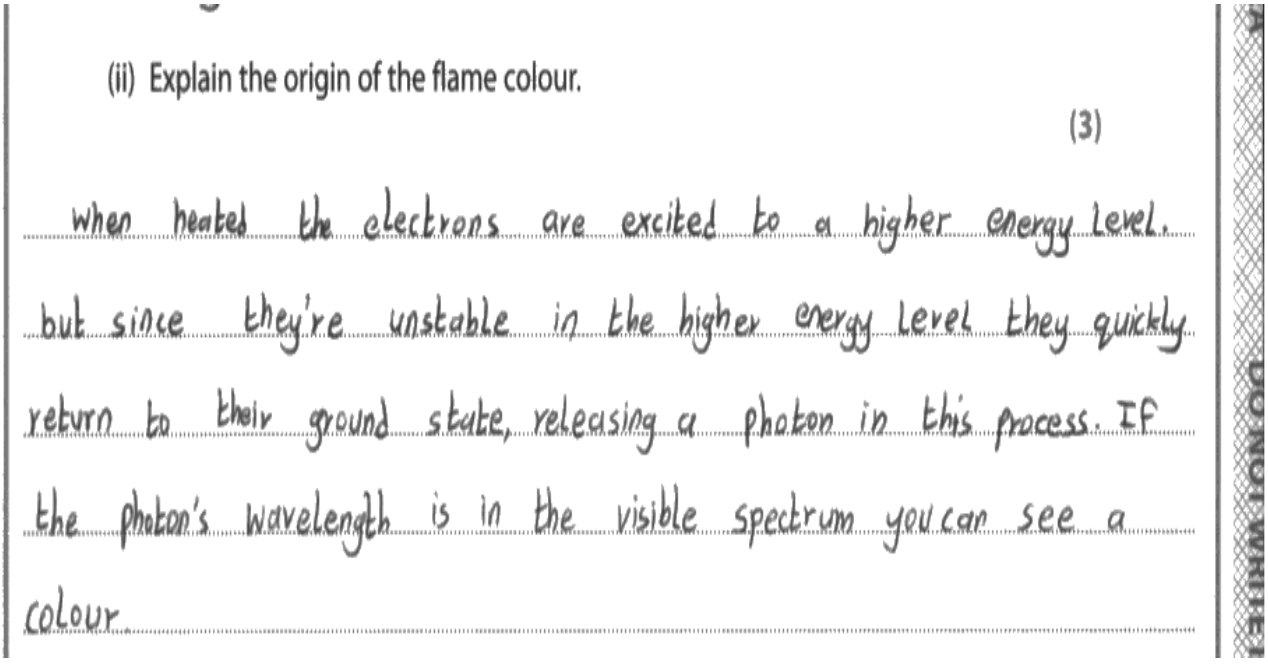
Item: QC0419000009416

Examiner Comment

This is an excellent answer that scored three marks.

Examiner Tip

Try to give full, concise answers such as this one.



(ii) Explain the origin of the flame colour.

(3)

when heated the electrons are excited to a higher energy level, but since they're unstable in the higher energy level they quickly return to their ground state, releasing a photon in this process. If the photon's wavelength is in the visible spectrum you can see a colour

WCH02_01_Q21bi-ii

Question Introduction

Many candidates struggled to write equations to show the thermal decomposition of sodium nitrate and magnesium nitrate. Common errors included: incorrect formulae of the reactants (for example, Na_2NO_3 and $MgNO_3$), not knowing the products of decomposition and not balancing the equations. Candidates would benefit from more practice in writing equations for the reactions in the specification.

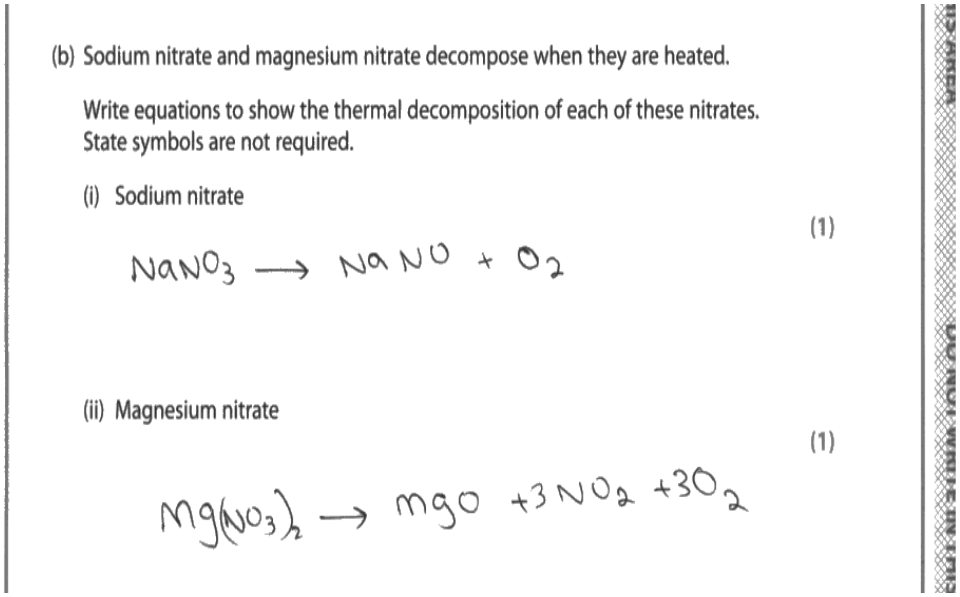
Item: QC0419000009407

Examiner Comment

This candidate has written the correct formulae of the reactants. The formula of sodium nitrite is incorrect. The formulae of the products in the decomposition of magnesium nitrate are correct, but the equation is balanced incorrectly. This response scored zero marks.

Examiner Tip

Practise writing balanced equation.



(b) Sodium nitrate and magnesium nitrate decompose when they are heated.

Write equations to show the thermal decomposition of each of these nitrates.
State symbols are not required.

(i) Sodium nitrate

(1)

$NaNO_3 \longrightarrow NaNO + O_2$

(ii) Magnesium nitrate

(1)

$Mg(NO_3)_2 \longrightarrow MgO + 3NO_2 + 3O_2$

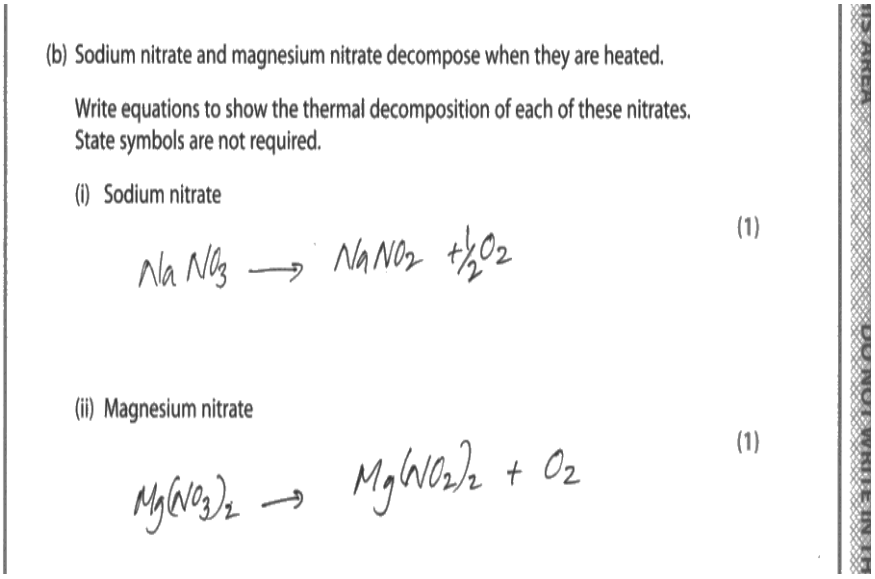
Item: QC0419000008832

Examiner Comment

The first equation is correct and scored 1 mark. The second equation is incorrect as magnesium nitrate decomposes to form magnesium oxide, nitrogen dioxide and oxygen.

Examiner Tip

Learn the products formed from the thermal decomposition of Group 1 and Group 2 nitrates and carbonates.



(b) Sodium nitrate and magnesium nitrate decompose when they are heated.

Write equations to show the thermal decomposition of each of these nitrates.
State symbols are not required.

(i) Sodium nitrate

$NaNO_3 \rightarrow NaNO_2 + \frac{1}{2}O_2$ (1)

(ii) Magnesium nitrate

$Mg(NO_3)_2 \rightarrow Mg(NO_2)_2 + O_2$ (1)

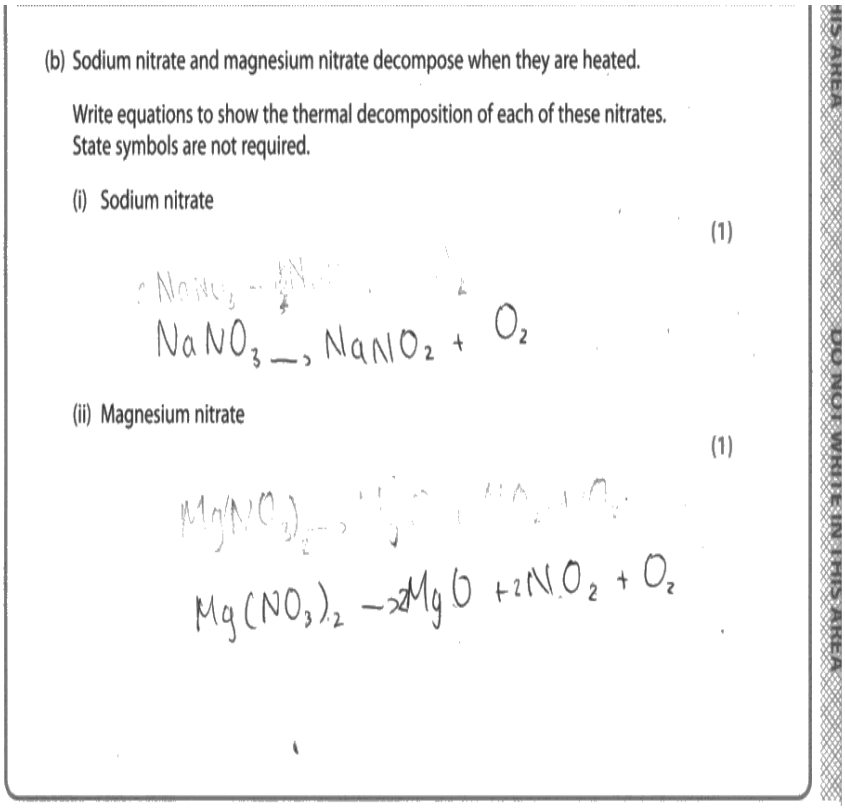
Item: QC0419000008548

Examiner Comment

These equations are not balanced. However, the products are correct in both equations so 1 mark was awarded.

Examiner Tip

Always write balanced equations.



(b) Sodium nitrate and magnesium nitrate decompose when they are heated.

Write equations to show the thermal decomposition of each of these nitrates.
State symbols are not required.

(i) Sodium nitrate

(1)

$NaNO_3 \rightarrow NaNO_2 + O_2$

(ii) Magnesium nitrate

(1)

$Mg(NO_3)_2 \rightarrow MgO + 2NO_2 + O_2$

DO NOT WRITE IN THIS AREA

WCH02_01_Q21c

Question Introduction

Some candidates clearly explained why magnesium carbonate decomposes more readily than sodium carbonate. However, some candidates lost marks as a result of using poor terminology, for example, referring to atoms instead of ions. Most candidates knew that a magnesium ion has a larger charge than a sodium ion but some thought that it was also larger in size. Some candidates thought that the magnesium ion would be polarised and some just stated that the magnesium ion causes more polarisation than the sodium ion but did not say what it polarises. A few candidates wrote about the size, charge and polarising ability of the metal carbonates instead of the cations. Other incorrect ideas included: referring to electronegativity, using polarity for polarising, referring to lattice energy, writing that the bond between the cation and the carbonate is polarised, not making a comparison and comparing the trend down a group instead of the period.

Item: QC0419000006755

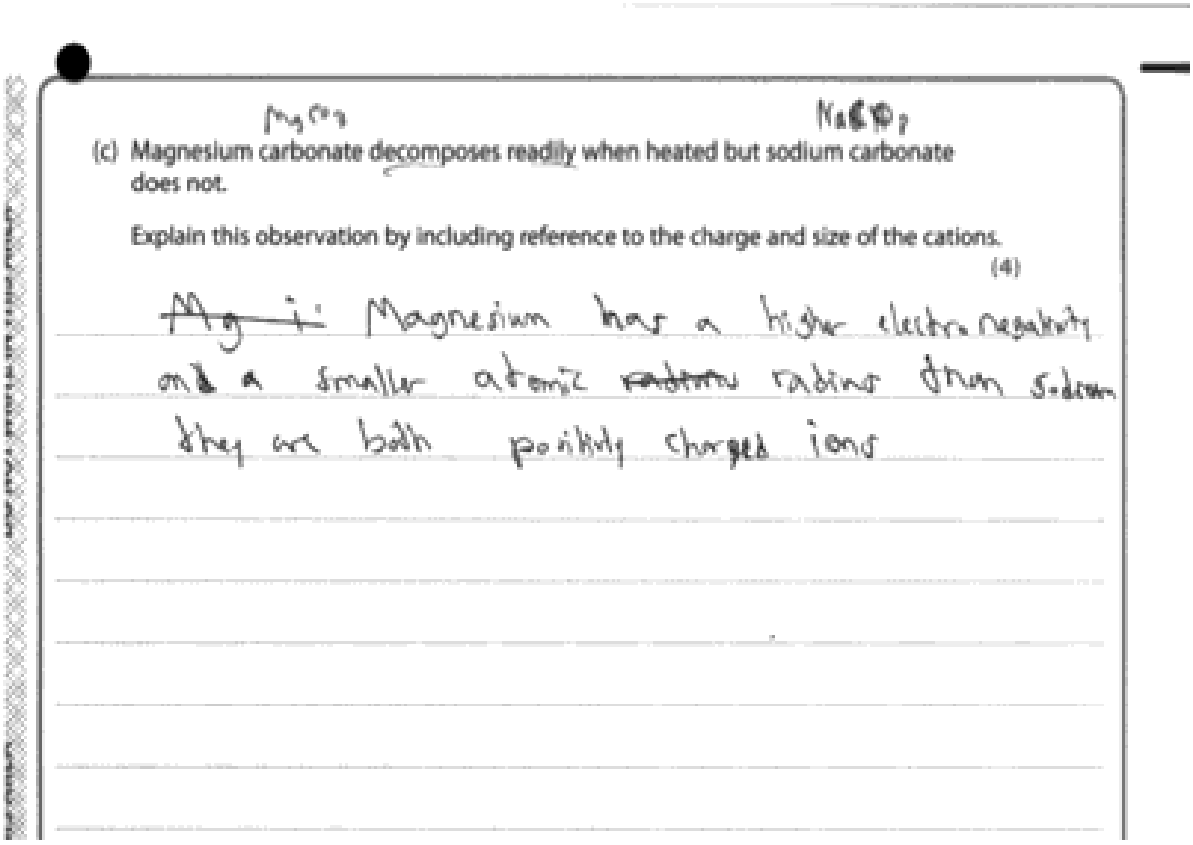
Examiner Comment

This candidate has written about electronegativity, which is not relevant to this question. They have attempted to write about size but have referred to atomic radius instead of ionic radius. There is no mention of the charge on the cations. This response scored zero marks.

Examiner Tip

Read the question carefully. The question specifically mentions charge and size of the cations, if you include correct statements about these, you will receive some credit.

Use correct scientific terminology. Ensure thtat you know the difference between atoms, ions and molecules.



(c) Magnesium carbonate decomposes readily when heated but sodium carbonate does not.

Explain this observation by including reference to the charge and size of the cations.

(4)

~~Mg~~ i Magnesium has a higher electronegativity and a smaller atomic ~~radium~~ radius than Sodium they are both positively charged ions

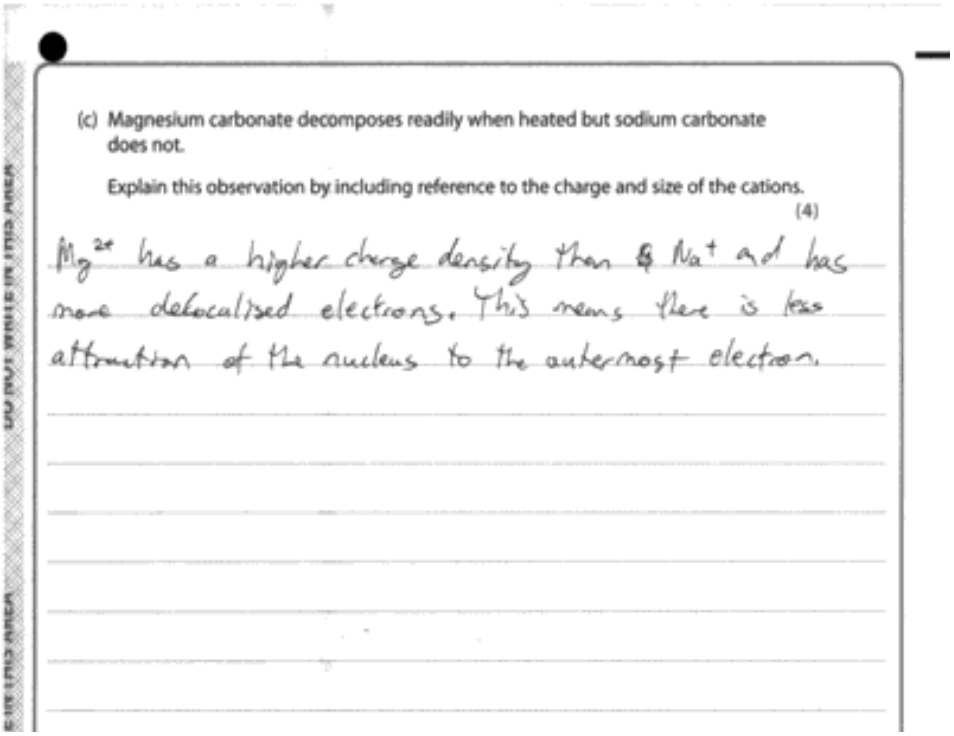
Item: QC0419000006135

Examiner Comment

This response scored one mark for the higher charge density on the magnesium ion. However, it does not refer specifically to the size of the cations. There is no explanation of the effect of the higher charge density on the anion so no further marks could be awarded.

Examiner Tip

Higher charge density is acceptable for higher charge but it does not clearly state the difference in size of the ions.



(c) Magnesium carbonate decomposes readily when heated but sodium carbonate does not.

Explain this observation by including reference to the charge and size of the cations.

(4)

Mg^{2+} has a higher charge density than Na^{+} and has more delocalised electrons. This means there is less attraction of the nucleus to the outermost electron.

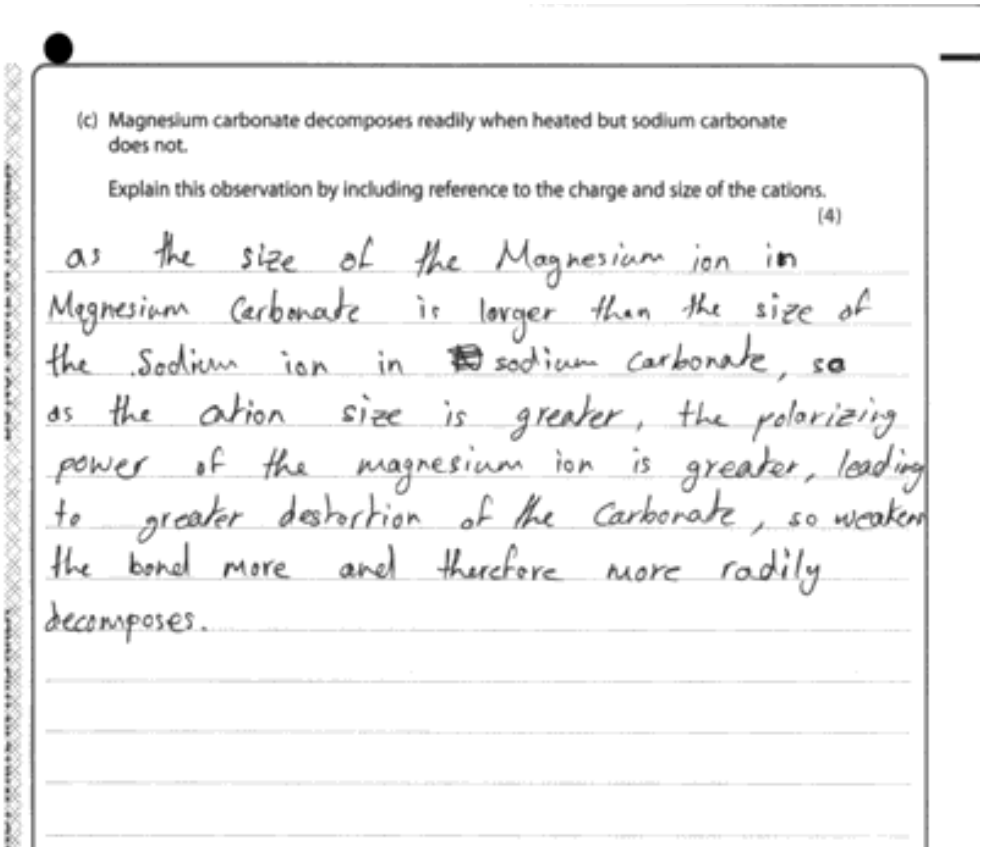
Item: QC0419000006752

Examiner Comment

This candidate thinks that magnesium ions are larger than sodium ions, which is incorrect. However, the polarising power and distortion of carbonate are correct so two marks were awarded.

Examiner Tip

Read the question carefully. This question asks for reference to the charge and size of the cations and this candidate has not mentioned the charge.



(c) Magnesium carbonate decomposes readily when heated but sodium carbonate does not.

Explain this observation by including reference to the charge and size of the cations.

(4)

as the size of the Magnesium ion in Magnesium Carbonate is larger than the size of the Sodium ion in sodium carbonate, so as the cation size is greater, the polarizing power of the magnesium ion is greater, leading to greater destortion of the Carborate, so weaken the bond more and therefore more radily decomposes.

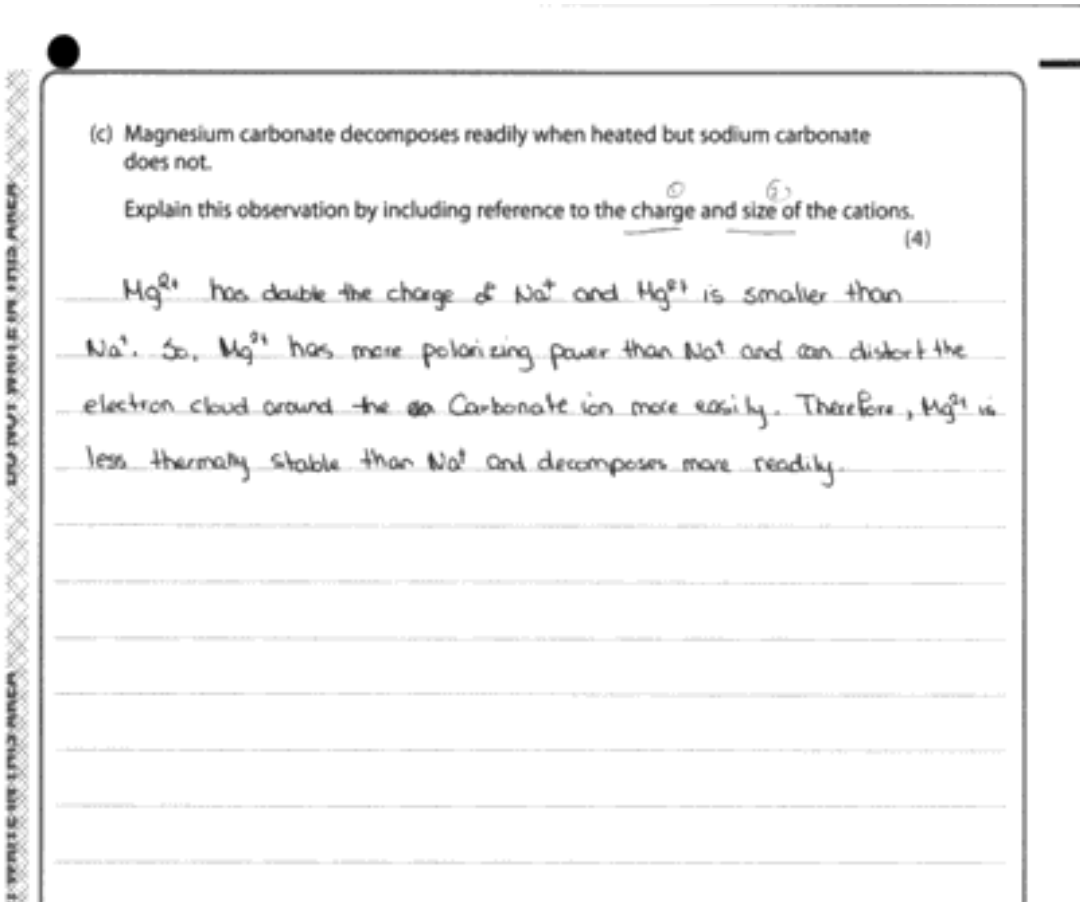
Item: QC0419000006760

Examiner Comment

This is an excellent response that scored four marks. It includes all the relevant points and is written concisely.

Examiner Tip

Try to write clear and concise explanations, such as this one.



(c) Magnesium carbonate decomposes readily when heated but sodium carbonate does not.

Explain this observation by including reference to the charge and size of the cations.

(4)

Mg^{2+} has double the charge of Na^+ and Mg^{2+} is smaller than Na^+. So, Mg^{2+} has more polarising power than Na^+ and can distort the electron cloud around the CO_3^{2-} carbonate ion more easily. Therefore, Mg^{2+} is less thermally stable than Na^+ and decomposes more readily.

WCH02_01_Q21diii

Question Introduction

This question was poorly answered by the majority of candidates. Many answers showed that candidates were unfamiliar with the technique of making up a standard solution. Some candidates had clearly never seen a weighing bottle and assumed that it was an alternative to using a balance rather than a receptacle for putting the solid in on the balance pan. Some candidates identified an error but did not explain the effect the error would have on the titration volume. Some candidates ignored the information in the question and discussed possible errors in carrying out a titration. Candidates would benefit from more experience in carrying out common practical techniques and thinking about the effect any errors will have on the results.

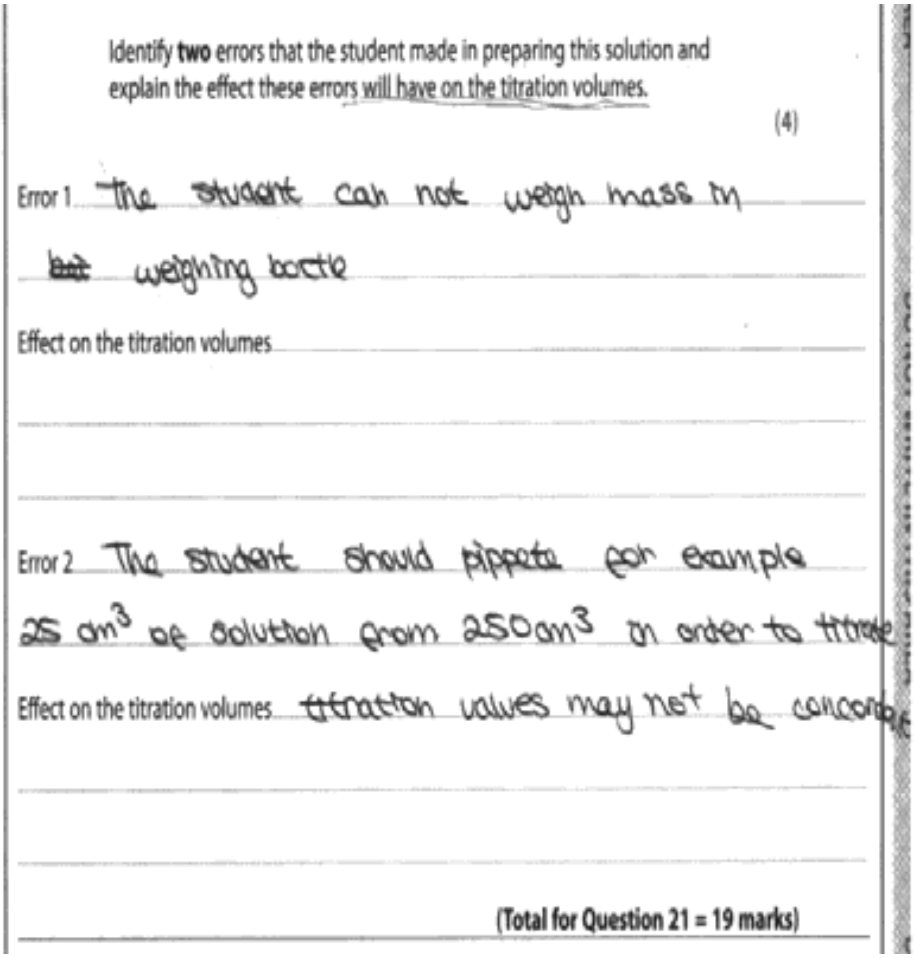
Item: QC0419000007014

Examiner Comment

This candidate appears to not know what a weighing bottle is used for. The second error refers to carrying out a titration, which is not relevant to this question. This response scored zero.

Examiner Tip

Carry out practical techniques, such as making up a standard solution, so that you know the correct procedure and can then identify errors.



Identify **two** errors that the student made in preparing this solution and explain the effect these errors will have on the titration volumes.

(4)

Error 1 The student can not weigh mass in the weighing bottle

Effect on the titration volumes

Error 2 The student should pipette for example 25 cm^3 of solution from 250 cm^3 in order to titrate

Effect on the titration volumes titration values may not be concord

(Total for Question 21 = 19 marks)

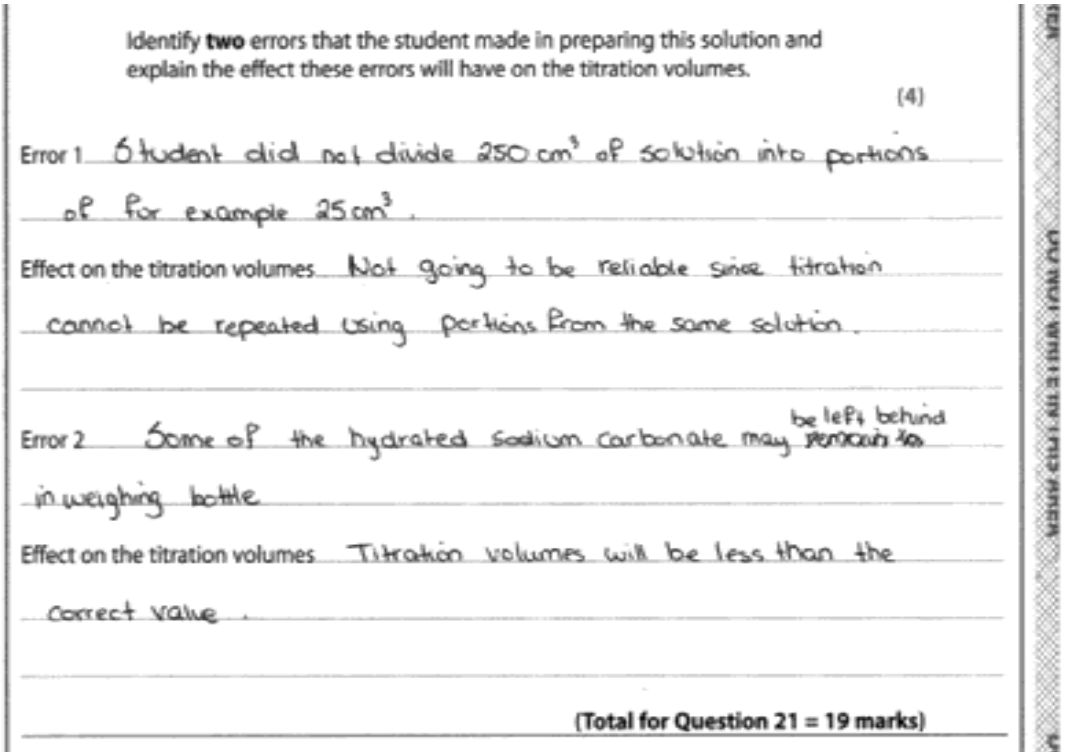
Item: QC0419000006760

Examiner Comment

The answer in Error 1 did not score a mark as it refers to carrying out a titration. However, the first statement in Error 2 is correct as is the effect on the titration volume. However, only one mark was scored as there was no explanation for the change in titration volume.

Examiner Tip

When a question asks for an explanation, you must include a reason for your answer. For example, in this answer the candidate could have stated that the titration volume would be less because the concentration of the sodium carbonate will be lower than expected.



Identify **two** errors that the student made in preparing this solution and explain the effect these errors will have on the titration volumes.

(4)

Error 1 Student did not divide 250 cm^3 of solution into portions of for example 25 cm^3.

Effect on the titration volumes Not going to be reliable since titration cannot be repeated using portions from the same solution.

Error 2 Some of the hydrated sodium carbonate may be left behind in weighing bottle

Effect on the titration volumes Titration volumes will be less than the correct value.

(Total for Question 21 = 19 marks)

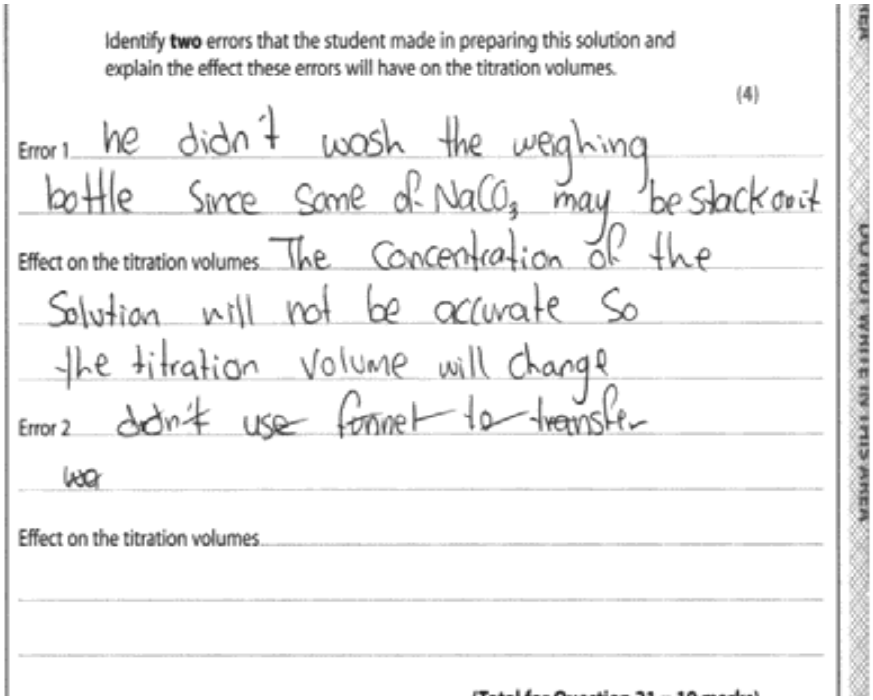
Item: QC0419000006622

Examiner Comment

This response scored 1 mark for Error 1. The candidate has made an attempt to explain by referring to the concentration and titration, volume but just stating that it is not accurate and will change are not precise enough. You must state how they will change.

Examiner Tip

Give clear reasons for your answers in explanations.



Identify **two** errors that the student made in preparing this solution and explain the effect these errors will have on the titration volumes.

(4)

Error 1 he didn't wash the weighing bottle since some of $NaCO_3$ may be stack on it

Effect on the titration volumes The concentration of the Solution will not be accurate so the titration volume will change

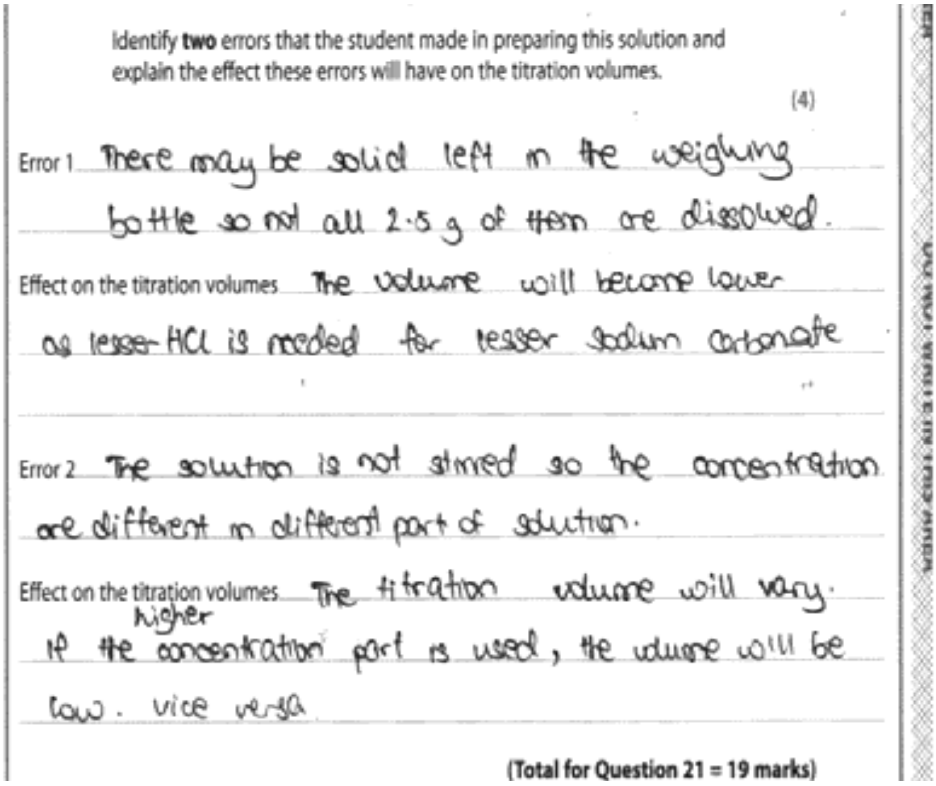
Error 2 didn't use funnel to transfer wer

Effect on the titration volumes

Item: QC0419000006634

Examiner Comment

This is a very good answer that scored three marks. The first error is correct as is the effect on the titration volume but there is not quite enough explanation as 'lesser sodium carbonate' is really just repeating the comment in the error. It would have been better explained in terms of the lower concentration of the sodium carbonate solution. The second error is acceptable, although it would have been better as not shaken instead of not stirred but the candidate has the correct idea that the solution has not been mixed. The explanation is very good.



Identify **two** errors that the student made in preparing this solution and explain the effect these errors will have on the titration volumes.

(4)

Error 1 There may be solid left in the weighing bottle so not all 2·5 g of them are dissolved.

Effect on the titration volumes The volume will become lower as lesser HCl is needed for lesser sodium carbonate

Error 2 The solution is not stirred so the concentration are different in different part of solution.

Effect on the titration volumes The titration volume will vary. If the higher concentration part is used, the volume will be low. vice versa

(Total for Question 21 = 19 marks)

WCH02_01_Q21di-ii

Question Introduction

Some candidates were able to carry out both parts of the calculation correctly and were awarded full marks. Common errors included: mixing up the volumes of sodium carbonate solution and hydrochloric acid, not using the mole ratio of 1:2 from the equation, not multiplying the number of moles of sodium carbonate in 25 cm^3 by 10 to determine the number of moles in 250 cm^3, not knowing how to calculate the molar mass from the number of moles and the mass of sodium carbonate and not knowing how to determine the value of x. Some candidates used an alternative method to find the value of x in (ii), which is acceptable, but they then needed to calculate the molar mass for the second mark.

Item: QC0419000006748

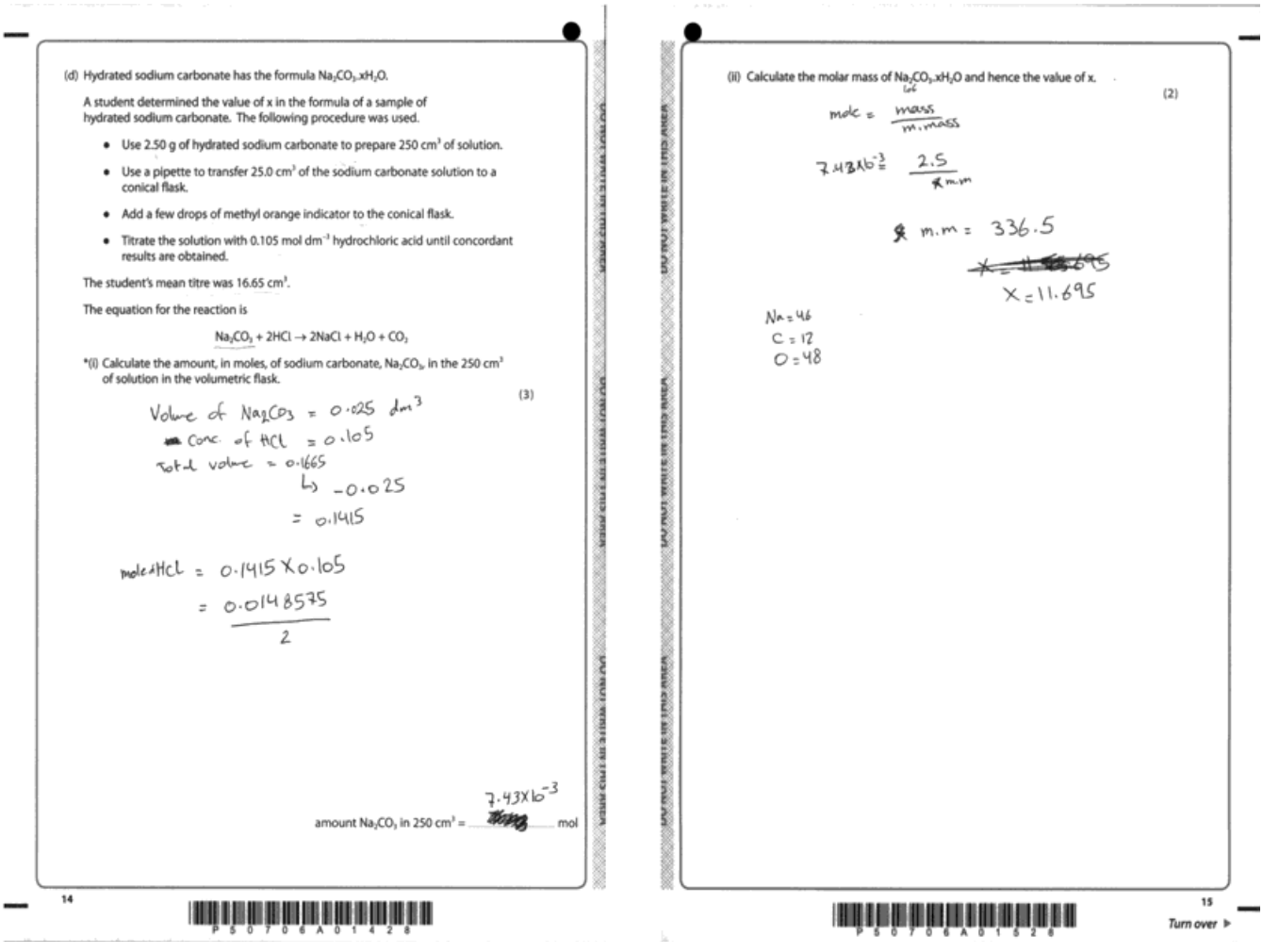
Examiner Comment

(i) This is quite a confused answer with incorrect calculation. However, the candidate has divided the moles of hydrochloric acid by 2 to determine the number of moles of sodium carbonate and this was awarded one mark.

(ii) The candidate has worked out a correct molar mass from the number of moles of sodium carbonate they calculated in (i). They could have scored the second mark if they had used that to calculate the number of moles of water correctly. It should be 12,8 from their molar mass. One mark was awarded.

Examiner Tip

Set out your working clearly so that even if you make a mistake in one step, the examiner can award marks for subsequent steps that are correct.



(d) Hydrated sodium carbonate has the formula $Na_2CO_3.xH_2O$.

A student determined the value of x in the formula of a sample of hydrated sodium carbonate. The following procedure was used.

- Use 2.50 g of hydrated sodium carbonate to prepare 250 cm^3 of solution.
- Use a pipette to transfer 25.0 cm^3 of the sodium carbonate solution to a conical flask.
- Add a few drops of methyl orange indicator to the conical flask.
- Titrate the solution with 0.105 mol dm^{-3} hydrochloric acid until concordant results are obtained.

The student's mean titre was 16.65 cm^3.

The equation for the reaction is

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

*(i) Calculate the amount, in moles, of sodium carbonate, Na_2CO_3, in the 250 cm^3 of solution in the volumetric flask. (3)

Volume of Na_2CO_3 = 0.025 dm^3
Conc of HCl = 0.105
Total volume = 0.1665
− 0.025
= 0.1415

mole HCl = 0.1415 × 0.105
= 0.014857 5
2

amount Na_2CO_3 in 250 cm^3 = 7.43×10^{-3} mol

14

(ii) Calculate the molar mass of $Na_2CO_3.xH_2O$ and hence the value of x. (2)

mole = mass / m.mass

7.43×10^{-3} = 2.5 / m.m

m.m = 336.5

x = 11.695

Na = 46
C = 12
O = 48

15

Turn over ▶

Item: QC0419000006747

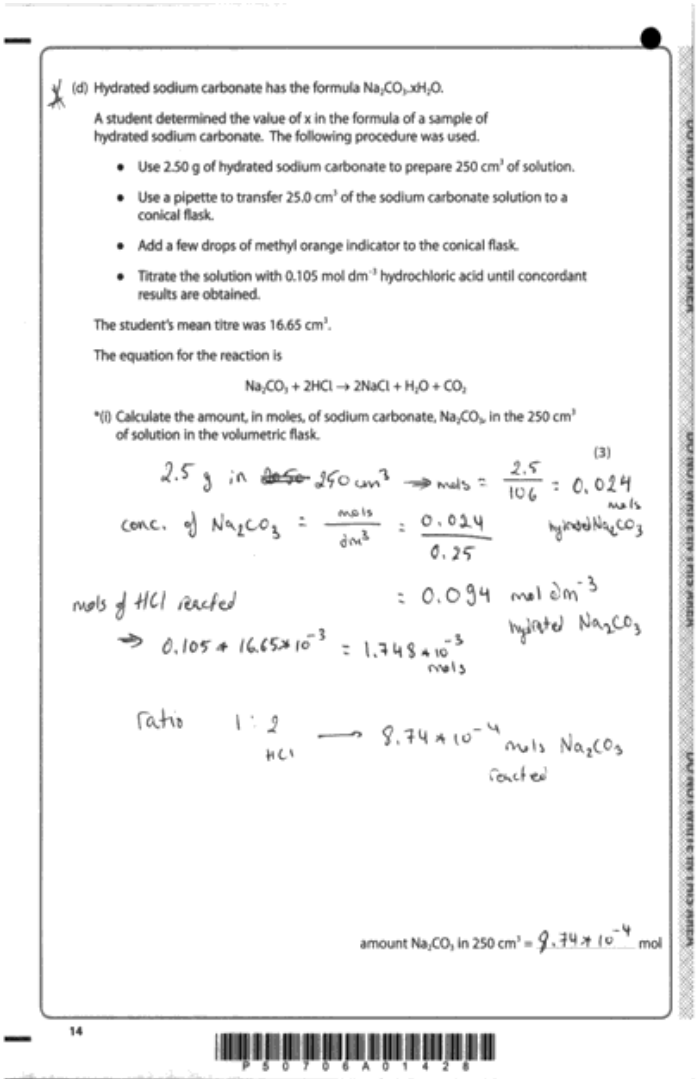
Examiner Comment

(i) This candidate has carried out the first 2 steps of the calculation correctly but has not taken account of the change in volume to 250 cm^3. This response scored two marks.
(ii)They have used their answer to (i) correctly to calculate a molar mass and value for x so scored two marks.

Examiner Tip

Use all the data given in the question and read the question carefully. The question clearly states that candidates need to calculate the number of moles of sodium carbonate in 250 cm^3 of solution.

If you get an answer that seems incorrect, for example, in this question 2860.4 is extremely high for the molar mass of a hydrated salt and 153 moles of water is obviously incorrect, go back and check your working to see if you can find your error.



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The student's mean titre was 16.65 cm^3.

The equation for the reaction is

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

*(i) Calculate the amount, in moles, of sodium carbonate, Na_2CO_3, in the 250 cm^3 of solution in the volumetric flask. (3)

2.5 g in ~~250~~ 250 cm^3 → mols = $\frac{2.5}{106}$ = 0.024 mols hydrated Na_2CO_3

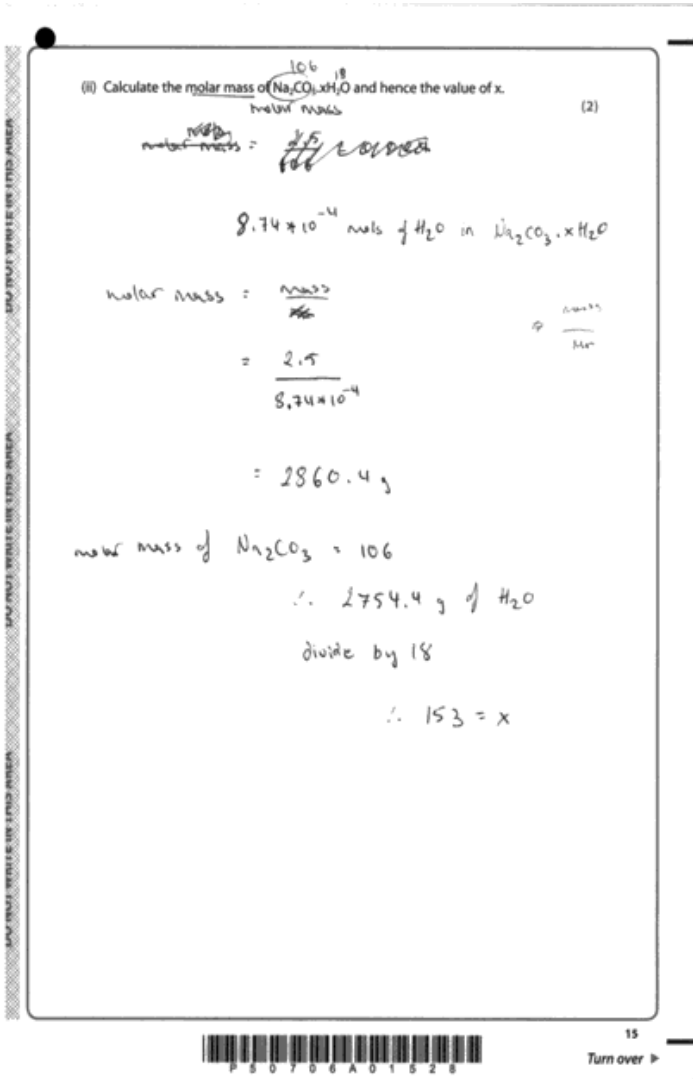
conc. of Na_2CO_3 = $\frac{\text{mols}}{dm^3}$ = $\frac{0.024}{0.25}$ = 0.094 mol dm^{-3} hydrated Na_2CO_3

mols of HCl reacted → $0.105 \times 16.65 \times 10^{-3} = 1.748 \times 10^{-3}$ mols

ratio 1 : 2 (HCl) → 8.74×10^{-4} mols Na_2CO_3 reacted

amount Na_2CO_3 in 250 cm^3 = 8.74×10^{-4} mol

14



(ii) Calculate the molar mass of $Na_2CO_3.xH_2O$ and hence the value of x. (2)

molar mass = ~~mass~~ / moles

8.74×10^{-4} mols of H_2O in $Na_2CO_3.xH_2O$

molar mass = $\frac{\text{mass}}{\text{moles}}$ = $\frac{2.5}{8.74 \times 10^{-4}}$ = 2860.4 g

molar mass of Na_2CO_3 = 106

∴ 2754.4 g of H_2O

divide by 18

∴ 153 = x

15

Turn over ▶

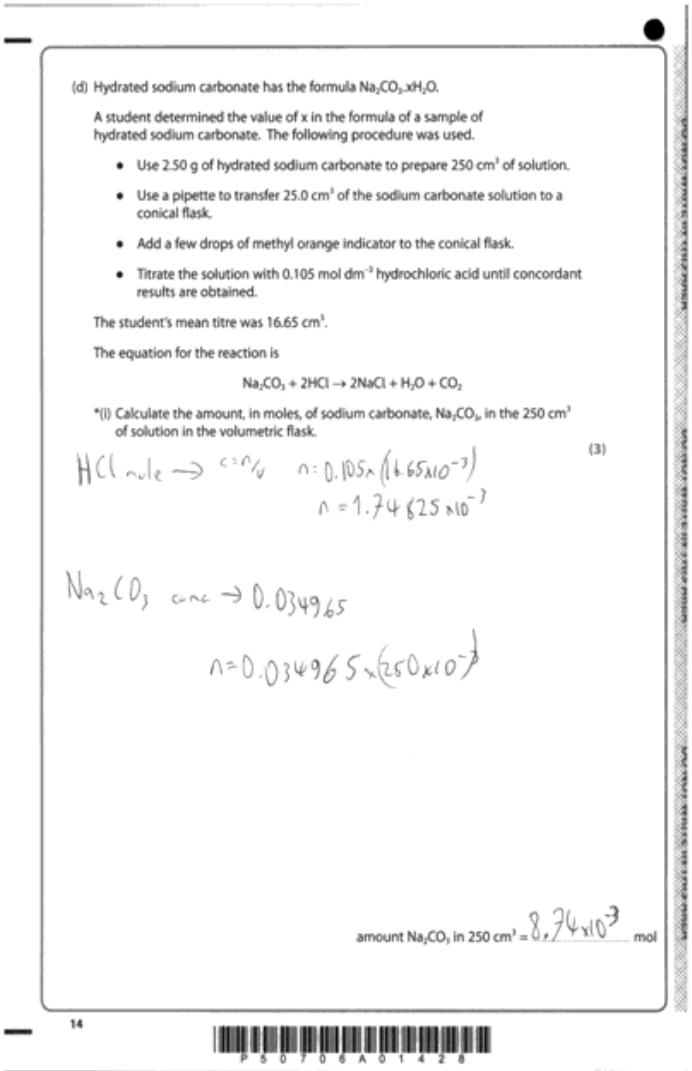
Item: QC0419000008184

Examiner Comment

(i) This is correct for three marks.
(ii) The candidate has started the calculation correctly but has calculated the percentage of water instead of the number of moles so scored zero.

Examiner Tip

Read the question carefully and check that you have answered it and not made up a different question.



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The equation for the reaction is

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

*(i) Calculate the amount, in moles, of sodium carbonate, Na_2CO_3, in the 250 cm^3 of solution in the volumetric flask. (3)

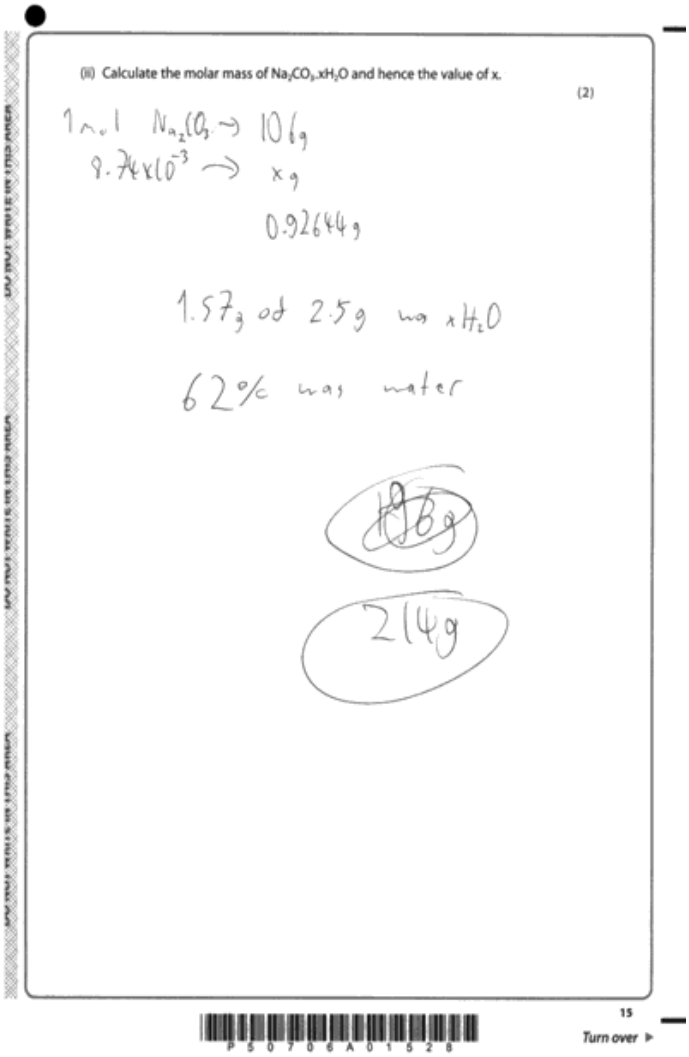
HCl mole → conc $n = 0.105 \times (16.65 \times 10^{-3})$
$n = 1.74825 \times 10^{-3}$

Na_2CO_3 conc → 0.034965

$n = 0.034965 \times (250 \times 10^{-3})$

amount Na_2CO_3 in 250 cm^3 = 8.74×10^{-3} mol

14



(ii) Calculate the molar mass of $Na_2CO_3.xH_2O$ and hence the value of x. (2)

1 mol Na_2CO_3 → 106 g
8.74×10^{-3} → x g
0.92644 g

1.57 g of 2.5 g was xH_2O

62% was water

~~108~~ g

214 g

15

Turn over ▶

Item: QC0419000006571

Examiner Comment

This is an excellent answer that scored full marks.

Examiner Tip

Set out your calculation clearly, as in this example.

(d) Hydrated sodium carbonate has the formula $Na_2CO_3.xH_2O$.

A student determined the value of x in the formula of a sample of hydrated sodium carbonate. The following procedure was used.

- Use 2.50 g of hydrated sodium carbonate to prepare 250 cm^3 of solution.
- Use a pipette to transfer 25.0 cm^3 of the sodium carbonate solution to a conical flask.
- Add a few drops of methyl orange indicator to the conical flask.
- Titrate the solution with 0.105 mol dm^{-3} hydrochloric acid until concordant results are obtained.

The student's mean titre was 16.65 cm^3.

The equation for the reaction is

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

*(i) Calculate the amount, in moles, of sodium carbonate, Na_2CO_3, in the 250 cm^3 of solution in the volumetric flask.

(3)

$n(HCl) = \frac{16.65}{1000}\ dm^3 \times 0.105\ mol\ dm^{-3} = 1.75 \times 10^{-3}\ mol$

$n(Na_2CO_3) = \frac{1}{2} \times 1.748 \times 10^{-3}\ mol = 8.74 \times 10^{-4}\ mol$

$n(Na_2CO_3)$ in 250 $cm^3 = \frac{250}{25} \times 8.74 \times 10^{-4}\ mol = 8.74 \times 10^{-3}\ mol$

amount Na_2CO_3 in 250 $cm^3 =$ 8.74×10^{-3} mol

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(ii) Calculate the molar mass of $Na_2CO_3.xH_2O$ and hence the value of x.

(2)

$M(Na_2CO_3) = \frac{2.80\ g}{8.74 \times 10^{-3}\ mol} = 286.50\ g\ mol^{-1}$

$M(Na_2CO_3) = 2(23) + 12 + 3(16) = 106\ g\ mol^{-1}$

$286.50 - 106.00 = 180.0\ g\ mol^{-1}$

$x = 10$

Turn over ▶

WCH02_01_Q22a

Question Introduction

The majority of candidates could identify the halogen as iodine.

WCH02_01_Q22b

Question Introduction

It was disappointing that a large number of candidates were unable to work out the oxidation numbers of fluorine and oxygen in all of the species in the equation. A significant number thought that oxygen would be -2 in OF_2, even though fluorine is the more electronegative atom and has the negative oxidation number. Quite a lot of candidates thought that the oxidation number of oxygen in OH^- is -1, presumably just writing down the overall charge. A common error was to assume that this was a disproportionation reaction. Many candidates tried to explain the redox reaction in terms of gain or loss of electrons, even though the question asked for it in terms of oxidation numbers. Many candidates would benefit from more experience in answering this style of question.

Item: QC0419000009407

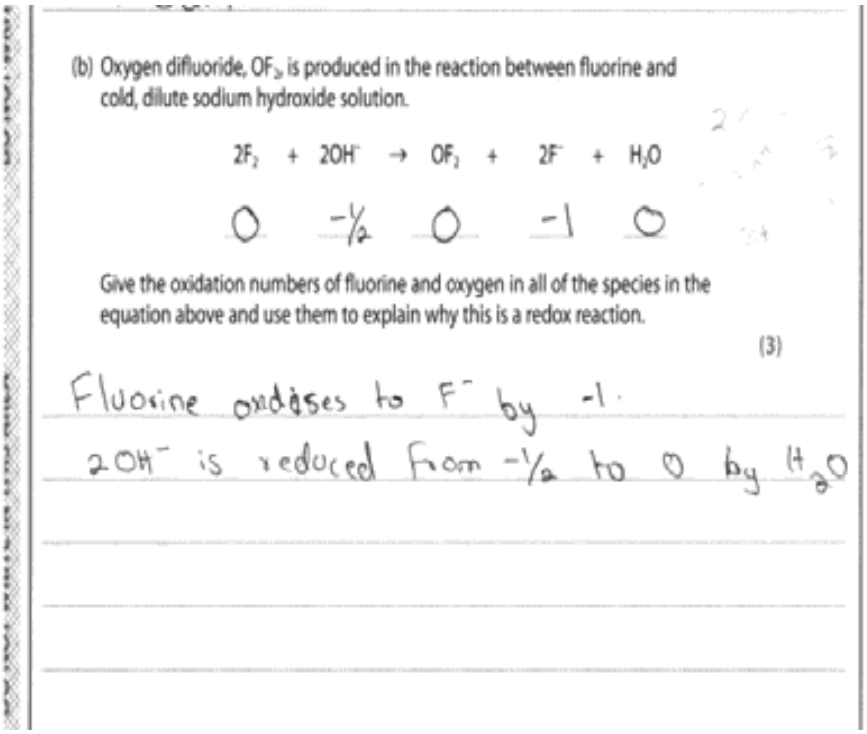
Examiner Comment

Only 2 oxidation numbers are correct - those in F_2 and F^-. This response scores zero as the oxidation numbers of oxygen and fluorine in both reactants must be correct for one mark. This candidate has also confused oxidation and reduction. Fluorine has decreased in oxidation number so has been reduced.

Examiner Tip

Learn the rules for working out oxidation numbers.

Remember that oxidation occurs when there is an increase in oxidation number and reduction occurs when there is a decrease in oxidation number.



(b) Oxygen difluoride, OF_2, is produced in the reaction between fluorine and cold, dilute sodium hydroxide solution.

$2F_2 + 2OH^- \rightarrow OF_2 + 2F^- + H_2O$

0 -½ 0 -1 0

Give the oxidation numbers of fluorine and oxygen in all of the species in the equation above and use them to explain why this is a redox reaction.

(3)

Fluorine oxidises to F^- by -1.

$2OH^-$ is reduced from -½ to 0 by H_2O

Item: QC0419000008541

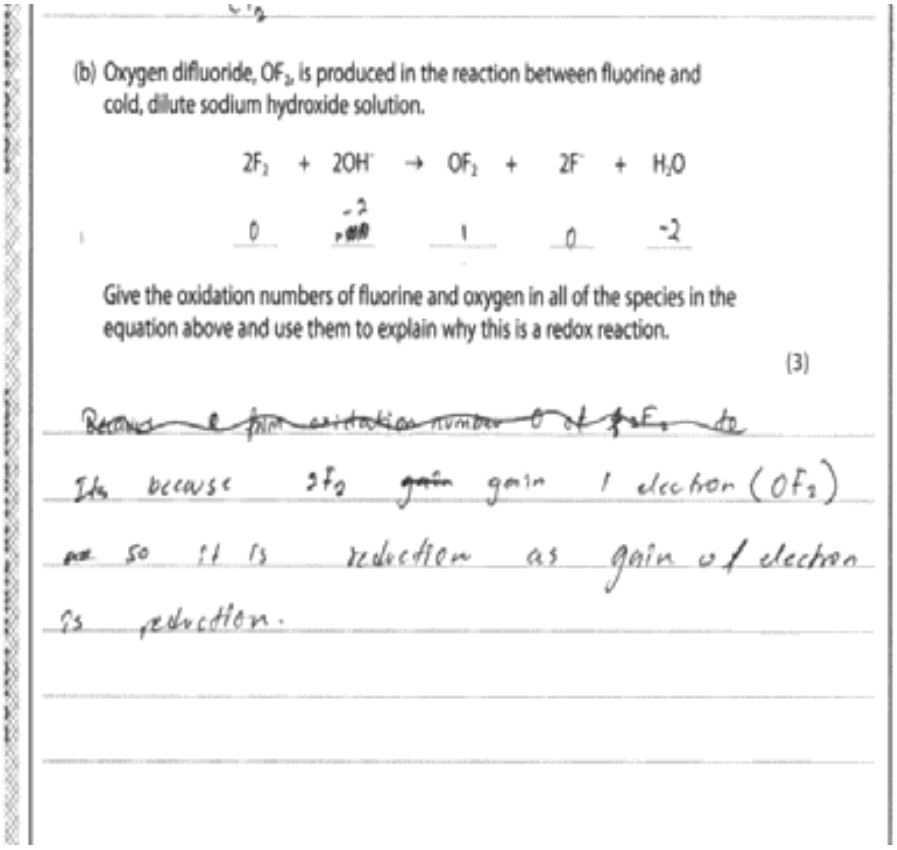
Examiner Comment

The oxidation numbers in the reactants are correct but the products are incorrect as is the explanation. This response scored one mark.

Examiner Tip

Learn the rules for working out oxidation numbers.

Read the question carefully. This question asks for an explanation in terms of oxidation numbers. You will not be given any credit for explaining it in terms of gain or loss of electrons.



(b) Oxygen difluoride, OF_2, is produced in the reaction between fluorine and cold, dilute sodium hydroxide solution.

$$2F_2 + 2OH^- \rightarrow OF_2 + 2F^- + H_2O$$

0 -2 +1 0 -2

Give the oxidation numbers of fluorine and oxygen in all of the species in the equation above and use them to explain why this is a redox reaction.

(3)

Because ~~a gain oxidation number 0 of F_2 to~~

Its because $2F_2$ ~~gain~~ gain 1 electron (OF_2)

so it is reduction as gain of electron

is reduction.

Item: QC0419000008569

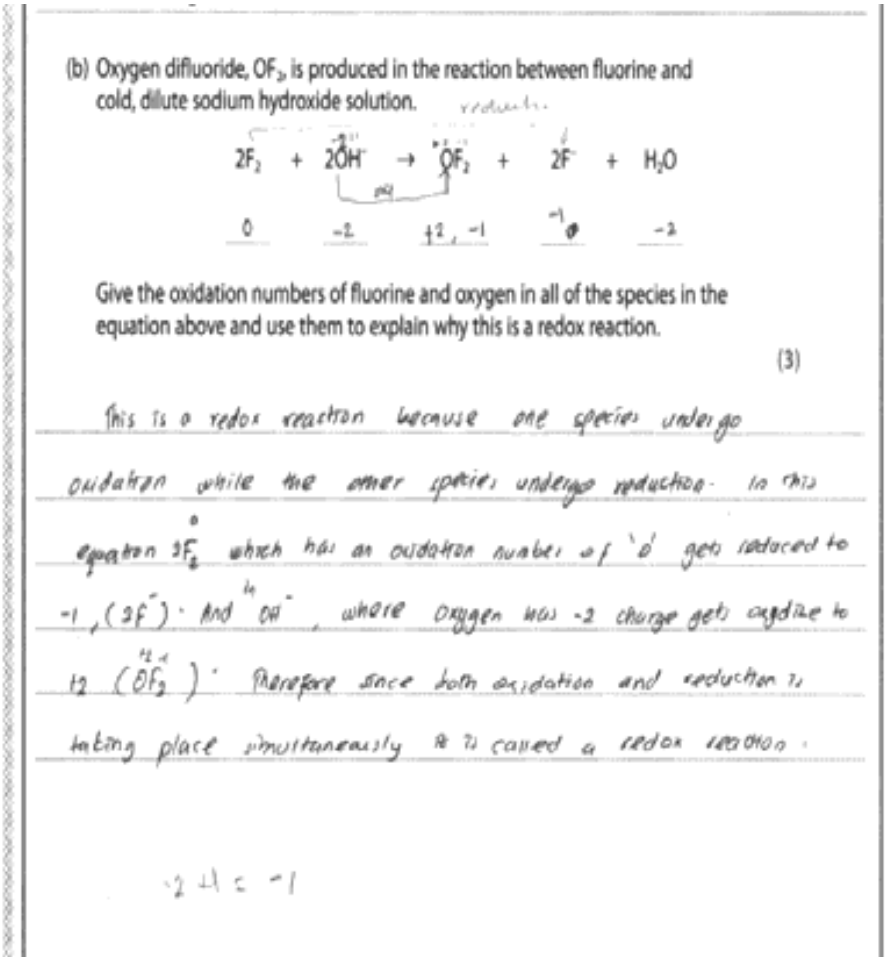
Examiner Comment

This is an excellent answer scoring three marks.

Examiner Tip

Make sure that you know the rules for working out oxidation numbers.

Write clear explanations for what is oxidised, what is reduced and the reason why.



(b) Oxygen difluoride, OF_2, is produced in the reaction between fluorine and cold, dilute sodium hydroxide solution.

$$2F_2 + 2OH^- \rightarrow OF_2 + 2F^- + H_2O$$

0 −2 +2, −1 −1 −2

Give the oxidation numbers of fluorine and oxygen in all of the species in the equation above and use them to explain why this is a redox reaction.

(3)

This is a redox reaction because one species undergo oxidation while the other species undergo reduction. In this equation F_2^0 which has an oxidation number of '0' gets reduced to −1, ($2F^-$). And OH^-, where Oxygen was −2 charge gets oxidise to +2 (OF_2). Therefore since both oxidation and reduction is taking place simultaneously it is called a redox reaction.

−2 + 1 = −1

WCH02_01_Q22c

Question Introduction

Many candidates were able to multiply the chlorine half-equation by four, add it to the thiosulfate half-equation and cancel the electrons to give the overall ionic equation. Common errors included: missing charges on some species, missing a species, not multiplying the chlorine half-equation by 4, multiplying Cl_2 by 4 but forgetting to do the same for the chloride ions, leaving electrons in the overall equation and copying the formula of thiosulfate ions incorrectly.

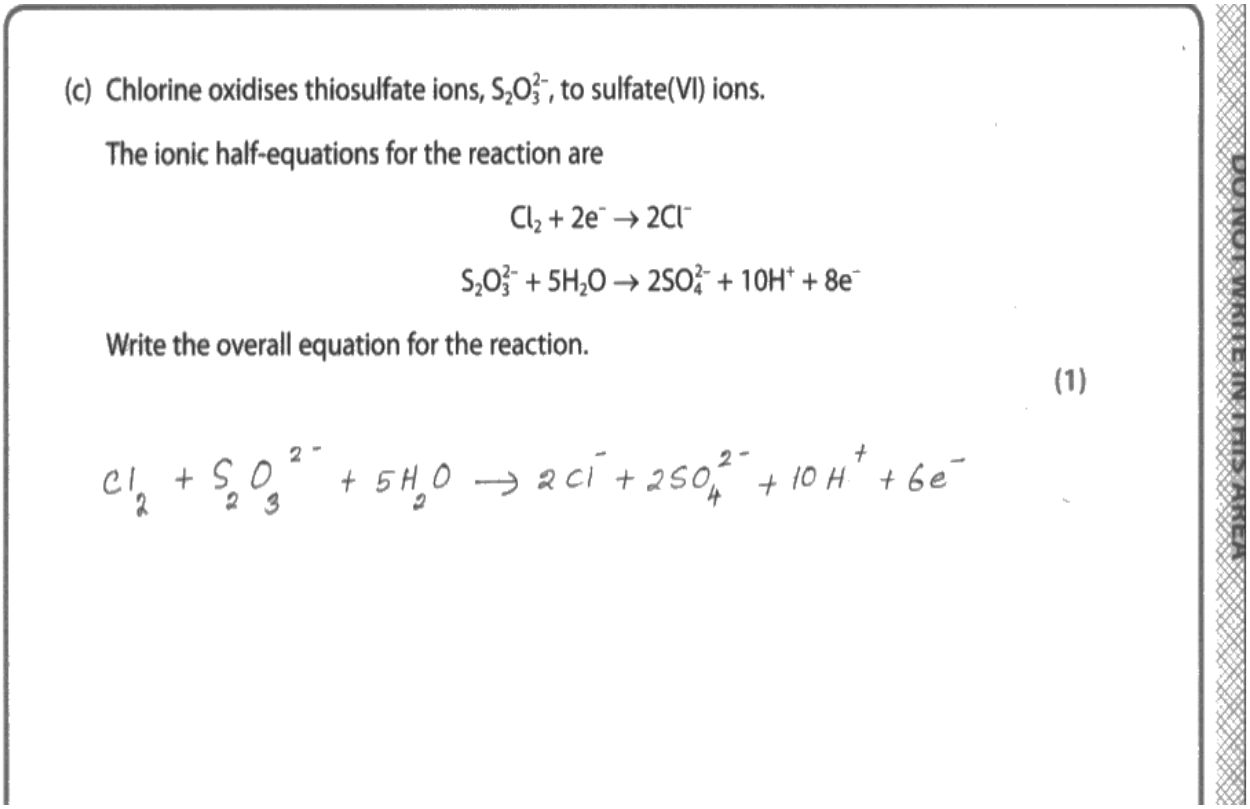
Item: QC0419000009774

Examiner Comment

This candidate has just added the half-equations together so the overall equation is not balanced and there are electrons on the right-hand side. This equation scored zero.

Examiner Tip

The electrons on the left-hand side and right-hand side must be the same so they cancel. Remember to multiply the half-equations by appropriate numbers so the electrons will cancel.



(c) Chlorine oxidises thiosulfate ions, $S_2O_3^{2-}$, to sulfate(VI) ions.

The ionic half-equations for the reaction are

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

$$S_2O_3^{2-} + 5H_2O \rightarrow 2SO_4^{2-} + 10H^+ + 8e^-$$

Write the overall equation for the reaction.

(1)

$Cl_2 + S_2O_3^{2-} + 5H_2O \rightarrow 2Cl^- + 2SO_4^{2-} + 10H^+ + 6e^-$

DO NOT WRITE IN THIS AREA

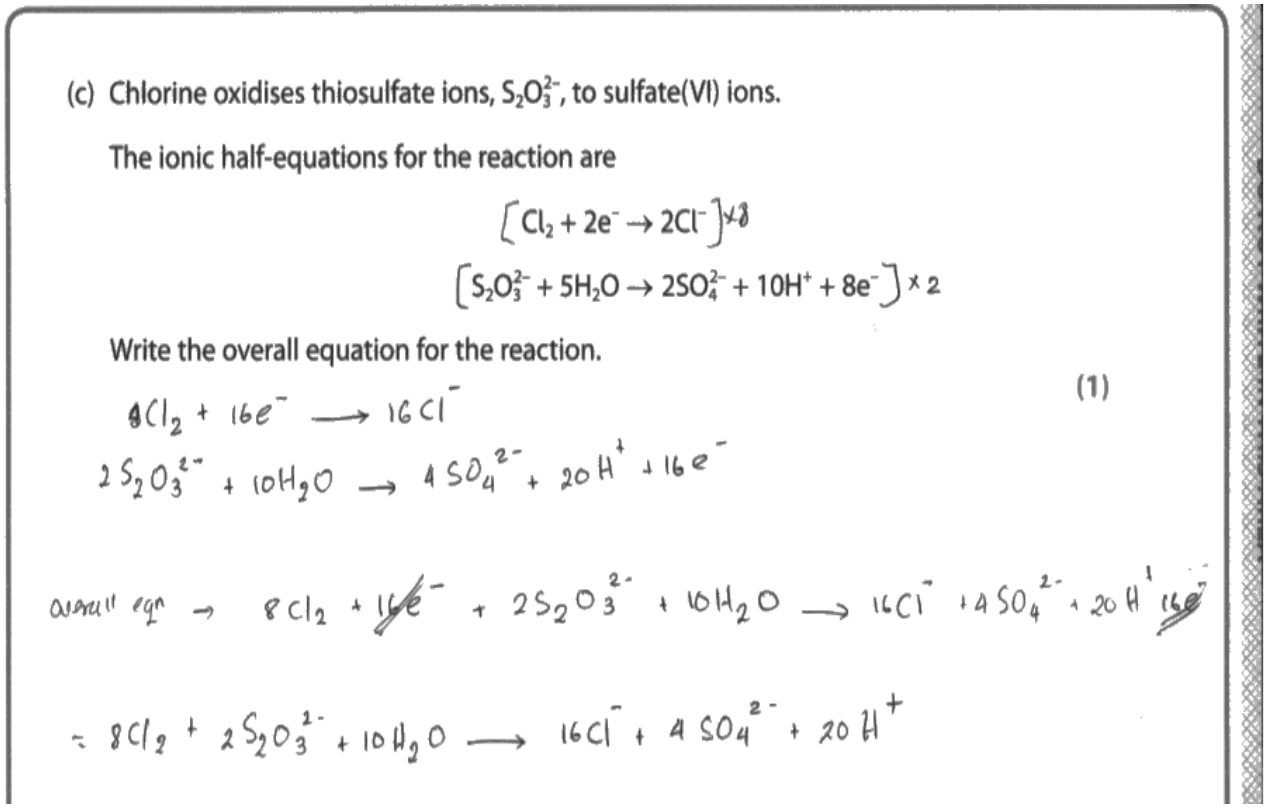
Item: QC0419000008569

Examiner Comment

This is an example of a correct answer. The candidate has shown their working and has multiplied the chlorine half-equation by 8 and the thiosulfate half-equation by 2 so there are 16 electrons on bothe sides of the equation. This is acceptable and scored 1 mark.

Examiner Tip

Work out the overall equation by writing down the multiplied half-equations, as shown in this example.



(c) Chlorine oxidises thiosulfate ions, $S_2O_3^{2-}$, to sulfate(VI) ions.

The ionic half-equations for the reaction are

$[Cl_2 + 2e^- \rightarrow 2Cl^-] \times 8$

$[S_2O_3^{2-} + 5H_2O \rightarrow 2SO_4^{2-} + 10H^+ + 8e^-] \times 2$

Write the overall equation for the reaction.

(1)

$8Cl_2 + 16e^- \longrightarrow 16Cl^-$

$2S_2O_3^{2-} + 10H_2O \longrightarrow 4SO_4^{2-} + 20H^+ + 16e^-$

overall eqn → $8Cl_2 + 16e^- + 2S_2O_3^{2-} + 10H_2O \longrightarrow 16Cl^- + 4SO_4^{2-} + 20H^+ + 16e^-$

$= 8Cl_2 + 2S_2O_3^{2-} + 10H_2O \longrightarrow 16Cl^- + 4SO_4^{2-} + 20H^+$

WCH02_01_Q22di

Question Introduction

A significant minority of candidates did not read the question carefully and attempted to explain the trend in the boiling temperatures of the hydrogen halides. Many candidates are familiar with instantaneous dipoles or could describe them. However, only a minority of candidates realised that they induce a dipole in a neighbouring molecule. Many candidates mentioned induced dipoles but either did not say where these dipoles are induced, or implied they are within the same molecule. Common errors included: referring to electronegativity, hydrogen bonding, dipole-dipole attractions, ions or delocalised electrons,

Item: QC0419000009769

Examiner Comment

This candidate has not read the question and has tried to explain why the London forces increase down Group 7. This response scored zero.

Examiner Tip

Read the question carefully and check that you have answered the question written.

(d) The boiling temperatures of the hydrogen halides are shown.

Hydrogen halide	Boiling temperature / K
HF	293
HCl	188
HBr	206
HI	238

*(i) London forces are present in **all** of these compounds.

Describe how these forces arise.

(2)

As we go down the group the electron cloud increases as the shells increases.

Repulsive force that occurs when the electrons is added to outer ~~last~~ ~~electron~~ shell.

Increase in electron cloud increases the london force.

Item: QC0419000008190

Examiner Comment

This response scores one mark for the mention of instantaneous dipoles. It would need a clear description of where the induced dipoles are to score the second mark.

Examiner Tip

Revise how London forces arise, and make sure you know the difference between an instantaneous dipole and an induced dipole.

(d) The boiling temperatures of the hydrogen halides are shown.

Hydrogen halide	Boiling temperature / K
HF	293
HCl	188
HBr	206
HI	238

*(i) London forces are present in **all** of these compounds.

Describe how these forces arise.

(2)

London forces are weak forces created by induced or instantaneous dipole attraction

Item: QC0419000007014

Examiner Comment

This is an excellent answer that gives a clear description of how London forces arise. It scored two marks.

(d) The boiling temperatures of the hydrogen halides are shown.

Hydrogen halide	Boiling temperature / K
HF	293
HCl	188
HBr	206
HI	238

*(i) London forces are present in **all** of these compounds.

Describe how these forces arise.

(2)

There will be fluctuations in the electron density ~~which~~ leading ~~leading~~ to a temporary dipole. This induces dipole in neighbouring molecule leading to attractions between molecules.

WCH02_01_Q22dii

Question Introduction

Many candidates did know that hydrogen iodide has stronger London forces as the molecules have more electrons. A few candidates referred to iodide ions, which is incorrect. Some candidates compared the size or mass of the iodine and bromine atoms but those are not sufficient to score the mark.

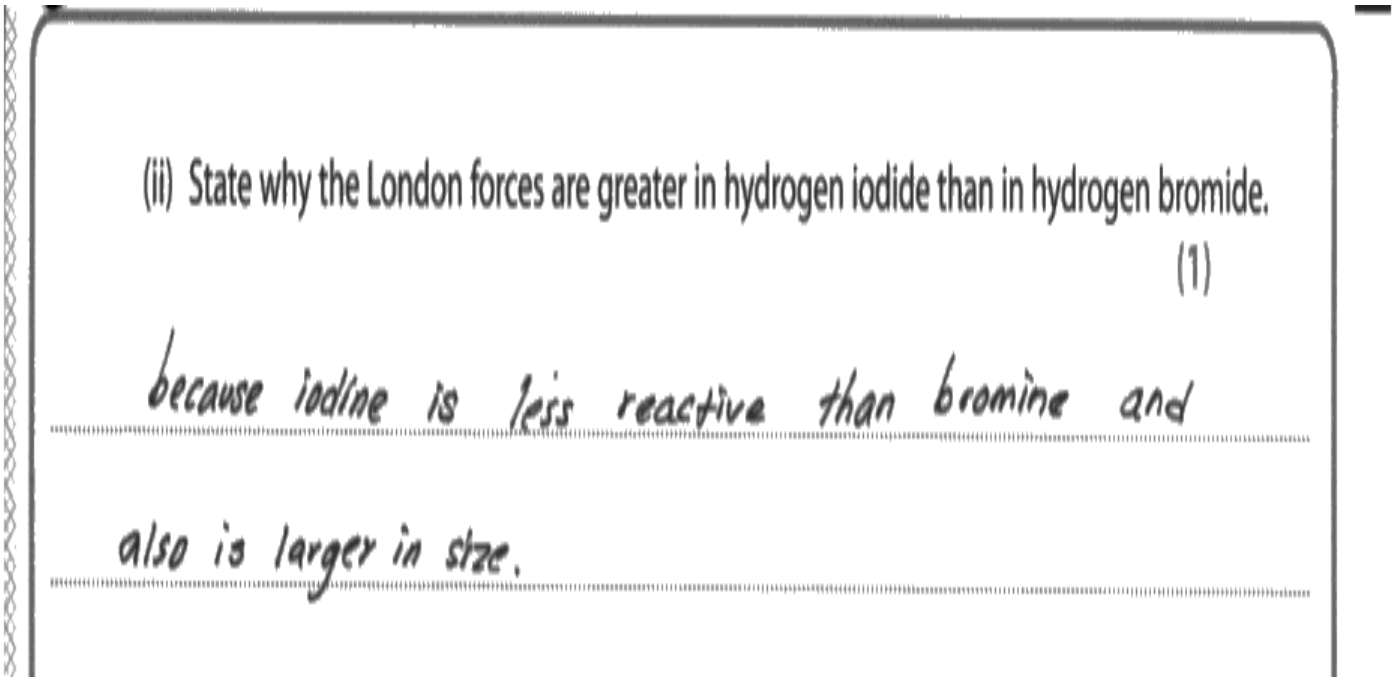
Item: QC0419000008575

Examiner Comment

Both of the points that the candidate has written are correct but neither of them explain why the London forces are greater in hydrogen iodide than hydrogen bromide. This response scored zero.

Examiner Tip

Remember that the strength of the London forces increases as the number of electrons in the molecule increases.



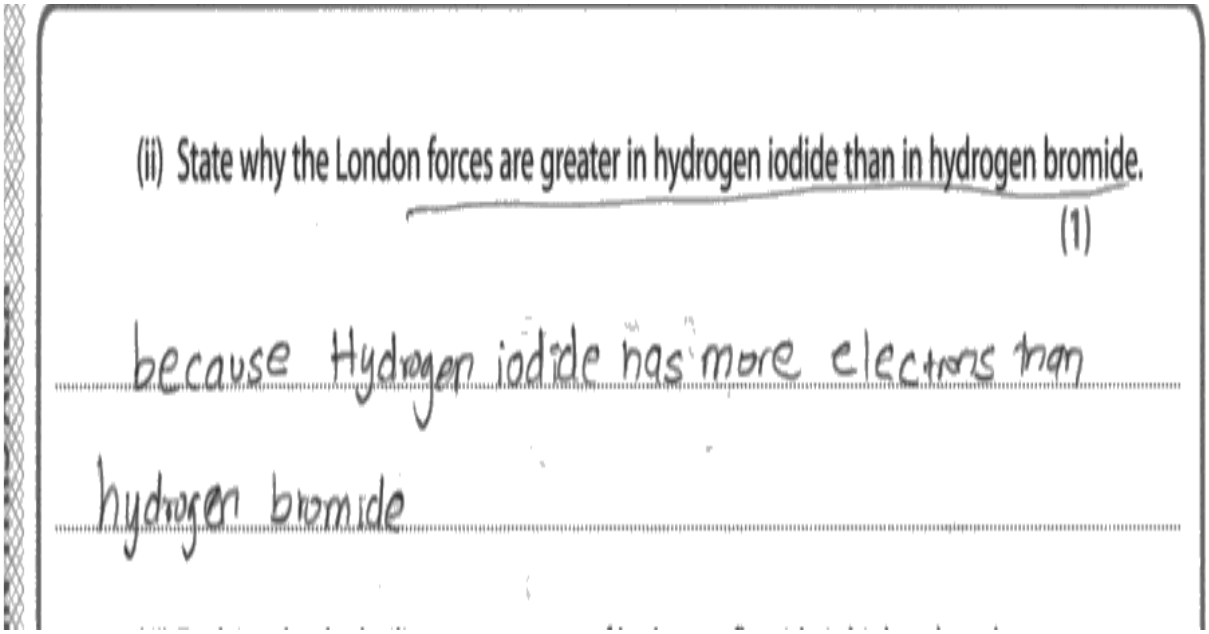
Item: QC0419000009402 Examiner

Comment

This response is correct and scored one.

Examiner Tip

Learn why London forces have different strengths between different molecules.



WCH02_01_Q22diii

Question Introduction

The majority of candidates identified hydrogen bonding in hydrogen fluoride but not all of them stated that it is stronger than the London forces in hydrogen chloride. Some candidates described why there is hydrogen bonding in hydrogen fluoride but that was not necessary here. A few candidates thought that the London forces are greater in hydrogen fluoride. Some candidates clearly stated that the hydrogen-halogen covalent bond broke when these compounds boil and others did not make it clear whether they were referring to the covalent bond or the intermolecular forces breaking. Candidates should be encouraged to be clear with their scientific language and should avoid the use of the word 'bond' when discussing intermolecular forces unless it specifically refers to hydrogen bonds.

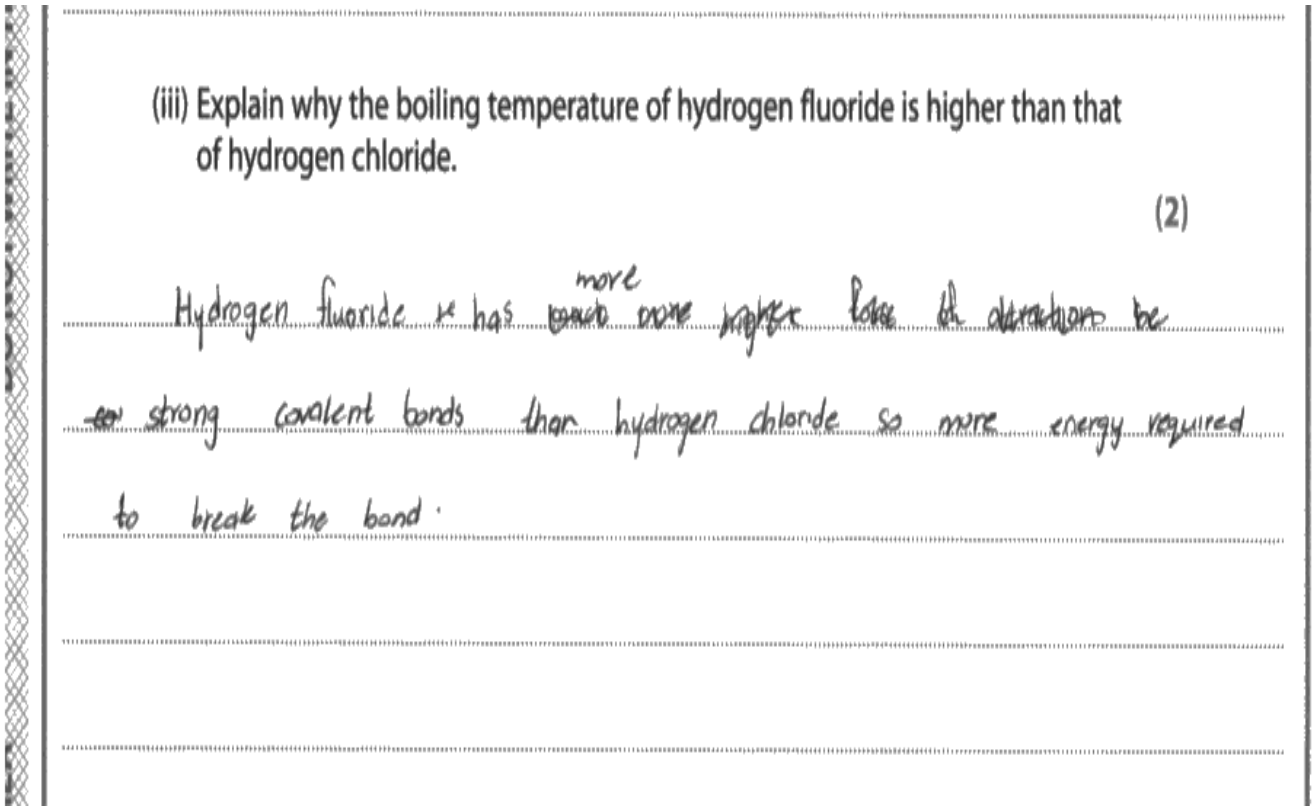
Item: QC0419000008576

Examiner Comment

This candidate has written about covalent bonds, which is incorrect. This response scored zero.

Examiner Tip

Remember that it is only the weak intermolecular forces in simple covalent molecular structures that are broken when the substance melts or boils.



(iii) Explain why the boiling temperature of hydrogen fluoride is higher than that of hydrogen chloride.

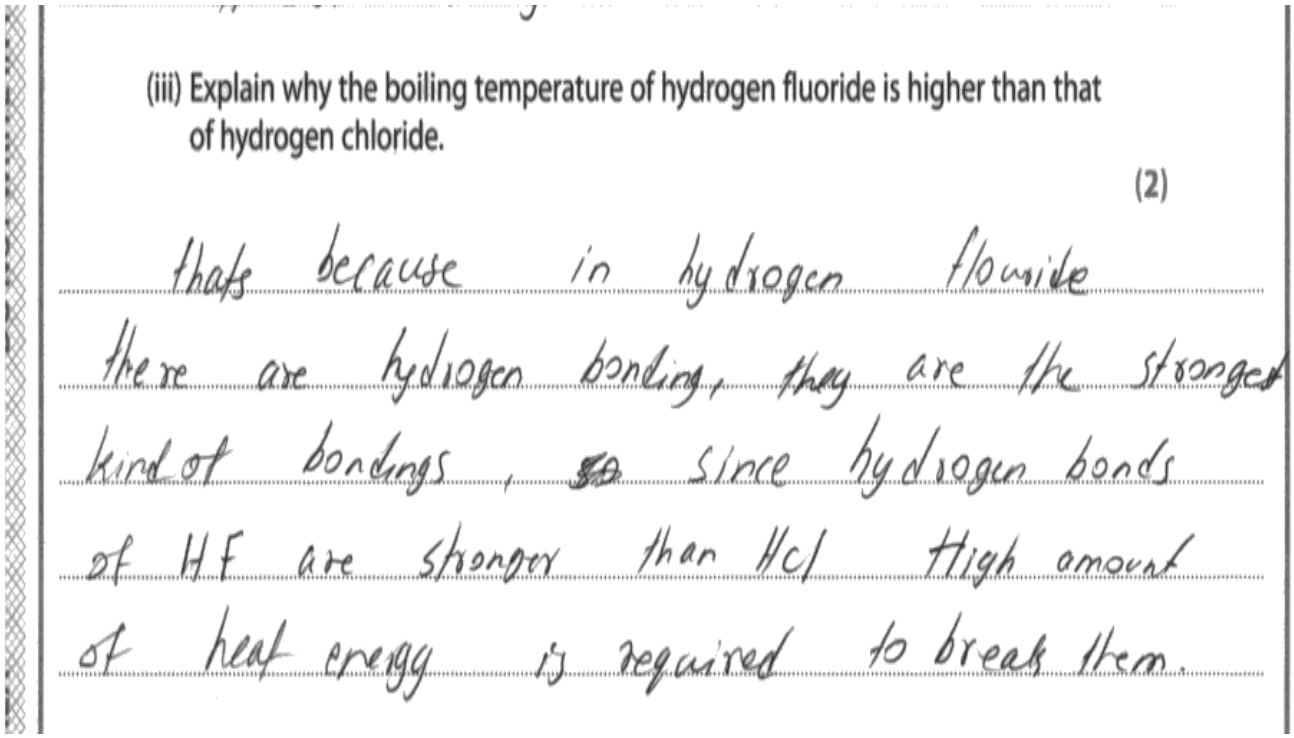
(2)

Hydrogen fluoride ~~is~~ has more ~~covalent~~ ~~more~~ higher ~~than~~ than the attraction be ~~ew~~ strong covalent bonds than hydrogen chloride so more energy required to break the bond.

Item: QC0419000009428

Examiner Comment

This candidate has identified hydrogen bonding in hydrogen fluoride. However, the phrase 'since hydrogen bonds of HF are stronger than HCl' implies that there is hydrogen bonding in HCl as well, which is incorrect. This response scored one mark. If the candidate had included '...stronger than the London forces in HCl', they would have scored two marks.



(iii) Explain why the boiling temperature of hydrogen fluoride is higher than that of hydrogen chloride.

(2)

thats because in hydrogen flouride there are hydrogen bonding, they are the strongest kind of bondings, so since hydrogen bonds of HF are stronger than HCl High amount of heat energy is required to break them.

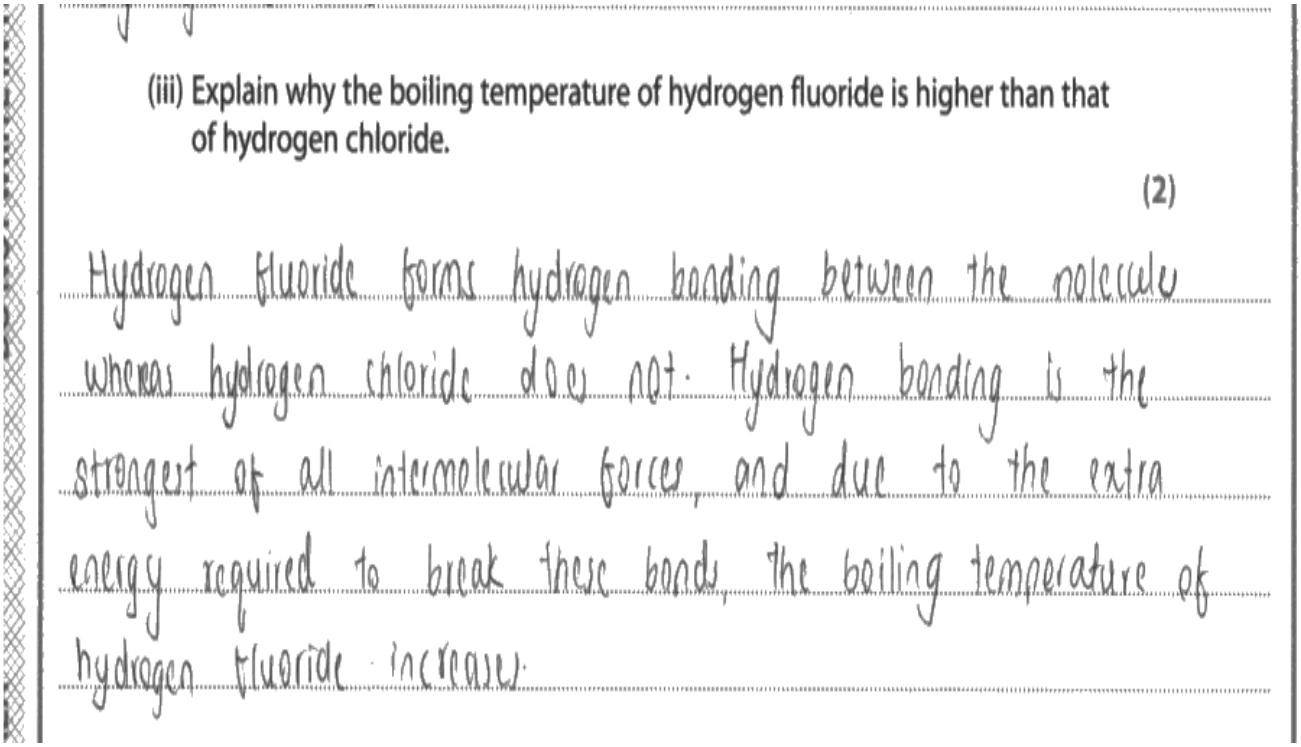
Item: QC0419000008564

Examiner Comment

This is an excellent answer that clearly explains the difference in boiling temperatures. This response scored two marks.

Examiner Tip

Revise intermolecular forces of attraction so that you can explain differences in boiling temperatures, as shown in this example.



(iii) Explain why the boiling temperature of hydrogen fluoride is higher than that of hydrogen chloride.

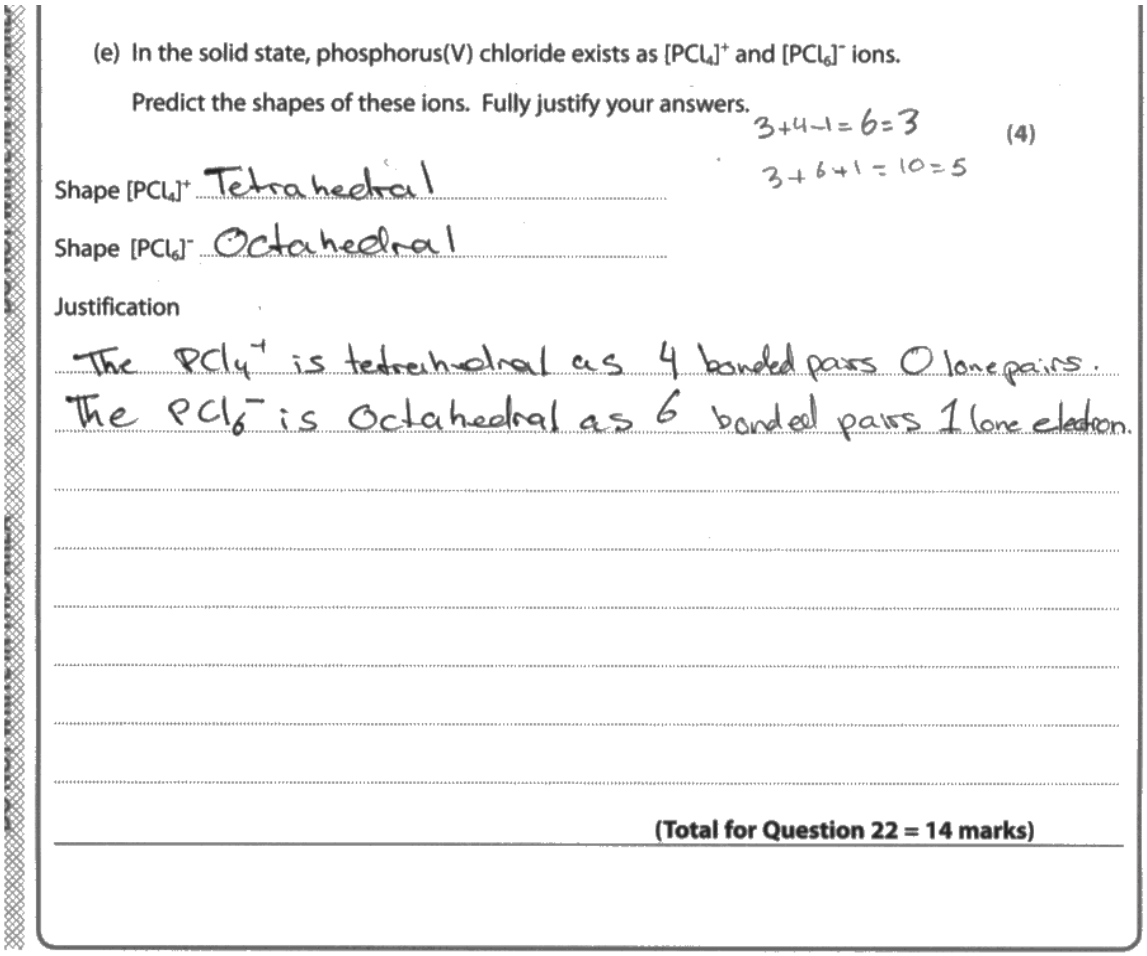
(2)

Hydrogen fluoride forms hydrogen bonding between the molecule whereas hydrogen chloride does not. Hydrogen bonding is the strongest of all intermolecular forces, and due to the extra energy required to break these bonds, the boiling temperature of hydrogen fluoride increase.

WCH02_01_Q22e

Question Introduction

It was disappointing that more candidates could not identify the shapes as tetrahedral and octahedral. Many variations of pyramidal were given and other shapes, such as hexagonal and octagonal. Some candidates worked out the numbers of bond pairs of electrons correctly, although some included lone pairs so lost the mark. Candidates should learn that the shape is caused by the electron pairs arranging to minimise repulsion between them, rather than bonds or atoms.



(e) In the solid state, phosphorus(V) chloride exists as $[PCl_4]^+$ and $[PCl_6]^-$ ions.

Predict the shapes of these ions. Fully justify your answers. (4)

3+4−1 = 6 = 3

3+6+1 = 10 = 5

Shape $[PCl_4]^+$ Tetrahedral

Shape $[PCl_6]^-$ Octahedral

Justification

The PCl_4^+ is tetrahedral as 4 bonded pairs 0 lone pairs.

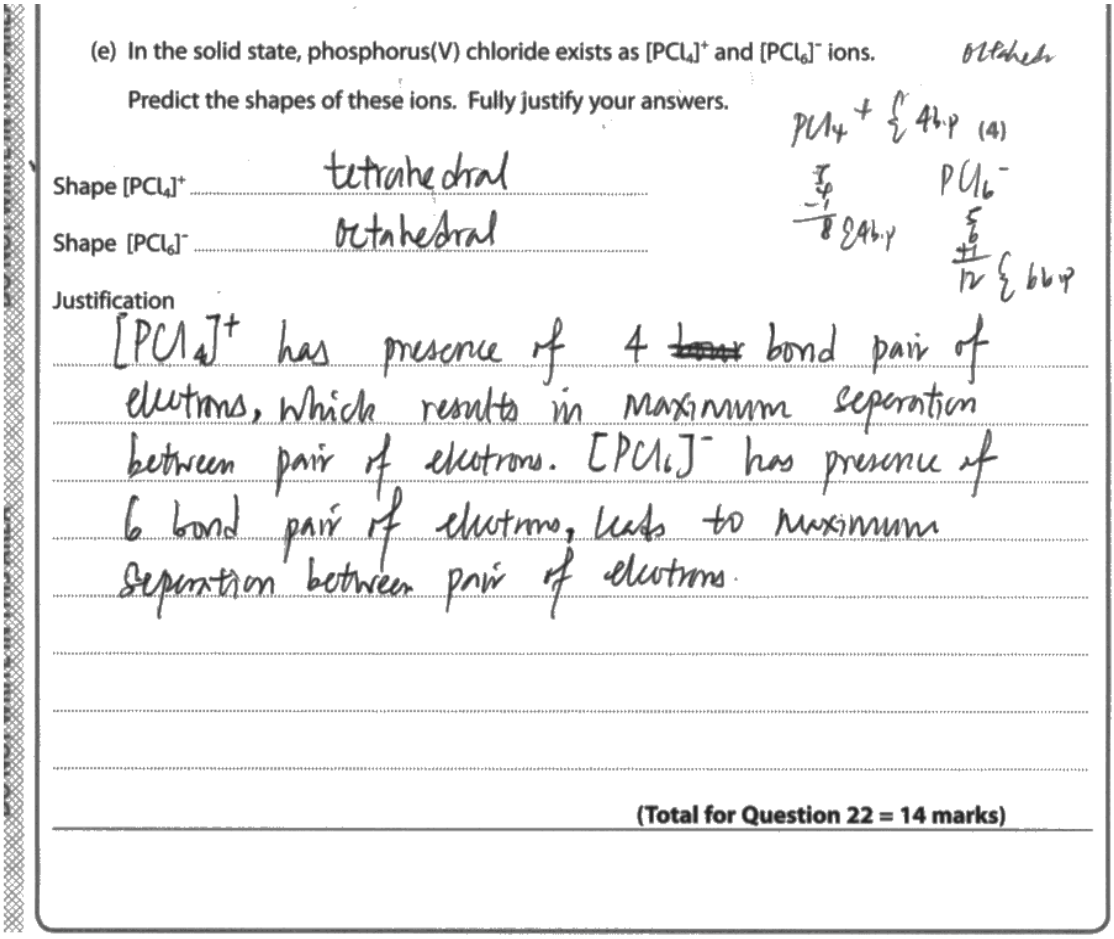
The PCl_6^- is Octahedral as 6 bonded pairs 1 lone electron.

(Total for Question 22 = 14 marks)

Item: QC0419000006635

Examiner Comment

This is an excellent answer with the correct shapes and a clear justification for these shapes. This response scored four marks.



(e) In the solid state, phosphorus(V) chloride exists as $[PCl_4]^+$ and $[PCl_6]^-$ ions.

Predict the shapes of these ions. Fully justify your answers.

Shape $[PCl_4]^+$ tetrahedral

Shape $[PCl_6]^-$ octahedral

Justification

$[PCl_4]^+$ has presence of 4 bond pair of electrons, which results in maximum seperation between pair of electrons. $[PCl_6]^-$ has presence of 6 bond pair of electrons, leads to maximum seperation between pair of electrons.

(Total for Question 22 = 14 marks)

WCH02_01_Q23ai

Question Introduction

It was surprising that only a minority of candidates scored full marks for completing this mechanism. Common errors included: omitting the dipole on the C-Br bond or showing full charges, not starting the curly arrow from the OH^- at the lone pair of electrons, the arrowhead from the OH^- curly arrow pointing into space or towards a bond and the curly arrow from the C-Br bond starting at the carbon atom or not finishing at the bromine atom. There were quite a number of candidates who just put curly arrows randomly between the atoms and bonds, showing that they did not understand what they mean. A few candidates clearly thought it was a free radical mechanism as they showed curly arrows with half-arrowheads and the formation of free radicals. However, some curly arrows were drawn carelessly and it was not clear whether they were full or half-headed. Candidates would benefit from more experience in writing mechanisms accurately and making sure that they understand the significance of the curly arrows.

Item: QC0419000008550

Examiner Comment

This response scored one mark for the curly arrow from the C-Br bond to the Br. The curly arrow from the OH^- ion seems to start from a space above the hydrogen atom.

Examiner Tip

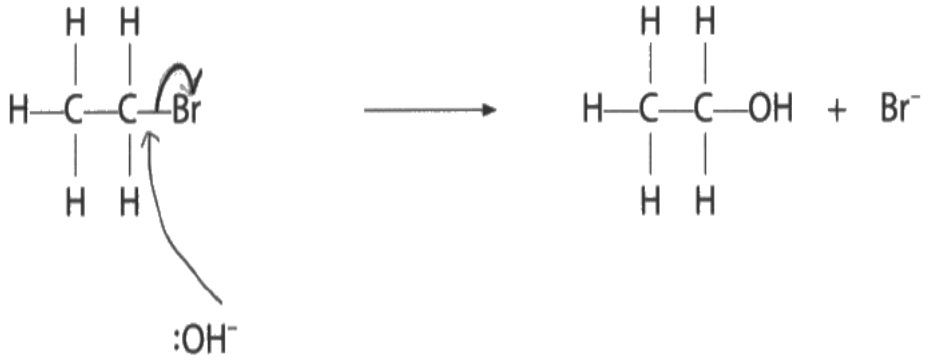
Curly arrows represent the movement of a pair of electrons. They must start from a covalent bond or a lone pair of electrons.

23 This question is about mechanisms involving halogenoalkanes.

(a) Bromoethane reacts with dilute aqueous potassium hydroxide in a nucleophilic substitution reaction to form ethanol.

(i) Complete the mechanism for the reaction by adding curly arrows and the relevant dipole.

(3)



Item: QC0419000009440

Examiner Comment

The dipole on the C-Br bond is correct and so is the curly arrow from the OH^- ion as it starts from close to the lone pair of electrons and points towards the carbon atom where the new bond will be formed. However, the curly arrow from the C-Br bond points back at the bond instead of towards the bromine atom. This response scored two marks.

Examiner Tip

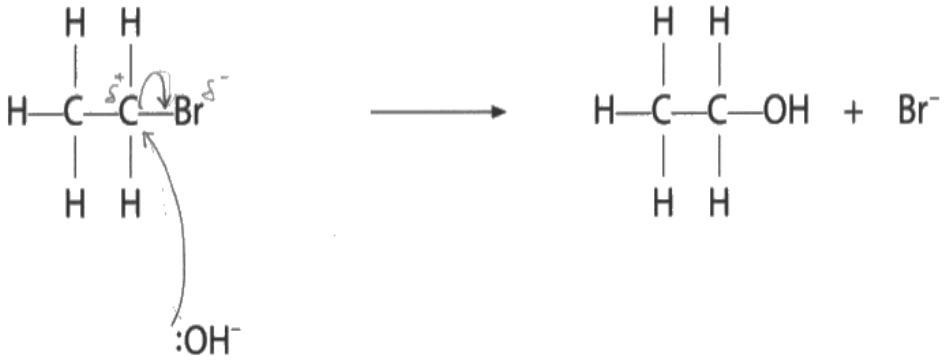
Curly arrows should point towards atoms, not bonds.

23 This question is about mechanisms involving halogenoalkanes.

(a) Bromoethane reacts with dilute aqueous potassium hydroxide in a nucleophilic substitution reaction to form ethanol.

(i) Complete the mechanism for the reaction by adding curly arrows and the relevant dipole.

(3)



Item: QC0419000009438

Examiner Comment

This is a good response that scored three marks.

Examiner Tip

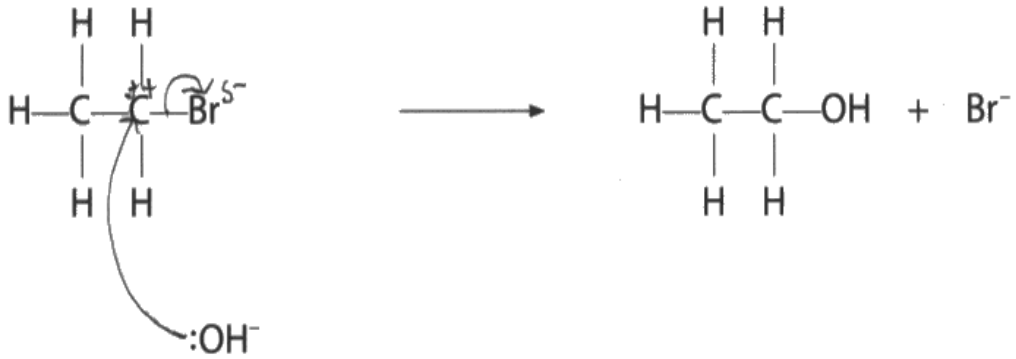
Draw the curly arrows accurately, as shown by this example. Don't forget to include the relevant dipole.

23 This question is about mechanisms involving halogenoalkanes.

(a) Bromoethane reacts with dilute aqueous potassium hydroxide in a nucleophilic substitution reaction to form ethanol.

(i) Complete the mechanism for the reaction by adding curly arrows and the relevant dipole.

(3)



WCH02_01_Q23aii

Question Introduction

A significant number of candidates did not read the question carefully and did not take note of 'in this mechanism' at the end of the sentence. As a consequence they wrote general descriptions of nucleophilic substitution. They could score one mark for two correct descriptions but this rarely happened as their descriptions were too vague. Quite a large number of candidates could describe substitution but they found nucleophilic more difficult. There were many vague answers seen, such as electron donor (instead of electron pair donor), an electron-rich species and seeking positive charges. Candidates should revise terms such as nucleophilic and electrophilic so they have a clear understanding of what they mean.

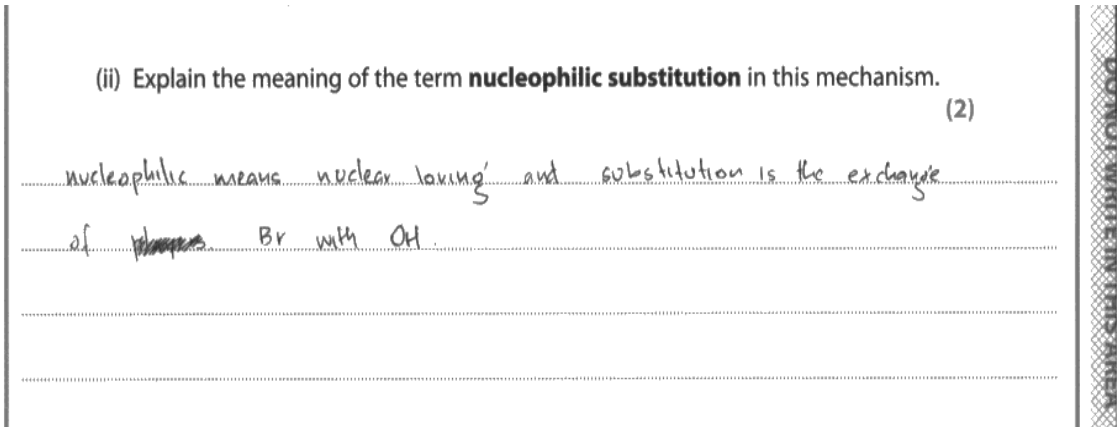
Item: QC0419000009772

Examiner Comment

This candidate has explained the meaning of substitution in the hydrolysis of bromoethane but 'nucleophilic means nucleus loving' is not a specific definition. This response scored one mark.

Examiner Tip

Learn the meaning of 'nucleophilic'.


(ii) Explain the meaning of the term **nucleophilic substitution** in this mechanism.

(2)

nucleophilic means nucleus loving's and substitution is the exchange of Br with OH.

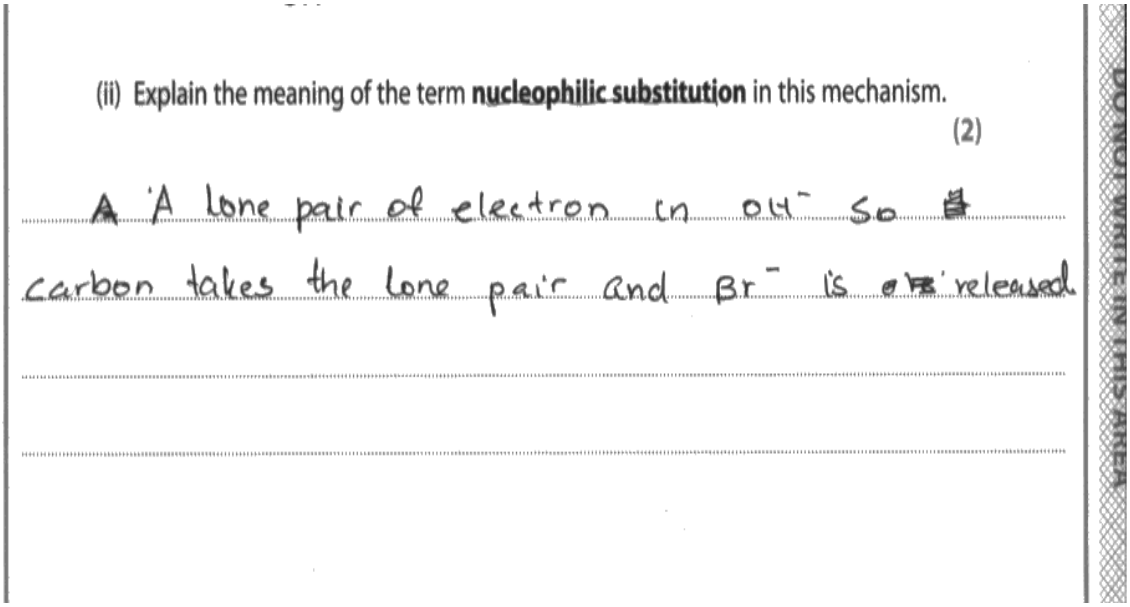
Item: QC0419000009405

Examiner Comment

This answer explains the meaning of nucleophilic substitution and refers to the reaction in the question.
This answer scored two marks.

Examiner Tip

Use the mechanism in the first part of the question to help you. In this question, you just needed to explain the mechanism in words.



(ii) Explain the meaning of the term **nucleophilic substitution** in this mechanism.

(2)

A 'A lone pair of electron in OH^- so carbon takes the lone pair and Br^- is released.

WCH02_01_Q23b

Question Introduction

The majority of candidates were able to write the correct equation. Some candidates tried to include additional species, such as oxygen or ozone, or to write additional steps. A small number of candidates omitted the dot to show the unpaired electron and a few wrote the equation in reverse.

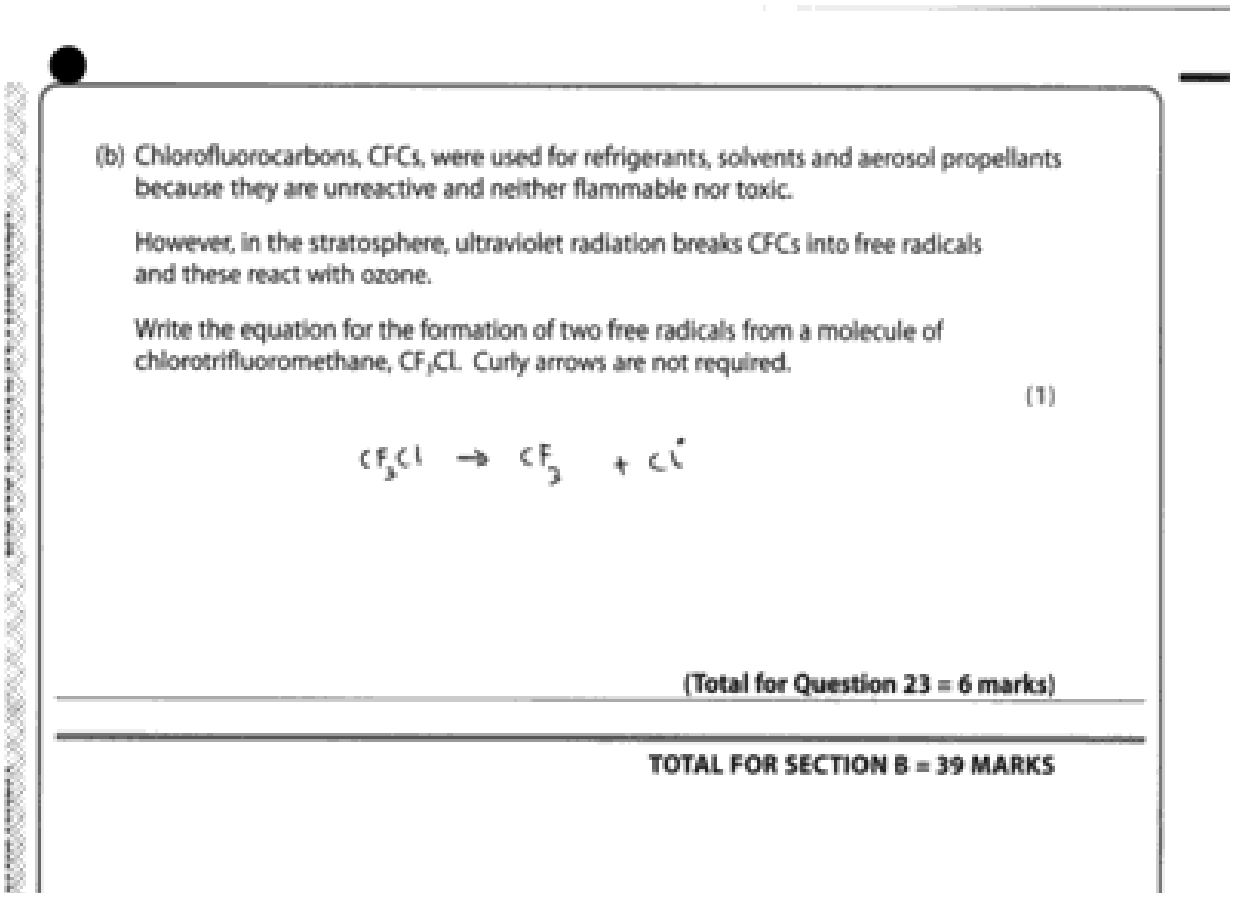
Item: QC0419000008550

Examiner Comment

This response scored zero as the candidate left out the dot to show that CF_3 has an unpaired electron.

Examiner Tip

Remember to include a dot by a free radical to show the unpaired electron.



(b) Chlorofluorocarbons, CFCs, were used for refrigerants, solvents and aerosol propellants because they are unreactive and neither flammable nor toxic.

However, in the stratosphere, ultraviolet radiation breaks CFCs into free radicals and these react with ozone.

Write the equation for the formation of two free radicals from a molecule of chlorotrifluoromethane, CF_3Cl. Curly arrows are not required.

(1)

$CF_3Cl \rightarrow CF_3 + Cl^{\bullet}$

(Total for Question 23 = 6 marks)

TOTAL FOR SECTION B = 39 MARKS

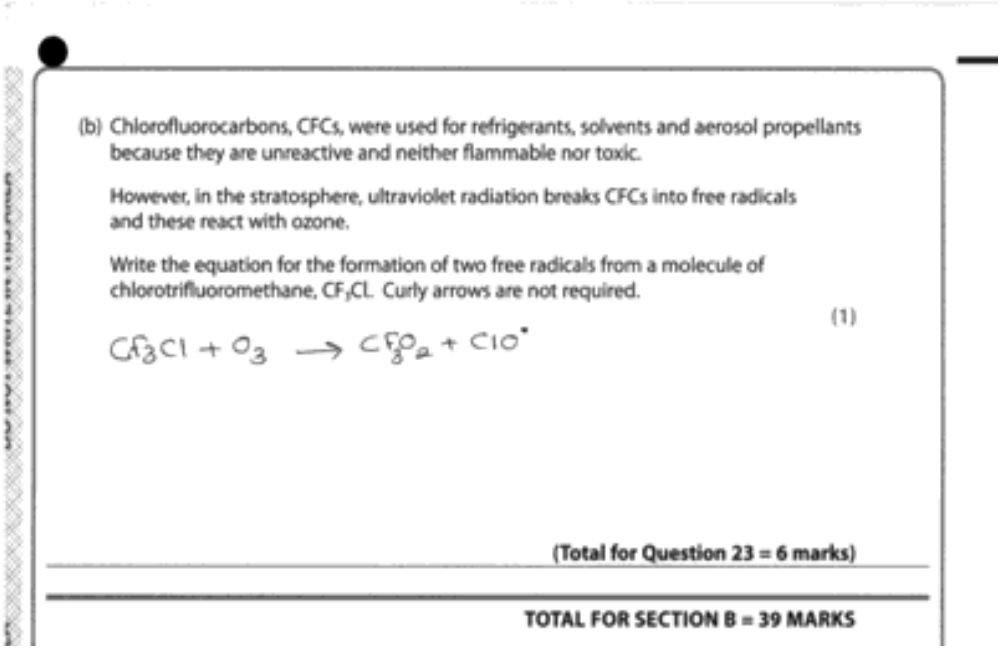
Item: QC0419000009404

Examiner Comment

This response scored 0 as the candidate has included ozone as a reactant.

Examiner Tip

Read the question carefully. It just asks for an equation for the formation of two free radicals from a molecule of chlorotrifluoromethane.



(b) Chlorofluorocarbons, CFCs, were used for refrigerants, solvents and aerosol propellants because they are unreactive and neither flammable nor toxic.

However, in the stratosphere, ultraviolet radiation breaks CFCs into free radicals and these react with ozone.

Write the equation for the formation of two free radicals from a molecule of chlorotrifluoromethane, CF_3Cl. Curly arrows are not required.

(1)

$CF_3Cl + O_3 \rightarrow CF_3O_2 + ClO^{\bullet}$

(Total for Question 23 = 6 marks)

TOTAL FOR SECTION B = 39 MARKS

WCH02_01_Q24ai

Question Introduction

Some candidates find it difficult to work out a molecular formula from a skeletal formula. They could practise this by writing the displayed formula or structural formula first then counting the number of each type of atom.

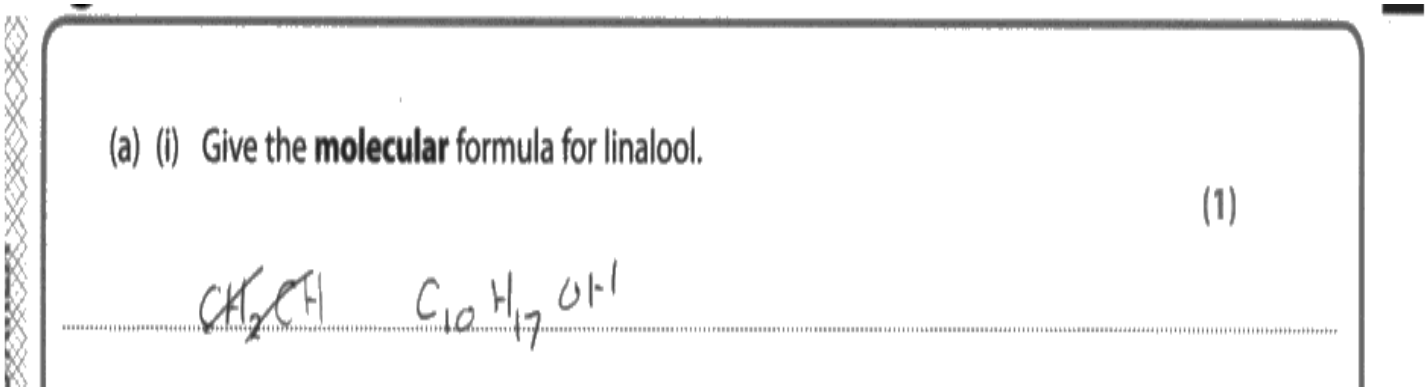
Item: QC0419000008567

Examiner Comment

This candidate has the correct numbers of each type of atom but this is not a molecular formula as there is a separate H at the end. It should be $C_{10}H_{18}O$. This response scored 0.

Examiner Tip

Revise the meaning of different types of formula, including empirical, molecular, structural, displayed and skeletal.



WCH02_01_Q24aii

Question Introduction

Less than half of the candidates were able to write the empirical formula for limonene.

Question Introduction

Many candidates did identify the two structural isomers but some included an additional, incorrect substance and lost the mark.

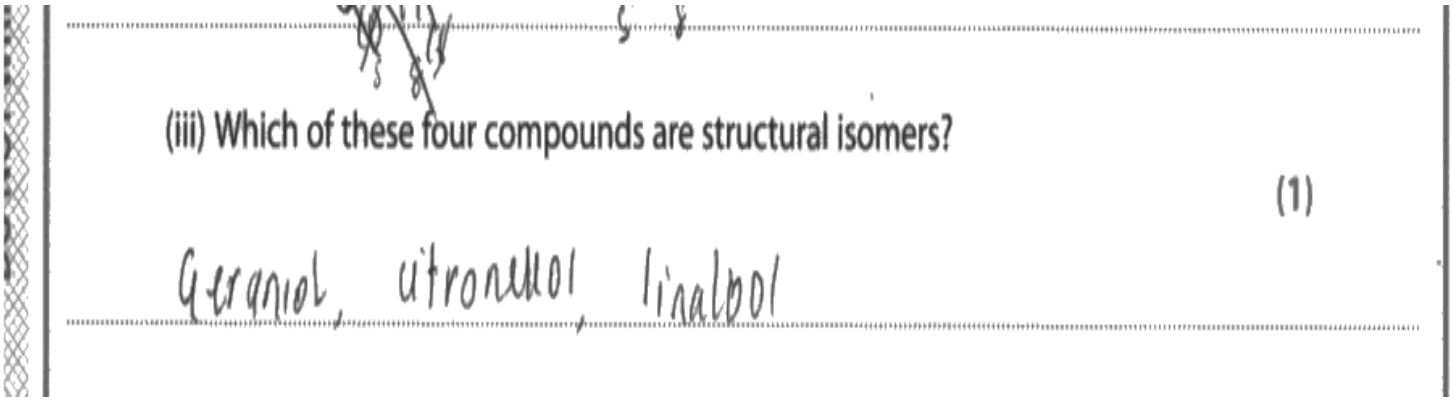
Item: QC0419000008552

Examiner Comment

The correct answers of geraniol and linalool are given however, this response scored 0 as the candidate wrote an additional incorrect answer of citronellol and this negated the mark.

Examiner Tip

Candidates should remember that if they write additional, incorrect chemistry in an answer, they will lose a mark.


(iii) Which of these four compounds are structural isomers?

(1)

Geraniol, citronellol, linalool

WCH02_01_Q24aiv

Question Introduction

Only a minority of candidates could identify the compounds that show geometric isomerism.

WCH02_01_Q24b

Question Introduction

This was a straightforward question asking candidates to describe the tests used to identify the functional groups in linalool and many candidates scored full marks. Some candidates lost a mark as they did not link the tests to the functional groups they were identifying. Some candidates knew the reagents for the tests but gave incorrect observations, for example, bromine water changing from orange to green. Some candidates were unfamiliar with suitable test tube reactions for alkenes and alcohols and they would benefit by carrying out these reactions in the laboratory.

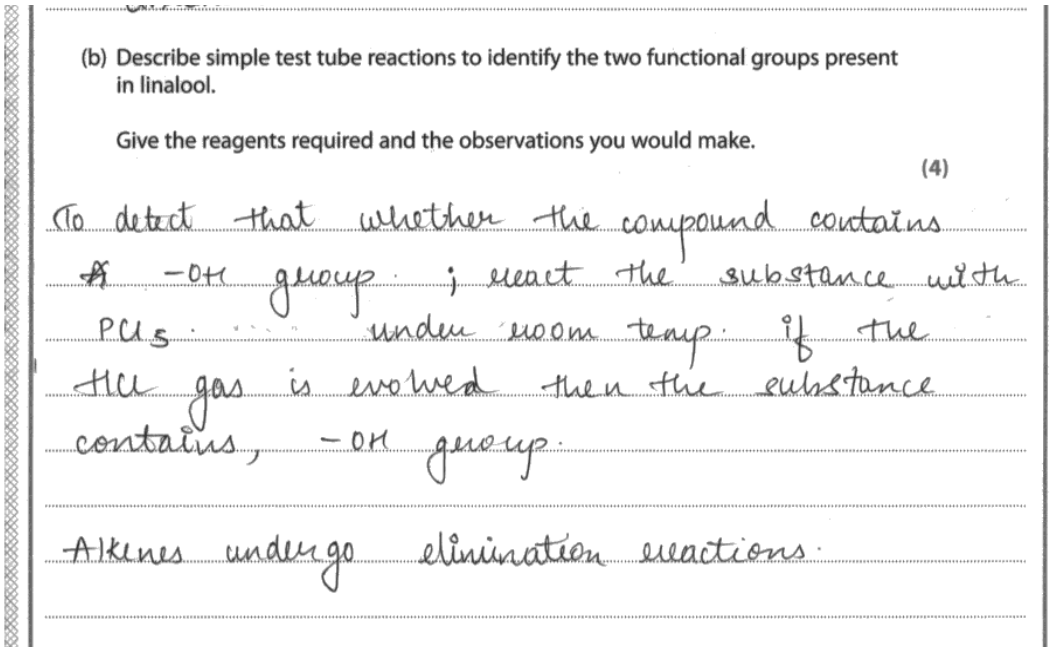
Item: QC0419000007994

Examiner Comment

This candidate knows that PCl_5 is used to test for the -OH group. HCl gas is evolved but this is not an observation so one mark was awarded.

Examiner Tip

When you are asked for an observation, always state what is seen - in this experiment it would be misty fumes.



(b) Describe simple test tube reactions to identify the two functional groups present in linalool.

Give the reagents required and the observations you would make.

(4)

To detect that whether the compound contains ~~A~~ -OH group ; react the substance with PCl_5 under room temp. if the HCl gas is evolved then the substance contains, -OH group.

Alkenes undergo elimination reactions.

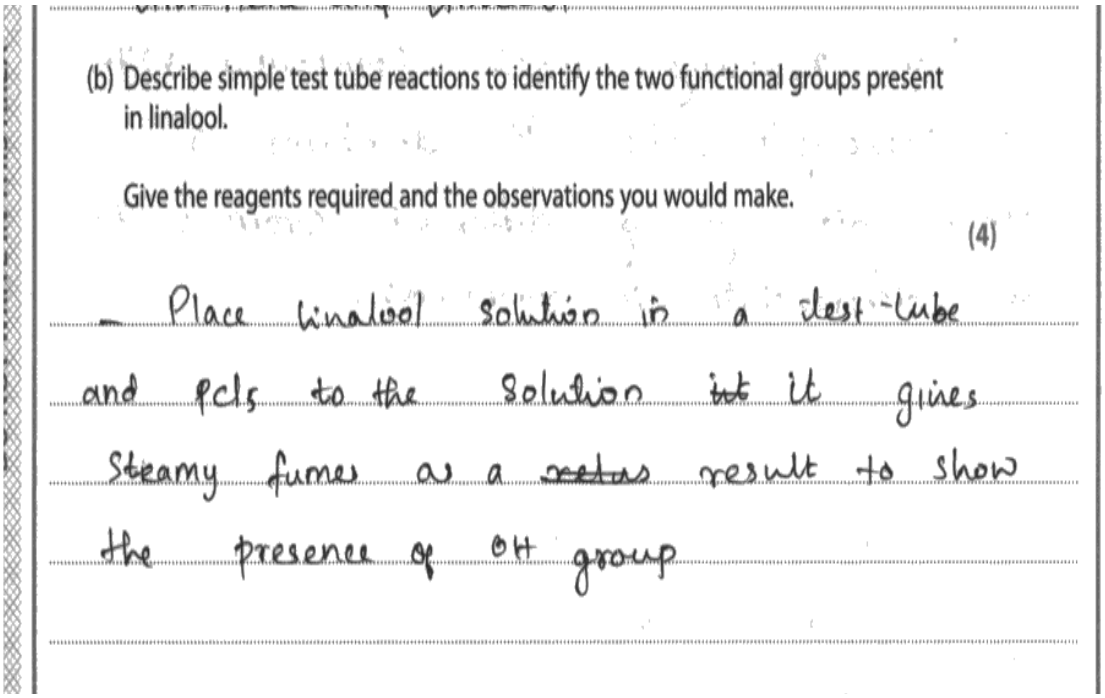
Item: QC0419000009711

Examiner Comment

This candidate has describe the test for one functional group and scored two marks.

Examiner Tip

Read the question carefully. This question asks for test tube reactions to identify the two functional groups present in linalool.



(b) Describe simple test tube reactions to identify the two functional groups present in linalool.

Give the reagents required and the observations you would make.

(4)

- Place linalool solution in a test-tube and pcl5 to the solution it it gives steamy fumes as a ~~reetas~~ result to show the presence of OH group

Item: QC0419000009244

Examiner Comment

This candidate has given two correct reagents and linked them to the functional groups. However, both observations are incorrect. This response scored two marks.

Examiner Tip

Learn the observations you would expect for each test tube reaction that identifies a functional group.

(b) Describe simple test tube reactions to identify the two functional groups present in linalool.

Give the reagents required and the observations you would make.

(4)

- Take linalool in a test tube and add bromine water into it. C=C present in Linalool causes colour of bromine water to change from orange to green.
- take linaloon in a test tupe and add PCl5 into it. OH group present in it causes the purple colour of PCl5 to decolourise.

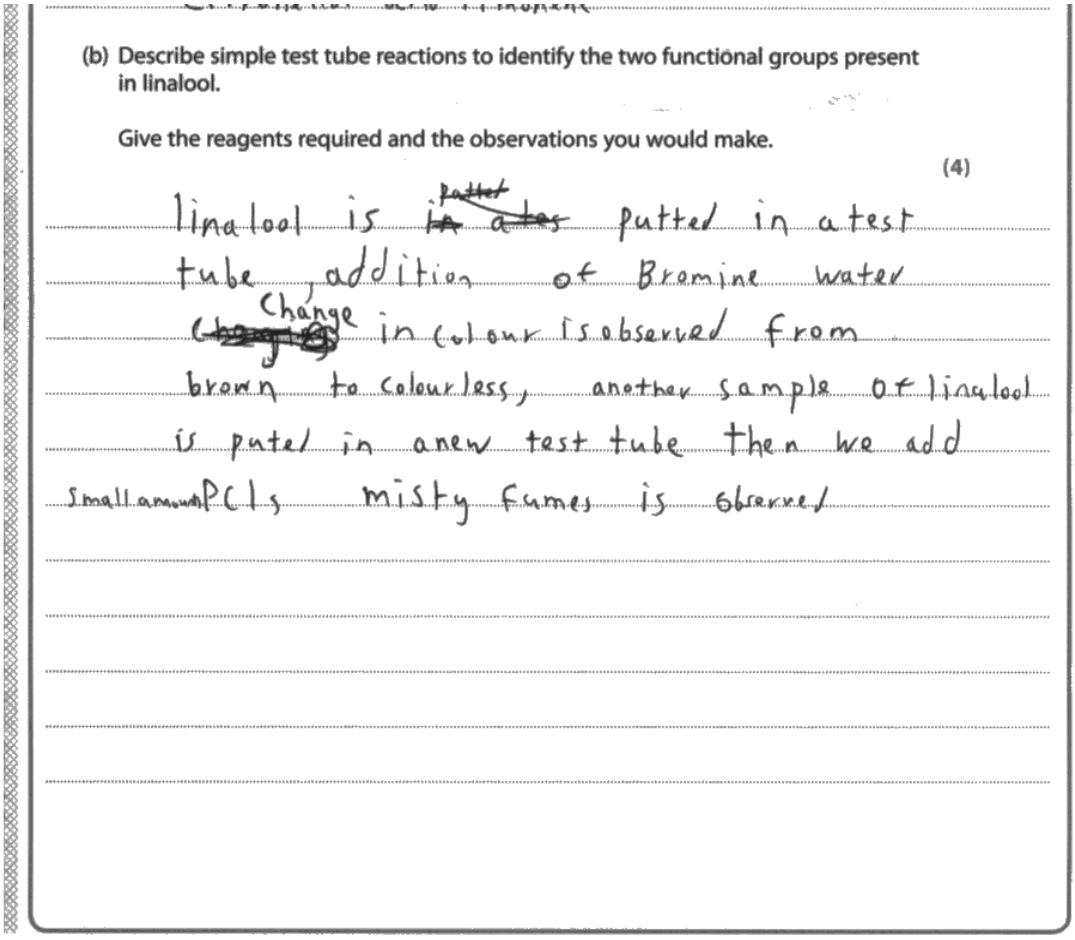
Item: QC0419000006741

Examiner Comment

This candidate has described the two tests correctly but has not linked them to the functional group they are identifying. This response scored three marks.

Examiner Tip

Always link a test to the functional group it is identifying.



(b) Describe simple test tube reactions to identify the two functional groups present in linalool.

Give the reagents required and the observations you would make.

(4)

linalool is ~~in~~ putted ~~a tes~~ putted in a test tube, addition of Bromine water ~~Change~~ Change in colour is observed from brown to colourless, another sample of linalool is puted in anew test tube then we add small amount PCl5 misty fumes is observed

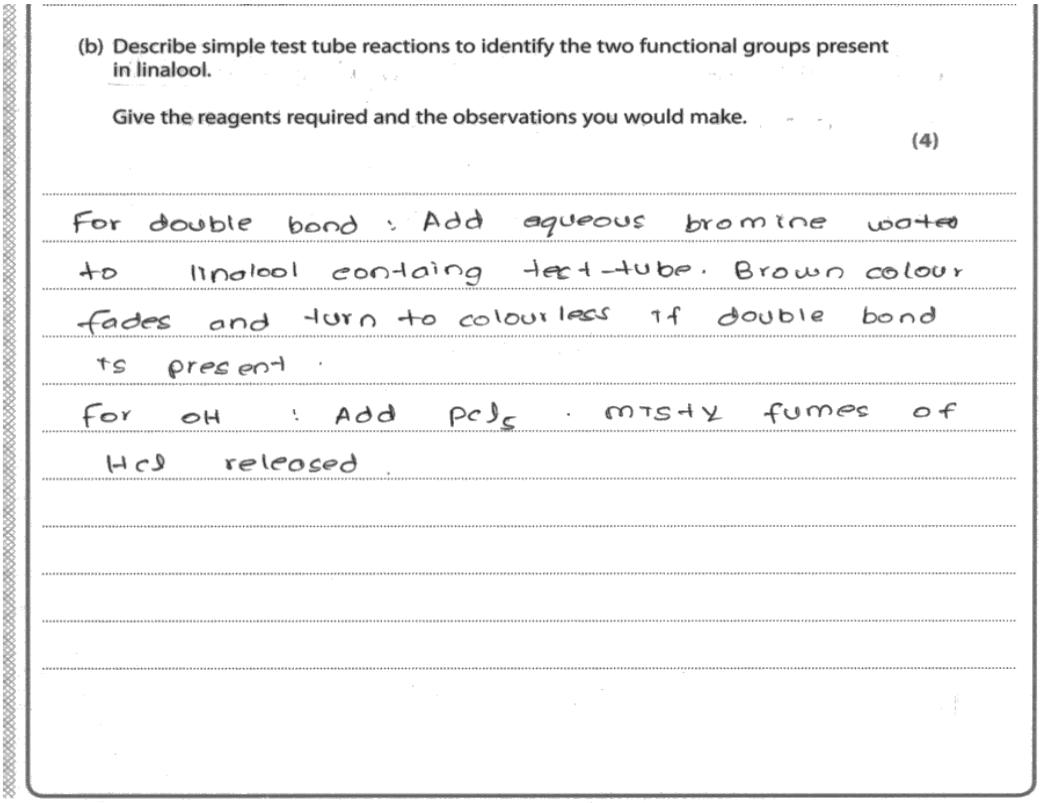
Item: QC0419000009710

Examiner Comment

This is an excellent answer that scored four marks. The candidate has given the reagents and the observations they would make and has linked the test to the functional group.

Examiner Tip

When you describe a test, always give the reagents and observations.



(b) Describe simple test tube reactions to identify the two functional groups present in linalool.

Give the reagents required and the observations you would make.

(4)

For double bond : Add aqueous bromine water to linalool containg test-tube. Brown colour fades and turn to colourless if double bond is present.

for OH : Add PCl_5. misty fumes of HCl released.

WCH02_01_Q24ci

Question Introduction

Candidates found it difficult to answer this question and to express their ideas clearly. Some candidates just identified the functional groups or bonds but did not link this to what would be seen in an infrared spectrum. A significant minority confused infrared spectroscopy with mass spectrometry as they discussed fragmentation patterns. Only a small minority mentioned the fingerprint region of the infrared spectrum.

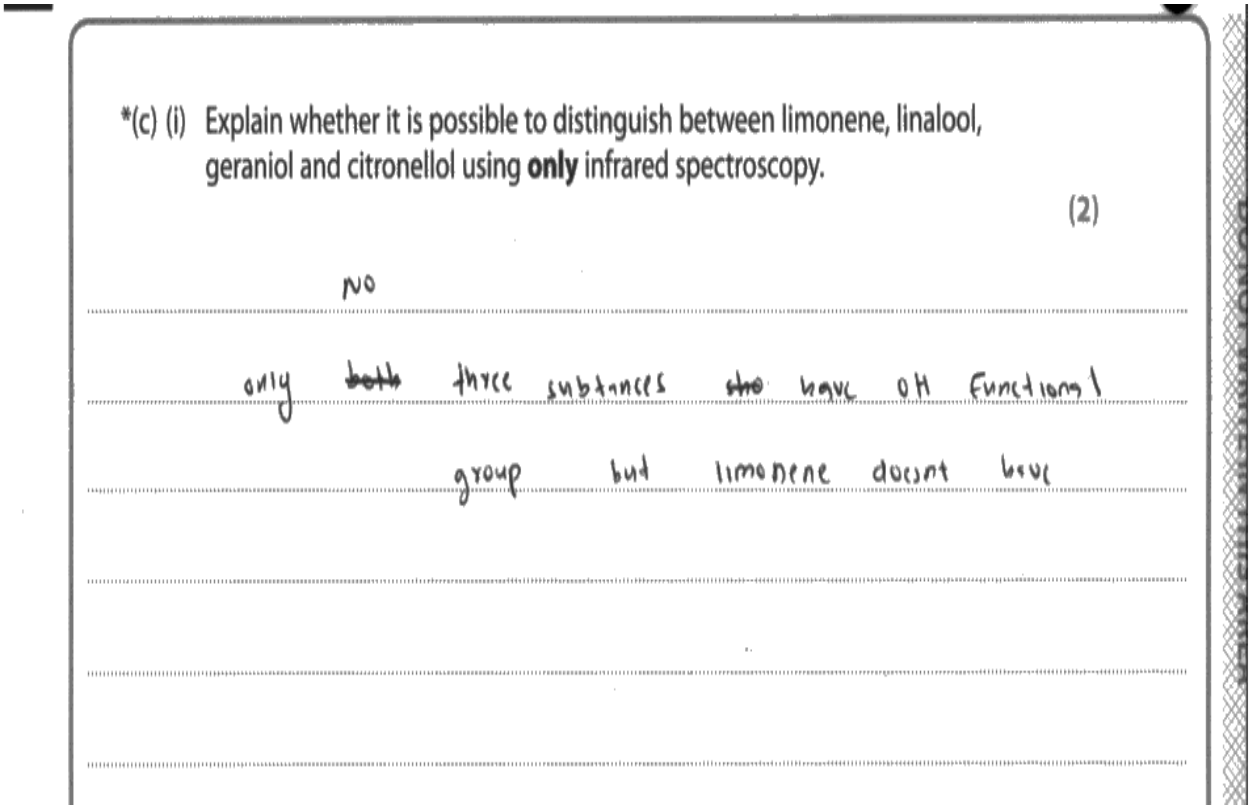
Item: QC0419000008550

Examiner Comment

This candidate realises that only limonene does not have an OH functional group but they have not linked this to the absence of a peak for OH on the infrared spectrum for limonene. This answer scored zero.

Examiner Tip

When you are asked a question about infrared spectroscopy, you should refer to the spectra that will be seen.



*(c) (i) Explain whether it is possible to distinguish between limonene, linalool, geraniol and citronellol using **only** infrared spectroscopy.

(2)

no

only ~~both~~ three substances ~~the~~ have OH Functional group but limonene doesnt have

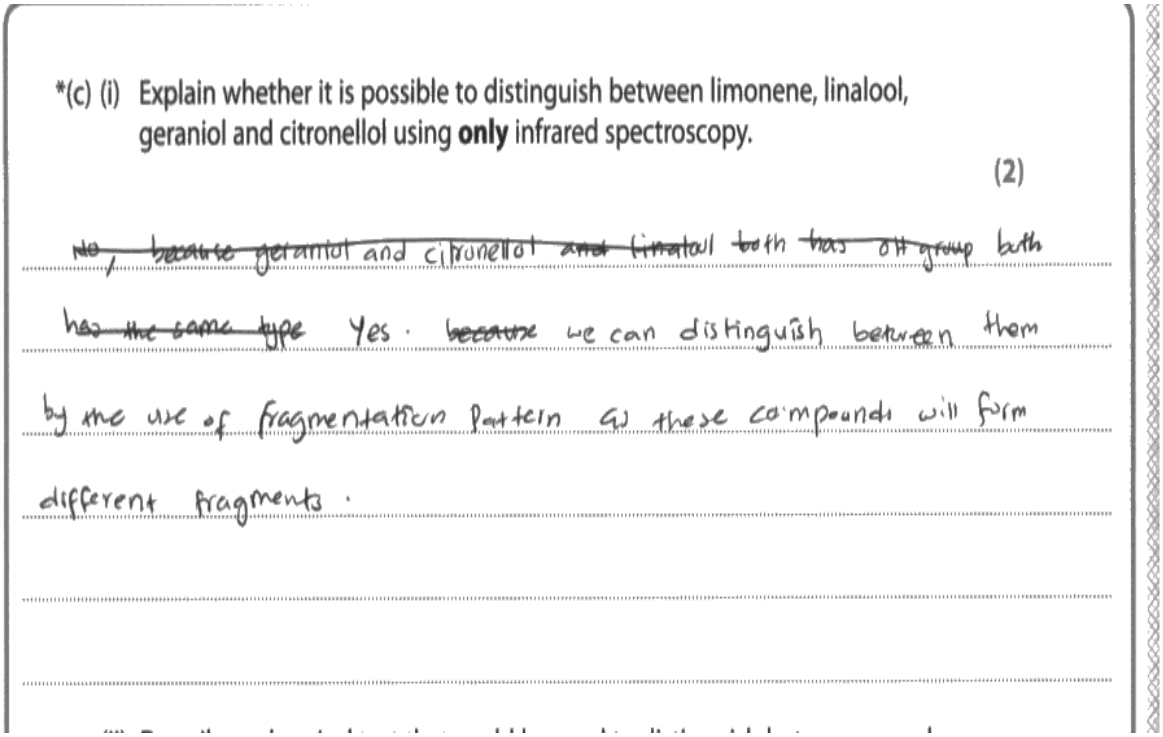
Item: QC0419000009439

Examiner Comment

This candidate has mentioned fragments and these are identified in mass spectrometry.

Examiner Tip

Learn the differences between infrared spectroscopy and mass spectrometry.



*(c) (i) Explain whether it is possible to distinguish between limonene, linalool, geraniol and citronellol using **only** infrared spectroscopy.

(2)

~~No, because geraniol and citronellol and linalool both has OH group~~ both has ~~the same type~~ Yes. ~~because~~ we can distinguish between them by the use of fragmentation pattern as these compounds will form different fragments.

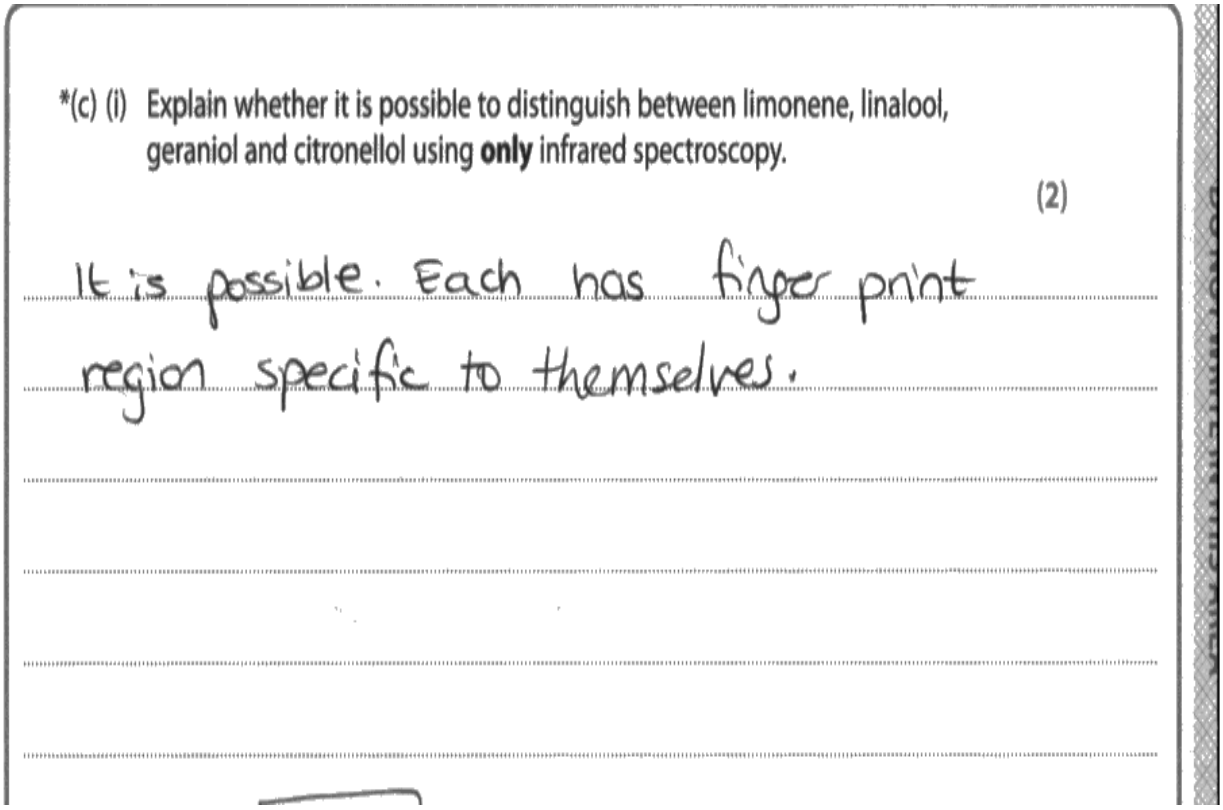
Item: QC0419000007011

Examiner Comment

This response scored one mark.

Examiner Tip

Remember that the fingerprint region of an infrared spectrum is unique to each substance.



*(c) (i) Explain whether it is possible to distinguish between limonene, linalool, geraniol and citronellol using **only** infrared spectroscopy.

(2)

It is possible. Each has finger print region specific to themselves.

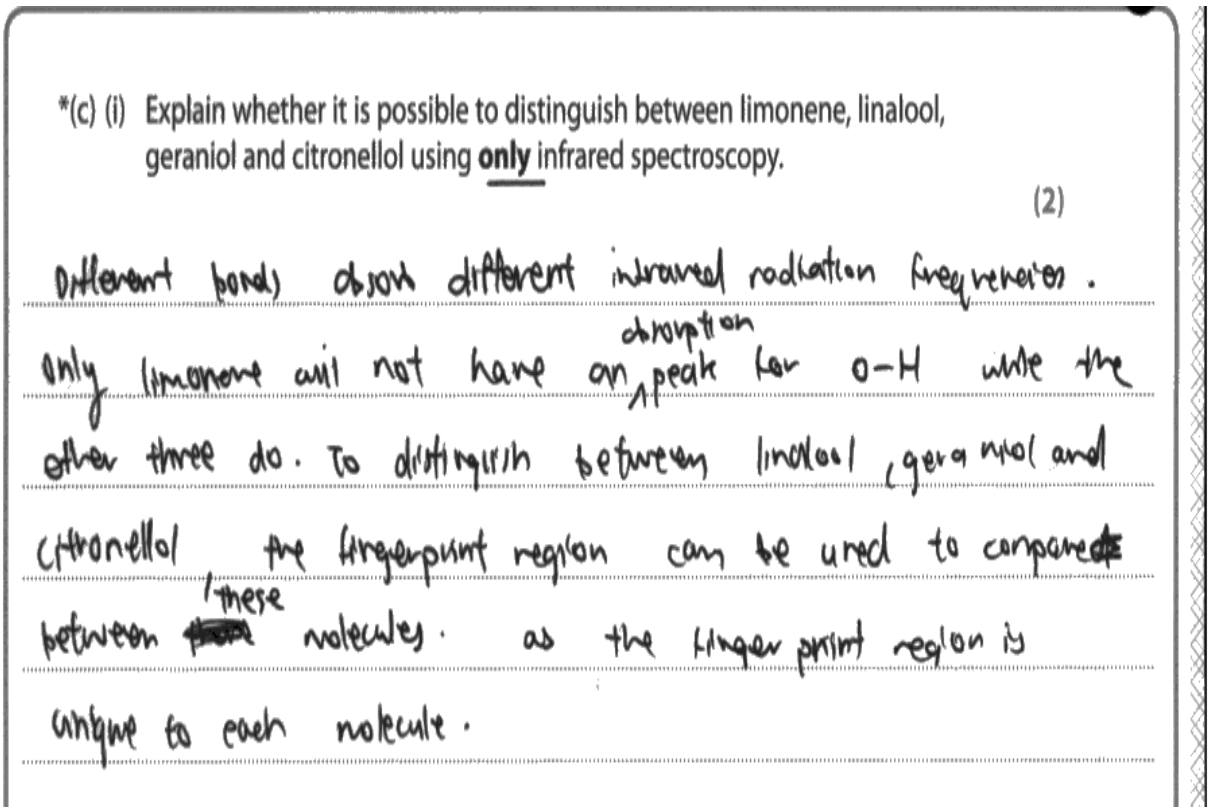
Item: QC0419000005151

Examiner Comment

This is an excellent answer that was awarded two marks.

Examiner Tip

Revise the techniques used to identify organic molecules.



*(c) (i) Explain whether it is possible to distinguish between limonene, linalool, geraniol and citronellol using **only** infrared spectroscopy.

(2)

Different bonds absorb different infrared radiation frequencies. Only limonene will not have an absorption peak for O–H while the other three do. To distinguish between linalool, geraniol and citronellol the fingerprint region can be used to compare between these molecules. as the finger print region is unique to each molecule.

WCH02_01_Q24cii

Question Introduction

There were many correct answers using acidified potassium dichromate(VI) to distinguish between the compounds. A significant minority of candidates omitted the acid from the test and lost a mark. Many candidates realised that geraniol is a primary alcohol and can be oxidised but linalool is a tertiary alcohol and cannot be easily oxidised, however, they did not always give a relevant observation to support this. Incorrect reagents that were mentioned included: Tollens', Fehling's, bromine, hydrogen bromide, sodium hydroxide and sodium carbonate.

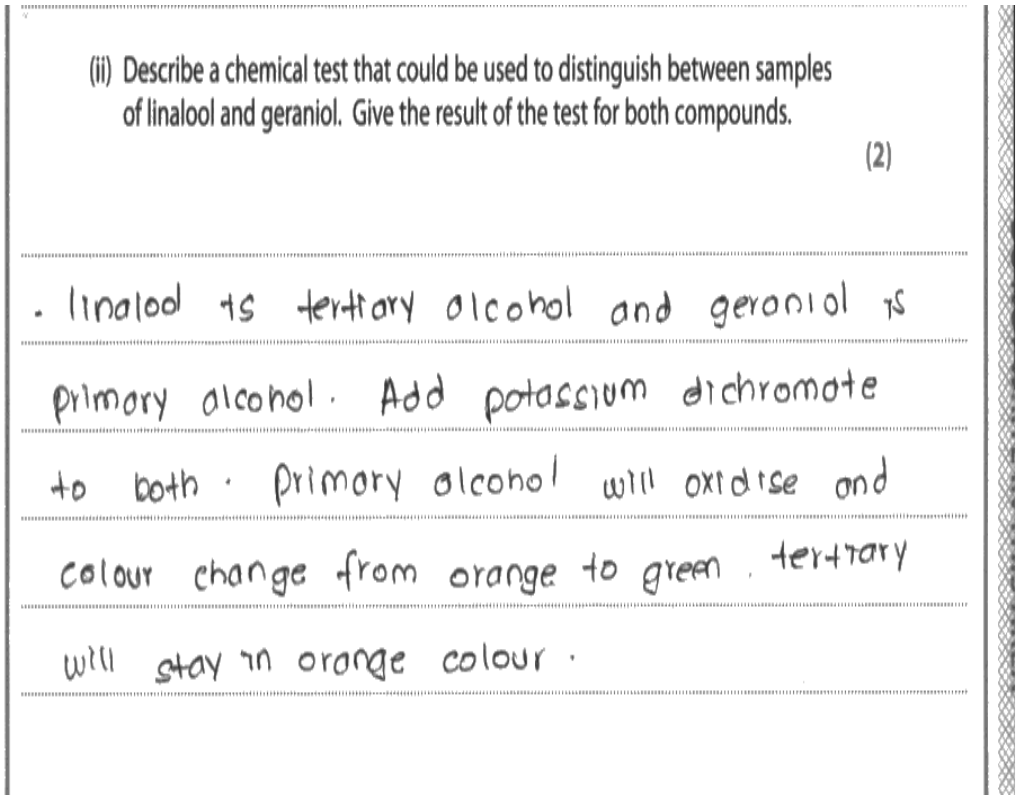
Item: QC0419000009710

Examiner Comment

This candidate has given the correct observations but has omitted the sulfuric acid from the test. This reaction will not work without acid so one mark was awarded.

Examiner Tip

Potassium dichromate(VI) always needs to be acidified with dilute sulfuric acid for it to act as an oxidising agent.



(ii) Describe a chemical test that could be used to distinguish between samples of linalool and geraniol. Give the result of the test for both compounds.

(2)

. linalool is tertiary alcohol and geraniol is primary alcohol. Add potassium dichromate to both. primary alcohol will oxidise and colour change from orange to green. tertiary will stay in orange colour.

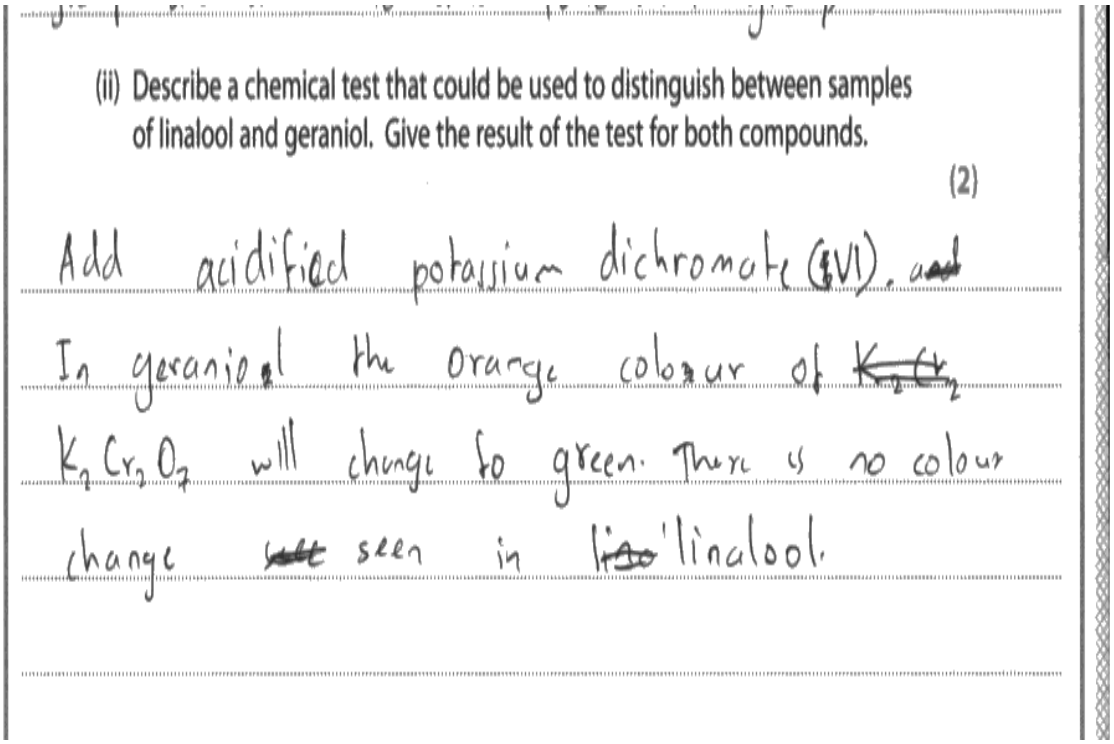
Item: QC0419000008543

Examiner Comment

This is a correct answer that scored two marks.

Examiner Tip

Remember to include all the reagents and the results of the tests.



(ii) Describe a chemical test that could be used to distinguish between samples of linalool and geraniol. Give the result of the test for both compounds.

(2)

Add acidified potassium dichromate (VI). ~~and~~

In geraniol the orange colour of ~~K_2Cr_2~~ $K_2Cr_2O_7$ will change to green. There is no colour change ~~seen~~ seen in ~~lino~~ linalool.

WCH02_01_Q24di

Question Introduction

The majority of candidates could identify a suitable catalyst for the reaction.

WCH02_01_Q24dii

Question Introduction

Many candidates gave correct equations but some candidates found it difficult to draw a correct skeletal formula for the product. It was acceptable to give other types of formulae for the product but many candidates who tried this left off a carbon or hydrogen atom or put the branches in the wrong places. Some candidates seemed unfamiliar with this reaction and they removed the OH group or just reacted the hydrogen with one of the double bonds.

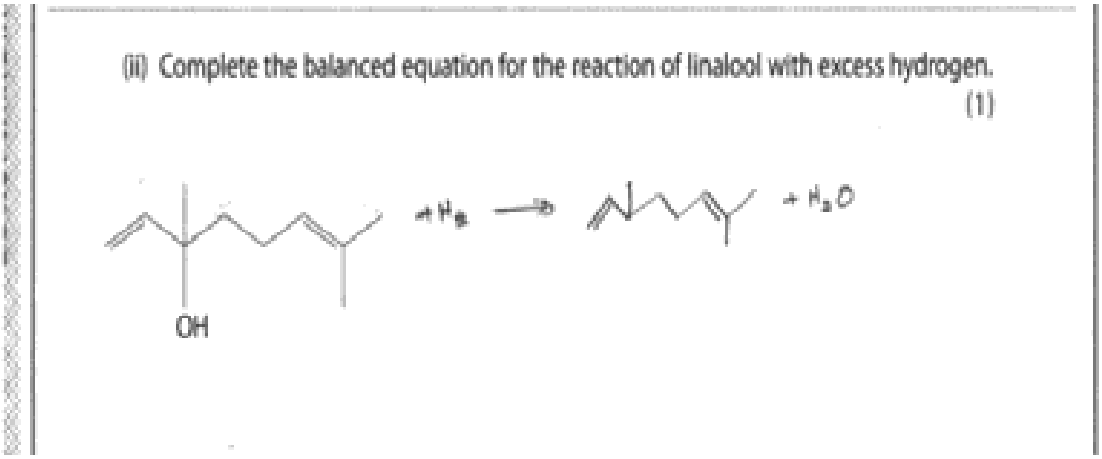
Item: QC0419000009770

Examiner Comment

This candidate is unfamiliar with the reaction between alkenes and hydrogen so has shown incorrect products and scored zero.

Examiner Tip

Learn the reactions in the specification.



Item: QC0419000009710

Examiner Comment

A correct answer that scored one mark.

(ii) Complete the balanced equation for the reaction of linalool with excess hydrogen.

(1)

WCH02_01_Q24diii

Question Introduction

Many correct answers to this calculation were seen. Candidates could score transferred errors, so even if they had the mole ratio incorrect in (i), they could still score full marks for this question. The most common error was not using the 70% of linalool in the sample of lavender oil. Some candidates were unsure about a calculation with the molar volume of a gas and they divided the number of moles by 24. A few candidates lost a mark for writing an incorrect unit for volume, for example, dm^{-3} or $dm^3\ mol^{-1}$

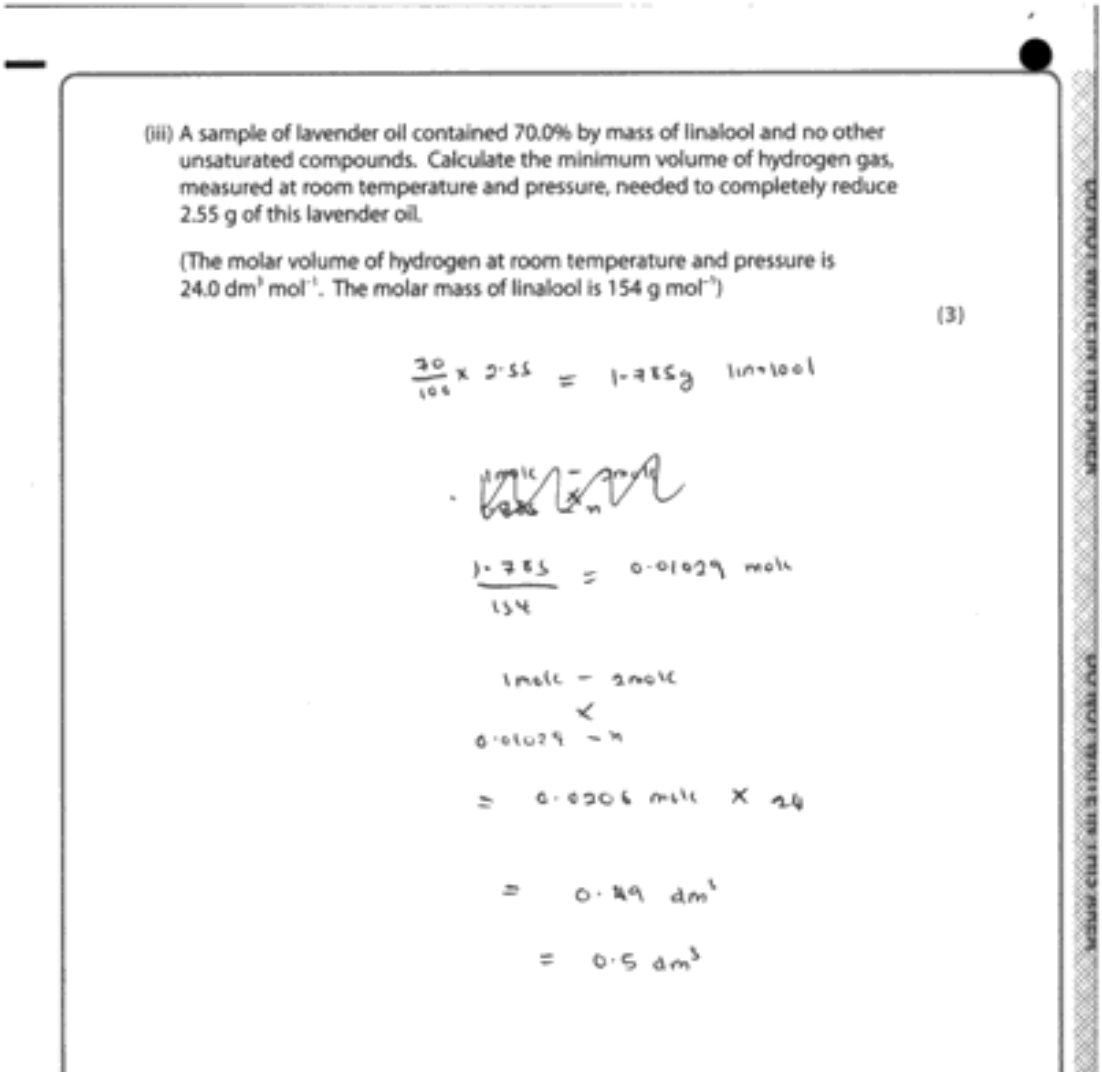
Item: QC0419000008550

Examiner Comment

This candidate has used the 70% to calculate the mass of linalool. They have shown the correct working to calculate the number of moles but the answer is incorrect. They could have scored a mark for multiplying the number of moles by 24 but they have given their answer to one significant figure, which is not accurate enough. This answer scored one mark.

Examiner Tip

Give your answer to the same number of significant figures as the data given in the question.



(iii) A sample of lavender oil contained 70.0% by mass of linalool and no other unsaturated compounds. Calculate the minimum volume of hydrogen gas, measured at room temperature and pressure, needed to completely reduce 2.55 g of this lavender oil.

(The molar volume of hydrogen at room temperature and pressure is 24.0 $dm^3\ mol^{-1}$. The molar mass of linalool is 154 g mol^{-1})

(3)

$\frac{70}{100} \times 2.55 = 1.785\text{g}$ linalool

$\frac{1.785}{154} = 0.01029$ mols

1 mole – 3 mole

0.01029 – n

$= 0.0206$ mole $\times$ 24

$= 0.49\ dm^3$

$= 0.5\ dm^3$

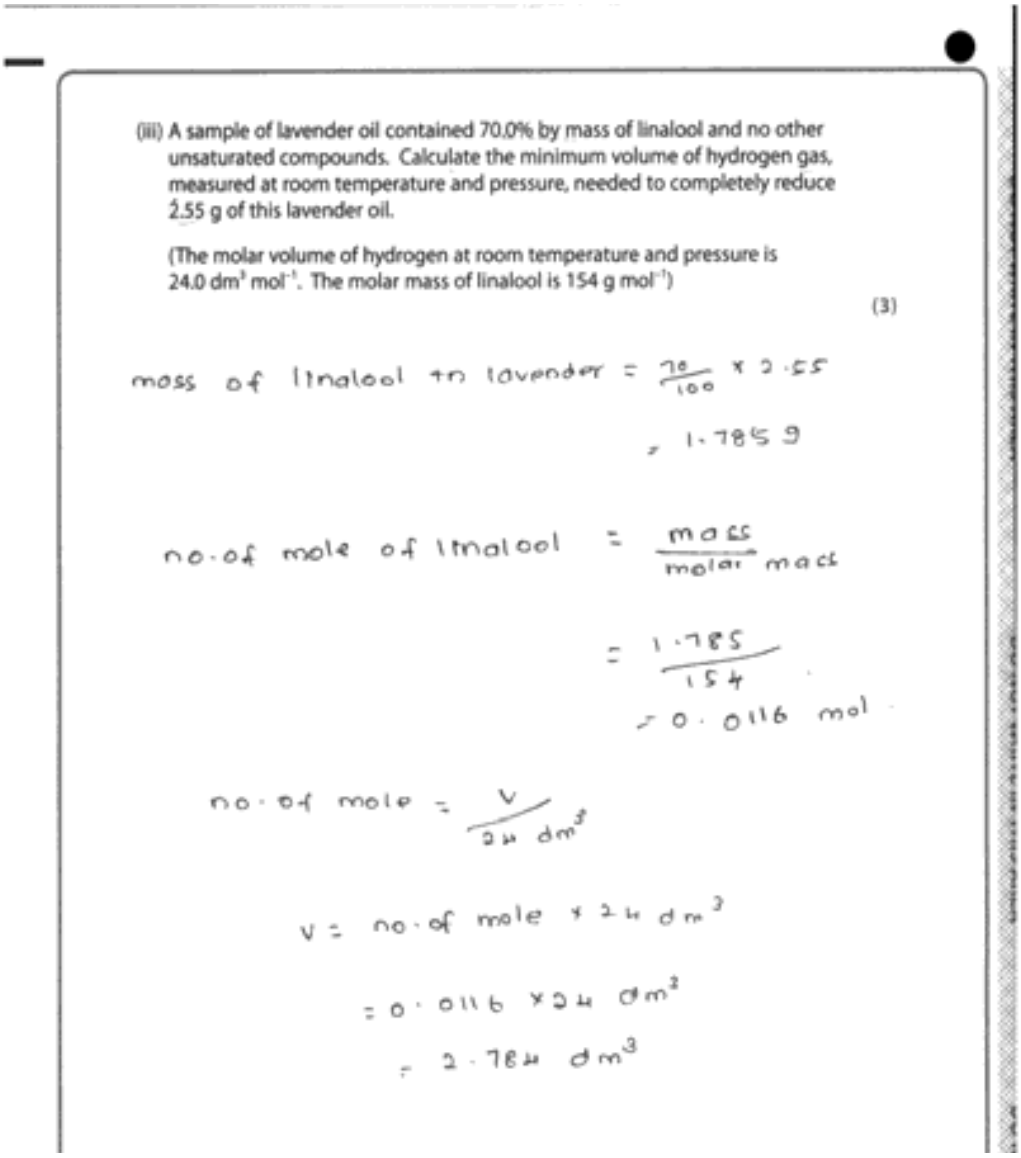
Item: QC0419000009710

Examiner Comment

This response scored two marks. The first two steps are correct but the final answer is ten times larger than it should be.

Examiner Tip

Check all of your answers to make sure that you have not made a slip with your calculator.



(iii) A sample of lavender oil contained 70.0% by mass of linalool and no other unsaturated compounds. Calculate the minimum volume of hydrogen gas, measured at room temperature and pressure, needed to completely reduce 2.55 g of this lavender oil.

(The molar volume of hydrogen at room temperature and pressure is 24.0 dm^3 mol^{-1}. The molar mass of linalool is 154 g mol^{-1})

(3)

mass of linalool in lavender = $\frac{70}{100} \times 2.55$

= 1.785 g

no. of mole of linalool = $\frac{\text{mass}}{\text{molar mass}}$

= $\frac{1.785}{154}$

= 0.0116 mol

no. of mole = $\frac{V}{24\ dm^3}$

V = no. of mole $\times$ 24 dm^3

= 0.0116 $\times$ 24 dm^3

= 2.784 dm^3

WCH02_01_Q24e

Question Introduction

Many candidates struggled to draw a clear mechanism for the electrophilic addition reaction. Common errors included: omitting the dipole on the hydrogen bromide, drawing a curly arrow from the delta positive hydrogen to the double bond, writing a partial charge on the carbon in the carbocation and not giving an intermediate carbocation. There were many imprecise curly arrows that seemed to start and finish in spaces. Candidates would benefit from practise at drawing the mechanisms from the specification.

Item: QC0419000008568

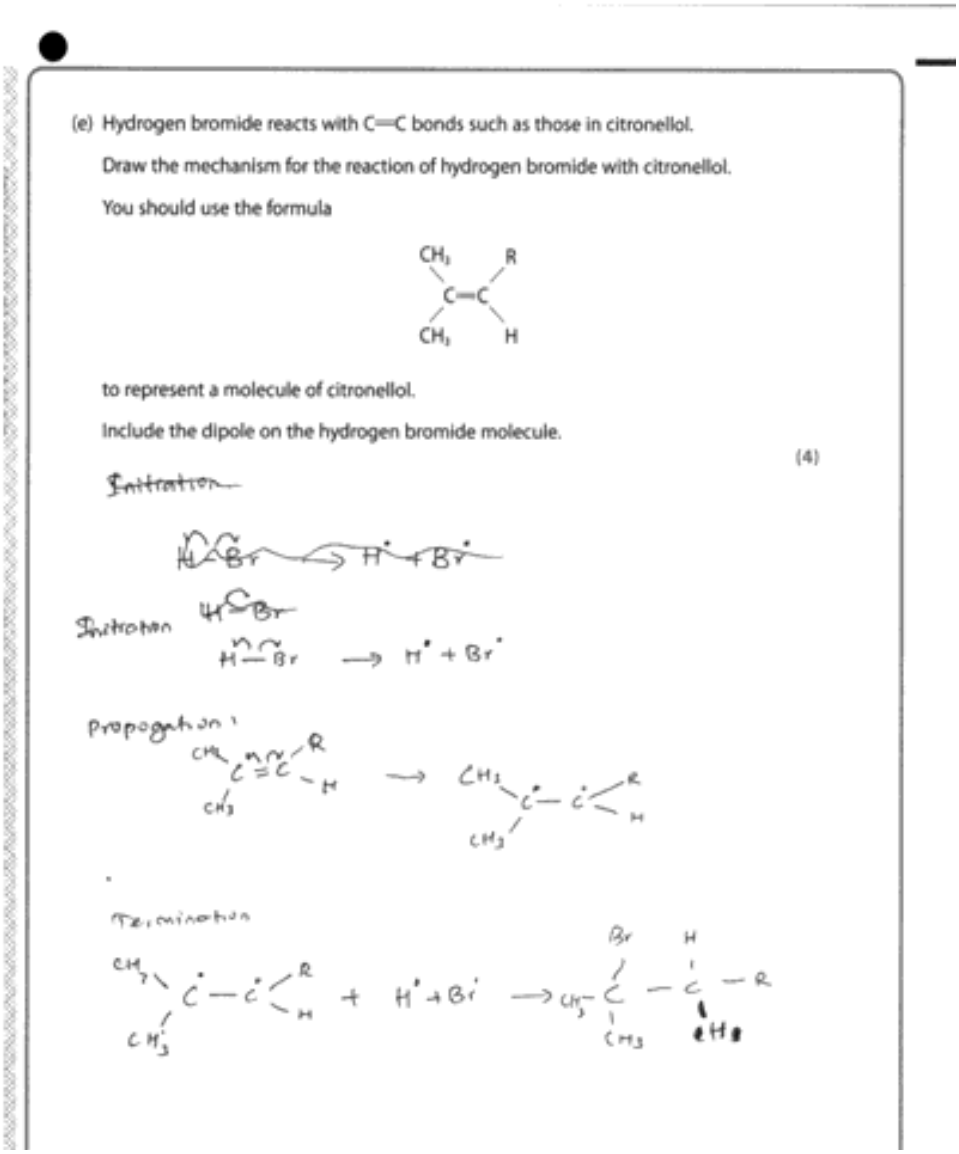
Examiner Comment

This candidate has attempted to draw a free radical mechanism, which is incorrect. This response scored zero.

Examiner Tip

Learn the types of mechanisms for each functional group.

This reaction of an alkene is an electrophilic addition reaction.



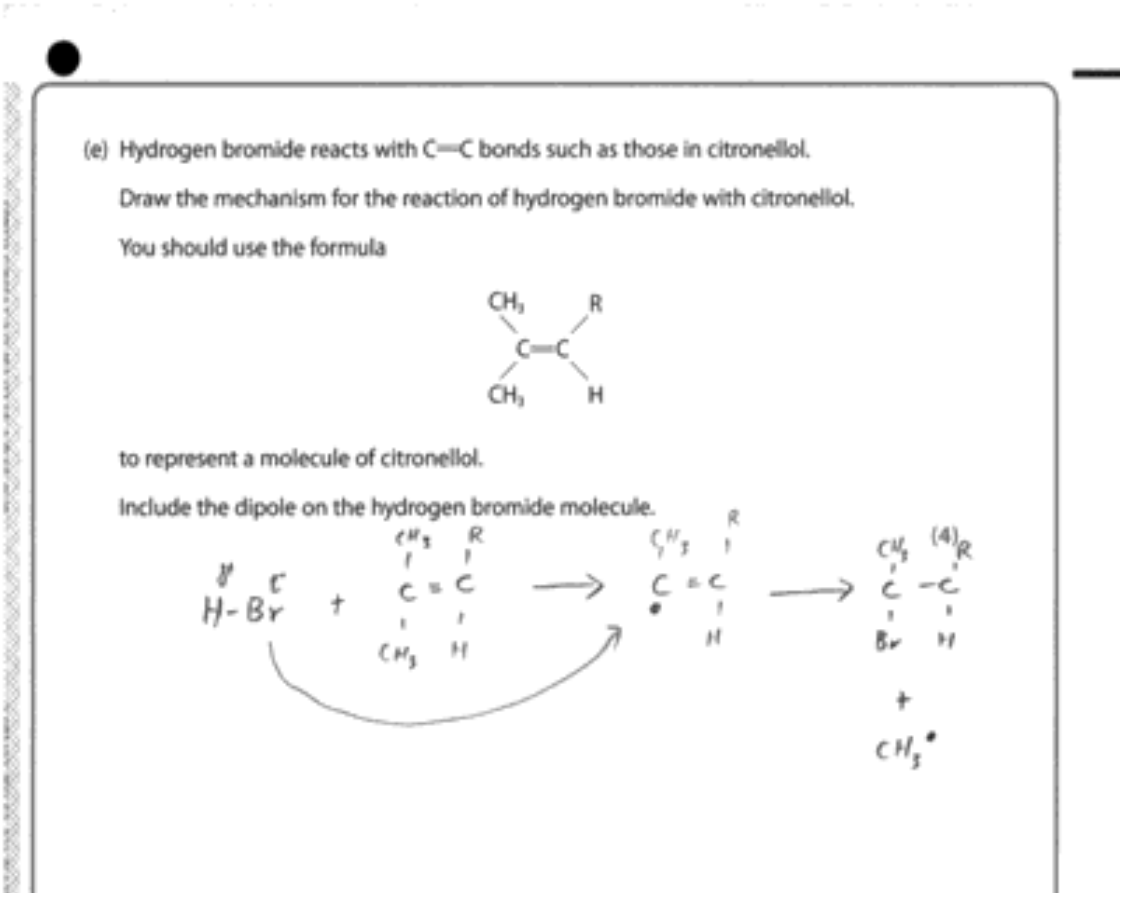
Item: QC0419000009416

Examiner Comment

This response scored one mark for the dipole on HBr. The curly arrow is incorrect, as is the intermediate.

Examiner Tip

Revise the mechanisms in the specification.



Item: QC0419000008564

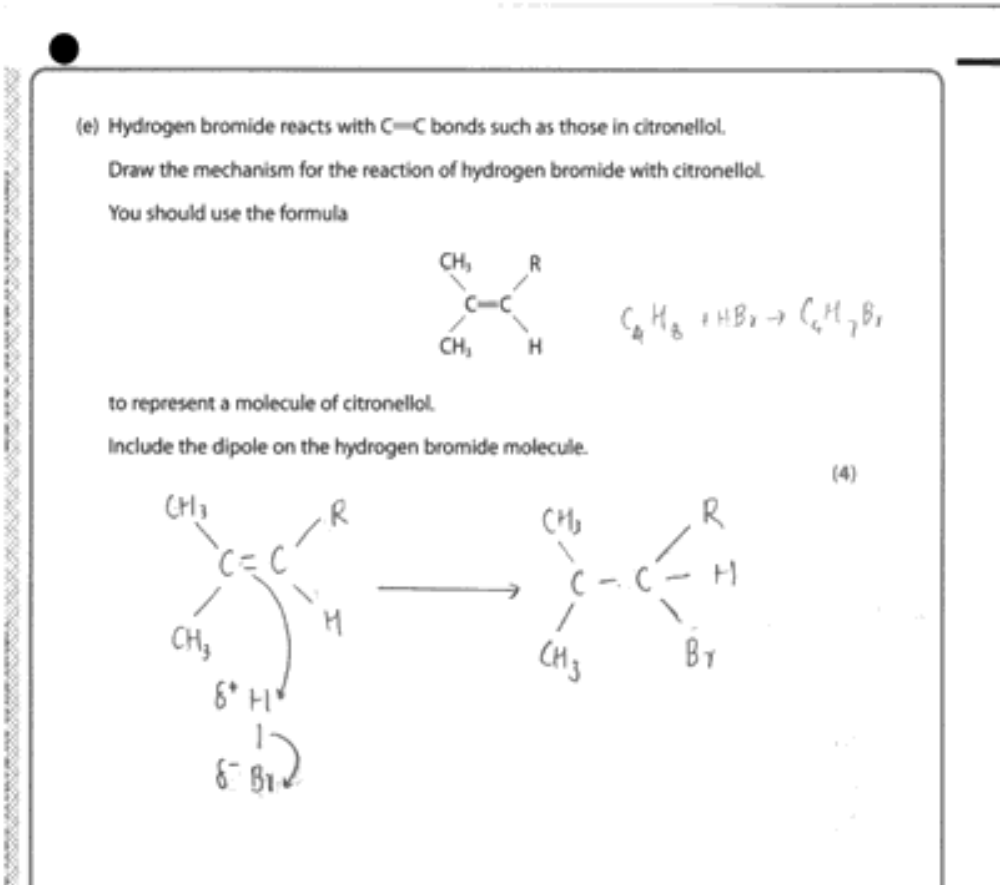
Examiner Comment

This response scored one marks for the dipole on HBr and the two curly arrows. There is no intermediate shown and the addition of bromide is also omitted.

Examiner Tip

Learn the full mechanisms, making sure that you understand what is happening at each stage.

Try to explain the mechanisms in words to help you to understand them.



Item: QC0419000008052

Examiner Comment

This is a correct mechanism that scored four marks.

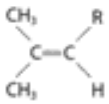
Examiner Tip

Practise drawing mechanisms until you can do them perfectly, as in this example.

(e) Hydrogen bromide reacts with C=C bonds such as those in citronellol.

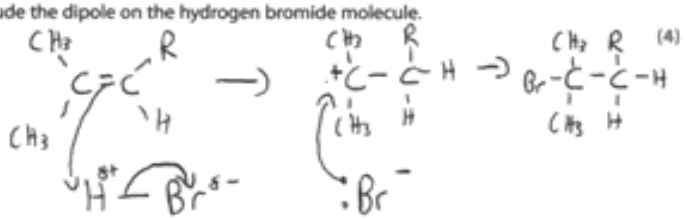
Draw the mechanism for the reaction of hydrogen bromide with citronellol.

You should use the formula



to represent a molecule of citronellol.

Include the dipole on the hydrogen bromide molecule.



(4)

Paper Summary

On the evidence of their performance on this paper, candidates are offered the following advice:

- Always read the question carefully and check that you understand what is required.
- Then, after you have written your answer, re-read the question and your answer to ensure you have fully answered the question.
- Make sure that you understand the precise meaning of chemical terms and can use them appropriately.
- In calculations, don't round the intermediate values; keep the number in your calculator then give the final answer to an appropriate number of significant figures.
- Organic reaction mechanisms need to be accurately drawn: ensure that 'curly arrows' are precisely located and that any intermediates are correct.
- Learn how to add half-equations to produce an overall equation.
- Practise basic experimental techniques, such as making up a standard solution.

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