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Examiners' Report
June 2010

GCE Chemistry 6CH08

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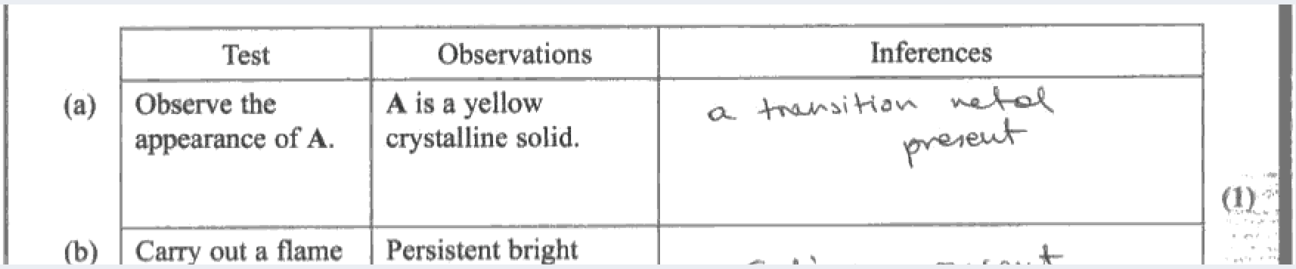
Introduction

This was the first of type of paper new to A2 designed as a written alternative to the continuous assessment of practical skills. The paper tested the ability of the candidates to read and correctly interpret questions and their skills in extended transactional writing, framing short but precise answers and in setting out calculations clearly and logically. While there were many excellent responses which showed a keen awareness of the practical dimension of this paper, the answers of quite a number of candidates suggested limited first-hand knowledge of some of the basic experimental techniques required by the A2 course; this was particularly apparent in the question on organic synthesis. The standard of work in calculations was generally very high; in contrast, few candidates seemed confident writing ionic equations.

Question 1(a)

The colour of a solid gives the first clue to its identity and generally a coloured solid suggests the presence of a transition metal ion although there are other possible compounds. The stem of the question clearly indicates an ionic compound so 'sulfur' should not come into consideration. Here, as elsewhere in the paper, clarity and precision are vital.



	Test	Observations	Inferences	
(a)	Observe the appearance of **A**.	**A** is a yellow crystalline solid.	a transition metal present	(1)
(b)	Carry out a flame	Persistent bright		

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Examiner Comments

This is a marginal mark: it is the metal ion that is responsible for the observed colour not the metal.

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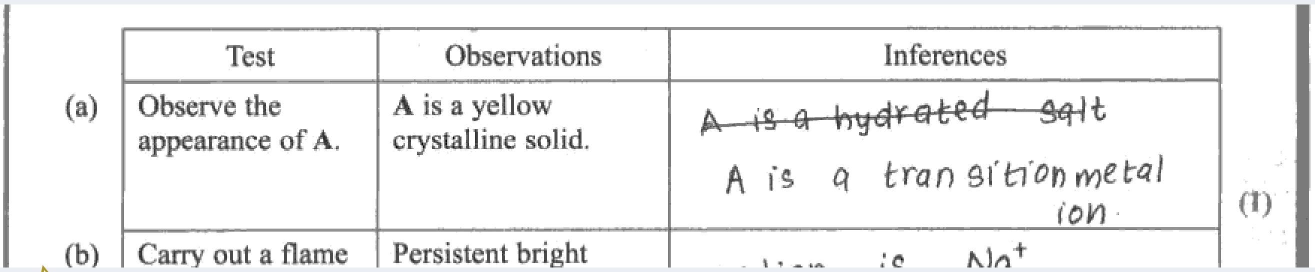
Examiner Tip

Try to make sure that your answer is absolutely clear: adding the word 'ion' makes a big difference.



	Test	Observations	Inferences	
(a)	Observe the appearance of **A**.	**A** is a yellow crystalline solid.	~~A is a hydrated salt~~ A is a transition metal ion	(1)
(b)	Carry out a flame	Persistent bright		

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Examiner Comments

While the mark has been awarded, the answer might have been better expressed as it implies that A is an ion.

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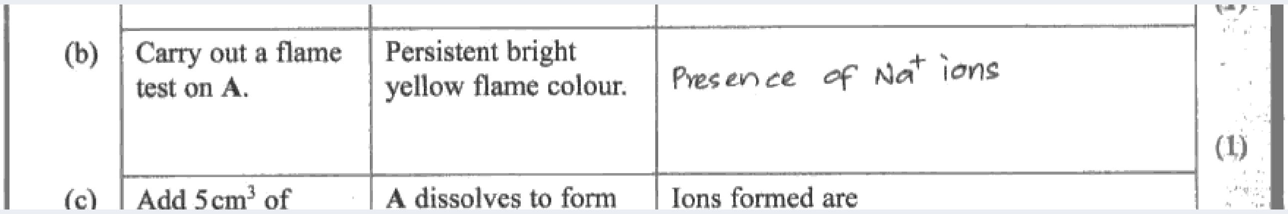
Examiner Tip

Review what you write and check that your meaning is clear and unambiguous.

Question 1(b)

A flame test is invariably used to test for the presence of certain cations; the answer must reflect this.



(b)	Carry out a flame test on **A**.	Persistent bright yellow flame colour.	Presence of Na^+ ions	(1)
(c)	Add $5 cm^3$ of	**A** dissolves to form	Ions formed are	

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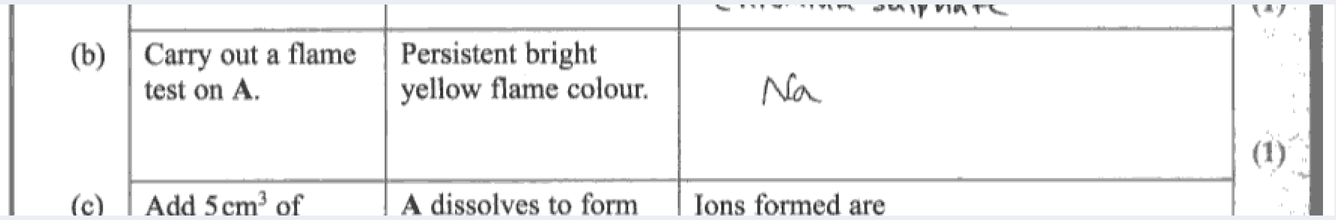
Examiner Comments

An answer that is simple, to the point and correct.



(b)	Carry out a flame test on **A**.	Persistent bright yellow flame colour.	Na	(1)
(c)	Add 5 cm^3 of	**A** dissolves to form	Ions formed are	

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Examiner Comments

Substance A is a compound but the use of the symbol implies that the element is present.

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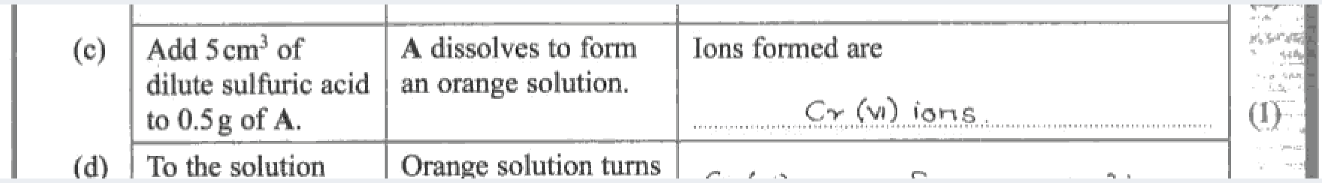
Examiner Tip

Apart from the inaccuracy, this answer is rather too concise.

Question 1(c)

The focus of this question is on the colour change from yellow to orange when A dissolves in acid; however, additional information will be ignored unless it is incorrect.



(c)	Add 5 cm^3 of dilute sulfuric acid to 0.5 g of **A**.	**A** dissolves to form an orange solution.	Ions formed are Cr (VI) ions.	(1)
(d)	To the solution	Orange solution turns		

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Examiner Comments

Addition of acid has no effect on the oxidation number of chromium so this answer gains no credit.

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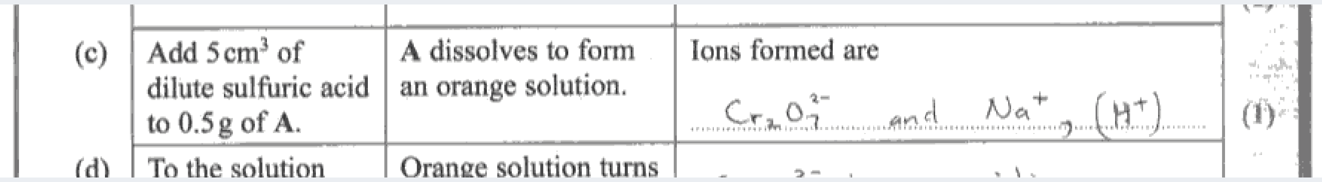
Examiner Tip

Some thought about the chemistry involved should have led to the realisation that Cr(VI) is present throughout.



(c)	Add 5 cm^3 of dilute sulfuric acid to 0.5 g of **A**.	**A** dissolves to form an orange solution.	Ions formed are $Cr_2O_7^{2-}$ and Na^+, (H^+)	(1)
(d)	To the solution	Orange solution turns		

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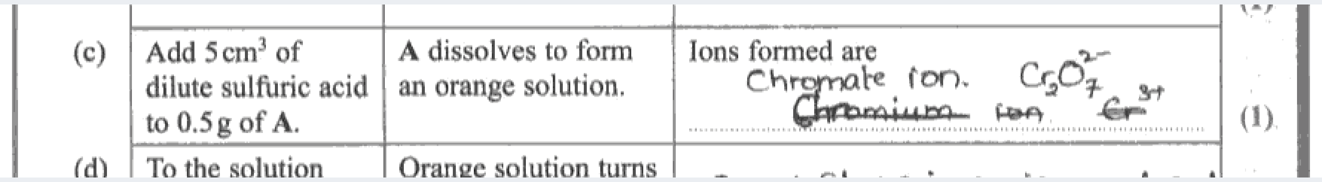
Examiner Comments

Additional correct information does not affect the mark gained for the formula of the dichromate(VI) ion.



(c)	Add 5 cm^3 of dilute sulfuric acid to 0.5 g of **A**.	**A** dissolves to form an orange solution.	Ions formed are Chromate ion. $Cr_2O_7^{2-}$ ~~Chromium ion~~ ~~Cr~~$^{3+}$	(1)
(d)	To the solution	Orange solution turns		

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Examiner Comments

In this example, two answers have been offered, but one (chromate ion) is incorrect so the mark is not awarded.

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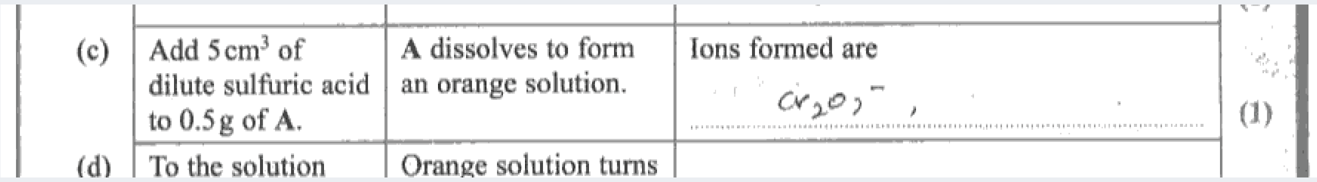
Examiner Tip

If you give more than one answer, make sure that they do not contradict each other.



(c)	Add 5 cm³ of dilute sulfuric acid to 0.5 g of **A**.	**A** dissolves to form an orange solution.	Ions formed are $Cr_2O_7^{-}$,	(1)
(d)	To the solution	Orange solution turns		

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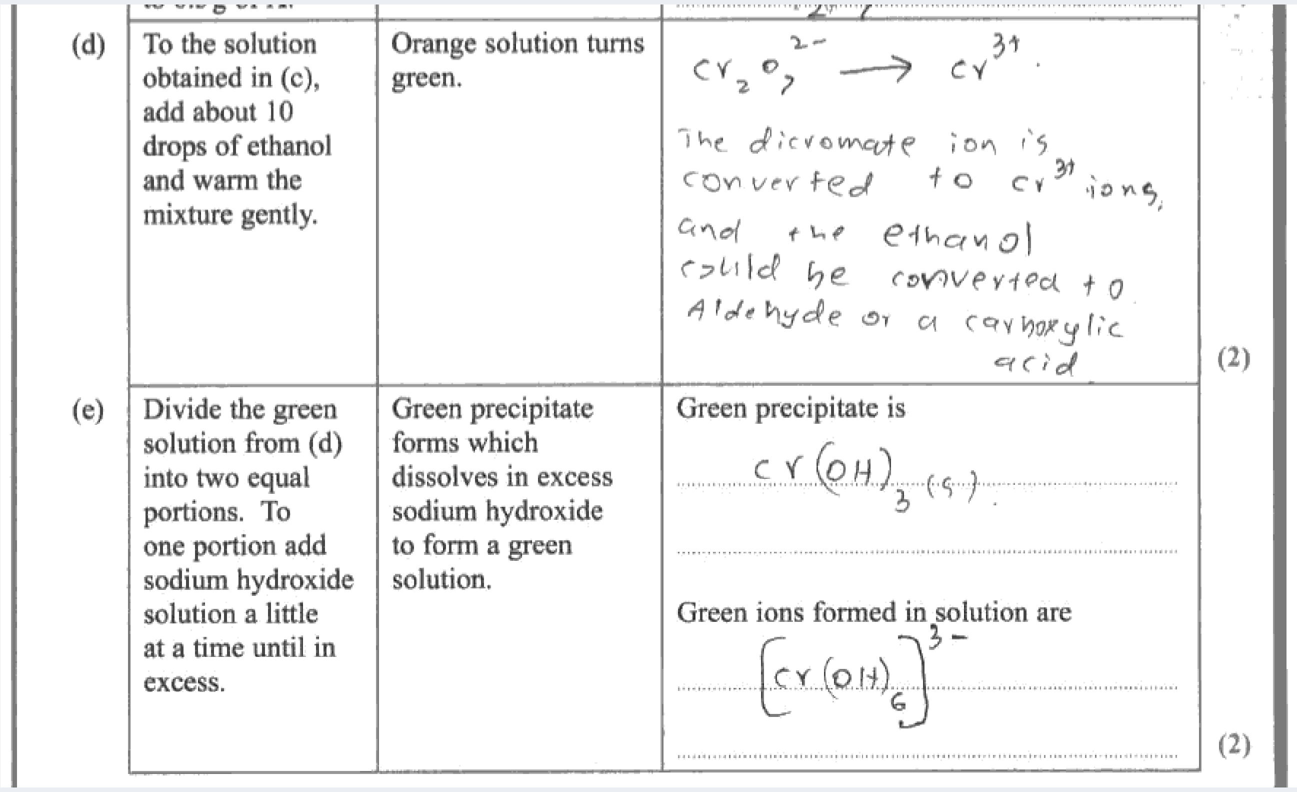
Examiner Comments

If the formula of an ion is used, the charge must be correct.

Question 1(d-e)

The chemical changes involved in this question are quite complex but should be familiar. It involves redox, precipitation of an insoluble hydroxide and finally, the formation of a complex ion.



(d)	To the solution obtained in (c), add about 10 drops of ethanol and warm the mixture gently.	Orange solution turns green.	$Cr_2O_7^{2-} \longrightarrow Cr^{3+}$. The dicromate ion is converted to Cr^{3+} ions, and the ethanol could be converted to Aldehyde or a carboxylic acid	(2)
(e)	Divide the green solution from (d) into two equal portions. To one portion add sodium hydroxide solution a little at a time until in excess.	Green precipitate forms which dissolves in excess sodium hydroxide to form a green solution.	Green precipitate is $Cr(OH)_3(s)$. Green ions formed in solution are $[Cr(OH)_6]^{3-}$	(2)

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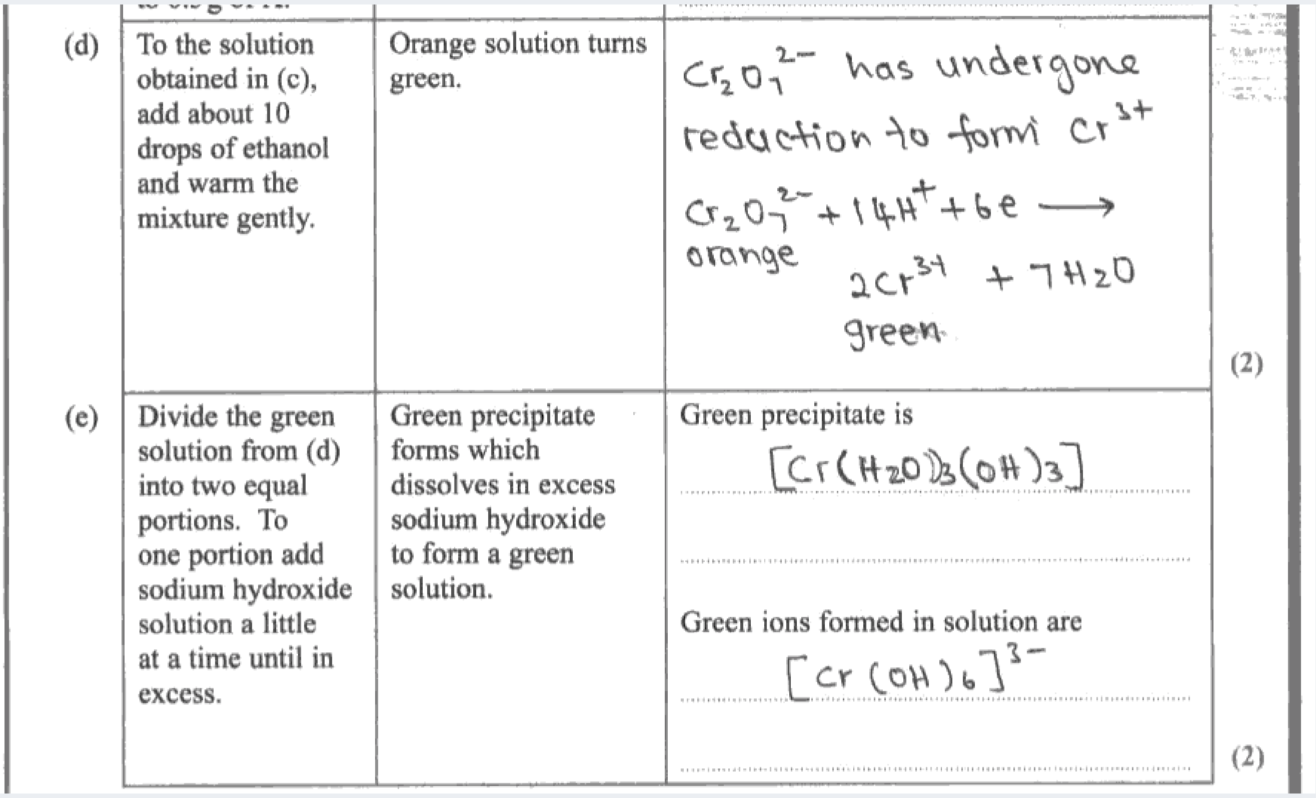
Examiner Comments

This candidate demonstrates a clear understanding of the chemistry involved and sets out his answer concisely but accurately.



(d)	To the solution obtained in (c), add about 10 drops of ethanol and warm the mixture gently.	Orange solution turns green.	$Cr_2O_7^{2-}$ has undergone reduction to form Cr^{3+} $Cr_2O_7^{2-} + 14H^+ + 6e \longrightarrow 2Cr^{3+} + 7H_2O$ orange green	(2)
(e)	Divide the green solution from (d) into two equal portions. To one portion add sodium hydroxide solution a little at a time until in excess.	Green precipitate forms which dissolves in excess sodium hydroxide to form a green solution.	Green precipitate is $[Cr(H_2O)_3(OH)_3]$ Green ions formed in solution are $[Cr(OH)_6]^{3-}$	(2)

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Examiner Comments

The use of the ionic half equation and the accurate formulae in this example, is impressive.

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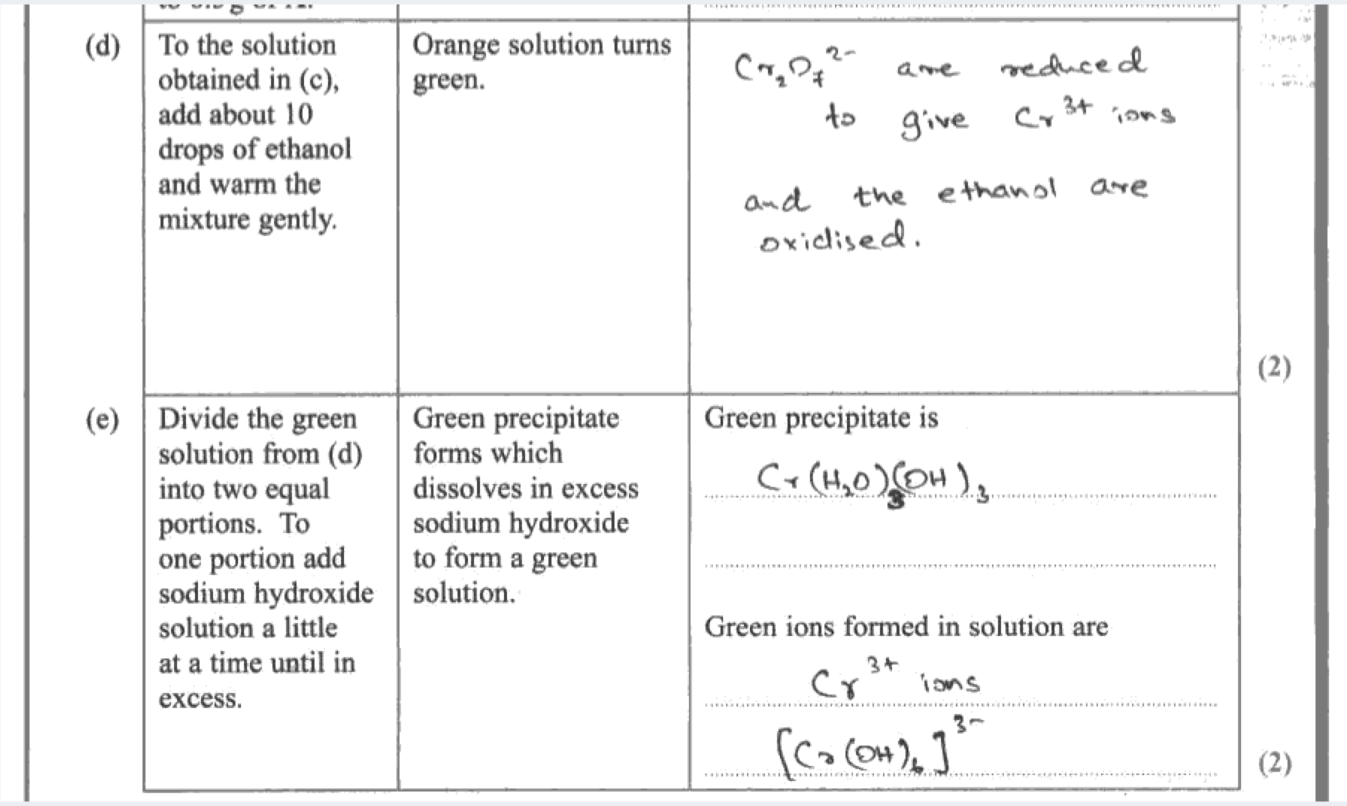
Examiner Tip

Using formulae and equations can add precision and make answers more concise, but accuracy is essential.



(d)	To the solution obtained in (c), add about 10 drops of ethanol and warm the mixture gently.	Orange solution turns green.	$Cr_2O_7^{2-}$ are reduced to give Cr^{3+} ions and the ethanol are oxidised.	(2)
(e)	Divide the green solution from (d) into two equal portions. To one portion add sodium hydroxide solution a little at a time until in excess.	Green precipitate forms which dissolves in excess sodium hydroxide to form a green solution.	Green precipitate is $Cr(H_2O)_3(OH)_3$ Green ions formed in solution are Cr^{3+} ions $[Cr(OH)_6]^{3-}$	(2)

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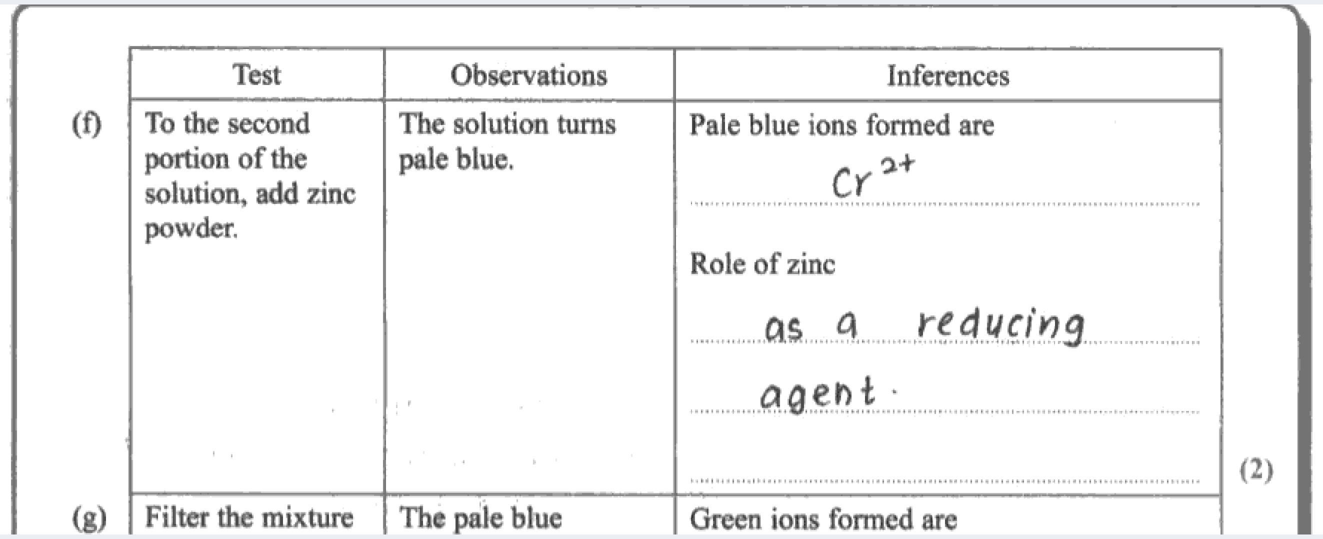
Examiner Comments

In the second part of (e), two answers have been given but only one is correct so a mark is lost.

Question 1(f)

Where candidates had followed the sequence in (1a) to (1e) the redox chemistry was well appreciated but, even when the chromium ion was not identified, the reducing property of zinc was widely known.



	Test	Observations	Inferences	
(f)	To the second portion of the solution, add zinc powder.	The solution turns pale blue.	Pale blue ions formed are Cr^{2+} Role of zinc as a reducing agent.	(2)
(g)	Filter the mixture	The pale blue	Green ions formed are	

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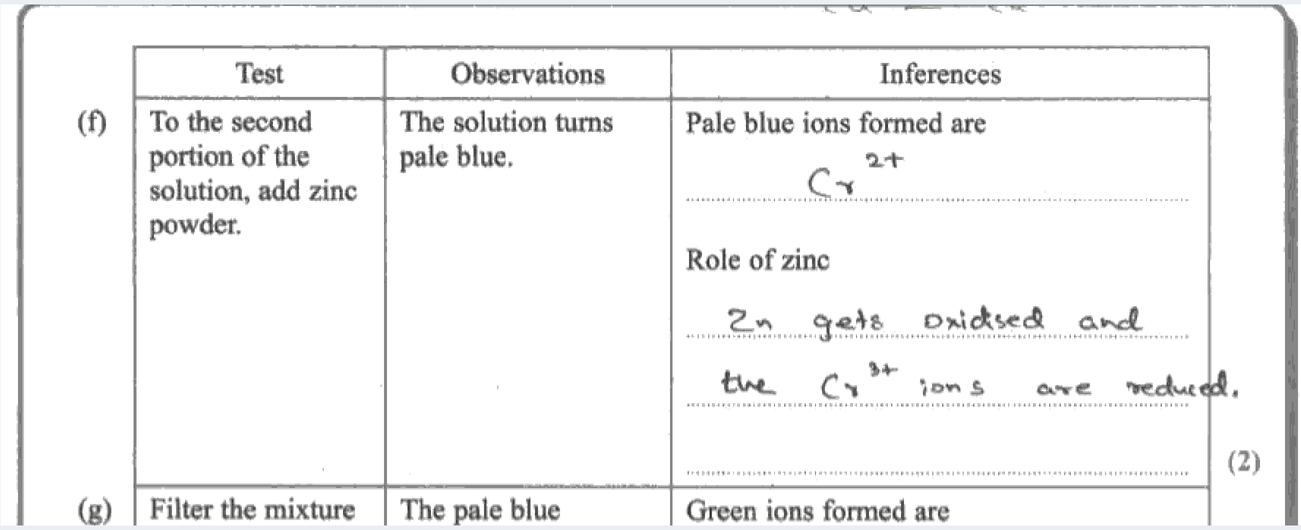
Examiner Comments

This candidate combines conciseness and accuracy.



	Test	Observations	Inferences
(f)	To the second portion of the solution, add zinc powder.	The solution turns pale blue.	Pale blue ions formed are Cr^{2+} Role of zinc Zn gets oxidsed and the Cr^{3+} ions are reduced. (2)
(g)	Filter the mixture	The pale blue	Green ions formed are

ResultsPlus
Examiner Comments

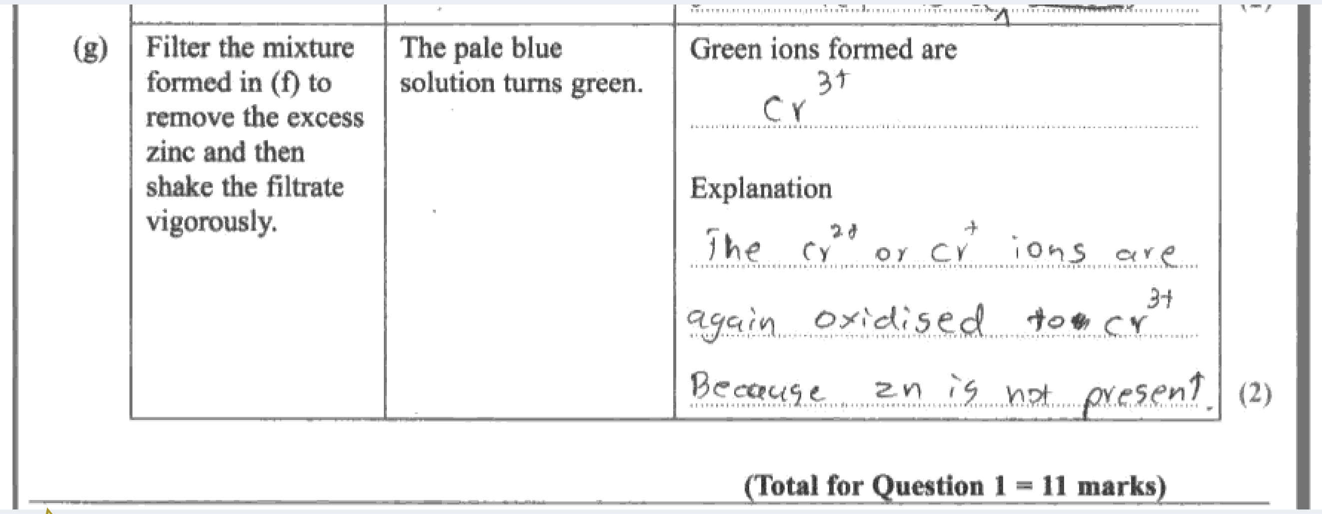
The role of zinc is explained, rather than stated, but the clear understanding gains the mark.

ResultsPlus
Examiner Tip

Good chemical understanding gains well-deserved credit here, although the answer looks different from the mark scheme.

Question 1(g)

In the explanation, the answer needs to move beyond a statement about oxidation to the practical issue of how it occurs.



(g)	Filter the mixture formed in (f) to remove the excess zinc and then shake the filtrate vigorously.	The pale blue solution turns green.	Green ions formed are Cr^{3+} Explanation The Cr^{2+} or Cr^{+} ions are again oxidised to Cr^{3+} Because Zn is not present	(2)

(Total for Question 1 = 11 marks)

ResultsPlus
Examiner Comments

The candidate has appreciated that the chromium species has re-oxidized, but not how removing the zinc has allowed it to occur.

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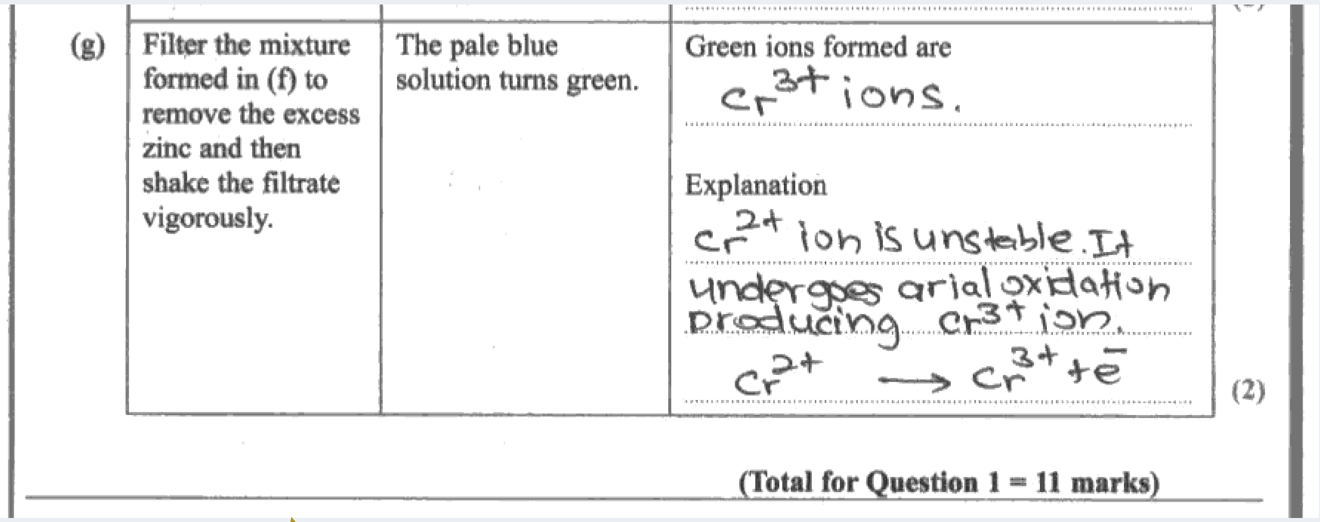
Examiner Tip

A little thought about what happened after the removal of the zinc would have been useful here.



(g)	Filter the mixture formed in (f) to remove the excess zinc and then shake the filtrate vigorously.	The pale blue solution turns green.	Green ions formed are Cr^{3+} ions. Explanation Cr^{2+} ion is unstable. It undergoes arial oxidation producing Cr^{3+} ion. $Cr^{2+} \longrightarrow Cr^{3+} + e^{-}$	(2)

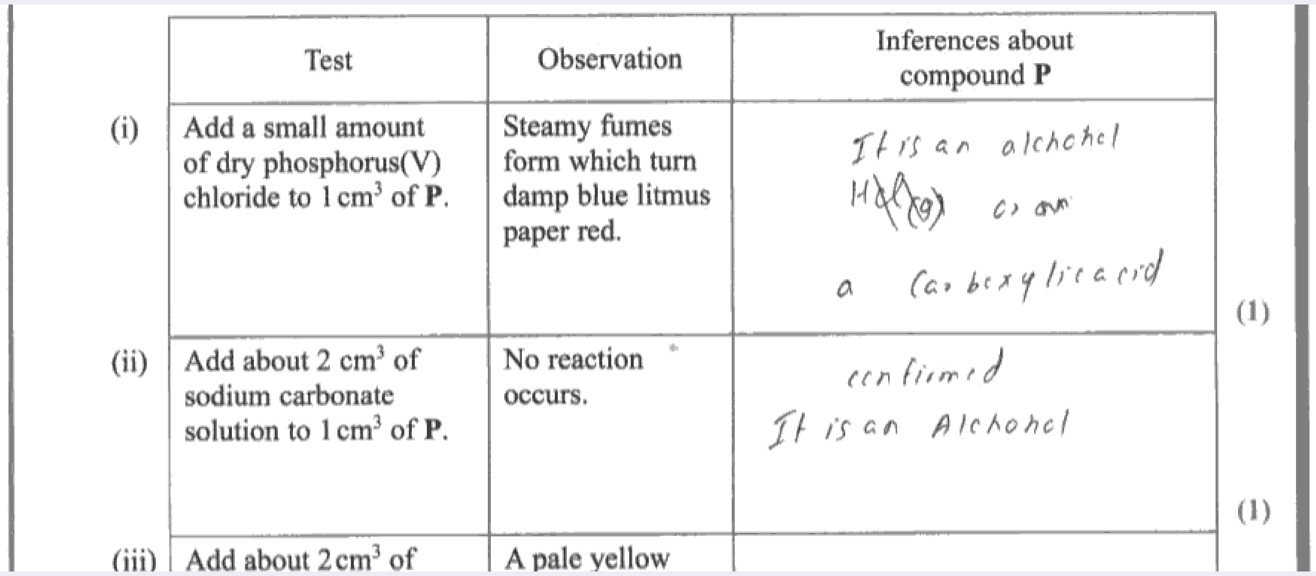
(Total for Question 1 = 11 marks)

ResultsPlus
Examiner Comments

This candidate makes it look quite easy. The mis-spelling of aerial is not penalized.

Question 2(a) (i-ii)

The stem of this question emphasises that the inferences must relate to compound P.



	Test	Observation	Inferences about compound **P**	
(i)	Add a small amount of dry phosphorus(V) chloride to 1 cm³ of **P**.	Steamy fumes form which turn damp blue litmus paper red.	It is an alchohol ~~HCl(g)~~ or an a carboxylic acid	(1)
(ii)	Add about 2 cm³ of sodium carbonate solution to 1 cm³ of **P**.	No reaction occurs.	confirmed It is an Alchohol	(1)
(iii)	Add about 2 cm³ of	A pale yellow		

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Examiner Comments

The second test eliminates the possibility that P is a carboxylic acid, so the second mark here is only awarded because alcohol and acid are mentioned in part (i).

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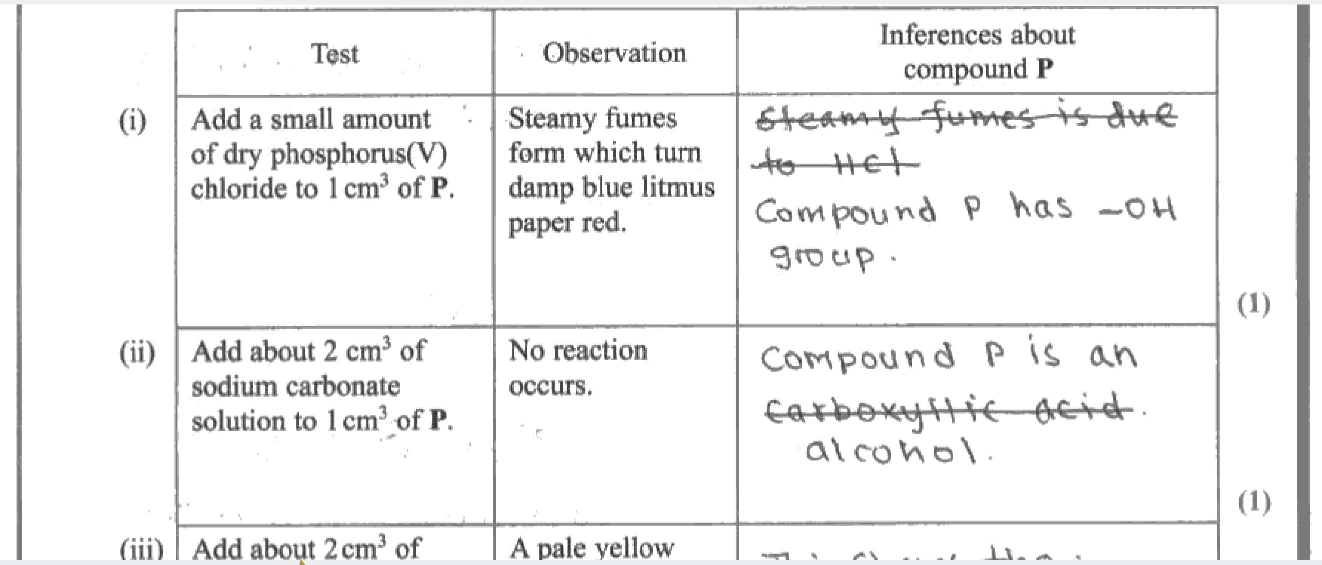
Examiner Tip

It is best to build up an inference starting with what can be directly deduced from the observation.



	Test	Observation	Inferences about compound **P**	
(i)	Add a small amount of dry phosphorus(V) chloride to 1 cm^3 of **P**.	Steamy fumes form which turn damp blue litmus paper red.	~~Steamy fumes is due to HCl~~ Compound P has –OH group.	(1)
(ii)	Add about 2 cm^3 of sodium carbonate solution to 1 cm^3 of **P**.	No reaction occurs.	Compound P is an ~~carboxylic acid~~. alcohol.	(1)
(iii)	Add about 2 cm^3 of	A pale yellow		

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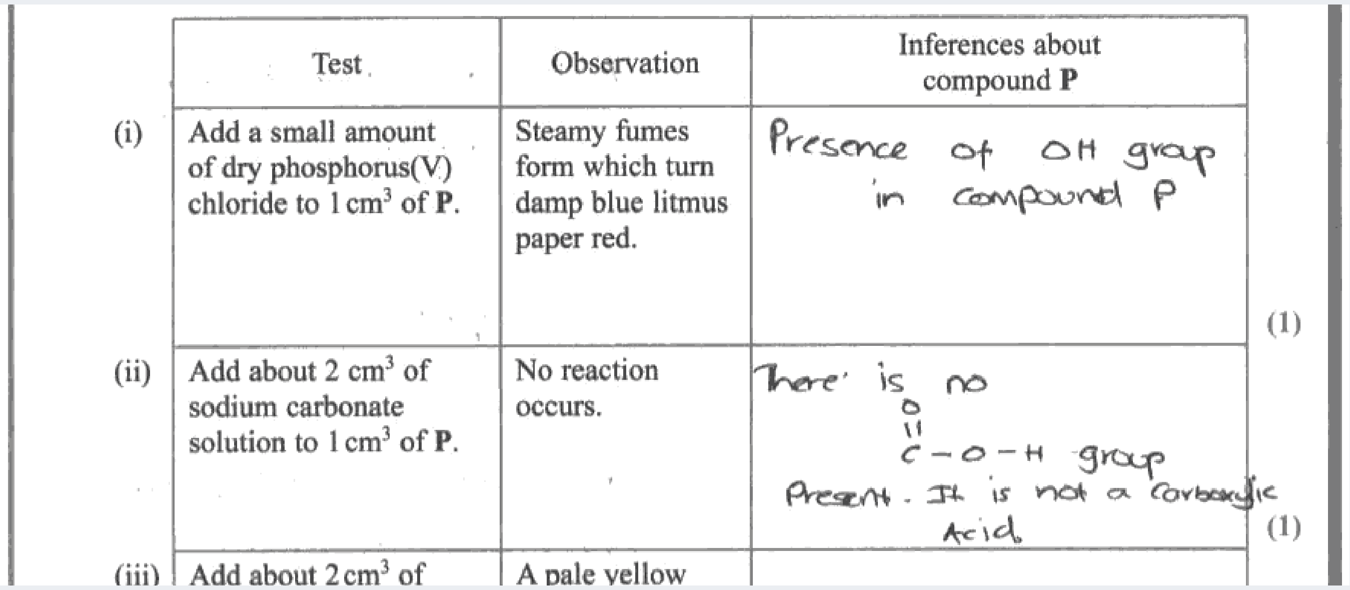
Examiner Comments

The first inference is the most precise but the second only follows indirectly from the observation.



	Test	Observation	Inferences about compound **P**	
(i)	Add a small amount of dry phosphorus(V) chloride to 1 cm^3 of **P**.	Steamy fumes form which turn damp blue litmus paper red.	Presence of OH grap in compound P	(1)
(ii)	Add about 2 cm^3 of sodium carbonate solution to 1 cm^3 of **P**.	No reaction occurs.	There is no $\overset{\overset{O}{\|}}{C}-O-H$ grap Present. It is not a Carboxylic Acid	(1)
(iii)	Add about 2 cm^3 of	A pale yellow		

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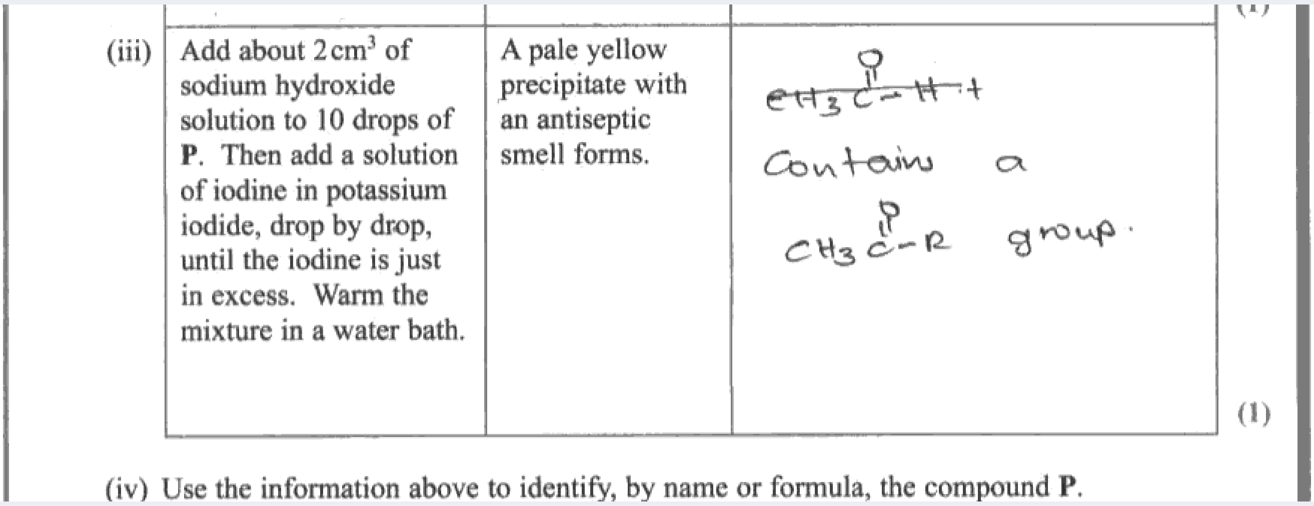
Examiner Comments

An excellent answer.

Question 2(a) (iii)

The iodoform test is not a test for a specific functional group but for a particular structural feature or the presence of a group that can be oxidized to produce that feature.



(iii)	Add about 2 cm^3 of sodium hydroxide solution to 10 drops of **P**. Then add a solution of iodine in potassium iodide, drop by drop, until the iodine is just in excess. Warm the mixture in a water bath.	A pale yellow precipitate with an antiseptic smell forms.	~~$CH_3\overset{O}{\overset{\|}{C}}-H$ +~~ Contain a $CH_3\overset{O}{\overset{\|}{C}}-R$ group.	(1)

(iv) Use the information above to identify, by name or formula, the compound **P**.

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Examiner Comments

This structure does give a positive iodoform test but cannot be present in P which must have an OH group.

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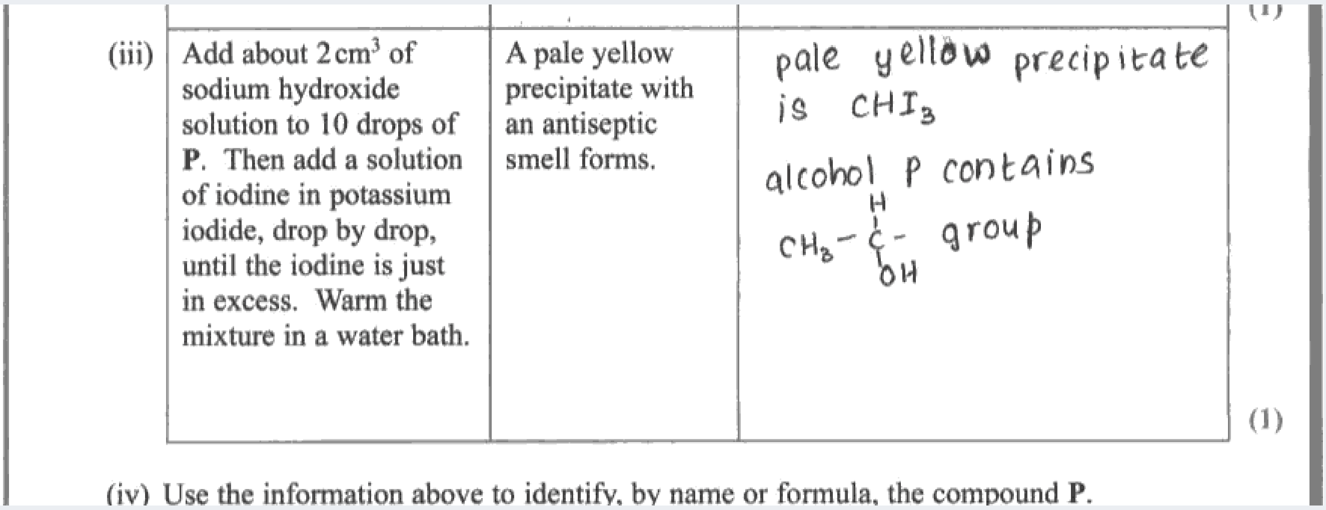
Examiner Tip

Make sure that the exact requirements of the question are fully understood. The question is about P.



(iii)	Add about 2 cm^3 of sodium hydroxide solution to 10 drops of **P**. Then add a solution of iodine in potassium iodide, drop by drop, until the iodine is just in excess. Warm the mixture in a water bath.	A pale yellow precipitate with an antiseptic smell forms.	pale yellow precipitate is CHI_3 alcohol P contains $CH_3-\overset{H}{\underset{OH}{C}}-$ group	(1)

(iv) Use the information above to identify, by name or formula, the compound **P**.

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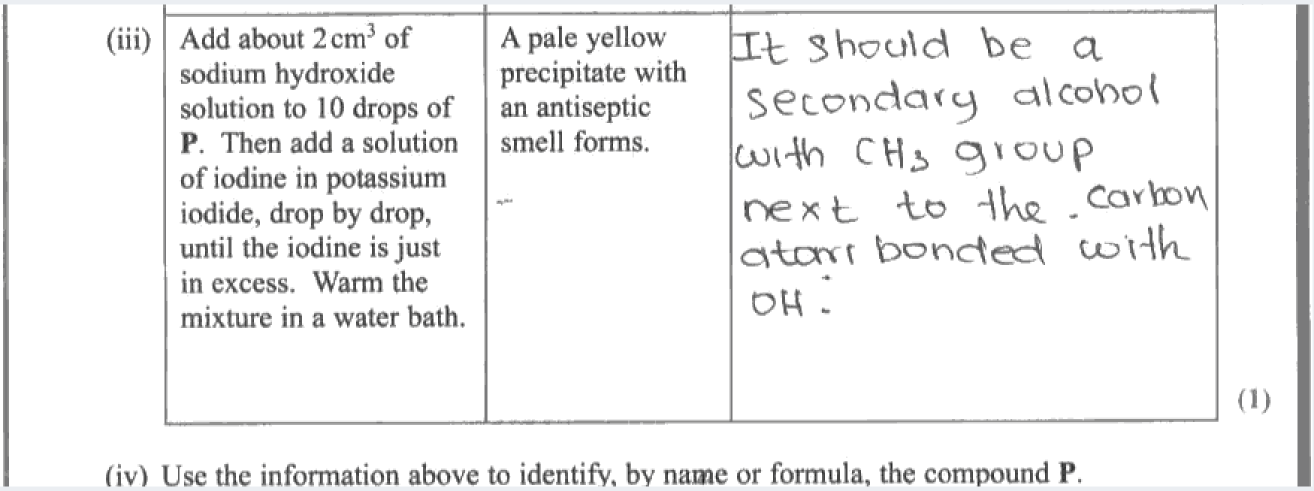
Examiner Comments

Note the way in which this candidate has structured the answer, identifying the precipitate and then the group that is present in P which gives rise to the formation of iodoform.



(iii)	Add about 2 cm^3 of sodium hydroxide solution to 10 drops of **P**. Then add a solution of iodine in potassium iodide, drop by drop, until the iodine is just in excess. Warm the mixture in a water bath.	A pale yellow precipitate with an antiseptic smell forms.	It should be a secondary alcohol with CH_3 group next to the carbon atom bonded with OH.	(1)

(iv) Use the information above to identify, by name or formula, the compound **P**.

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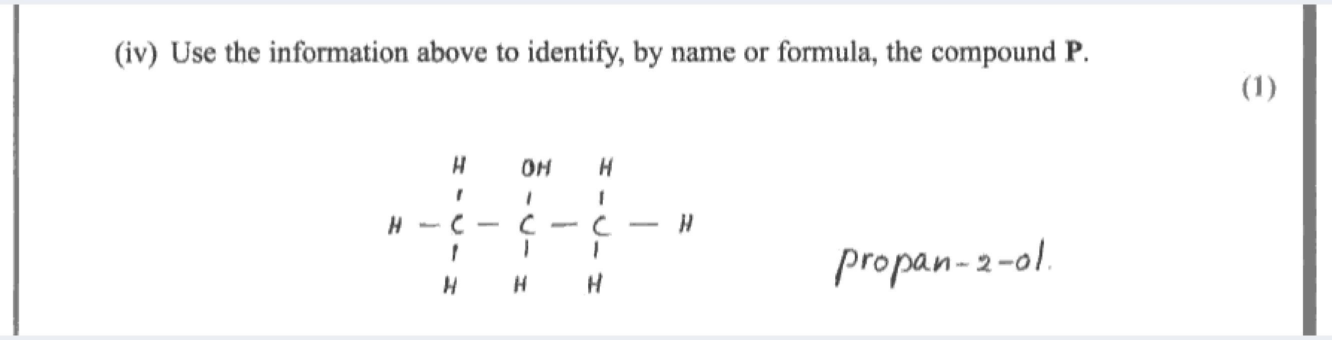
Examiner Comments

This answer carefully identifies the type of secondary alcohol which will give a positive iodoform test.

Question 2(a) (iv)

Most candidates were able to answer this question correctly using either name or formula and frequently both.



(iv) Use the information above to identify, by name or formula, the compound **P**.

(1)

propan-2-ol.

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Examiner Comments

Both name and structural formula are given and both are correct so the mark is awarded.

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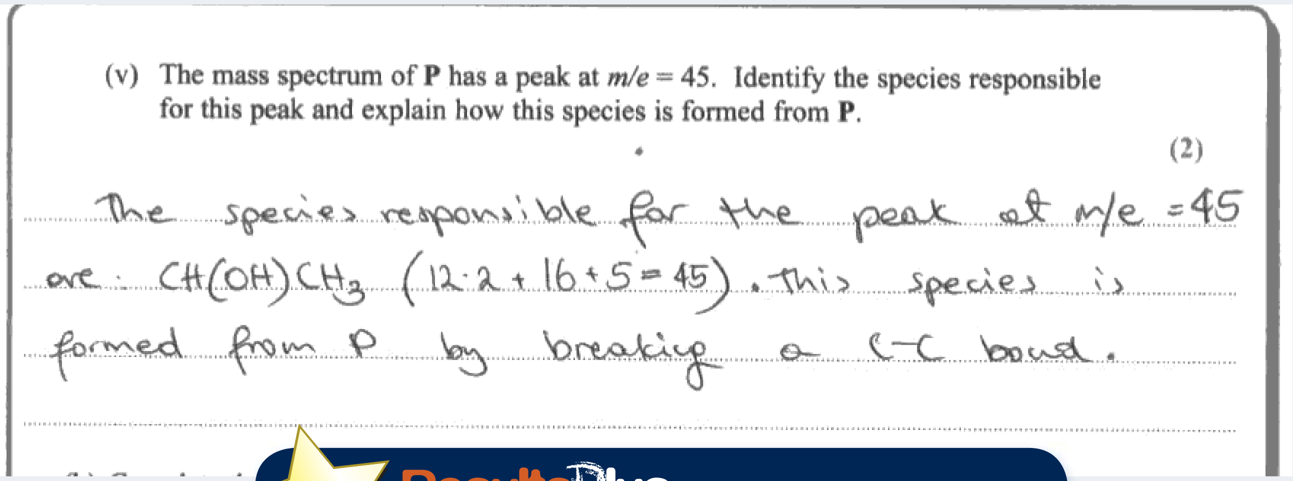
Examiner Tip

The bond between the central carbon and the OH group is not very carefully drawn. Candidates should ensure that the points of attachment of bonds are drawn accurately.

Question 2(a) (v)

The simplest way to view the processes in the mass spectrometer is that the molecular ion is formed initially and that, subsequently, some of the molecular ions break up with the loss of uncharged species leaving smaller, positively charged ions which are picked up by the detector.



(v) The mass spectrum of **P** has a peak at *m/e* = 45. Identify the species responsible for this peak and explain how this species is formed from **P**.

(2)

The species responsible for the peak at m/e =45 are: $CH(OH)CH_3$ (12·2 + 16 + 5 = 45). this species is formed from P by breaking a C–C bond.

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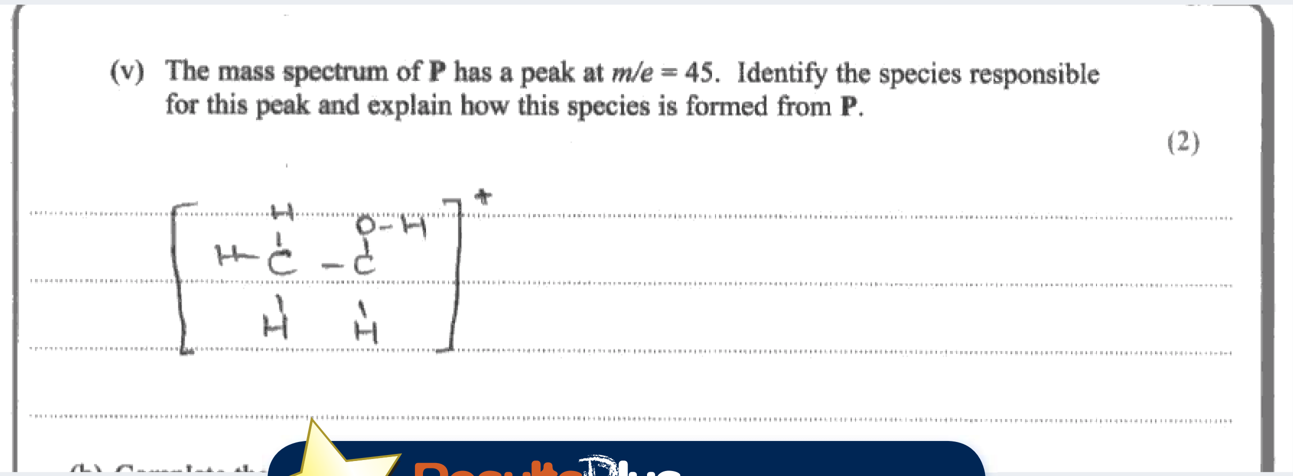
Examiner Comments

The species responsible for peaks in a mass spectrum are all positively charged and the second marking point is identifying the loss of the methyl group.



(v) The mass spectrum of **P** has a peak at *m/e* = 45. Identify the species responsible for this peak and explain how this species is formed from **P**.

(2)

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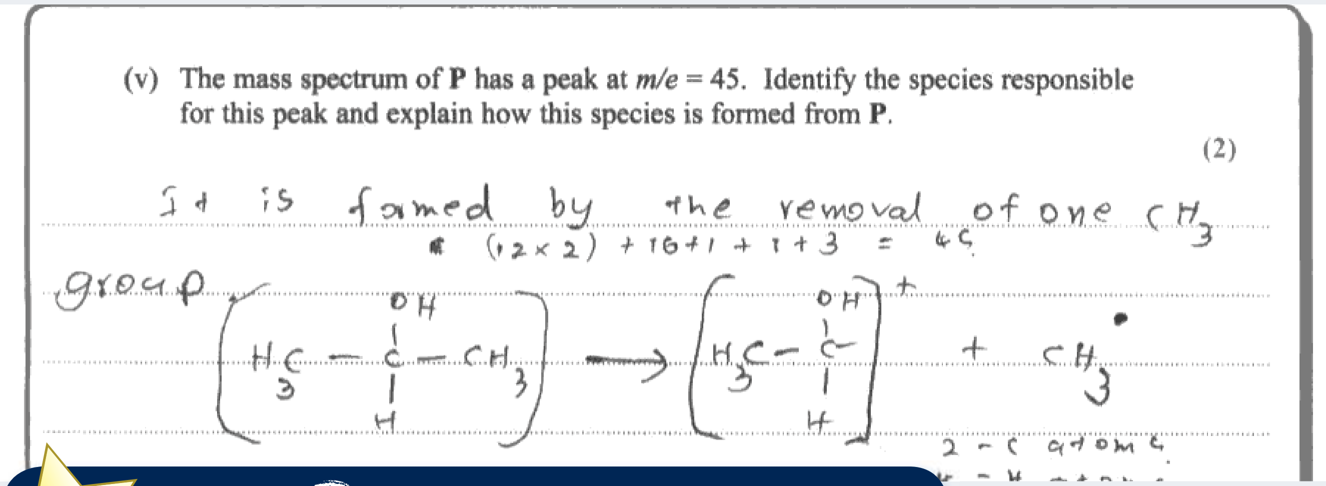
Examiner Comments

The species is clear and correct.



(v) The mass spectrum of **P** has a peak at *m/e* = 45. Identify the species responsible for this peak and explain how this species is formed from **P**.

(2)

It is formed by the removal of one CH_3 group

$(12 \times 2) + 16 + 1 + 1 + 3 = 45$

$$\left[H_3C-\overset{OH}{\underset{H}{\overset{|}{\underset{|}{C}}}}-CH_3\right] \longrightarrow \left[H_3C-\overset{OH}{\underset{H}{\overset{|}{\underset{|}{C}}}}\right]^+ + CH_3^\bullet$$

2 – C atoms

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Examiner Comments

There is sufficient material in this answer to gain full marks as the ion at m/e = 45 is correctly identified as is the loss of the (neutral) methyl group.

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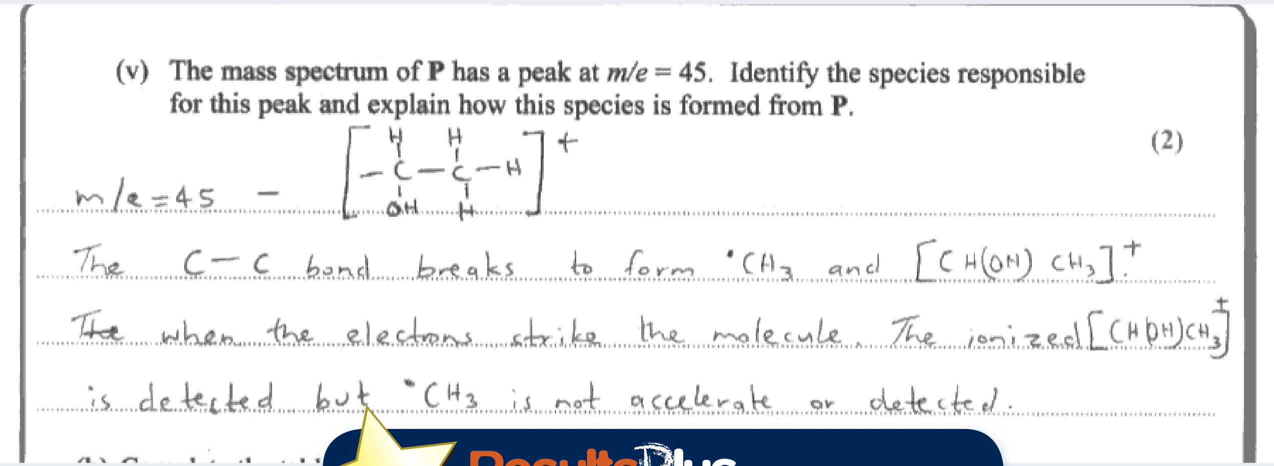
Examiner Tip

Equations should balance for charge as well as mass, so, ideally, the first species should carry a positive charge.



(v) The mass spectrum of **P** has a peak at *m/e* = 45. Identify the species responsible for this peak and explain how this species is formed from **P**.

(2)

$m/e = 45$ – $\left[-\overset{H}{\underset{OH}{\overset{|}{\underset{|}{C}}}}-\overset{H}{\underset{H}{\overset{|}{\underset{|}{C}}}}-H\right]^+$

The C – C bond breaks to form $^\bullet CH_3$ and $[CH(OH)CH_3]^+$. ~~The~~ when the electrons strike the molecule. The ionized $[CH(OH)CH_3]^+$ is detected but $^\bullet CH_3$ is not accelerate or detected.

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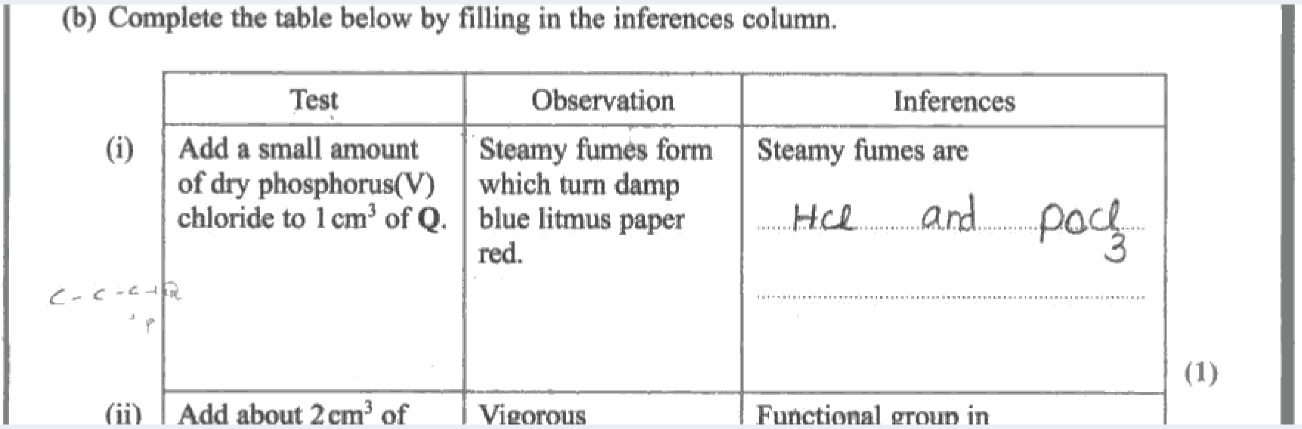
Examiner Comments

An excellent answer.

Question 2(b) (i)

Most candidates could identify the steamy fumes as hydrogen chloride.



(b) Complete the table below by filling in the inferences column.

	Test	Observation	Inferences	
(i)	Add a small amount of dry phosphorus(V) chloride to 1 cm³ of **Q**.	Steamy fumes form which turn damp blue litmus paper red.	Steamy fumes are Hcl and $pocl_3$	(1)
(ii)	Add about 2 cm³ of	Vigorous	Functional group in	

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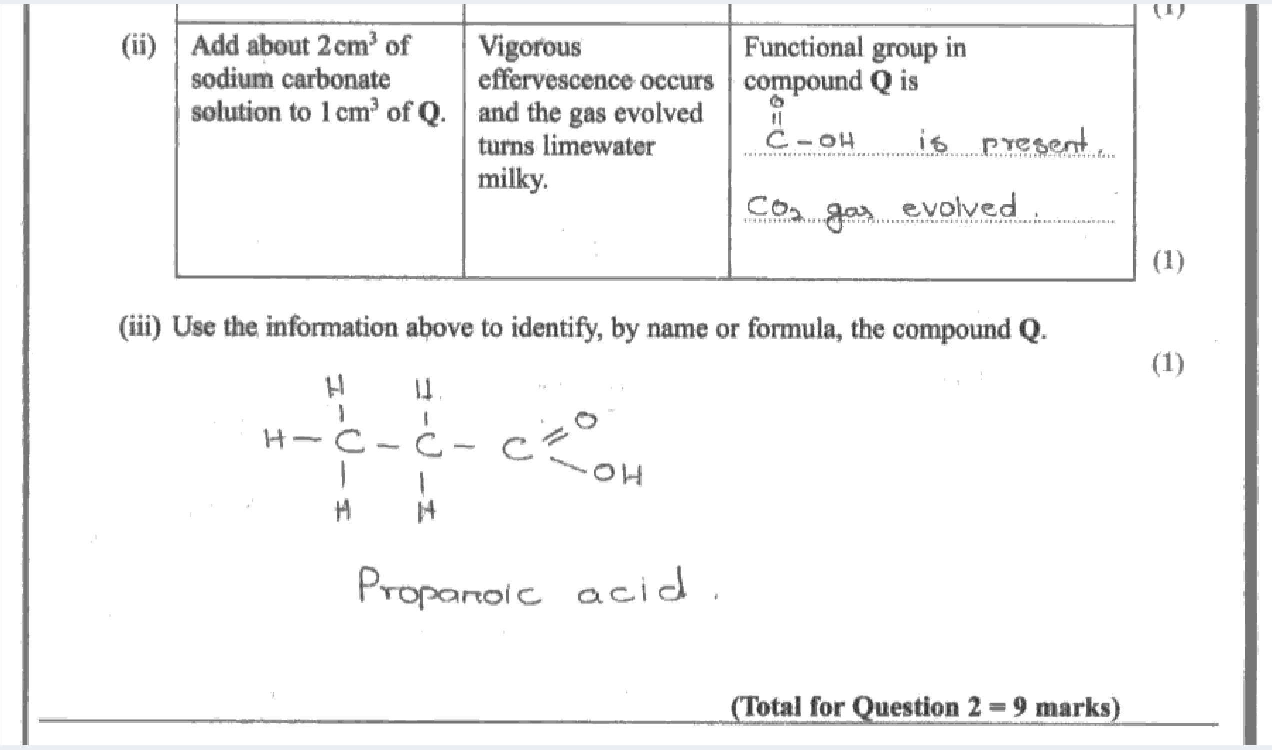
Examiner Comments

$POCl_3$ cannot be responsible for the steamy fumes.

Question 2(b) (ii-iii)

These questions were correctly answered by most candidates.



(ii)	Add about 2 cm³ of sodium carbonate solution to 1 cm³ of **Q**.	Vigorous effervescence occurs and the gas evolved turns limewater milky.	Functional group in compound **Q** is $\overset{O}{\overset{\|}{C}}-OH$ is present. CO_2 gas evolved.	(1)

(iii) Use the information above to identify, by name or formula, the compound **Q**. (1)

Propanoic acid.

(Total for Question 2 = 9 marks)

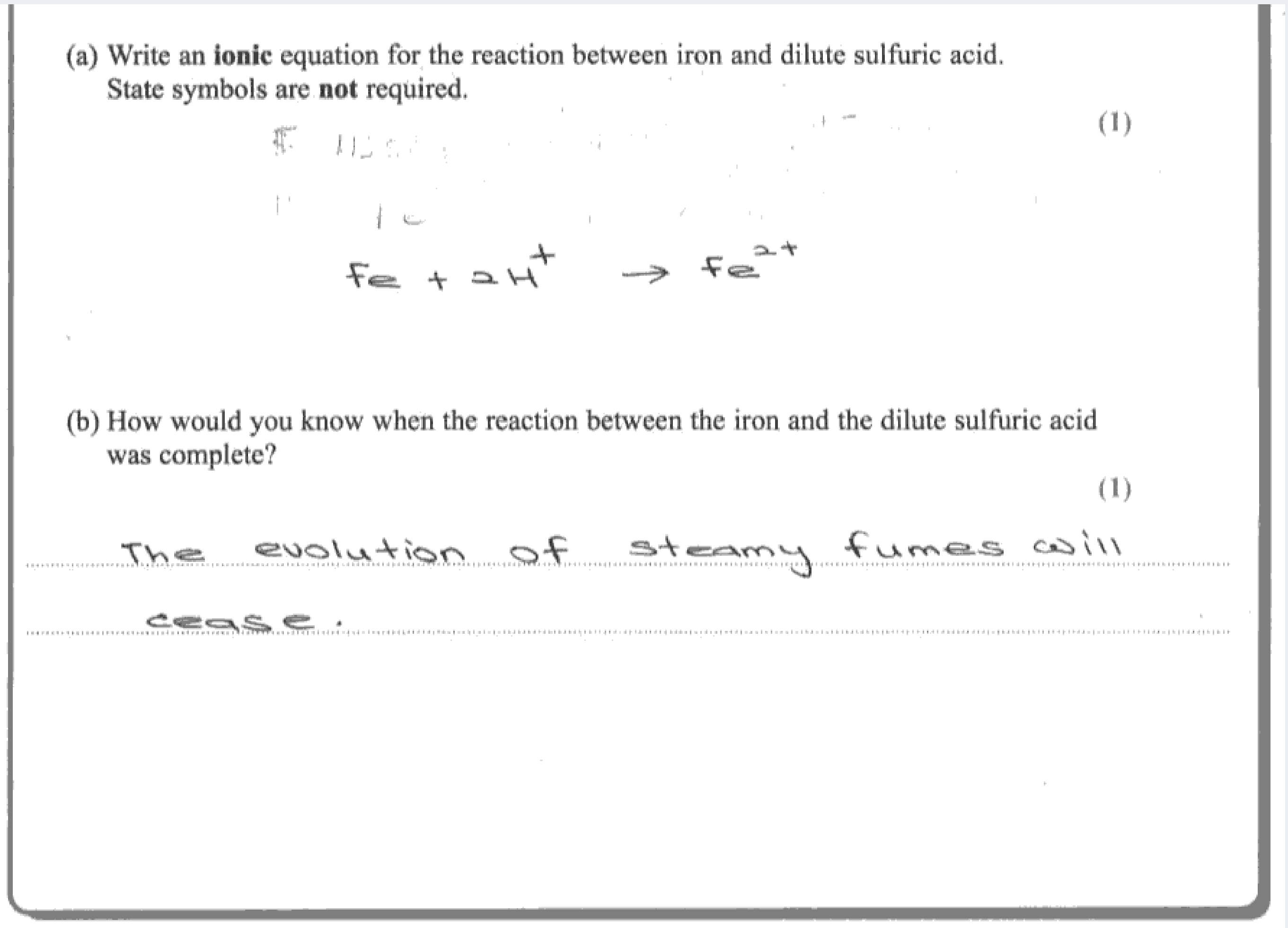
ResultsPlus

Examiner Comments

A typical high quality answer.

Question 3(a-b)

Writing ionic equations is a key skill in mastering inorganic chemistry. Ionic equations do not have electrons (although ionic half equations do) and remember to balance charge as well as mass.



(a) Write an **ionic** equation for the reaction between iron and dilute sulfuric acid. State symbols are **not** required.

(1)

$Fe + 2H^+ \rightarrow Fe^{2+}$

(b) How would you know when the reaction between the iron and the dilute sulfuric acid was complete?

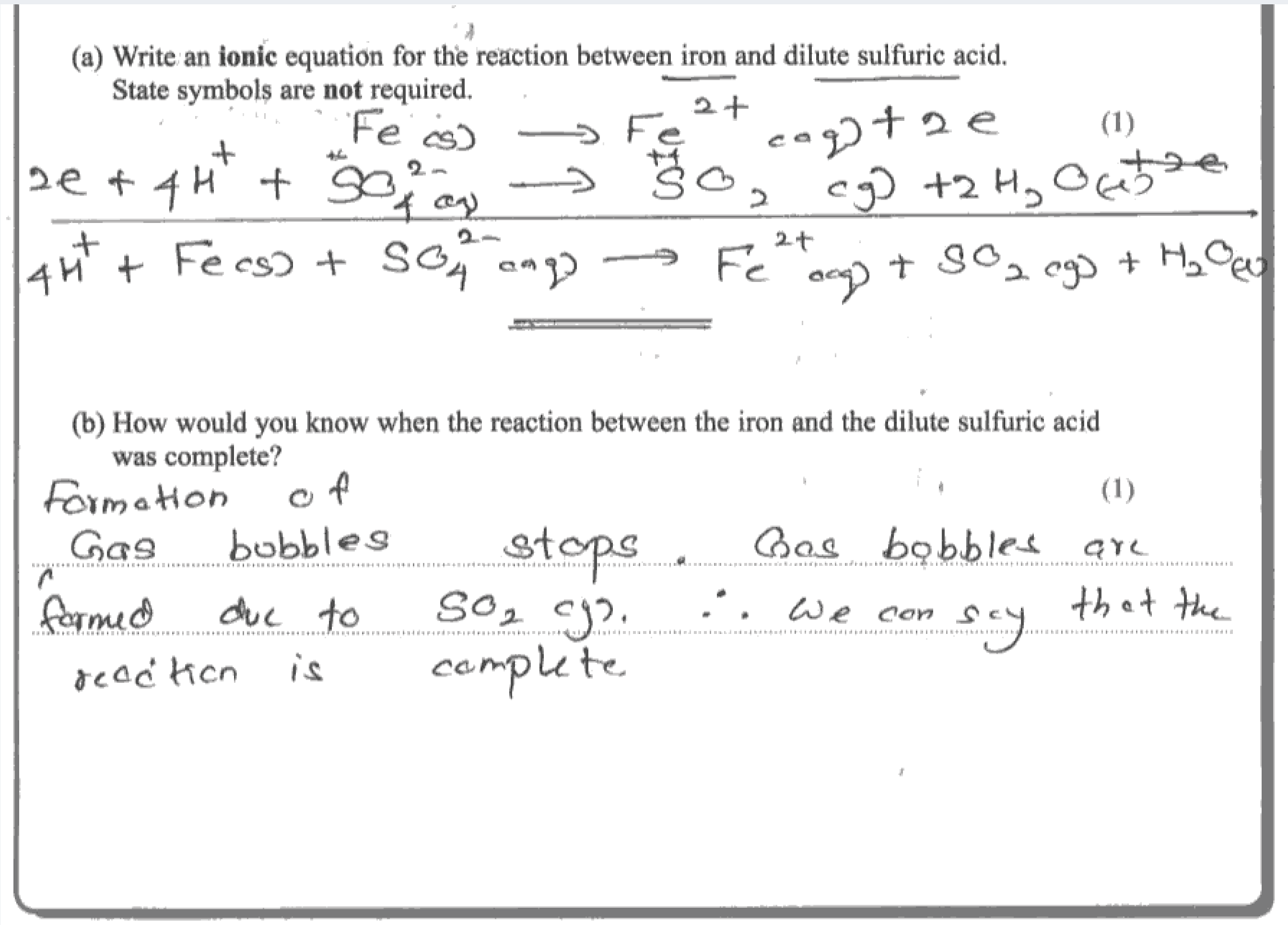
(1)

The evolution of steamy fumes will cease.

ResultsPlus

Examiner Comments

The masses in the equation clearly do not balance and steamy fumes are not an appropriate observation for a gas such as hydrogen.



(a) Write an **ionic** equation for the reaction between iron and dilute sulfuric acid.
State symbols are **not** required.

$Fe_{(s)} \longrightarrow Fe^{2+}{}_{(aq)} + 2e$

(1)

$2e + 4H^+ + \overset{+6}{S}O_4^{2-}{}_{(aq)} \longrightarrow \overset{+4}{S}O_2{}_{(g)} + 2H_2O_{(l)} \cancel{+2e}$

$4H^+ + Fe_{(s)} + SO_4^{2-}{}_{(aq)} \longrightarrow Fe^{2+}{}_{(aq)} + SO_2{}_{(g)} + H_2O_{(l)}$

(b) How would you know when the reaction between the iron and the dilute sulfuric acid was complete?

Formation of Gas bubbles stops. Gas bobbles are formed due to SO_2 (g). ∴ We can say that the reaction is complete

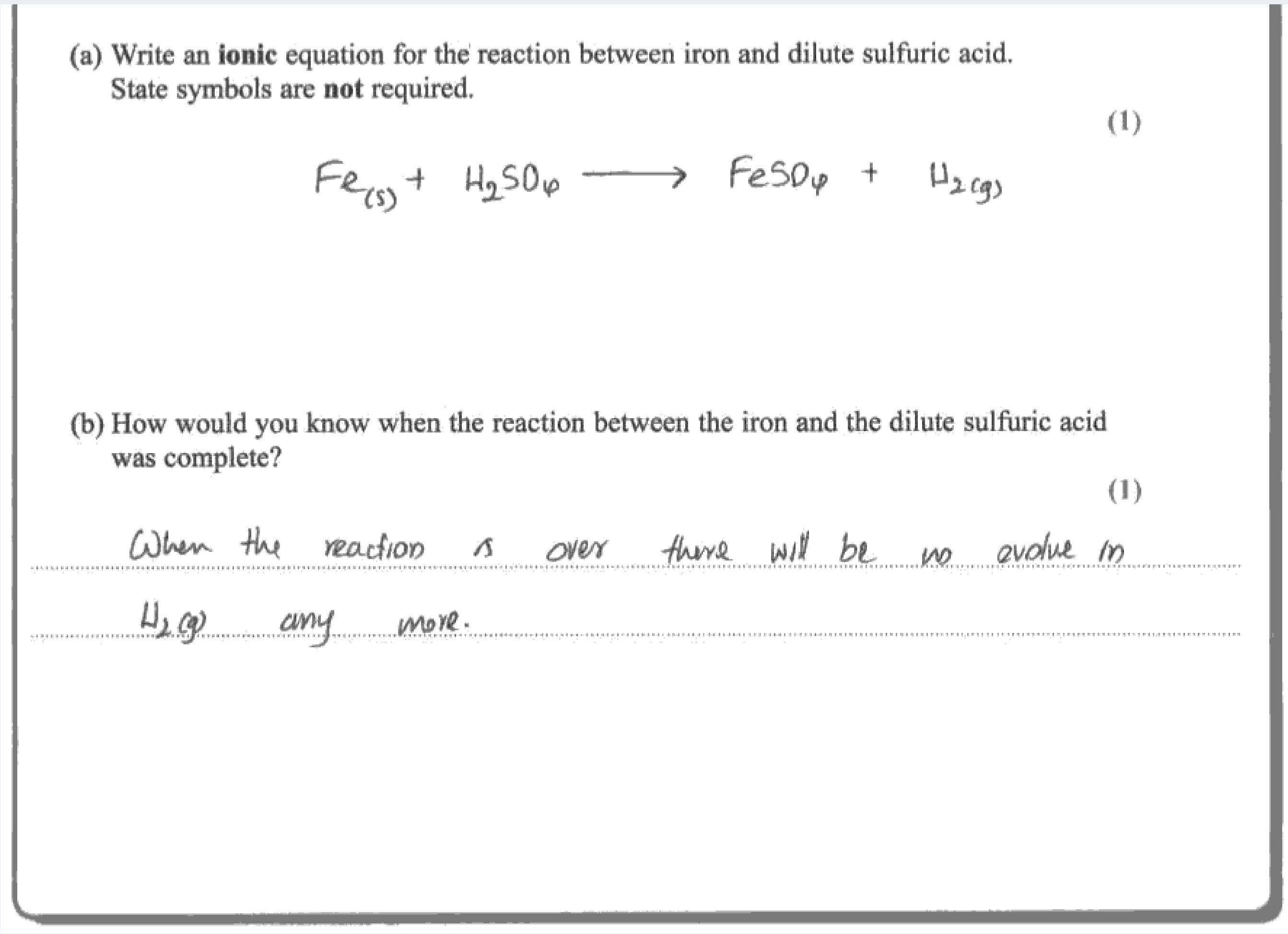
(1)

ResultsPlus
Examiner Comments

Dilute sulfuric acid is not an oxidizing agent so the reaction is incorrect. Note that the final equation does not balance. The second mark remains available although the answer is unnecessarily elaborate; the first sentence gains the mark.

ResultsPlus
Examiner Tip

Double check that equations balance and keep answers concise.



(a) Write an **ionic** equation for the reaction between iron and dilute sulfuric acid. State symbols are **not** required.

(1)

$Fe_{(s)} + H_2SO_4 \longrightarrow FeSO_4 + H_{2(g)}$

(b) How would you know when the reaction between the iron and the dilute sulfuric acid was complete?

(1)

When the reaction is over there will be no evolve in $H_{2(g)}$ any more.

ResultsPlus

Examiner Comments

Despite the clear requirement this candidate has written a full equation. The second mark is just achieved, but the relevant observation (effervescence stops) would have been more appropriate.

ResultsPlus

Examiner Tip

In this paper, it is important to focus on the practical aspects of the questions.

Question 3(c)

Most candidates attempted this calculation in a logical fashion and set out their answers with impressive clarity. This approach is to be commended; experience shows that a well presented solution to a numerical question has a high chance of success.

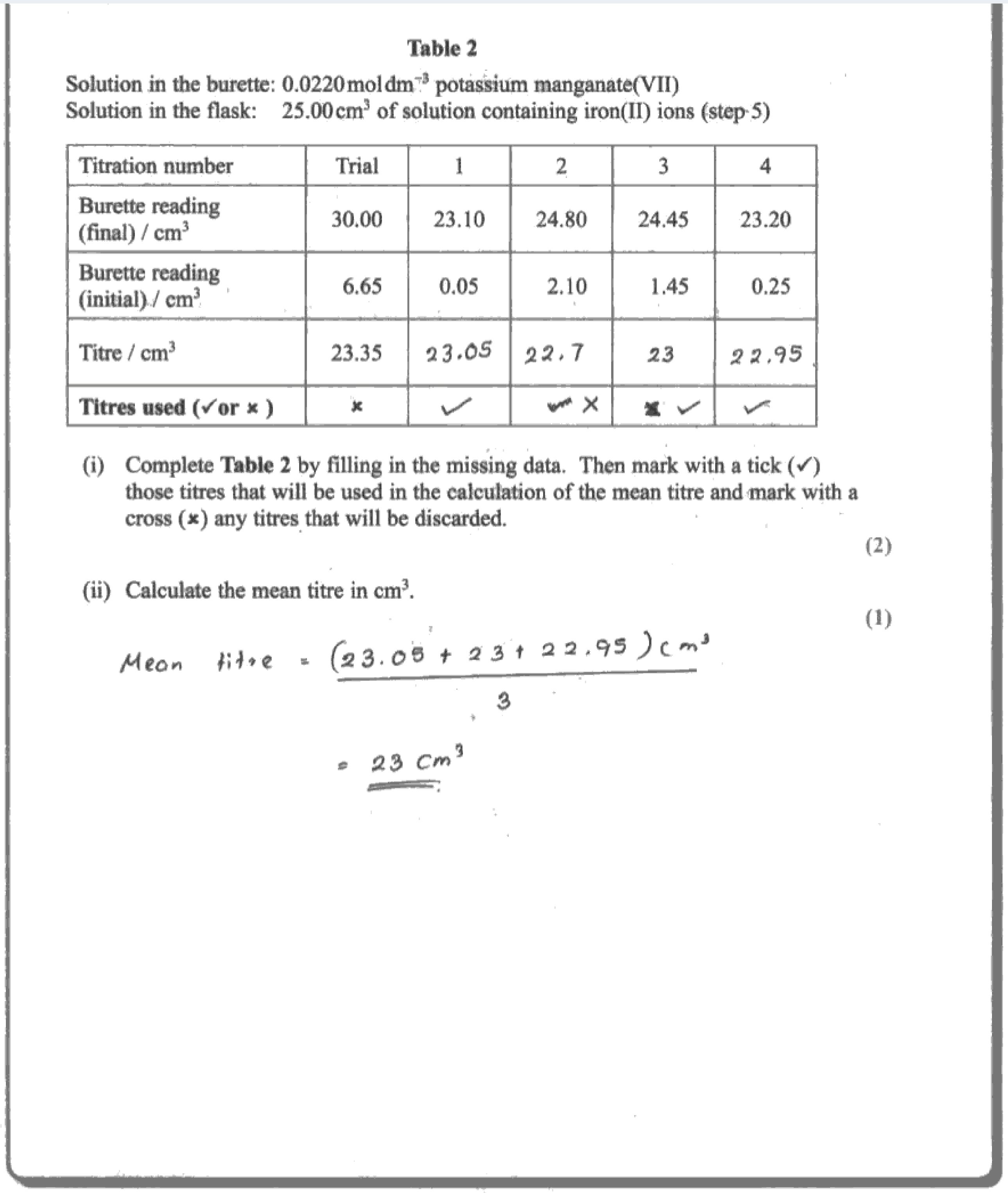


Table 2

Solution in the burette: 0.0220 mol dm^{-3} potassium manganate(VII)
Solution in the flask: 25.00 cm^3 of solution containing iron(II) ions (step 5)

Titration number	Trial	1	2	3	4
Burette reading (final) / cm^3	30.00	23.10	24.80	24.45	23.20
Burette reading (initial) / cm^3	6.65	0.05	2.10	1.45	0.25
Titre / cm^3	23.35	23.05	22.7	23	22.95
Titres used (✓or ✗)	✗	✓	✗	✓	✓

(i) Complete **Table 2** by filling in the missing data. Then mark with a tick (✓) those titres that will be used in the calculation of the mean titre and mark with a cross (✗) any titres that will be discarded.

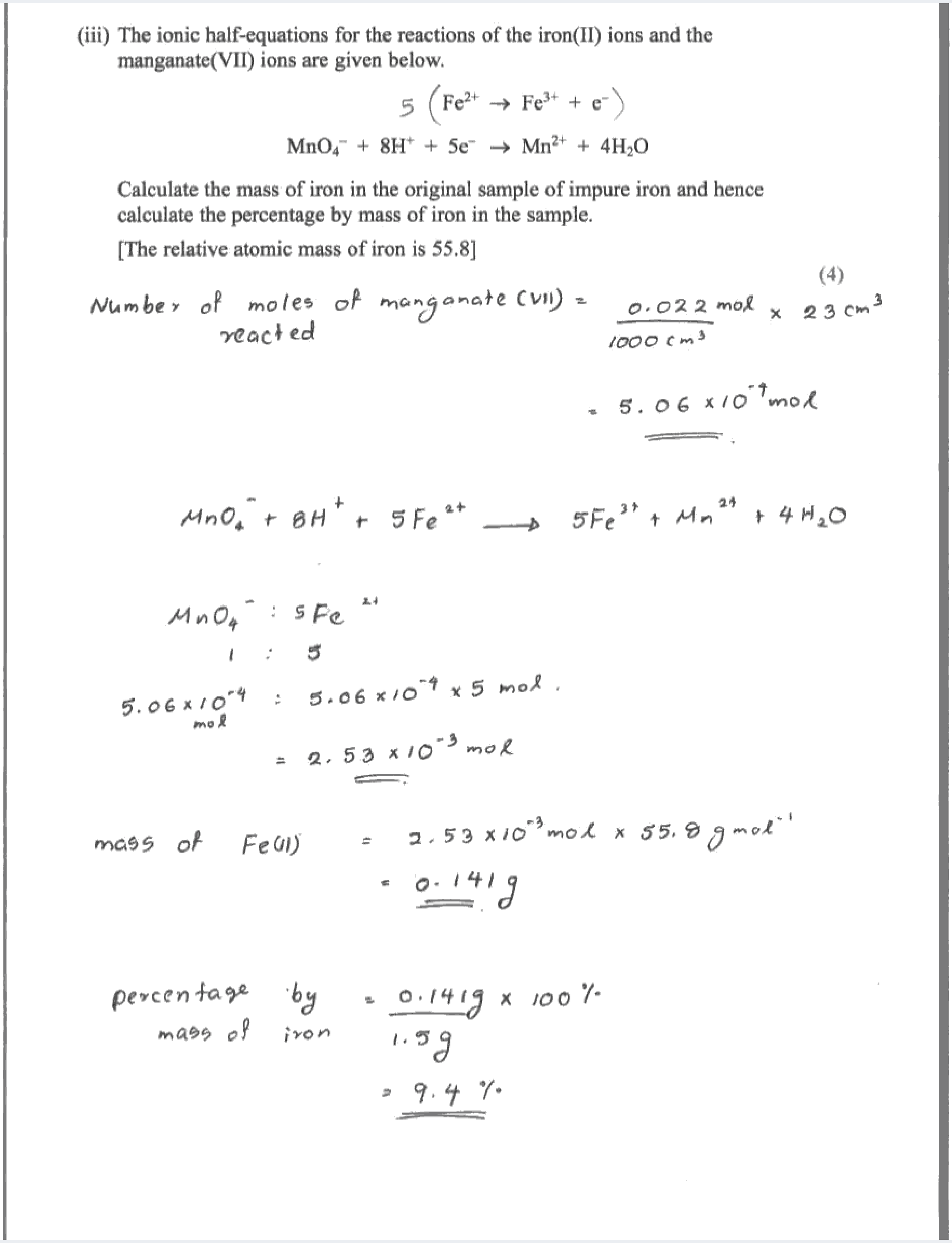
(2)

(ii) Calculate the mean titre in cm^3.

(1)

$$\text{Mean titre} = \frac{(23.05 + 23 + 22.95)\,\text{cm}^3}{3}$$

$$= \underline{23\ \text{cm}^3}$$



(iii) The ionic half-equations for the reactions of the iron(II) ions and the manganate(VII) ions are given below.

$$5\left(Fe^{2+} \rightarrow Fe^{3+} + e^{-}\right)$$

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

Calculate the mass of iron in the original sample of impure iron and hence calculate the percentage by mass of iron in the sample.

[The relative atomic mass of iron is 55.8]

(4)

Number of moles of manganate (VII) reacted = $\frac{0.022\ mol}{1000\ cm^3} \times 23\ cm^3$

$= \underline{\underline{5.06}} \times 10^{-4}\ mol$

$$MnO_4^{-} + 8H^{+} + 5Fe^{2+} \longrightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$$

$MnO_4^{-} : 5Fe^{2+}$

1 : 5

5.06×10^{-4} mol : $5.06 \times 10^{-4} \times 5$ mol.

$= \underline{\underline{2.53}} \times 10^{-3}$ mol

mass of Fe(II) = 2.53×10^{-3} mol × 55.8 g mol^{-1}

$= \underline{\underline{0.141}}\ g$

percentage by mass of iron = $\frac{0.141g}{1.5g} \times 100\%$

$= \underline{\underline{9.4\%}}$

ResultsPlus

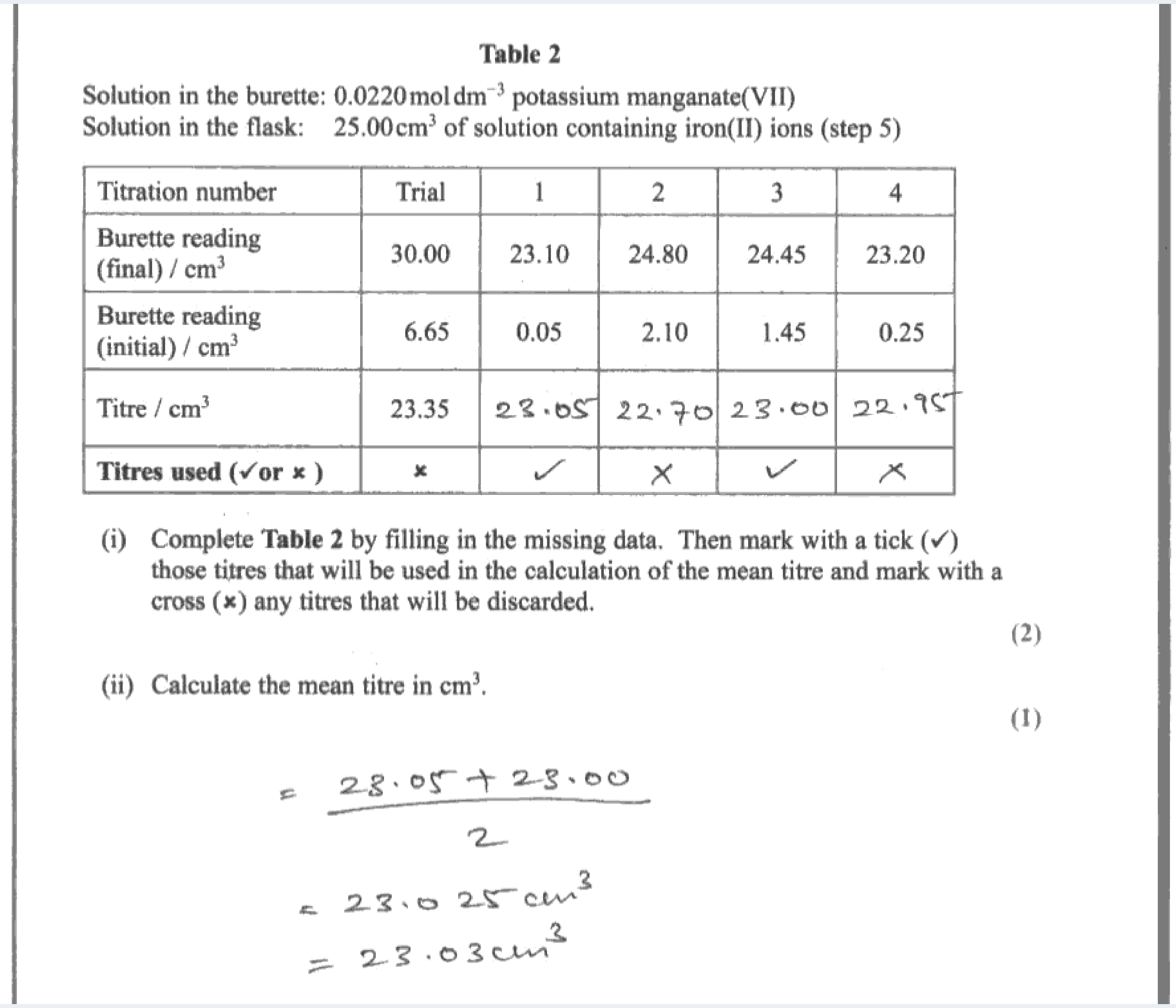
Examiner Comments

Ideally burette readings should be given to 2 decimal places so the third accurate titre and the final value should both be 23.00 cm3. In the calculation the candidate has failed to scale the volume of the iron(II) sulfate solution from 25 to 250 cm3 and also used the target mass of iron rather than the actual weighed amount.

ResultsPlus

Examiner Tip

An answer as low as 9.4 %should prompt a review of the calculation for an obvious factor of 10 error.



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Titration number	Trial	1	2	3	4
Burette reading (final) / cm^3	30.00	23.10	24.80	24.45	23.20
Burette reading (initial) / cm^3	6.65	0.05	2.10	1.45	0.25
Titre / cm^3	23.35	23.05	22.70	23.00	22.95
Titres used (✓or ✗)	✗	✓	✗	✓	✗

(i) Complete **Table 2** by filling in the missing data. Then mark with a tick (✓) those titres that will be used in the calculation of the mean titre and mark with a cross (✗) any titres that will be discarded.

(2)

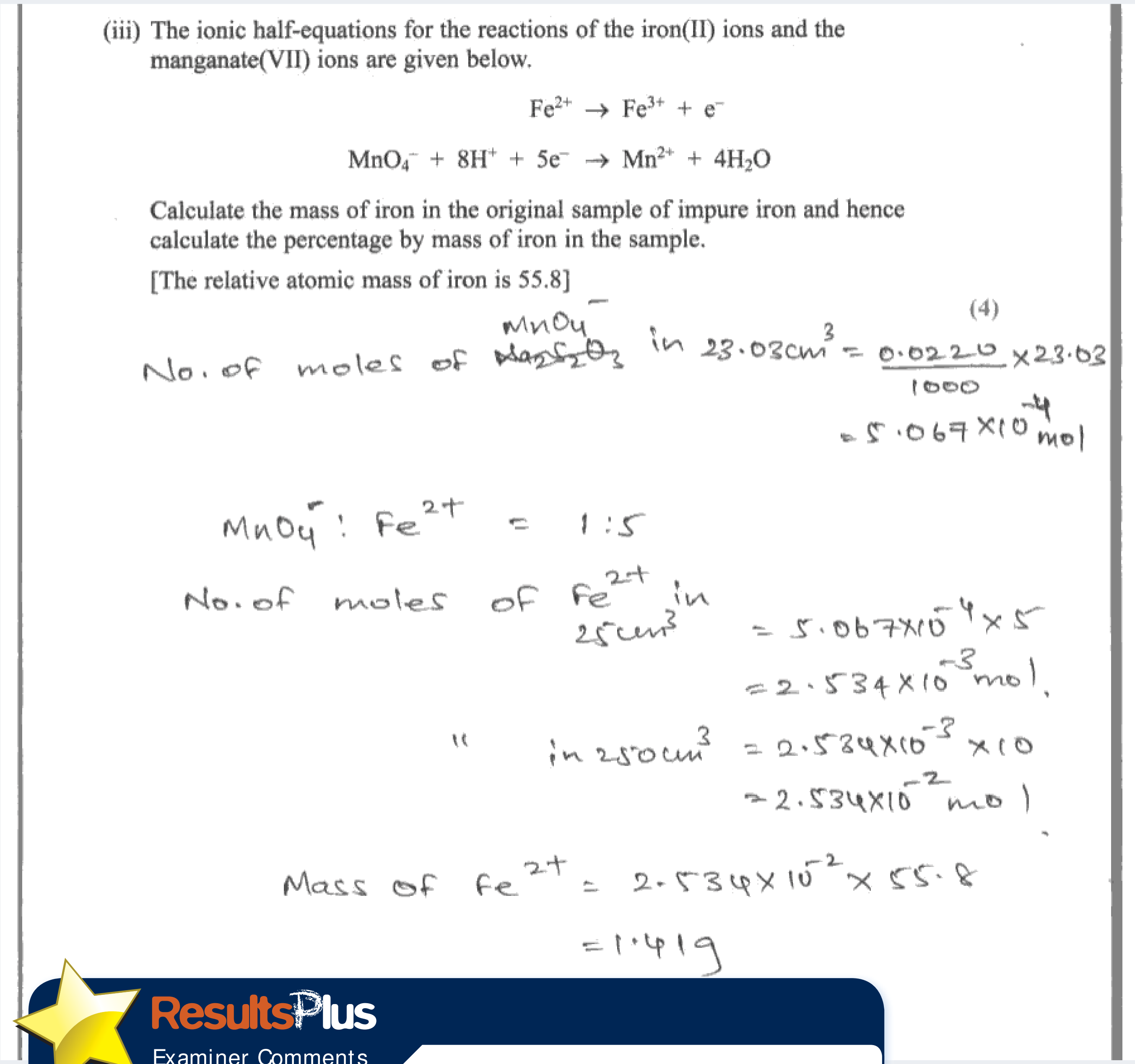
(ii) Calculate the mean titre in cm^3.

(1)

$$= \frac{23.05 + 23.00}{2}$$

$$= 23.025 \text{ cm}^3$$

$$= 23.03 \text{ cm}^3$$



(iii) The ionic half-equations for the reactions of the iron(II) ions and the manganate(VII) ions are given below.

$$Fe^{2+} \rightarrow Fe^{3+} + e^-$$

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

Calculate the mass of iron in the original sample of impure iron and hence calculate the percentage by mass of iron in the sample.

[The relative atomic mass of iron is 55.8]

(4)

No. of moles of MnO_4^- ~~$Na_2S_2O_3$~~ in 23.03cm^3 = $\frac{0.0220}{1000} \times 23.03$

= 5.067×10^{-4} mol

$MnO_4^- : Fe^{2+} = 1:5$

No. of moles of Fe^{2+} in 25cm^3 = $5.067 \times 10^{-4} \times 5$

= 2.534×10^{-3} mol.

" in 250cm^3 = $2.534 \times 10^{-3} \times 10$

= 2.534×10^{-2} mol

Mass of Fe^{2+} = $2.534 \times 10^{-2} \times 55.8$

= 1.41g

ResultsPlus

Examiner Comments

The rule of thumb in calculating the mean titre is to include values within 0.2 cm3 (superscript 3) so it is puzzling that this candidate omits the fourth titre value. Similarly the calculation is exemplary but the percentage calculation is omitted.

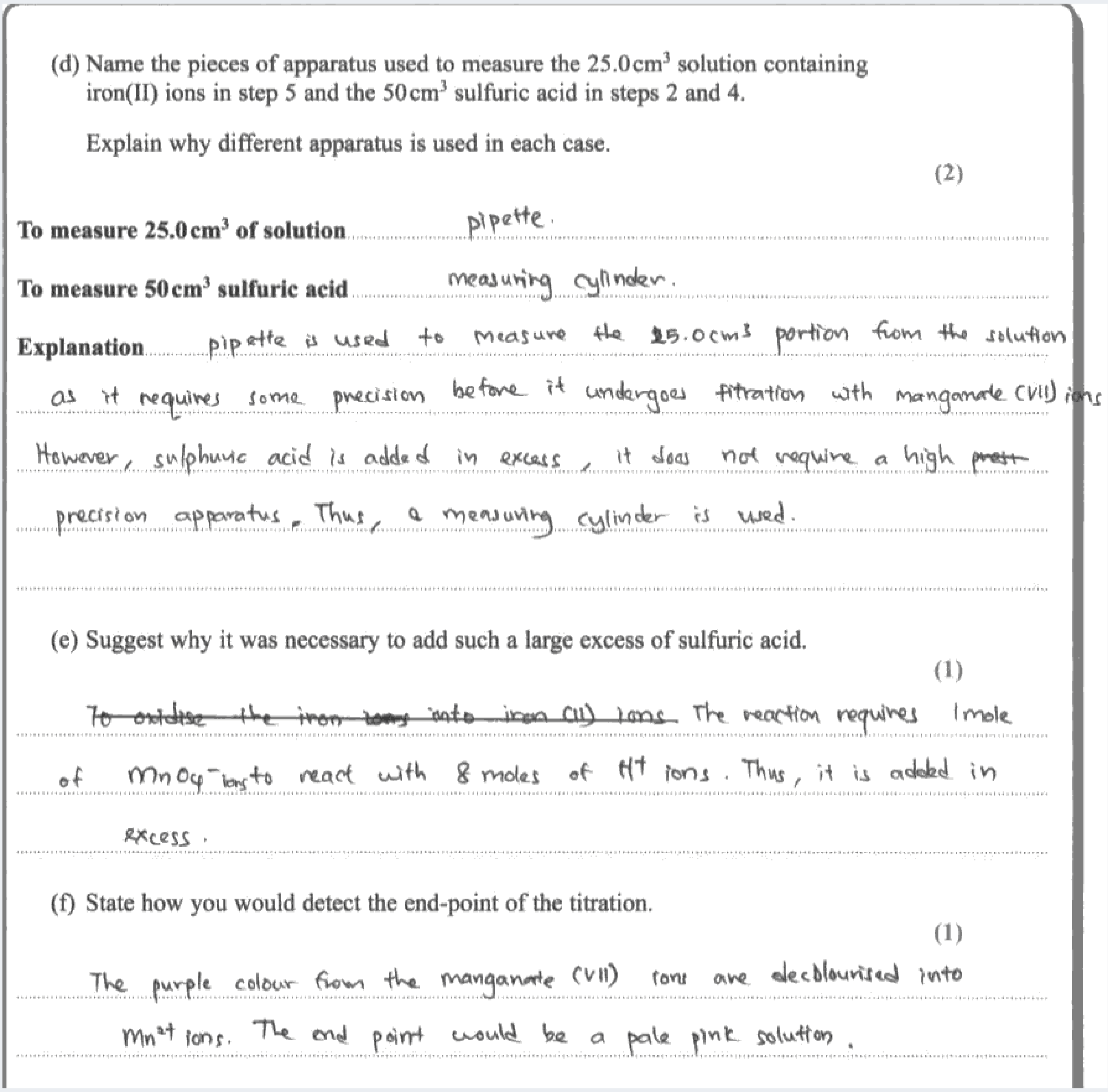
ResultsPlus

Examiner Tip

Check the question requirements and check your work.

Question 3(d-g)

This group of questions tested knowledge and understanding of titration procedures with particular reference to the manganate(VII) titration with iron(II). Candidates were also expected to demonstrate their ability to apply understanding using information provided in the question. In part (d) many candidates commented that accuracy was unimportant in the measurement of the acid, but this is incorrect; the point is that a lower degree of accuracy is acceptable.



(d) Name the pieces of apparatus used to measure the 25.0 cm^3 solution containing iron(II) ions in step 5 and the 50 cm^3 sulfuric acid in steps 2 and 4.

Explain why different apparatus is used in each case.

(2)

To measure 25.0 cm^3 of solution pipette.

To measure 50 cm^3 sulfuric acid measuring cylinder.

Explanation pipette is used to measure the 25.0cm^3 portion from the solution as it requires some precision before it undergoes titration with manganate (VII) ions However, sulphuric acid is added in excess, it does not require a high ~~prest~~ precision apparatus. Thus, a measuring cylinder is used.

(e) Suggest why it was necessary to add such a large excess of sulfuric acid.

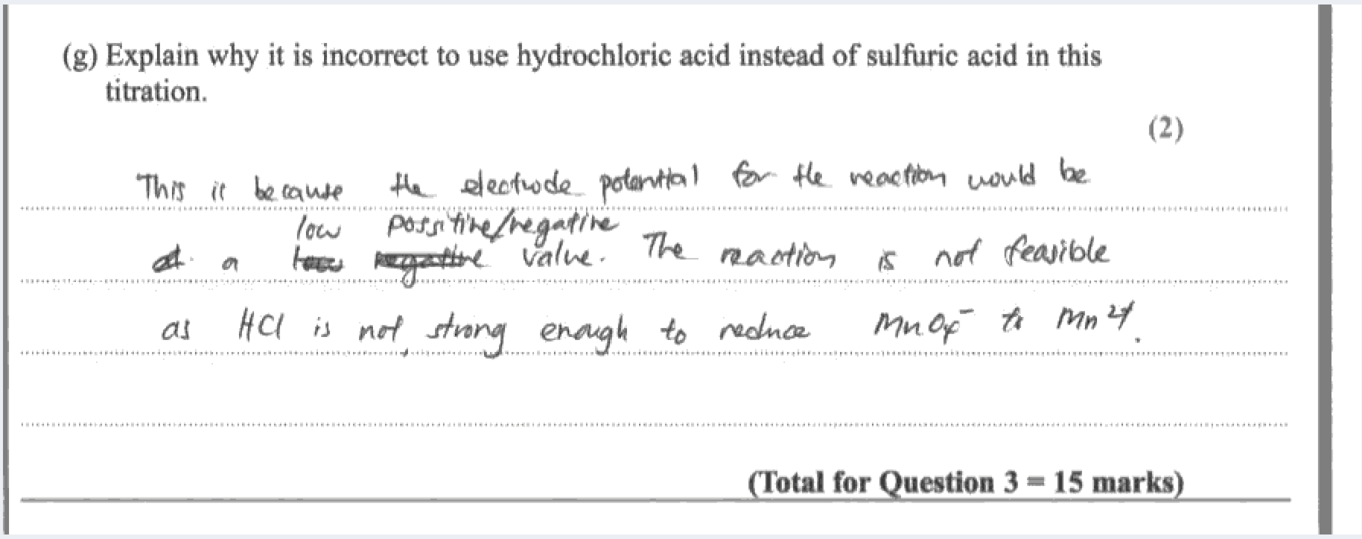
(1)

~~To oxidise the iron ions into iron (II) ions~~ The reaction requires 1 mole of MnO_4^- ions to react with 8 moles of H^+ ions. Thus, it is added in excess.

(f) State how you would detect the end-point of the titration.

(1)

The purple colour from the manganate (VII) ions are decolourised into Mn^{2+} ions. The end point would be a pale pink solution.



(g) Explain why it is incorrect to use hydrochloric acid instead of sulfuric acid in this titration.

(2)

This it because the electrode potential for the reaction would be ~~at~~ a ~~low~~ low ~~negative~~ possitive/negative value. The reaction is not feasible as HCl is not strong enough to reduce MnO_4^- to Mn^{2+}.

(Total for Question 3 = 15 marks)

ResultsPlus

Examiner Comments

In (d), the apparatus is correctly identified but the second mark is only just gained. The pipette is essential because the determination of the amount of iron in the sample depends on it whereas, as the acid is in excess, high accuracy is not vital.

In (e), the candidate correctly uses the information available in the question.

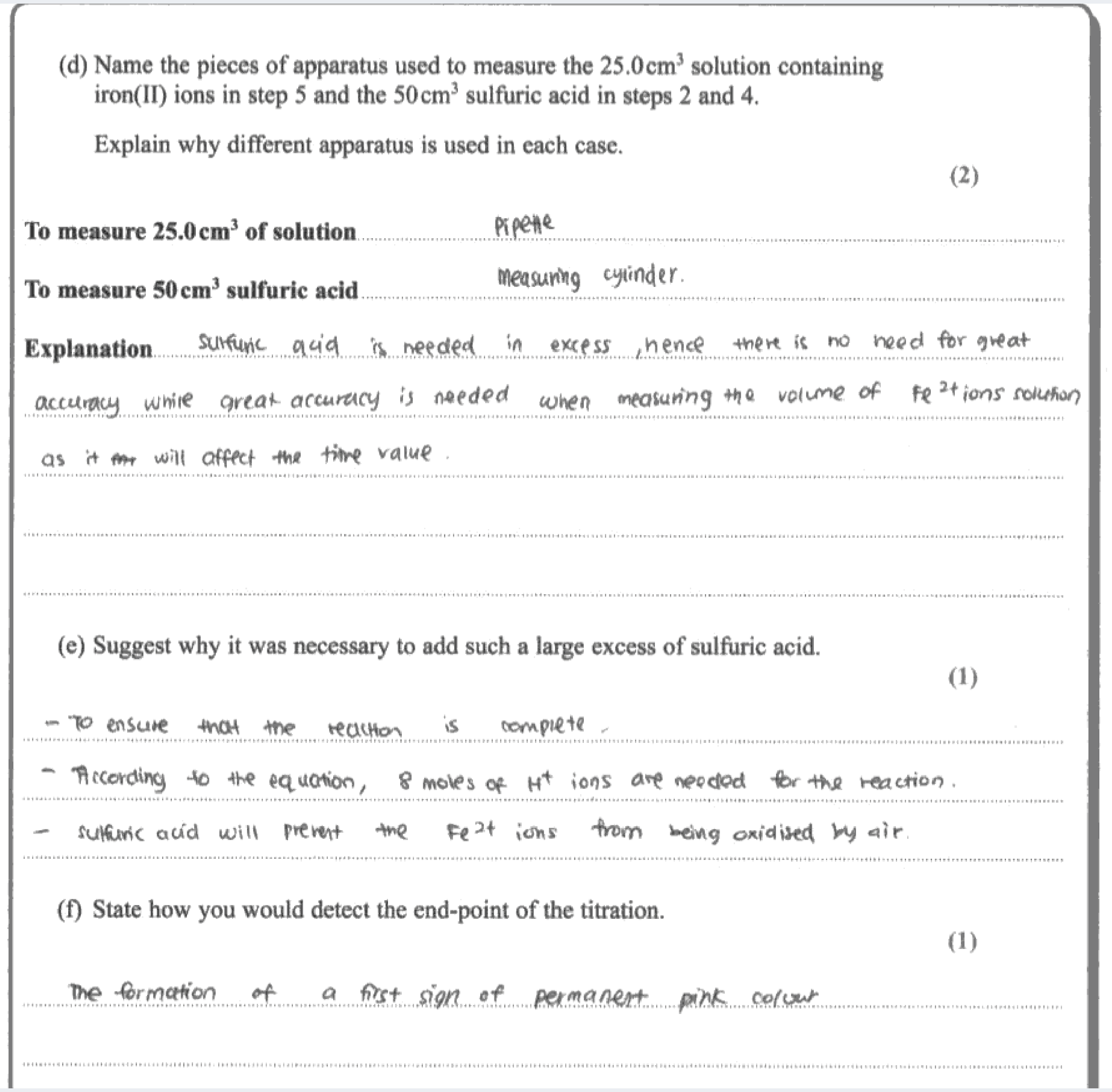
In (f), the candidate has become confused about which solution is in which piece of apparatus in the titration.

In (g), the candidate, having identified redox as the relevant issue, fails to think through the point being made

ResultsPlus

Examiner Tip

After completing three quite large items (a, b and c), it is a good idea to re-read the relevant parts of the question.



(d) Name the pieces of apparatus used to measure the 25.0 cm^3 solution containing iron(II) ions in step 5 and the 50 cm^3 sulfuric acid in steps 2 and 4.

Explain why different apparatus is used in each case.

(2)

To measure 25.0 cm^3 of solution Pipette

To measure 50 cm^3 sulfuric acid Measuring cylinder.

Explanation Sulfuric acid is needed in excess, hence there is no need for great accuracy while great accuracy is needed when measuring the volume of Fe^{2+} ions solution as it ~~the~~ will affect the time value.

(e) Suggest why it was necessary to add such a large excess of sulfuric acid.

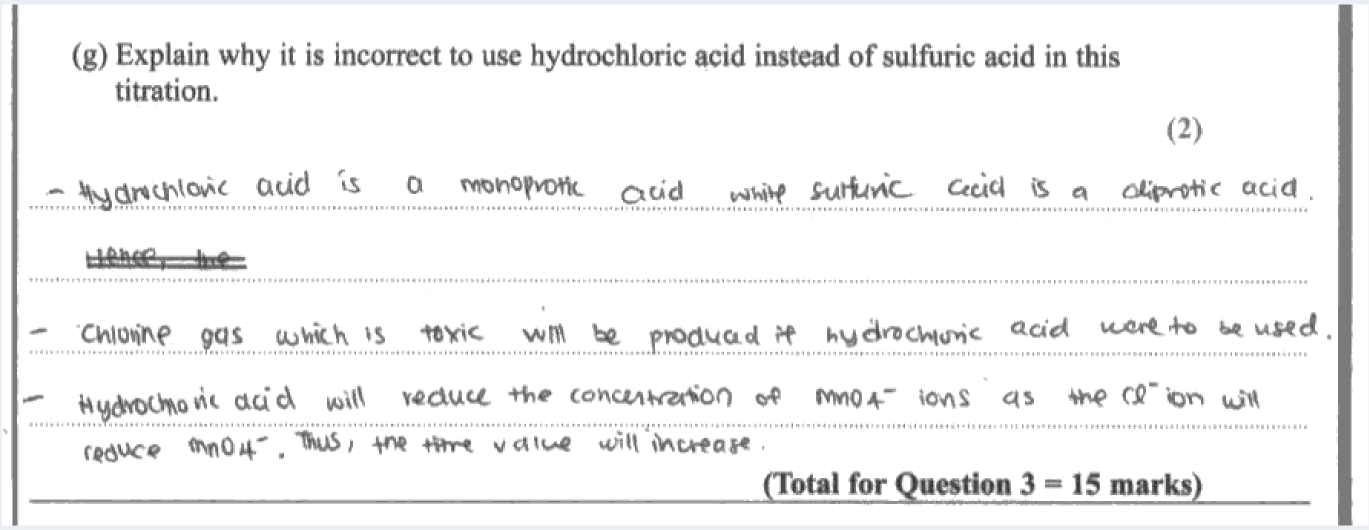
(1)

- To ensure that the reaction is complete.
- According to the equation, 8 moles of H$^+$ ions are needed for the reaction.
- sulfuric acid will prevent the Fe^{2+} ions from being oxidised by air.

(f) State how you would detect the end-point of the titration.

(1)

The formation of a first sign of permanent pink colour



(g) Explain why it is incorrect to use hydrochloric acid instead of sulfuric acid in this titration.

(2)

- Hydrochloric acid is a monoprotic acid while sulfuric acid is a diprotic acid.

~~Hence, the~~

- Chlorine gas which is toxic will be produced if hydrochloric acid were to be used.
- Hydrochloric acid will reduce the concentration of MnO_4^- ions as the Cl^- ion will reduce MnO_4^-. Thus, the titre value will increase.

(Total for Question 3 = 15 marks)

ResultsPlus

Examiner Comments

The first three parts of this answer are very good but in (g) the candidate has several attempts at the question finally gaining a mark for showing a good understanding of the effect on the titre of manganate(VII) reacting with HCl.

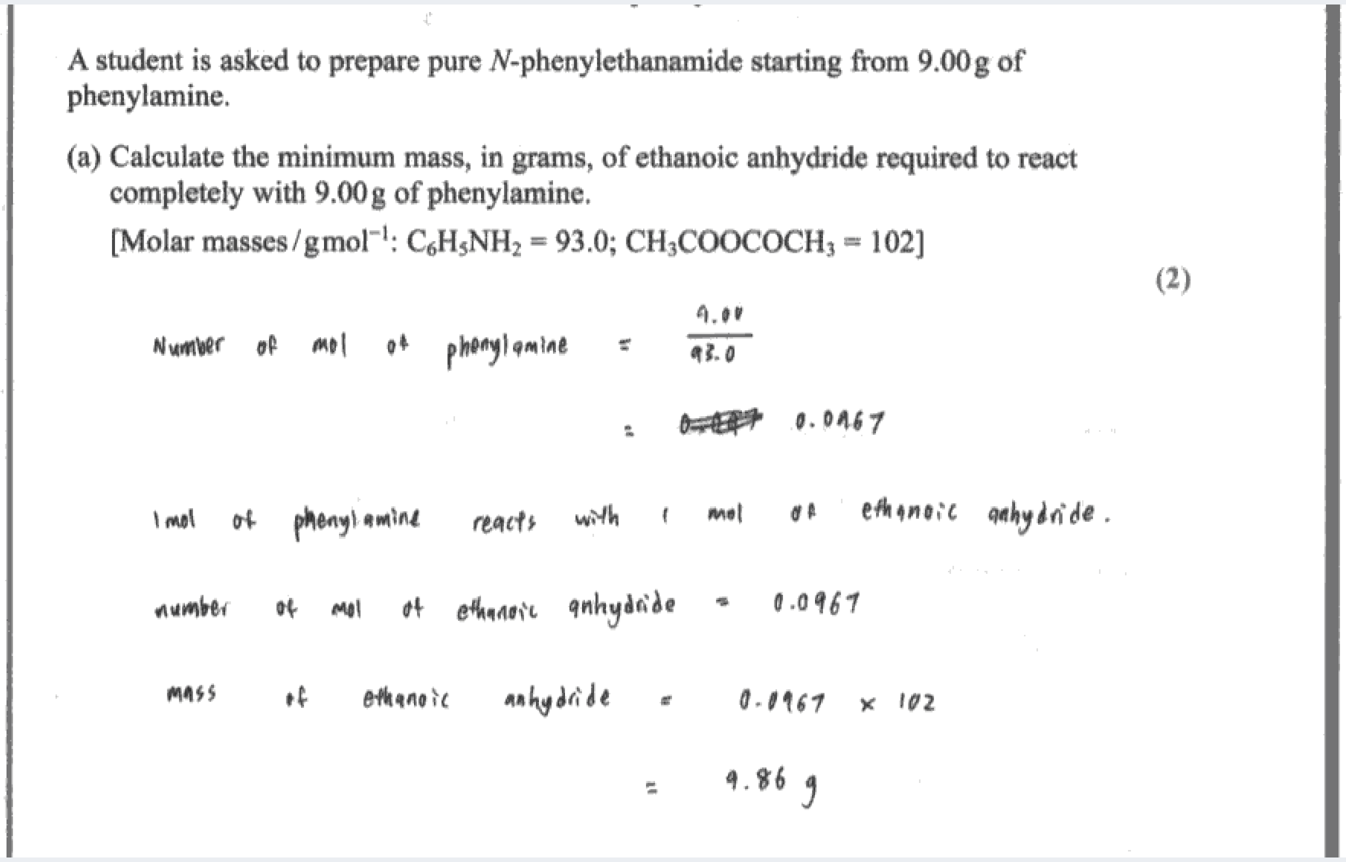
ResultsPlus

Examiner Tip

Avoid a "scattergun" approach to explanations.

Question 4(a)

Most candidates were able to complete this straightforward calculation, but correct rounding and use of significant figures remains an issue for some. In general, intermediate rounding should be avoided.



A student is asked to prepare pure *N*-phenylethanamide starting from 9.00 g of phenylamine.

(a) Calculate the minimum mass, in grams, of ethanoic anhydride required to react completely with 9.00 g of phenylamine.

[Molar masses / g mol^{-1}: $C_6H_5NH_2$ = 93.0; $CH_3COOCOCH_3$ = 102]

(2)

Number of mol of phenylamine = $\frac{9.00}{93.0}$

= [illegible] 0.0967

1 mol of phenylamine reacts with 1 mol of ethanoic anhydride.

number of mol of ethanoic anhydride = 0.0967

mass of ethanoic anhydride = 0.0967 × 102

= 9.86 g

ResultsPlus

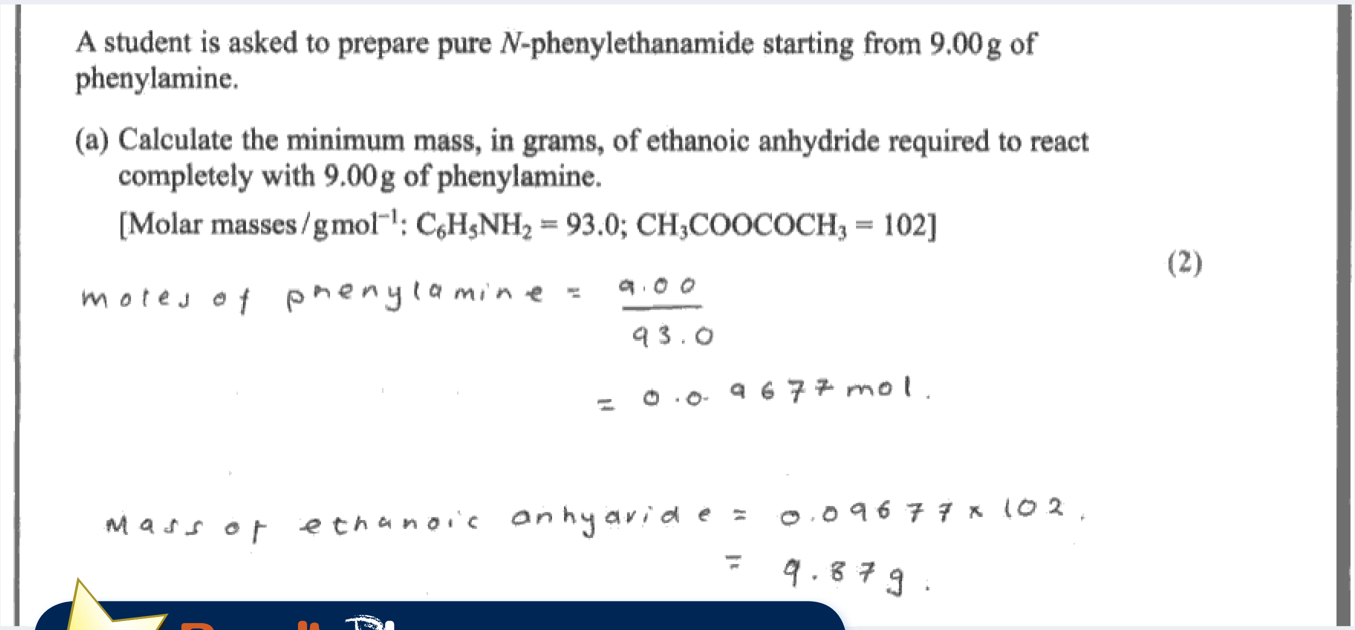
Examiner Comments

This is a very well presented answer with the steps clearly shown, but the result of the first mole calculation has been incorrectly rounded and this number has been used in the final calculation.

ResultsPlus

Examiner Tip

Use the numbers stored in your calculator for each step in a calculation and only round at the very end. Make sure that you know how to round a number correctly.



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[Molar masses / g mol^{-1}: $C_6H_5NH_2$ = 93.0; $CH_3COOCOCH_3$ = 102]

(2)

moles of phenylamine = $\frac{9.00}{93.0}$

= 0.09677 mol.

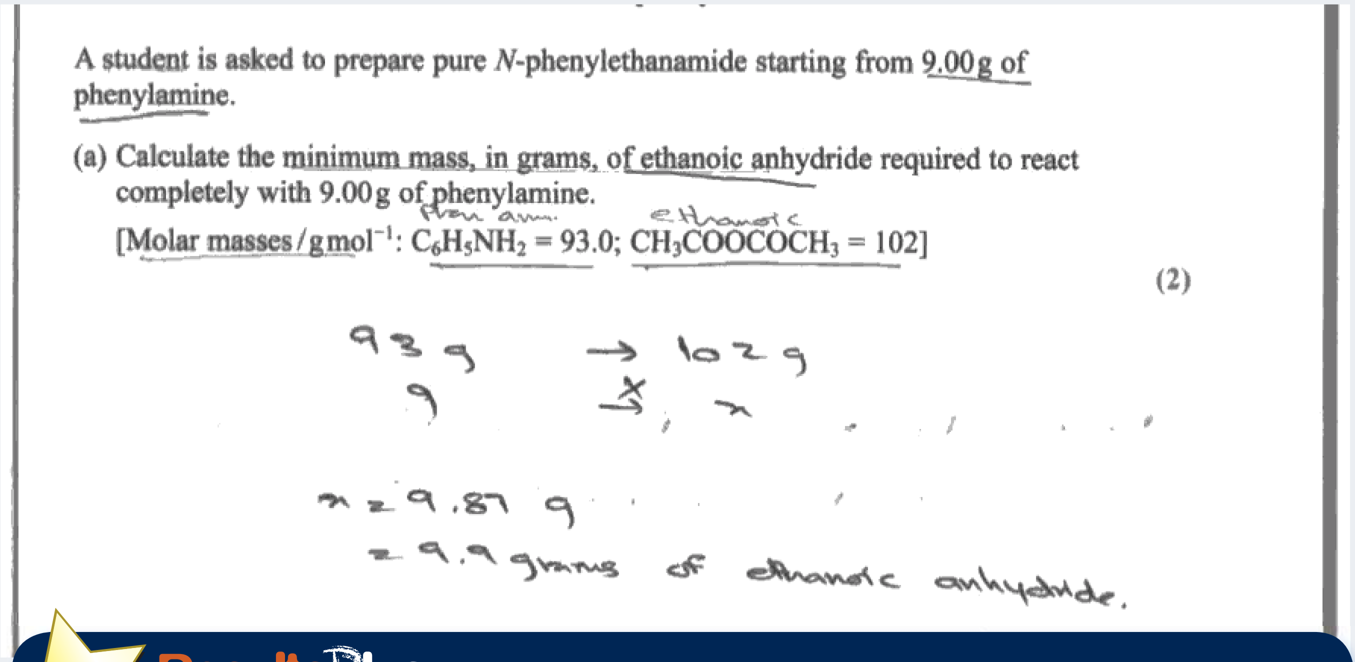
Mass of ethanoic anhydride = 0.09677 × 102.

= 9.87 g.

ResultsPlus

Examiner Comments

A perfect answer, complete but very economically presented.



A student is asked to prepare pure *N*-phenylethanamide starting from 9.00 g of phenylamine.

(a) Calculate the minimum mass, in grams, of ethanoic anhydride required to react completely with 9.00 g of phenylamine.

phen ami. ethanoic

[Molar masses / g mol^{-1}: $C_6H_5NH_2$ = 93.0; $CH_3COOCOCH_3$ = 102]

(2)

93 g → 102 g

9 → x

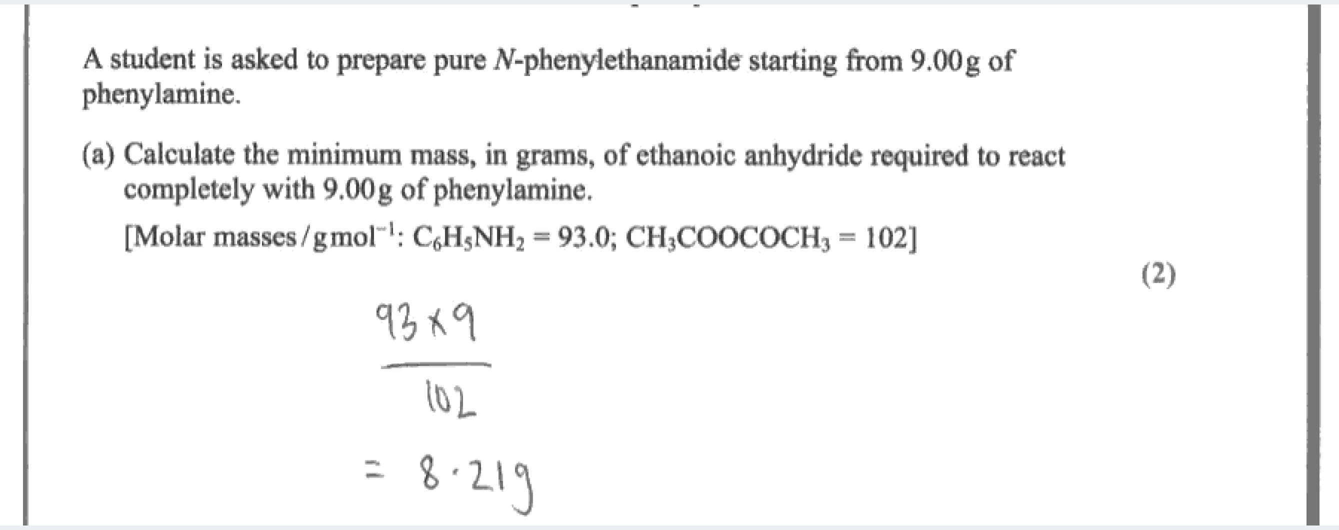
x = 9.87 g

= 9.9 grams of ethanoic anhydride.

ResultsPlus

Examiner Comments

The basic rule of significant figures is that the answer should be expressed to the same number of significant figures, as are used in the data, so here it should be three. The candidate has been allowed a little leeway.



A student is asked to prepare pure *N*-phenylethanamide starting from 9.00 g of phenylamine.

(a) Calculate the minimum mass, in grams, of ethanoic anhydride required to react completely with 9.00 g of phenylamine.

[Molar masses / g mol^{-1}: $C_6H_5NH_2$ = 93.0; $CH_3COOCOCH_3$ = 102]

(2)

$$\frac{93 \times 9}{102}$$

$= 8 \cdot 21g$

ResultsPlus

Examiner Comments

The candidate has reversed the Mr values but, with no explanation, scores zero.

ResultsPlus

Examiner Tip

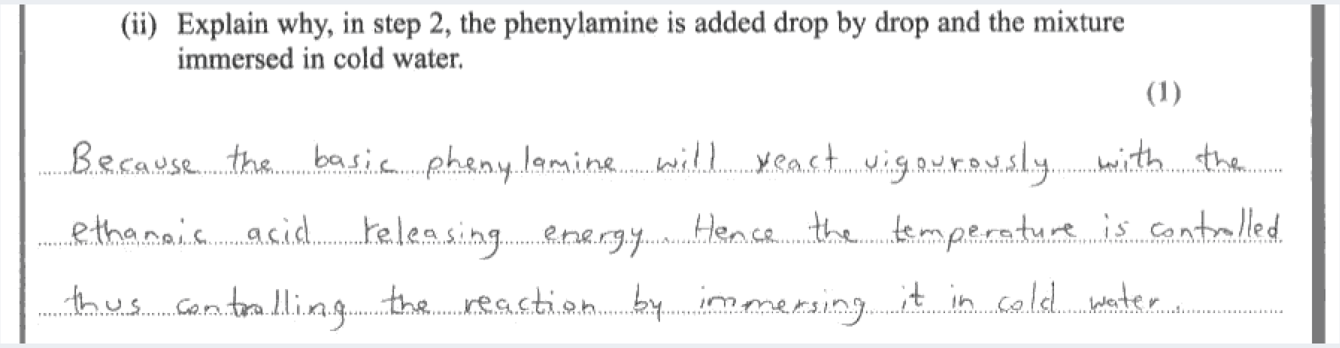
A step-by-step calculation makes it easier to gain some marks when an error is made.

Question 4(b) (i)

This question tested understanding of the practical purpose of one aspect of the experimental instructions. This is a specific question so a specific answer is required.

Question 4(b) (ii)

In organic synthesis it is common to cool containers in which reagents are mixed because the reactions are frequently exothermic and therefore volatile reactants or products may be lost.



(ii) Explain why, in step 2, the phenylamine is added drop by drop and the mixture immersed in cold water.

(1)

Because the basic phenylamine will react vigourously with the ethanoic acid releasing energy. Hence the temperature is controlled thus controlling the reaction by immersing it in cold water.

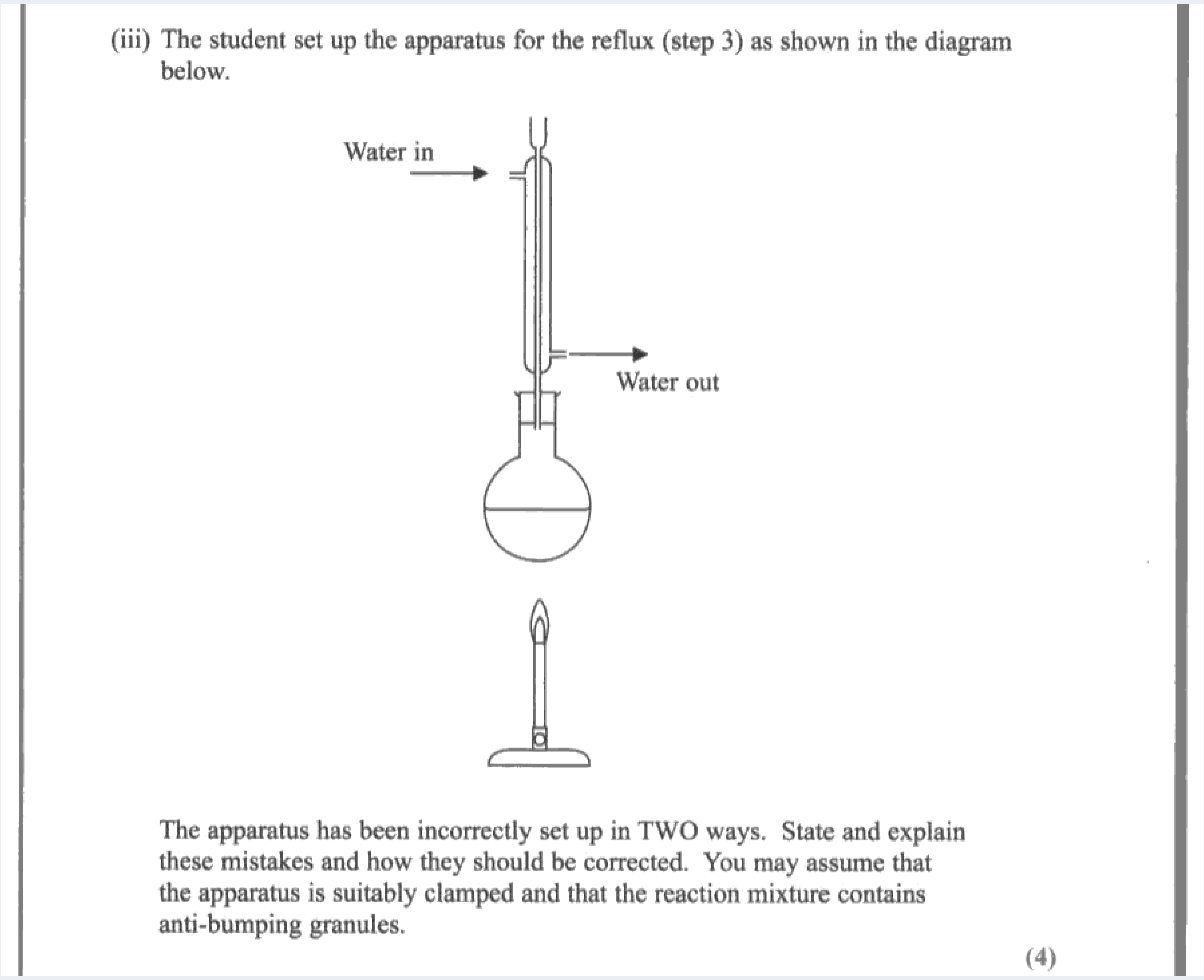
ResultsPlus

Examiner Comments

Although the key word (exothermic) is omitted, the candidate implies this by referring to the vigorous reaction and, even better, to the consequent increase in temperature.

Question 4(b) (iii)

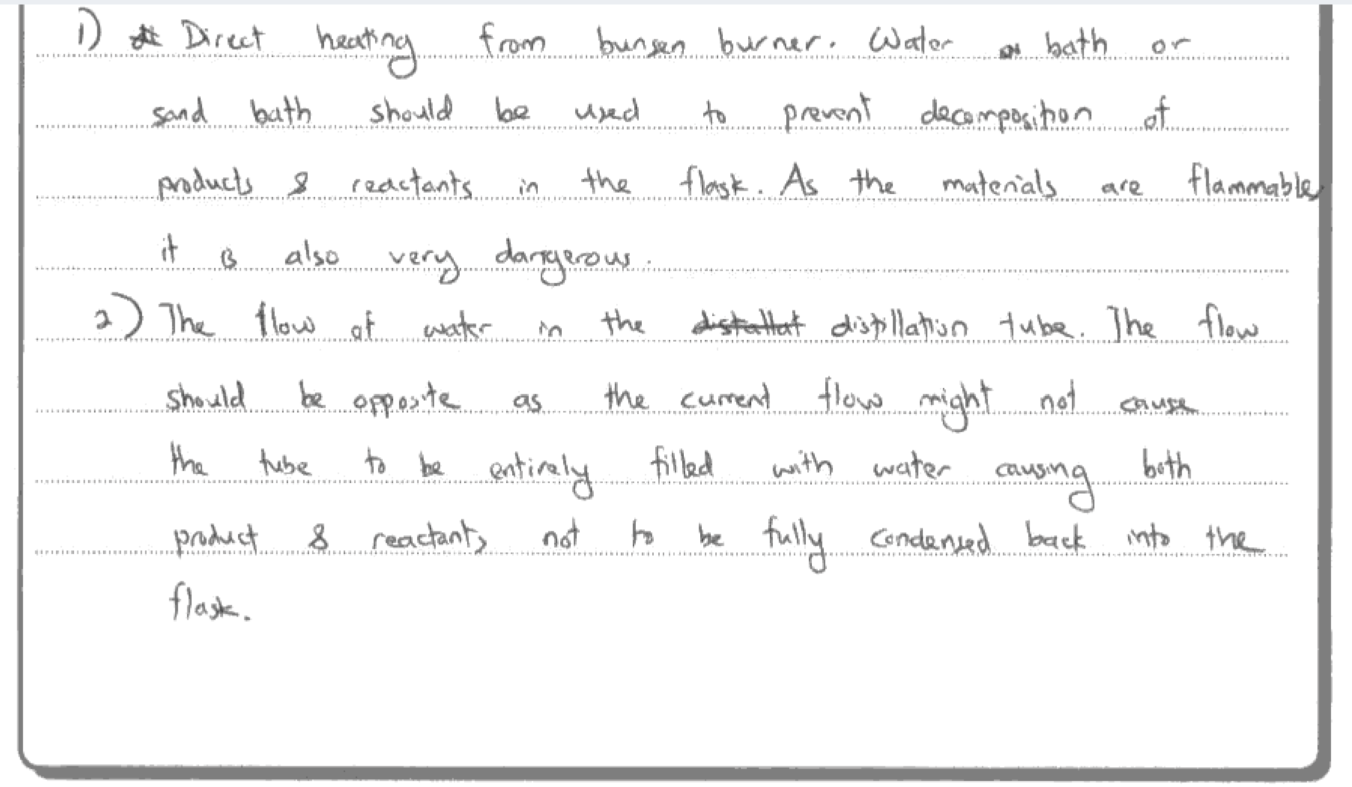
Most candidates were able to identify the errors in the diagram and to explain why the use of the Bunsen was incorrect. However, clear explanations on why it is preferable for the water to enter the condenser at the lower inlet were much less common.



(iii) The student set up the apparatus for the reflux (step 3) as shown in the diagram below.

The apparatus has been incorrectly set up in TWO ways. State and explain these mistakes and how they should be corrected. You may assume that the apparatus is suitably clamped and that the reaction mixture contains anti-bumping granules.

(4)



1) ~~at~~ Direct heating from bunsen burner. Water ~~or~~ bath or sand bath should be used to prevent decomposition of products & reactants in the flask. As the materials are flammable it is also very dangerous.

2) The flow of water in the ~~distallat~~ distillation tube. The flow should be opposite as the current flow might not cause the tube to be entirely filled with water causing both product & reactants not to be fully condensed back into the flask.

ResultsPlus

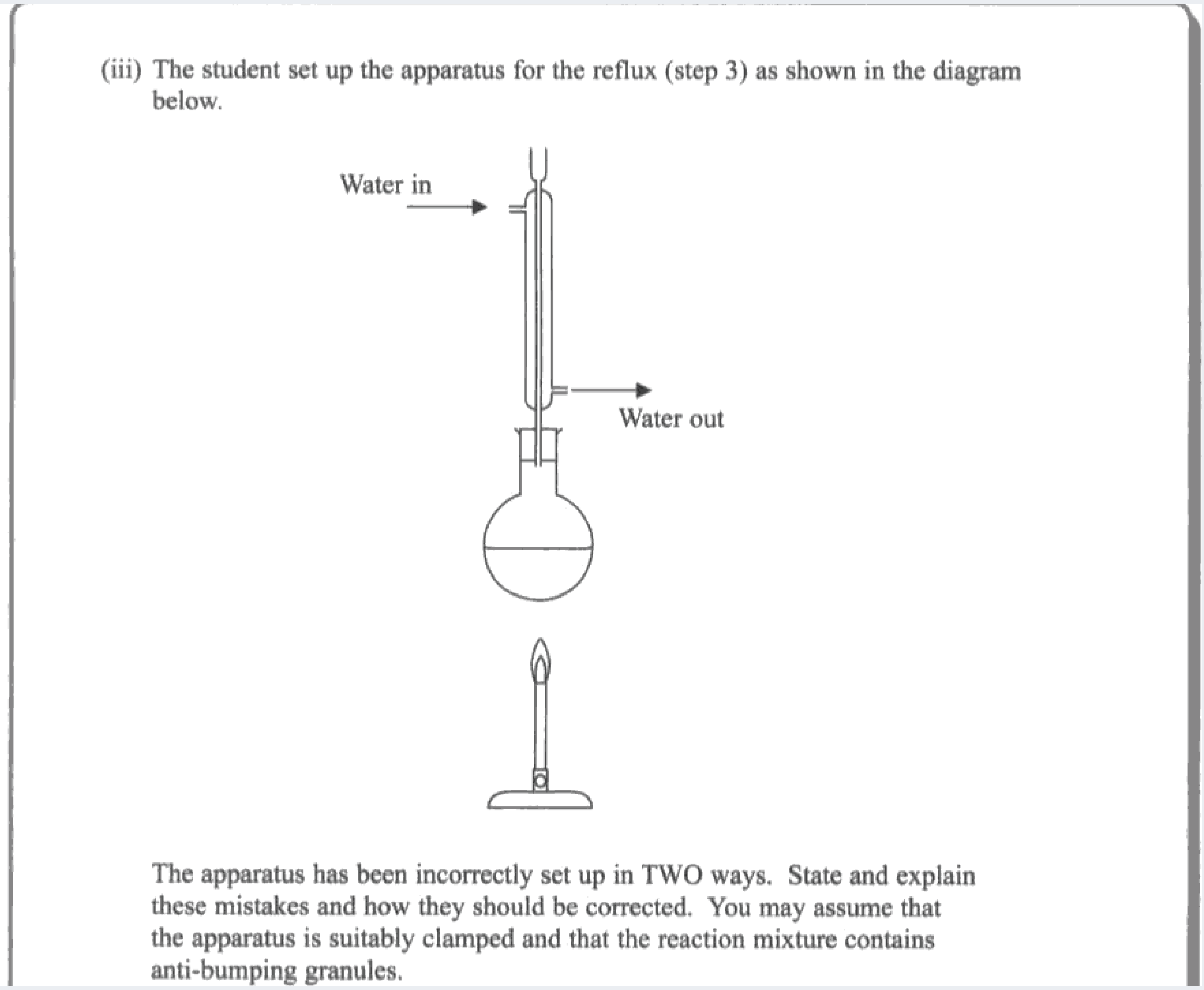
Examiner Comments

The explanation for using an alternative to the Bunsen gains the mark as heating would be too strong (implied by decomposition) was an allowed mark so the extra explanation did not disallow the flammability argument.

ResultsPlus

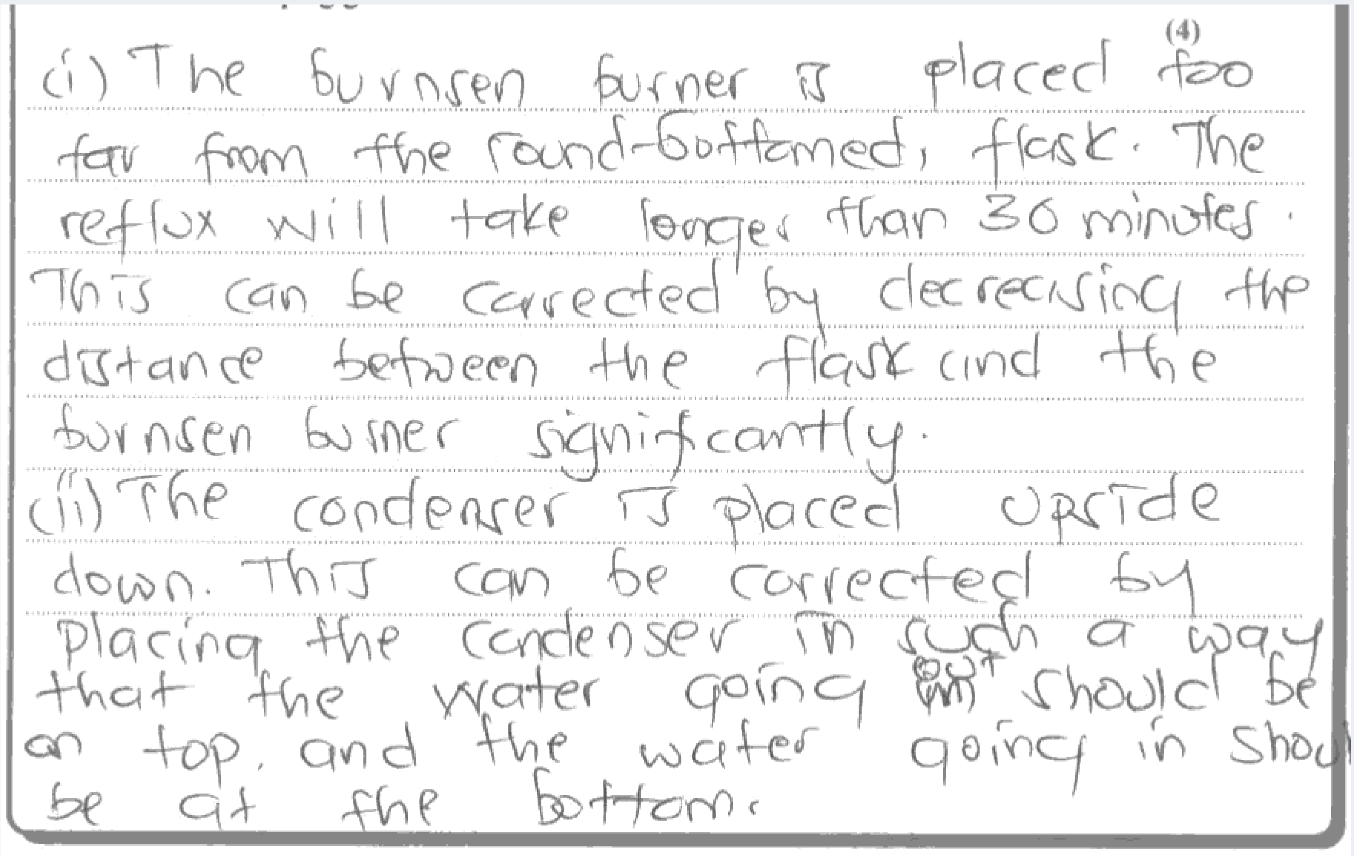
Examiner Tip

Unless asked, for several reasons it is best to limit the answer to just one.



(iii) The student set up the apparatus for the reflux (step 3) as shown in the diagram below.

The apparatus has been incorrectly set up in TWO ways. State and explain these mistakes and how they should be corrected. You may assume that the apparatus is suitably clamped and that the reaction mixture contains anti-bumping granules.



(4)

(i) The bunsen burner is placed too far from the round-bottomed, flask. The reflux will take longer than 30 minutes. This can be corrected by decreasing the distance between the flask and the bunsen buner significantly.

(ii) The condenser is placed upside down. This can be corrected by placing the condenser in such a way that the water going ~~in~~ out should be on top, and the water going in shou be at the bottom.

ResultsPlus

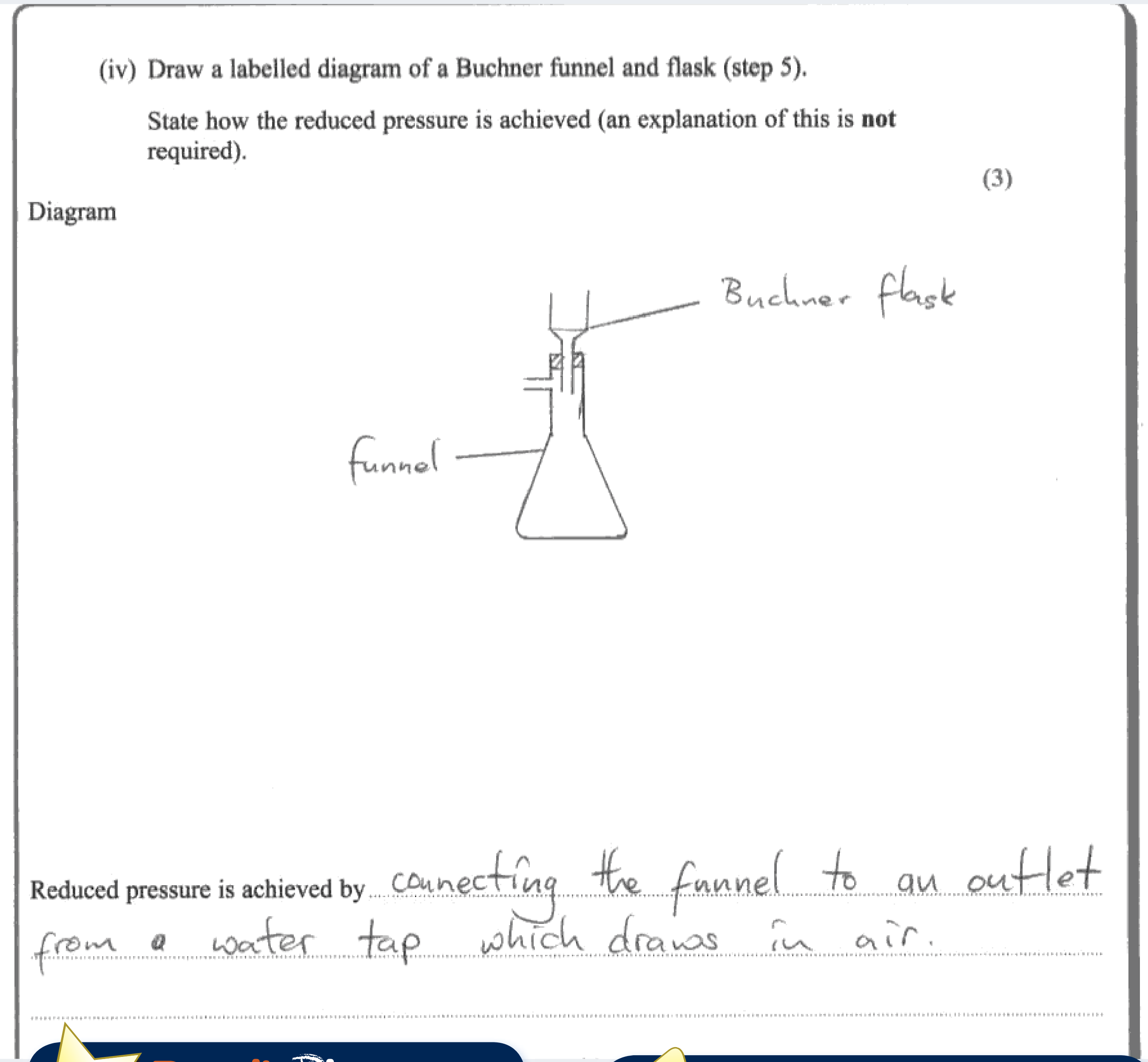
Examiner Comments

The first error and the associated explanation are incorrect. The mark is gained for appreciating that the water flow in the condenser is incorrect but the idea that the condenser is upside down is implausible.

Question 4(b) (iv)

Candidates are expected to be familiar with the chemical apparatus used at this level and to be able to draw clear diagrams of such apparatus in use.

While there were many excellent diagrams, a significant number of candidates were unable to draw diagrams of a suitable quality, while a few were clearly unfamiliar with the apparatus used to filter under reduced pressure.



(iv) Draw a labelled diagram of a Buchner funnel and flask (step 5).

State how the reduced pressure is achieved (an explanation of this is **not** required).

(3)

Diagram

Reduced pressure is achieved by connecting the funnel to an outlet from a water tap which draws in air.

ResultsPlus

Examiner Comments

This diagram is clear and the explanation is sufficient (just) to gain the third mark.

ResultsPlus

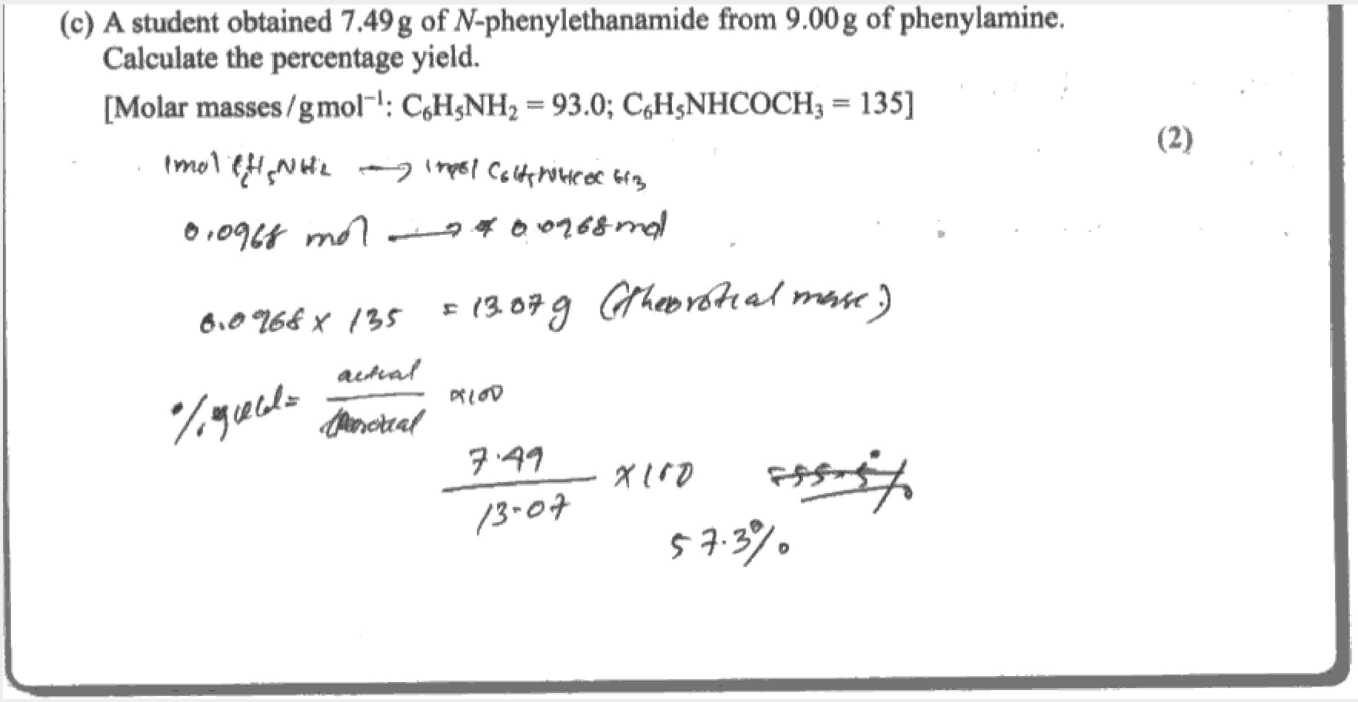
Examiner Tip

A diagram would have clarified the explanation of how reduced pressure is achieved and made the third mark more secure.

Question 4(c)

Calculation of yield is a very standard requirement at Advanced level and most candidates were well-prepared for this question.

Where errors occurred, they most frequently involved incorrect rounding either during or at the end of the calculation, although some candidates simply calculated the mass ratio and converted that into a percentage.



(c) A student obtained 7.49 g of *N*-phenylethanamide from 9.00 g of phenylamine.
Calculate the percentage yield.
[Molar masses / g mol^{-1}: $C_6H_5NH_2$ = 93.0; $C_6H_5NHCOCH_3$ = 135]
(2)

1mol $C_6H_5NH_2$ ⟶ 1mol $C_6H_5NHCOCH_3$

0.0968 mol ⟶ 0.0968 mol

0.0968 × 135 = 13.07 g (theoretical mass)

$\%\text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100$

$\frac{7.49}{13.07} \times 100$ ~~[illegible]~~

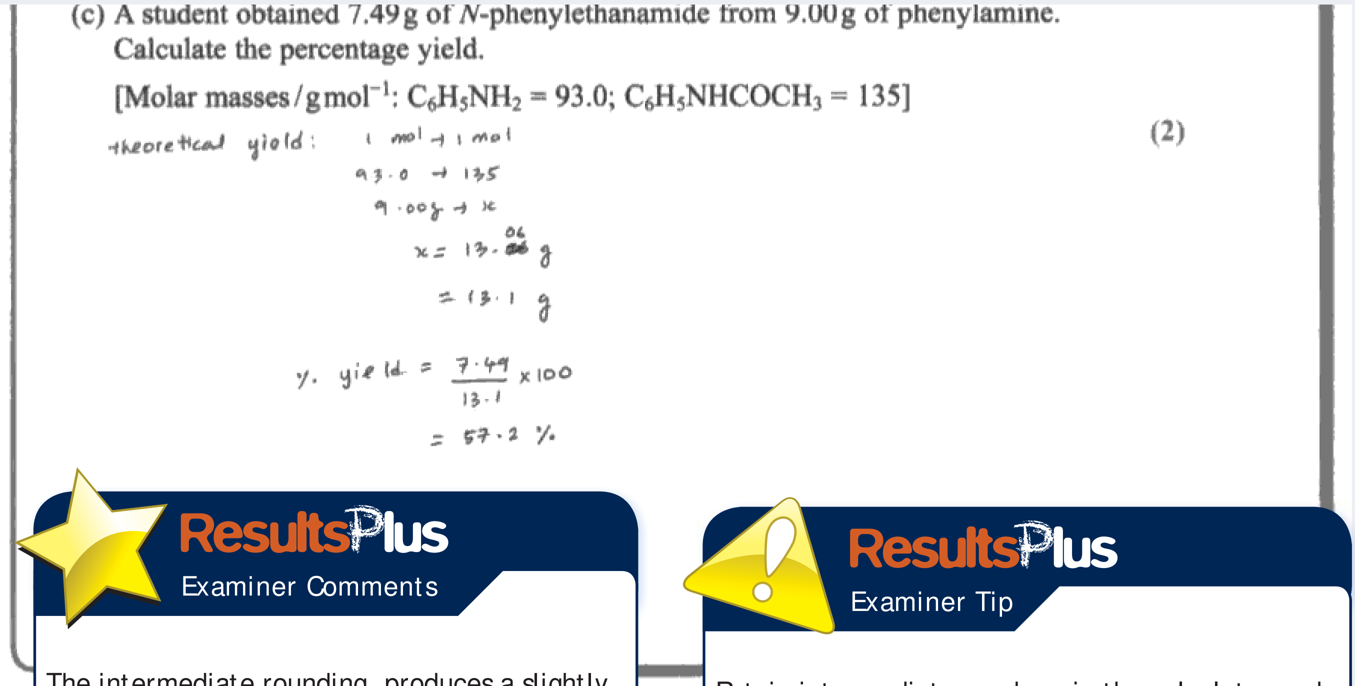
57.3%

ResultsPlus
Examiner Comments

A very clearly executed and presented calculation.

ResultsPlus
Examiner Tip

By including the key steps this candidate guards against the possibilty of an arithmetical error costing both marks.



(c) A student obtained 7.49 g of *N*-phenylethanamide from 9.00 g of phenylamine. Calculate the percentage yield.

[Molar masses / g mol^{-1}: $C_6H_5NH_2$ = 93.0; $C_6H_5NHCOCH_3$ = 135]

(2)

theoretical yield : 1 mol → 1 mol

93.0 → 135

9.00g → x

$x = 13.\overset{06}{\cancel{}}$ g

= 13.1 g

$\% \text{ yield} = \frac{7.49}{13.1} \times 100$

= 57.2 %

ResultsPlus

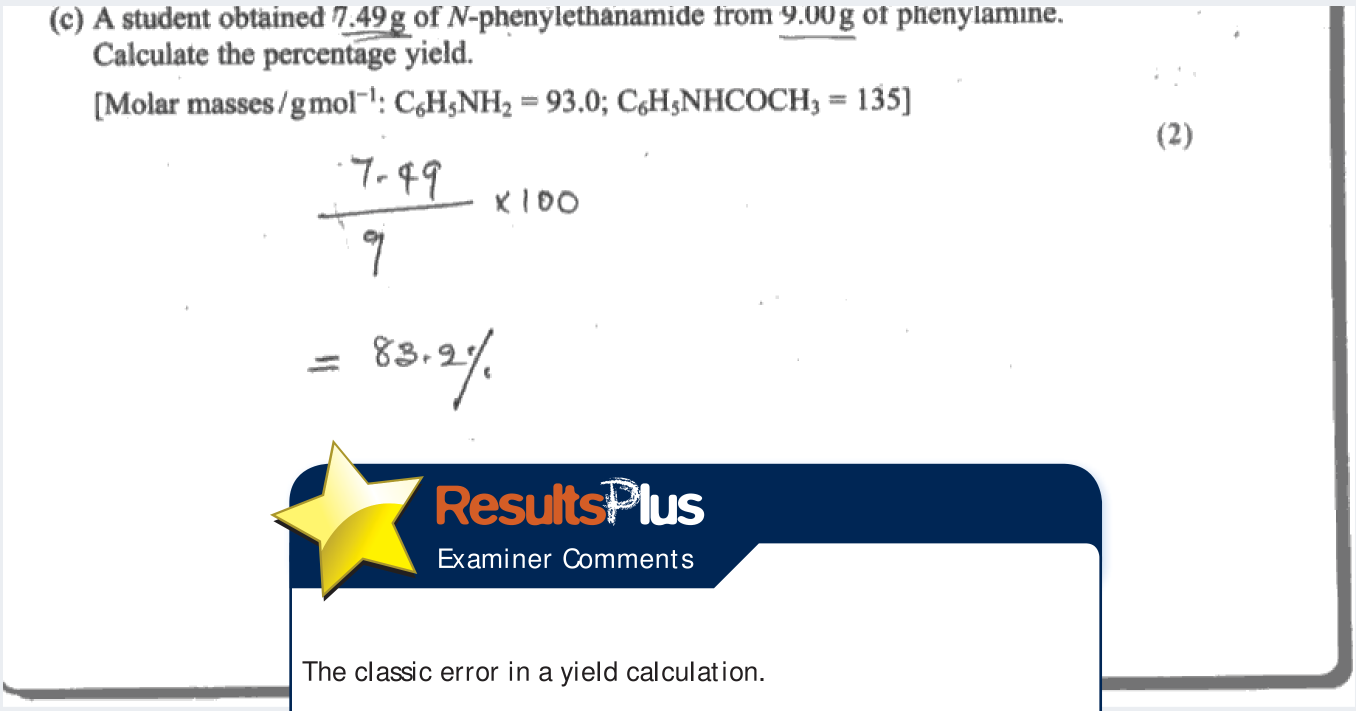
Examiner Comments

The intermediate rounding, produces a slightly different answer in this case.

ResultsPlus

Examiner Tip

Retain intermediate numbers in the calculator and round at the end of the calculation.



(c) A student obtained 7.49 g of *N*-phenylethanamide from 9.00 g of phenylamine. Calculate the percentage yield.

[Molar masses / g mol^{-1}: $C_6H_5NH_2$ = 93.0; $C_6H_5NHCOCH_3$ = 135]

(2)

$\frac{7.49}{9} \times 100$

= 83.2%

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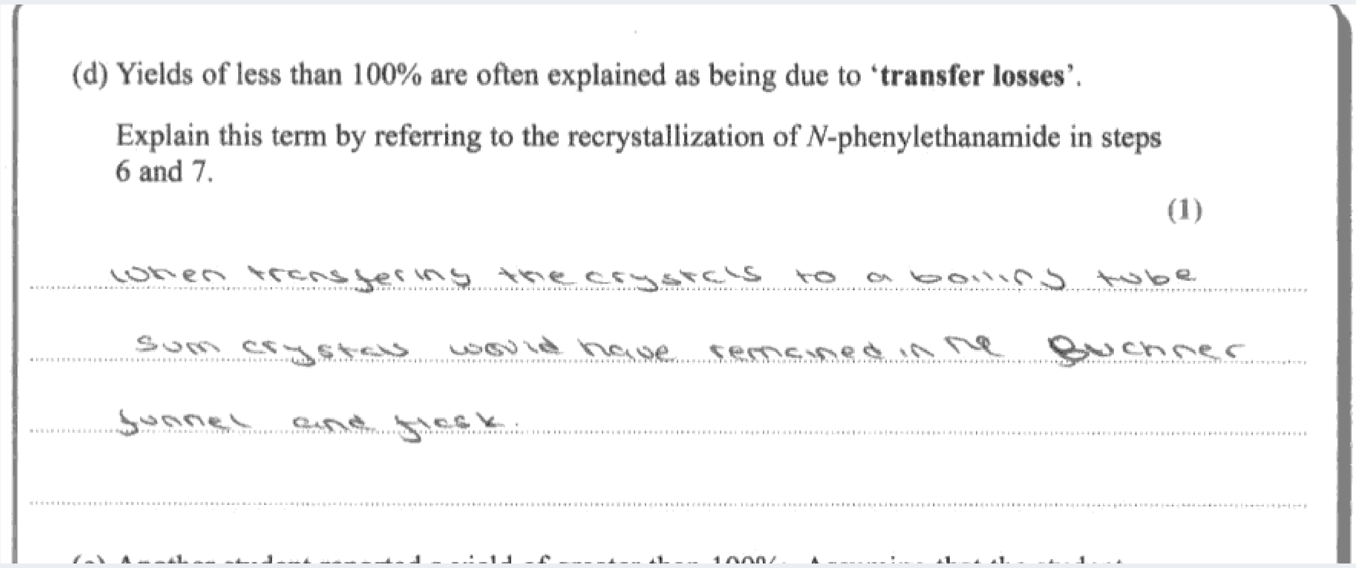
Examiner Comments

The classic error in a yield calculation.

Question 4(d)

The idea of transfer losses is a standard feature of organic (and inorganic) preparations and this question tests the candidates' understanding of the phrase.



(d) Yields of less than 100% are often explained as being due to '**transfer losses**'.

Explain this term by referring to the recrystallization of *N*-phenylethanamide in steps 6 and 7.

(1)

When transfering the crystals to a boiling tube sum crystals would have remained in the Buchner funnel and flask.

(e) Another student reported a yield of greater than 100%. Assuming that the student

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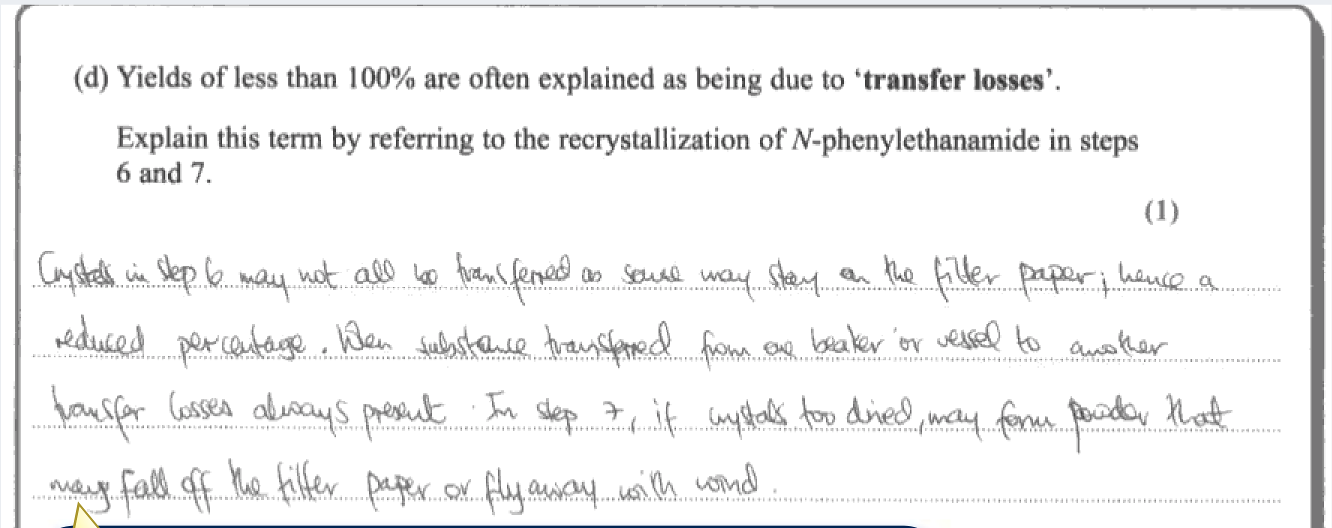
Examiner Comments

This a simple and sensible response which gains the mark.



(d) Yields of less than 100% are often explained as being due to '**transfer losses**'.

Explain this term by referring to the recrystallization of *N*-phenylethanamide in steps 6 and 7.

(1)

Crystals in step 6 may not all be transferred as some may stay on the filter paper; hence a reduced percentage. When substance transferred from one beaker or vessel to another transfer losses always present. In step 7, if crystals too dried, may form powder that may fall off the filter paper or fly away with wind.

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Examiner Comments

While this gains the mark, the answer is weakened by reference to material 'falling off the filter paper'.

Candidates should appreciate that transfer losses are unavoidable, while dropping product material is just careless.

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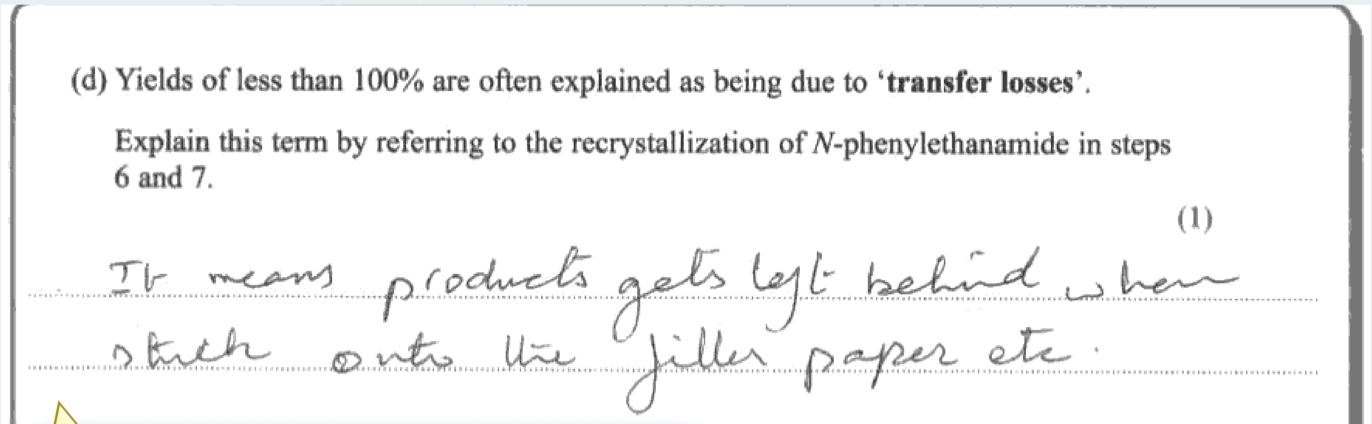
Examiner Tip

In practical questions, it is usually best to assume that the experiment is carried out correctly and focus on the intrinsic shortcomings of the procedure.



(d) Yields of less than 100% are often explained as being due to '**transfer losses**'.

Explain this term by referring to the recrystallization of *N*-phenylethanamide in steps 6 and 7.

(1)

It means products gets left behind when stuck onto the filter paper etc.

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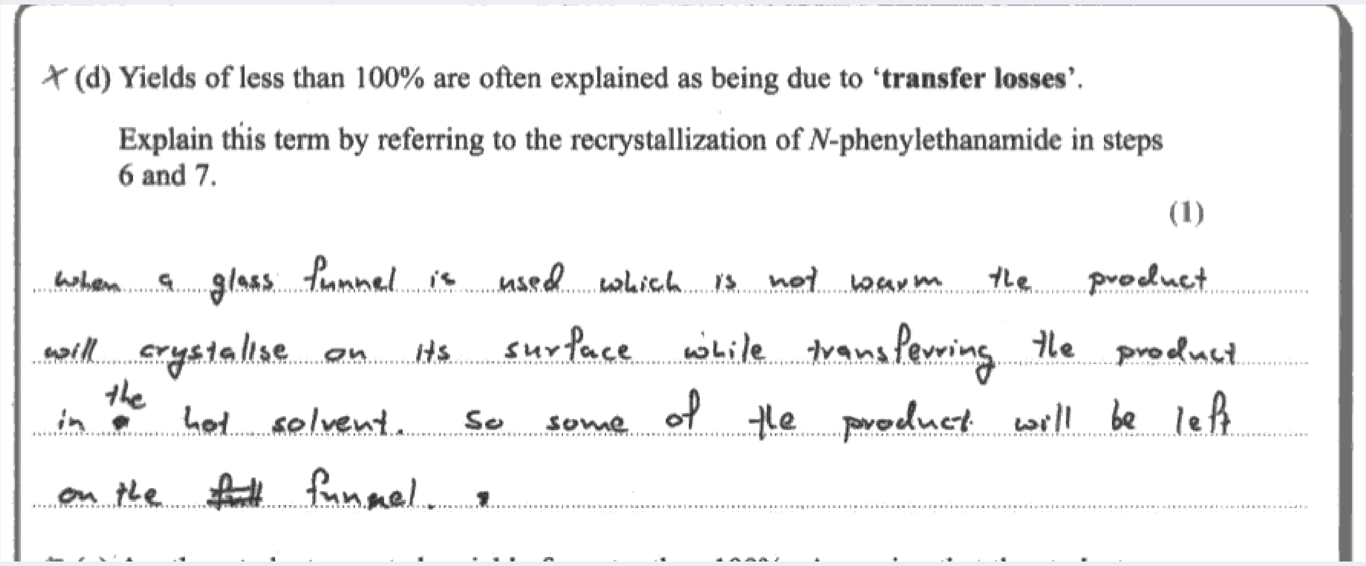
Examiner Comments

Avoid 'etc' in your answers.



✗ (d) Yields of less than 100% are often explained as being due to '**transfer losses**'.

Explain this term by referring to the recrystallization of *N*-phenylethanamide in steps 6 and 7.

(1)

when a glass funnel is used which is not warm the product will crystalise on its surface while transferring the product in the hot solvent. So some of the product will be left on the ~~full~~ funnel.

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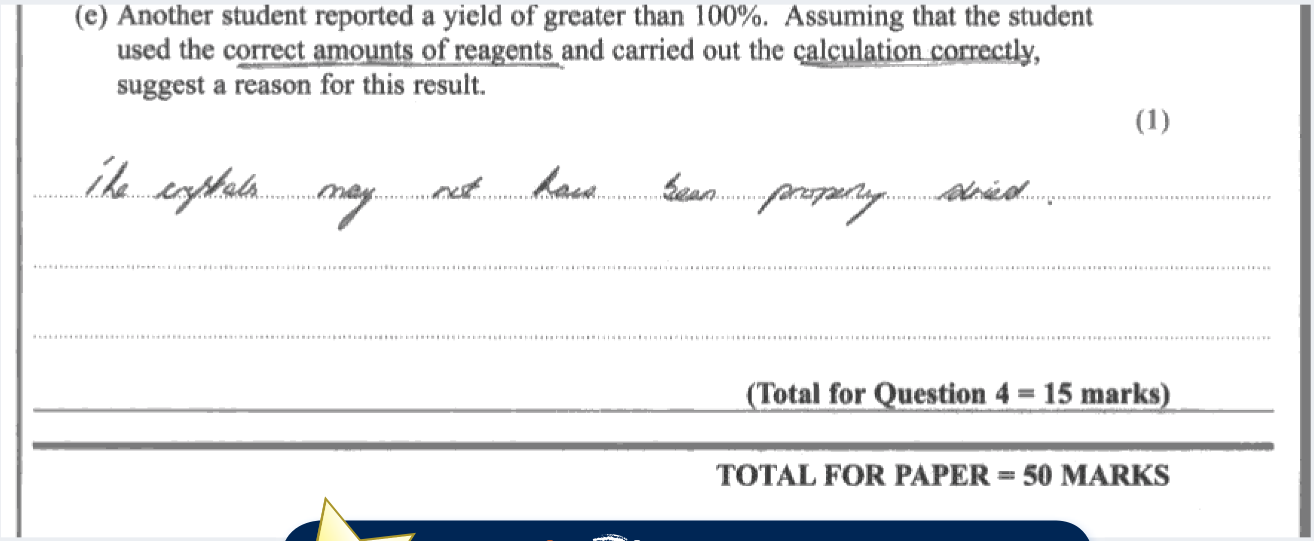
Examiner Comments

A nice answer which focuses on a specific and unavoidable practical shortcoming of recrystallization.

Question 4(e)

Most candidates appreciated that the most likely explanation for a yield in excess of 100%, was failure to dry the product but some sought more elaborate explanations.



(e) Another student reported a yield of greater than 100%. Assuming that the student used the correct amounts of reagents and carried out the calculation correctly, suggest a reason for this result.

(1)

The crystals may not have been properly dried.

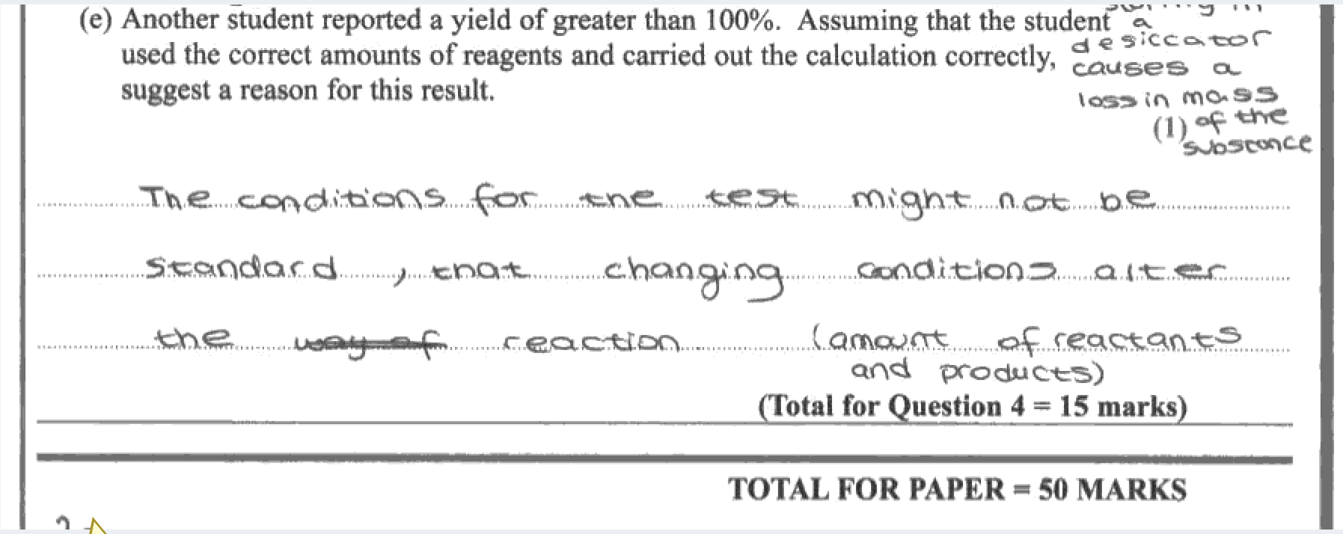
(Total for Question 4 = 15 marks)

TOTAL FOR PAPER = 50 MARKS

ResultsPlus

Examiner Comments

This candidate makes it look very easy.



(e) Another student reported a yield of greater than 100%. Assuming that the student used the correct amounts of reagents and carried out the calculation correctly, suggest a reason for this result.

(1)

storing in a desiccator causes a loss in mass of the substance

The conditions for the test might not be standard, that changing conditions alter the ~~way of~~ reaction (amount of reactants and products)

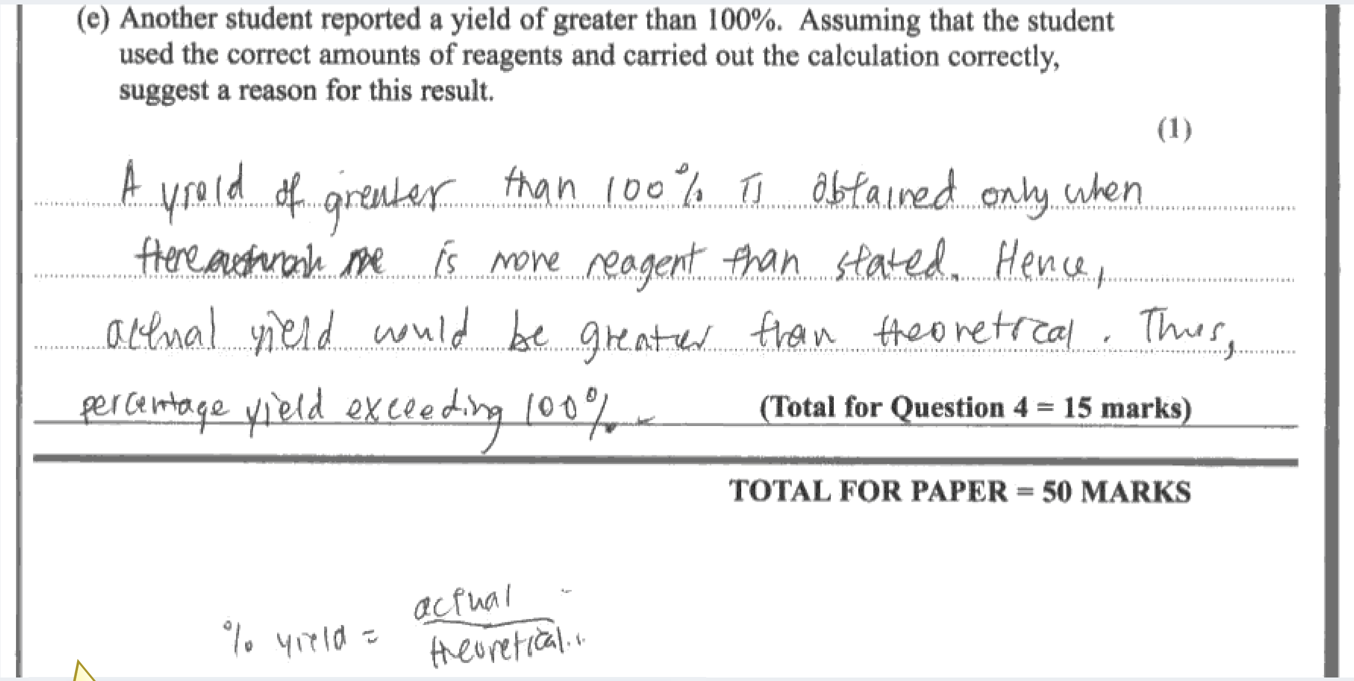
(Total for Question 4 = 15 marks)

TOTAL FOR PAPER = 50 MARKS

ResultsPlus

Examiner Comments

This candidate has not really attempted to think about the problem, taking refuge in learned answers.



(e) Another student reported a yield of greater than 100%. Assuming that the student used the correct amounts of reagents and carried out the calculation correctly, suggest a reason for this result.

(1)

A yield of greater than 100% is obtained only when there ~~actually one~~ is more reagent than stated. Hence, actual yield would be greater than theoretical. Thus, percentage yield exceeding 100%.

(Total for Question 4 = 15 marks)

TOTAL FOR PAPER = 50 MARKS

$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}}$

ResultsPlus

Examiner Comments

This candidate ignores the part of the question, which states that the correct amounts of reagents have been used.

ResultsPlus

Examiner Tip

Read the question carefully.

Candidates need to be aware that at A2 they are expected to apply their knowledge of Chemistry in familiar and unfamiliar situations; this requires practice in thinking through problems and selecting sensible answers. Particularly in practical situations there may be more than one plausible answer, however, while offering several correct alternative answers will gain credit, a mix of right and wrong answers is unlikely to score full marks.

Candidates should be able to draw clear and precise diagrams of the apparatus used in chemistry laboratories at Advanced level.

Review what you write and check that your meaning is clear and unambiguous.

Grade Boundries

Grade	Max. Mark	A*	A	B	C	D	E	N	U
Raw mark boundary	50	38	34	30	26	22	18	14	0
Uniform mark scale boundary	60	54	48	42	36	30	24	18	0

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