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Examiners' Report
January 2011

GCE Chemistry 6CH05 01

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Introduction

In general the paper seemed to have some question accessible to all candidates but with sufficient challenge to allow discrimination.

In section A candidates at the E boundary often managed to score an average mark of 10, whereas those at the A boundary generally managed to score 16 or more marks. The most successfully answered questions were 1, 12(a), 8(c), 12 (b) and 2. The least successfully answered question were 8(a), 10, 3, 6 and 13.

In sections B and C questions requiring simple recall were, as perhaps you would expect, well answered. Application proved demanding, especially within in a practical framework, as candidates seemed to struggle to use their practical experience in new contexts. The notable exception to this was the ability to process titration data.

The high level skill of evaluation of unfamiliar data and information, as in question 18, proved demanding for all candidates. Processing and using this sort of data, rather than simply repeating it, is critical for success in this type of question.

Question 15(a)(i)

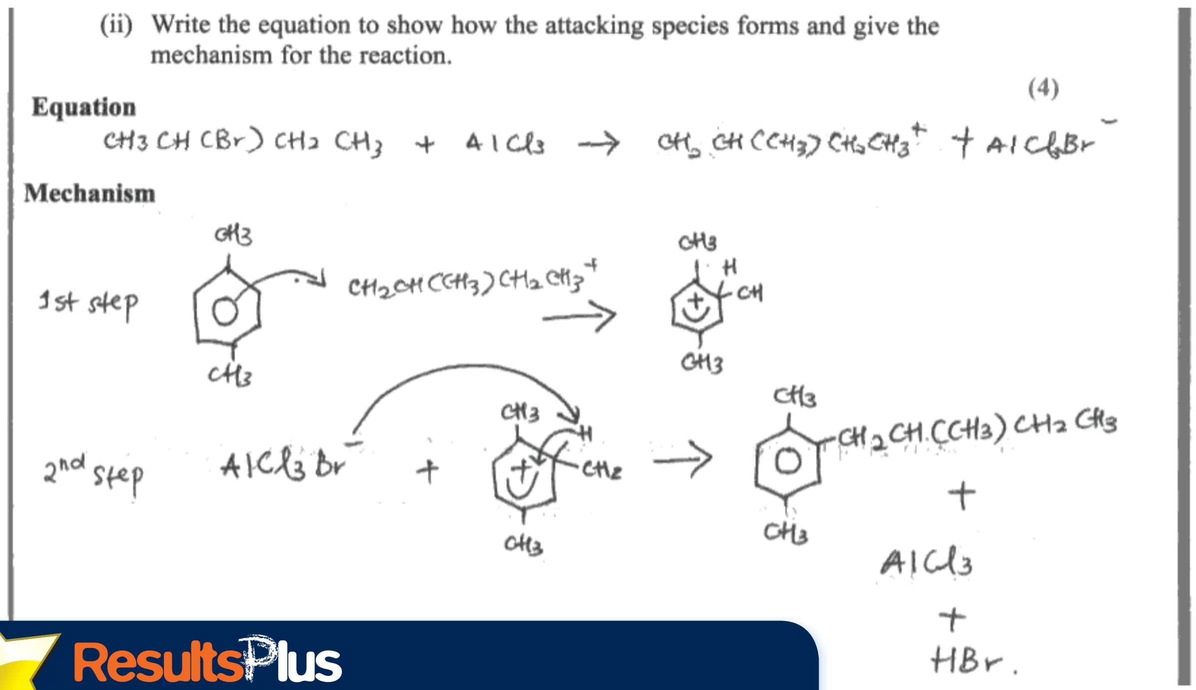
This proved to be a straightforward start to the structured questions for most candidates. Many included extra information such as ‘alkylation’ and ‘Friedal-Crafts’. A few failed to score, as whilst including such extra information they did not give the key information i.e. electrophilic substitution.

Question 15(a)(ii)

Many candidates can recall the key features of an electrophilic substitution mechanism. However the less usual features of this example did help differentiate between candidates. For instance, the use of a bromoalkane caught some unaware and formation of $AlCl_4^-$ was a common error.

The branched nature of the alkyl group also gave a degree of challenge, though it was pleasing to see many of the better candidates draw a correct carbocation and show attack at the appropriate carbon. A minority of candidates still seem to try to memorise such mechanisms without an appreciation of what the arrows represent. Hence a number of arrows from the carbocation to the ring were seen, as well as arrows from the H **atom** rather than the bond between the H and the ring, to reform full delocalisation.

In this example the candidate has struggled to apply knowledge of electrophilic substitution to an unfamiliar scenario.



(ii) Write the equation to show how the attacking species forms and give the mechanism for the reaction.

(4)

Equation

$CH_3CH(Br)CH_2CH_3 + AlCl_3 \rightarrow CH_2CH(CH_3)CH_2CH_3^+ + AlCl_3Br^-$

Mechanism

ResultsPlus Examiner Comments

The candidate nearly scores the first mark, despite the position of the charge on the terminal carbon, but misses out due to the introduction of an extra carbon into the chain. They then miss the second and third marks as the attack from the ring is to the terminal carbon and the alkyl group on the intermediate is incorrect. Even so they have a chance to score the fourth mark. However the electron pair needed to reinstate the delocalised ring comes incorrectly from a hydrogen atom rather than the bond pair.

ResultsPlus Examiner Tip

When revising mechanisms practise explaining rather than memorising each step, as this will help you apply the concepts across in range of different reactants.

Question 15(b)

This was mark was accessible for all levels of candidate, with many appreciating that the presence of graphite in a different phase to the reactants would make separation of the catalyst easier. A small number seized on the phrase heterogenous and described in detail how such a catalyst may work in a gaseous reaction but neglected to really answer the question posed.

Question 15(c)(i)

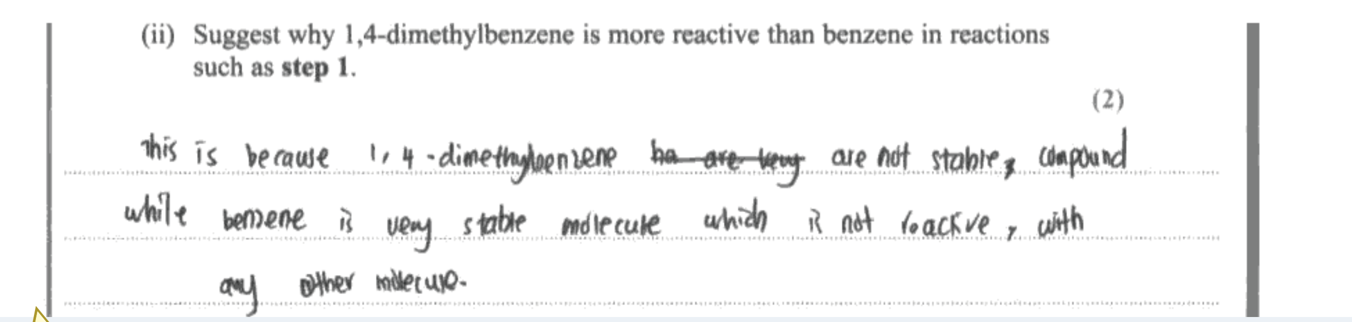
As suggested in the introduction, recall such as this was very well known. The common reason for not scoring two marks here, were responses suggesting the use of dilute acids.

Question 15(c)(ii)

Again this question was a useful discriminator. Better candidates gave clear description of the role of the methyl groups and its specific effect on the electron density of the ring. Terms such as electrophile and nucleophile (with respect to the ring) were used accurately.

However, weaker answers often confused the role of the methyl group, suggesting the ring withdrew electron density from them, rather than the other way round. A minority of candidates tried to argue that the carbon atoms on the methyl groups had lone pairs, perhaps trying to use a phenol-type answer to this question.

This example didn't develop an idea sufficiently well to score any mark.



(ii) Suggest why 1,4-dimethylbenzene is more reactive than benzene in reactions such as **step 1**.

(2)

this is because 1,4-dimethylbenzene ~~ha are very~~ are not stable, compound while benzene is very stable molecule which is not reactive, with any other molecule.

ResultsPlus

Examiner Comments

The candidate has recognised the inherent stability of benzene and has proposed that 1,4-dimethylbenzene is less stable, so more reactive.

ResultsPlus

Examiner Tip

On its own this is little more than repeating information in the question. To score, this answer would need to consider why 1,4-dimethylbenzene is less stable, so more reactive.

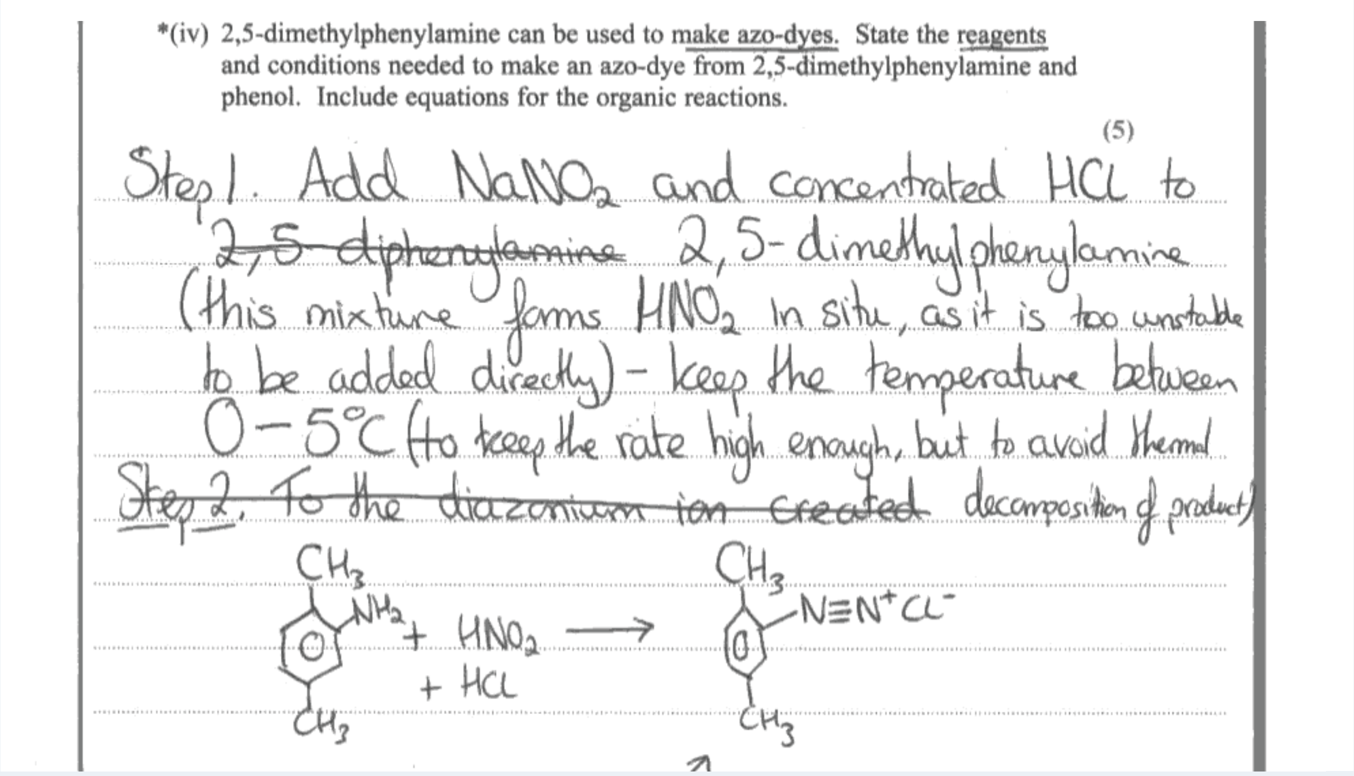
Question 15(c)(iii)

This question was less well known than electrophilic substitution, with common incorrect answers including hydration, hydrogenation and hydrolysis.

Question 15(c)(iv)

The less structured nature of this question did not unduly worry candidates and it was common to see at least one or two marks awarded. Most often these were for the use of $NaNO_2$ and HCl as reactants in the formation of the diazonium ion and the use of temperatures of less than 10 °C in the same process.

The remaining three marks were harder to achieve. Better candidates often recognised the need to use an alkaline solution of phenol and could draw a correct structure for the azo-dye, though some persist in maintaining the triple nitrogen bond from the diazonium ion. Seemingly only the best candidates were able to construct a balanced equation for the formation of the diazonium ion.



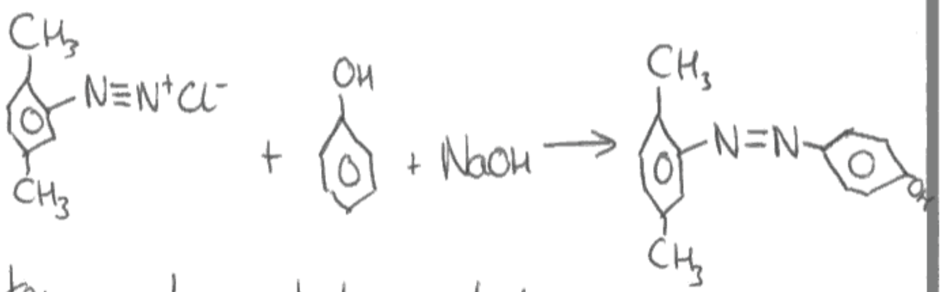
*(iv) 2,5-dimethylphenylamine can be used to make azo-dyes. State the reagents and conditions needed to make an azo-dye from 2,5-dimethylphenylamine and phenol. Include equations for the organic reactions.

(5)

Step 1. Add $NaNO_2$ and concentrated HCl to ~~2,5 diphenylamine~~ 2,5-dimethylphenylamine (this mixture forms HNO_2 in situ, as it is too unstable to be added directly) – keep the temperature between 0 – 5°C (to keep the rate high enough, but to avoid thermal decomposition of product)

~~Step 2. To the diazonium ion created~~

Step 2. To the diazonium ion produced, add phenol and NaOH, giving;



- keep temperature ~~betwe~~ below 10°C to avoid thermal decomposition of products/reactants, but above 0°C to keep rate of reaction reasonably high.

ResultsPlus

Examiner Comments

Here the candidate structures their answer into two clear sections, so it is easy to identify their suggestions for the two parts of the process. Conditions, reagents and structures are clearly shown. The only omission is that the equation for the formation of the diazonium ion does not balance.

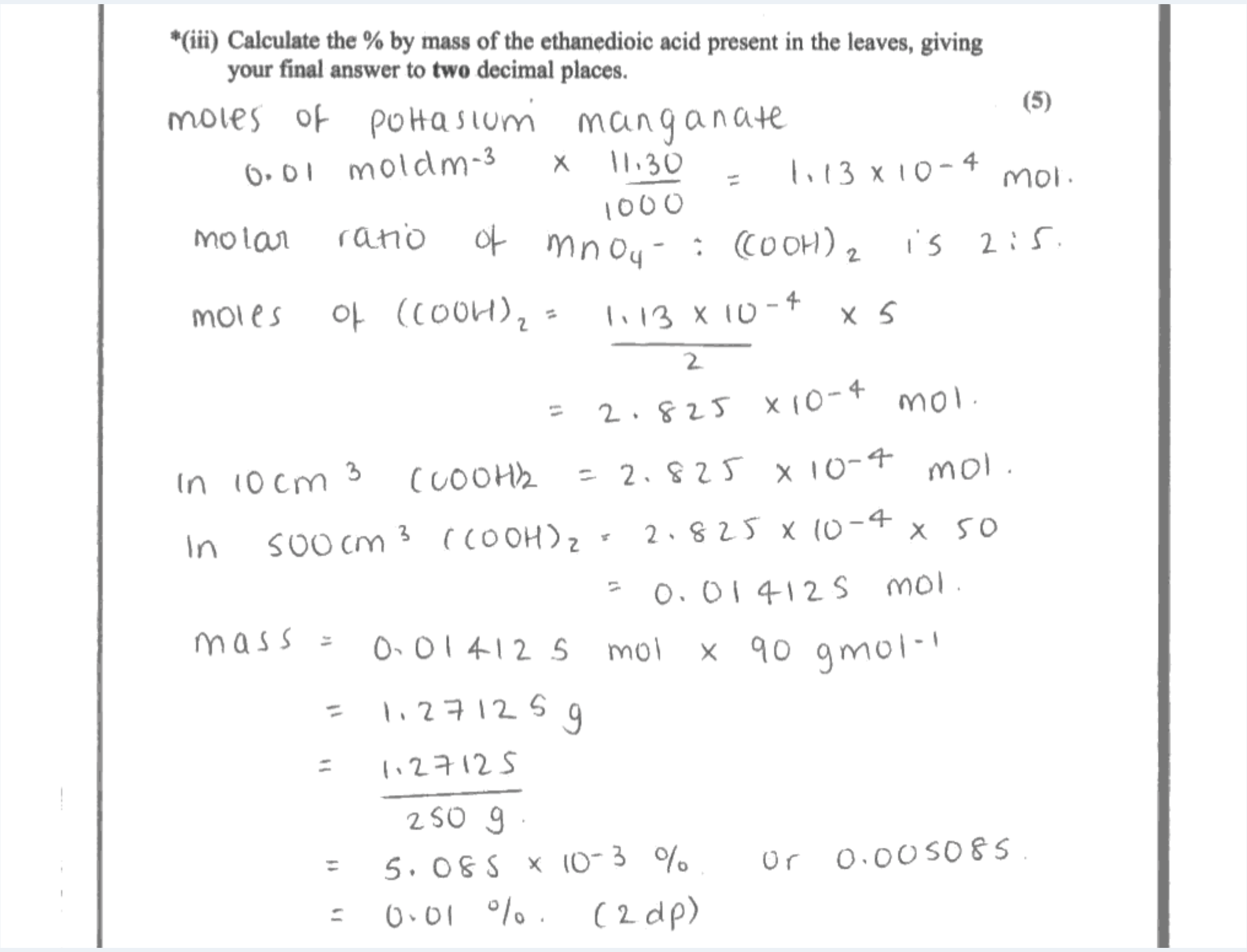
ResultsPlus

Examiner Tip

Use the stem of the question as a checklist to help you structure your answer. If necessary re-read the stem after you have answered the question to check you have not left out anything it requires you to do.

Question 16(a)(iii)

A concern with this type of question is that candidates will find the lack of structure intimidating and as a result fail to demonstrate the chemistry they know. However, it is pleasing to report that many answers followed a clear and logical route through the problem. This is to be encouraged, especially as it helps examiners identify the point at which a calculation 'breaks down' and so award further credit later in the question. The most common reasons for 'breakdown' were use of a 2:5 ratio, instead of 5:2 and a failure to scale up from 10 cm³ to 500 cm³.



*(iii) Calculate the % by mass of the ethanedioic acid present in the leaves, giving your final answer to **two** decimal places.

(5)

moles of pottasium manganate

$0.01 \text{ moldm}^{-3} \times \frac{11.30}{1000} = 1.13 \times 10^{-4}$ mol.

molar ratio of MnO_4^- : $(COOH)_2$ is 2 : 5.

moles of $(COOH)_2 = \frac{1.13 \times 10^{-4}}{2} \times 5$

$= 2.825 \times 10^{-4}$ mol.

In 10cm^3 $(COOH)_2 = 2.825 \times 10^{-4}$ mol.

In 500cm^3 $(COOH)_2 = 2.825 \times 10^{-4} \times 50$

$= 0.014125$ mol.

mass $= 0.014125$ mol $\times 90 \text{ gmol}^{-1}$

$= 1.27125$ g

$= \frac{1.27125}{250 \text{ g}}$.

$= 5.085 \times 10^{-3}$ % or 0.005085.

$= 0.01$ %. (2dp)

ResultsPlus

Examiner Comments

Each step is clearly described using text as well as by showing the actual calculation being processed, rather than just the numerical answer. As a result it is easy to follow and so four marks awarded. The only slip is in the last step when the candidate forgets to multiply by 100 to determine the percentage.

ResultsPlus

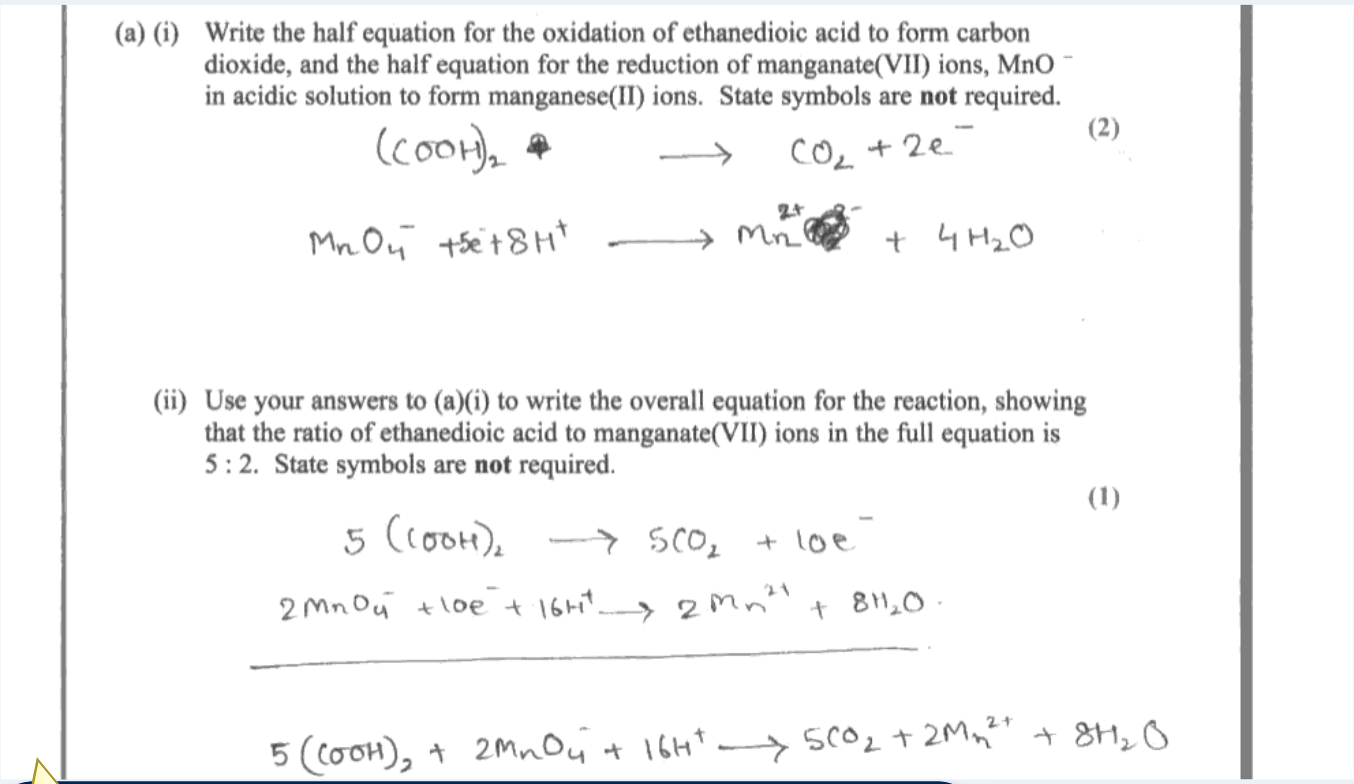
Examiner Tip

Label each step of a complex calculation to help you focus on what you are trying to work out.

Question 16(a)(i-ii)

The manganate(VII) half equation was well known, but the non-systematic approach to construction of the half equation for the oxidation of the ethanedioic acid suggested many had used recall rather than working it out. A significant minority attempted to balance the latter using [O], O_2 and left out electrons.

Inevitably those who could not write the half-equations in (a) (i) struggled with (a) (ii), though a small number persisted and managed to construct the full equation by trial and error.



(a) (i) Write the half equation for the oxidation of ethanedioic acid to form carbon dioxide, and the half equation for the reduction of manganate(VII) ions, MnO $^-$ in acidic solution to form manganese(II) ions. State symbols are **not** required.

(2)

$(COOH)_2 \longrightarrow CO_2 + 2e^-$

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

(ii) Use your answers to (a)(i) to write the overall equation for the reaction, showing that the ratio of ethanedioic acid to manganate(VII) ions in the full equation is 5 : 2. State symbols are **not** required.

(1)

$5(COOH)_2 \longrightarrow 5CO_2 + 10e^-$

$2MnO_4^- + 10e^- + 16H^+ \longrightarrow 2Mn^{2+} + 8H_2O$.

$5(COOH)_2 + 2MnO_4^- + 16H^+ \longrightarrow 5CO_2 + 2Mn^{2+} + 8H_2O$

ResultsPlus
Examiner Comments

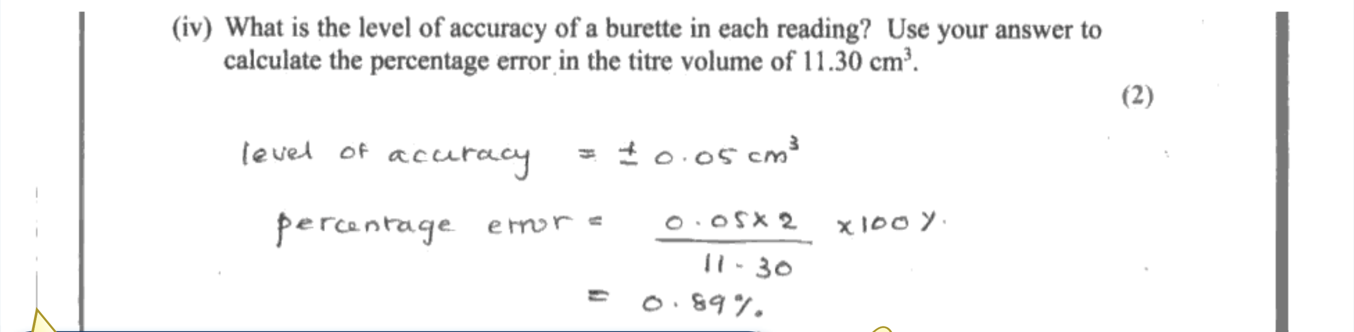
The candidate has correctly recognised the need to balance hydrogen in the manganate(VII) equation but ignores it in the acid half equation. This was a common error and perhaps suggests some candidates had remembered the former equation, rather than worked it out. As a consequence the candidate did not manage to balance the full equation, despite confirming the ratio.

ResultsPlus
Examiner Tip

Learn the rules for balancing half-equations rather than trying to remember numerous specific examples. Once you know the rules you should be able to balance any half-equation, even if you have not seen it before.

Question 16(a)(iv)

This calculation was poorly done with some evidence that candidates are not really considering the significance of their answer. For instance it was quite common to see answers of 98 or 99% quoted, presumably because candidates were trying to give a figure for the overall accuracy of the process rather than the percentage error. Few seemed to take into account that two readings are needed to give a final titre so even if they correctly identified the level of accuracy, they did not multiply this by two to calculate the error.



(iv) What is the level of accuracy of a burette in each reading? Use your answer to calculate the percentage error in the titre volume of 11.30 cm^3.

(2)

level of accuracy $= \pm 0.05\ \text{cm}^3$

percentage error $= \frac{0.05 \times 2}{11.30} \times 100\%$

$= 0.89\%$

ResultsPlus

Examiner Comments

This is an example of a clearly laid out solution that leaves the examiner in no doubt as to what the candidate is trying to achieve and scored both marks.

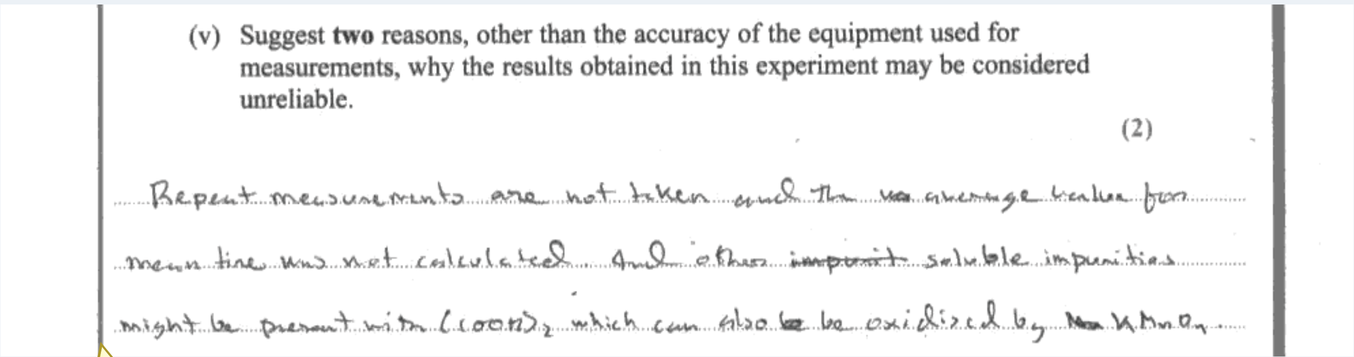
ResultsPlus

Examiner Tip

Don't be afraid to use words to briefly label each step of a calculation. This helps examiners follow your progress and award credit for working even if you make a mathematical error.

Question 16(a)(v)

Many answers to this question revolved around confessions of less than competent technique, which did not receive credit. Candidates should be encouraged to consider the methodology followed, assume it is carried out competently, and then consider the validity of the process, rather than the individual carrying it out. Hence, the best answers spotted the use of only one titre and the possibility that additional substances from the leaf may have interacted with the oxidising agent.



(v) Suggest **two** reasons, other than the accuracy of the equipment used for measurements, why the results obtained in this experiment may be considered unreliable.

(2)

Repeat measurements are not taken and the ~~va~~ average value for mean titre was not calculated. And other ~~impurit~~ soluble impurities might be present with $(COOH)_2$ which can also ~~be~~ be oxidized by ~~Mn~~ $KMnO_4$

ResultsPlus

Examiner Comments

This good example considers possible inbuilt problems with the method rather than 'human errors'.

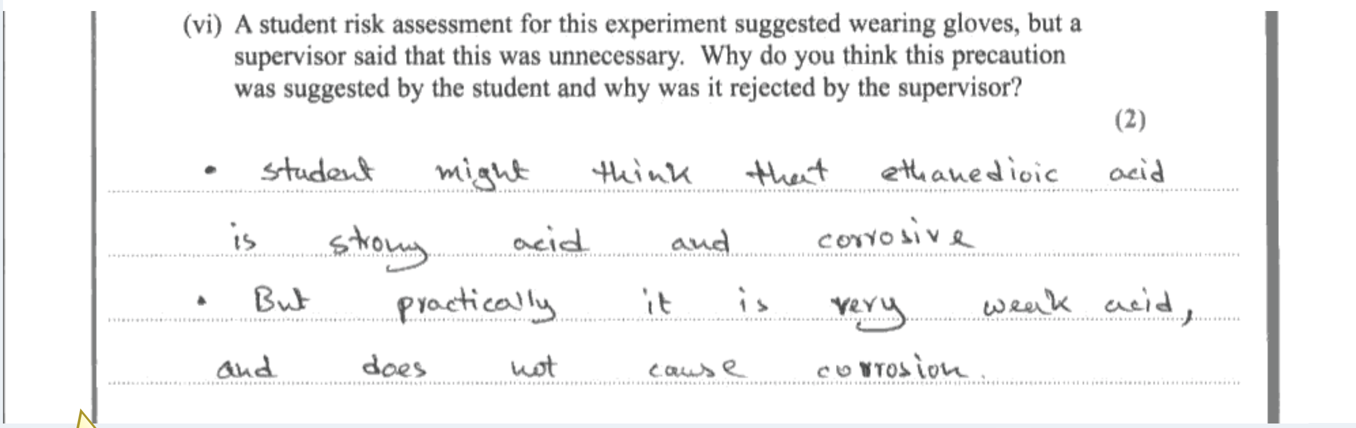
ResultsPlus

Examiner Tip

Read the experimental method carefully and then assume it has been followed as described. Going on to then suggest the method has not been followed correctly is very unlikely to receive credit in this type of question.

Question 16avi

The better candidates could apply generic health and safety considerations to this specific example, often citing the toxicity from the question stem and using their answer from (a) (iii) to justify their reasoning. Some credit could be gained by considering the acidity of the mixture, though too often answers that pursued this idea gave a justification based on relative strength rather than concentration.



(vi) A student risk assessment for this experiment suggested wearing gloves, but a supervisor said that this was unnecessary. Why do you think this precaution was suggested by the student and why was it rejected by the supervisor?

(2)

- student might think that ethanedioic acid is strong acid and corrosive
- But practically it is very weak acid, and does not cause corrosion.

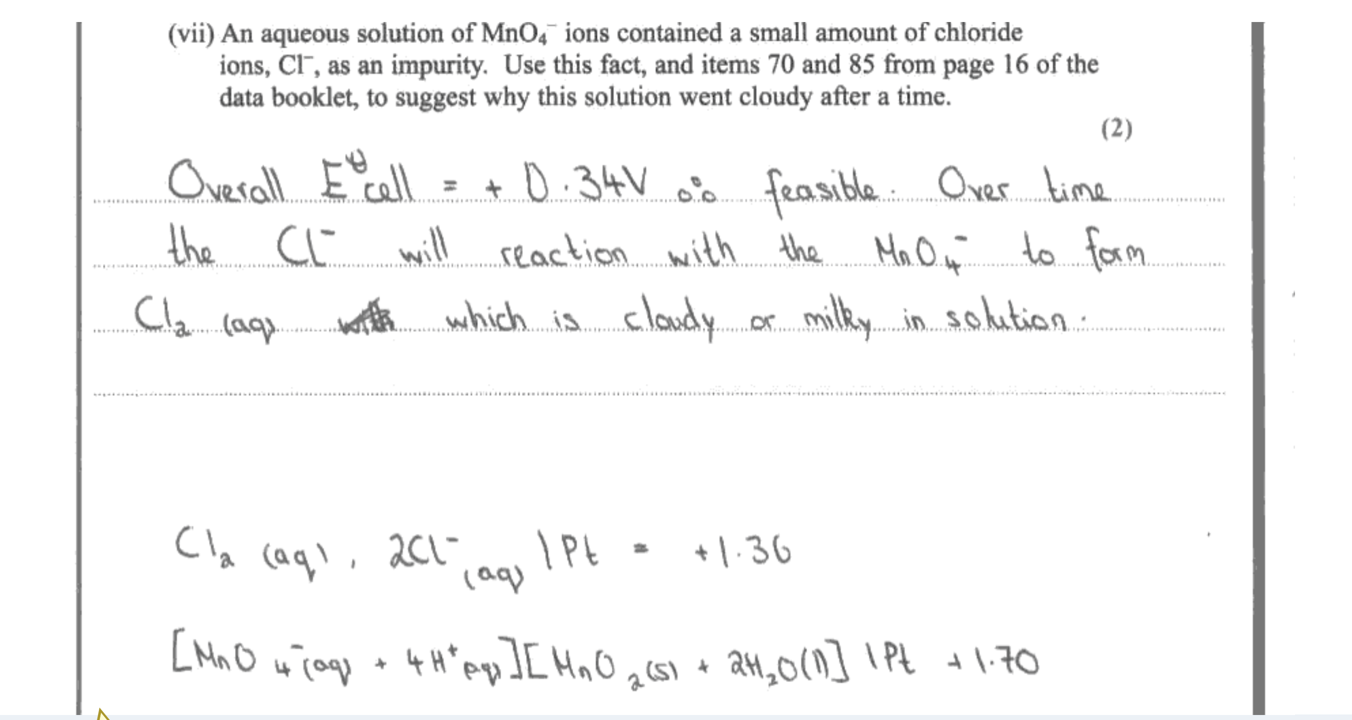
ResultsPlus

Examiner Comments

This was a common answer, which with correct chemistry could have received some credit. Unfortunately confusion between ‘strong’ and ‘concentrated’ prevented this, and many other similar responses, from scoring.

Question 16(a)(vii)

This question proved more challenging than anticipated. Whilst more able candidates had few problems justifying the occurrence of a reaction between Cl^- and MnO_4^- ions, many thought the cloudiness was caused by the formation of $Cl_2(g)$. Many weaker answers tried to justify the formation of HCl, as they clearly felt that steamy fumes of this gas would also result in cloudiness. It seemed as if candidates expected to just know what caused the observation, rather than work it out from the guidance in the stem of the question.



(vii) An aqueous solution of MnO_4^- ions contained a small amount of chloride ions, Cl^-, as an impurity. Use this fact, and items 70 and 85 from page 16 of the data booklet, to suggest why this solution went cloudy after a time.

(2)

Overall $E^\ominus_{cell}$ = + 0.34V ∴ feasible. Over time the Cl^- will reaction with the MnO_4^- to form Cl_2 (aq) ~~with~~ which is cloudy or milky in solution.

$Cl_2(aq), 2Cl^-_{(aq)} | Pt = +1.36$

$[MnO_4^-(aq) + 4H^+(aq)][MnO_{2(s)} + 2H_2O(l)] | Pt \quad +1.70$

ResultsPlus

Examiner Comments

This answer scored the first mark for correctly using the data to confirm the reaction would occur. However, the reference to chlorine causing the cloudiness did not score the second mark.

ResultsPlus

Examiner Tip

When presented with unfamiliar reagents, use the stem to help you. In this case it refers you to a half equation that most candidates realised would move in the direction of $MnO_2(s)$, but only a few used the solid state symbol to help answer the question.

Question 16(b)(i)

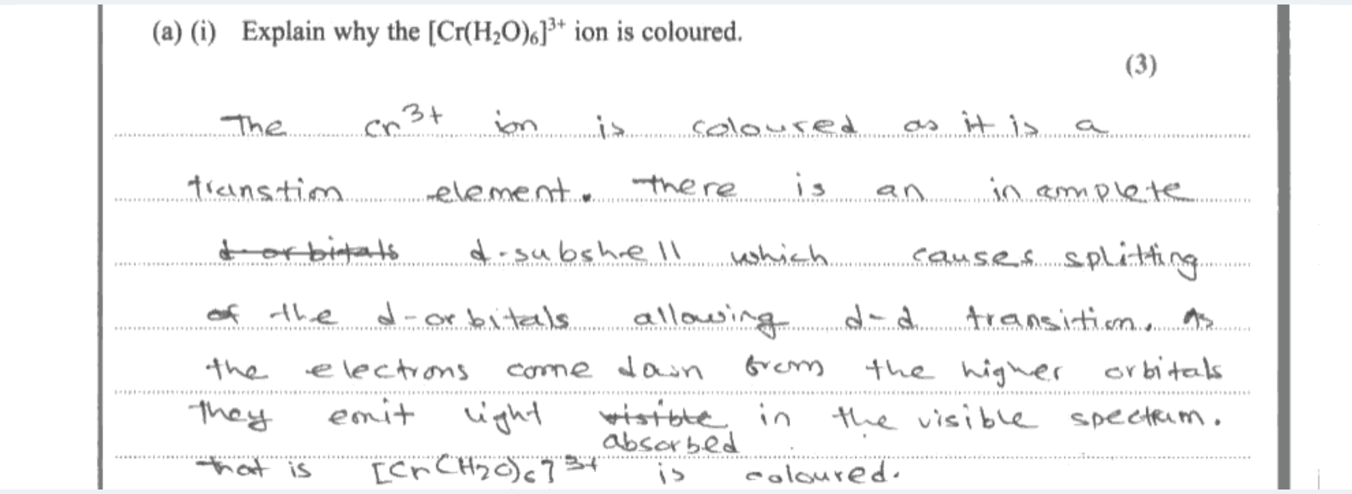
Although it was not hard to predict the common errors (e.g. $3d^5\ 4s^2$ or $3d^3\ 4s^2$) they were surprisingly common, even in some otherwise very good scripts.

Question 16(b)(ii)

The shape was very well known at all levels, with only a few alternatives, most commonly ‘octagon’ or ‘hexagonal’ that failed to score.

Question 17(a)(i)

Many candidates at all levels could explain the colour of the complex ion with clear reference to the splitting of d orbitals and subsequent electron transitions. Some answers did not manage to convey the idea that only some frequencies of light were absorbed whilst others seemed to confuse this concept with flame tests / emission spectra and discussed emission of light as electrons return to a lower energy state.



(a) (i) Explain why the $[Cr(H_2O)_6]^{3+}$ ion is coloured.

(3)

The Cr^{3+} ion is coloured as it is a transtion element. there is an in complete ~~d-orbitals~~ d-subshell which causes splitting of the d-orbitals allowing d-d transition. As the electrons come down from the higher orbitals they emit light ~~visible~~ absorbed in the visible spectrum. that is $[Cr(H_2O)_6]^{3+}$ is coloured.

ResultsPlus

Examiner Comments

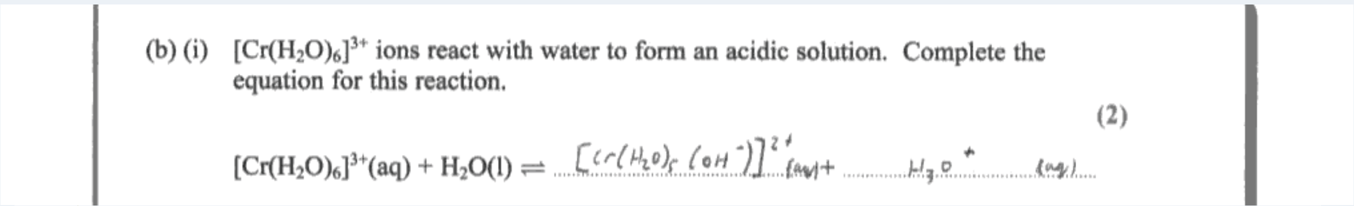
Here the splitting of the d orbitals is recognised but from then on the candidate seems to be confusing the process with emission spectra or flame tests.

Question 17(a)(ii)

The reaction type was well known, though a few missed out on scoring by using language more commonly found in organic chemistry, for instance nucleophilic substitution. The idea of a reagent being the actual substance used in a reaction, rather than the specific particle involved in ligand exchange, was misunderstood by some candidates. Hence, a number of answers simply suggested use of Cl^- ions rather than HCl and did not score.

Question 17(b)(i)

More able candidates had little problems with this question, with the most common error being to use H^+ rather than H_3O^+ or omission of the charge on the new complex ion. However, weaker candidates found it challenging. Even if they realised the water gained a proton, they often assumed three (or sometimes two) protons had been removed from the complex. If they had then gone on to balance the equation accordingly they could have scored full marks, but very few managed to balance the number of hydroxonium ions in line with their proposed complex.



(b) (i) $[Cr(H_2O)_6]^{3+}$ ions react with water to form an acidic solution. Complete the equation for this reaction.

(2)

$[Cr(H_2O)_6]^{3+}(aq) + H_2O(l) \rightleftharpoons$ $[Cr(H_2O)_5(OH^-)]^{2+}$ (aq) + H_3O^+ (aq)

ResultsPlus

Examiner Comments

This was quite a common error and lost a mark because the candidate left a charge on the ligand and the overall complex, giving an incorrect overall charge for this answer.

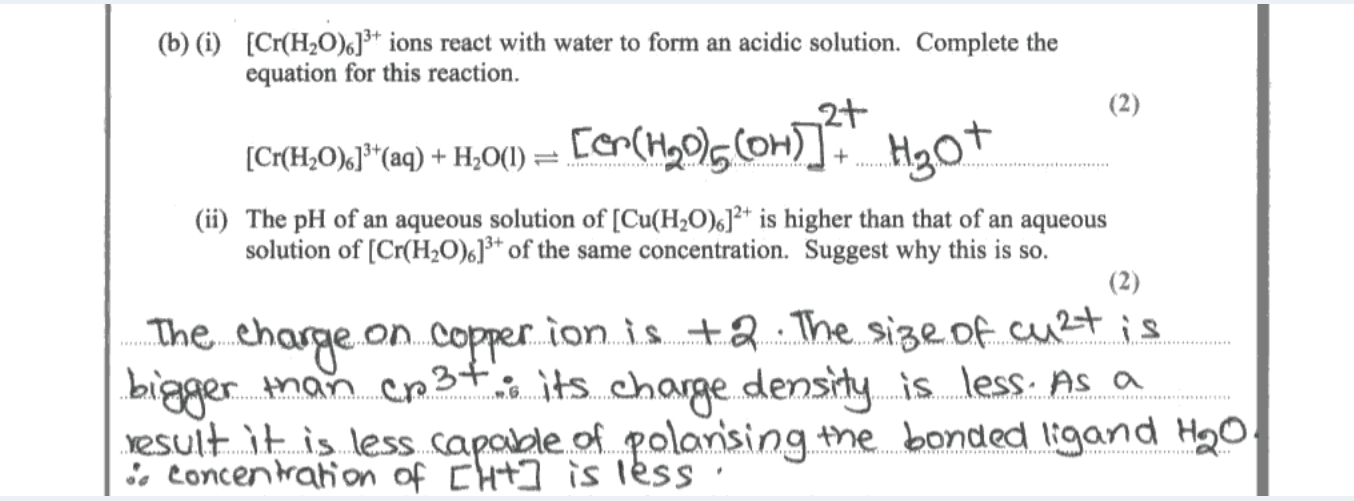
ResultsPlus

Examiner Tip

Remember to add up all the charges of both the cation and ligand in a complex ion to give a single overall value for the charge.

Question 17(b)(ii)

The most challenging part of this question was the difficulty candidates had in relating high pH to the idea of having a lower concentration of hydrogen ions. A great many answers at all levels attempted to justify the greater acidity of the copper complex. Of those who realised the chromium complex was more acidic, only a few were able to explain this in terms of the ability of the cation to weaken the O-H bond in the ligand.



(b) (i) $[Cr(H_2O)_6]^{3+}$ ions react with water to form an acidic solution. Complete the equation for this reaction.

(2)

$[Cr(H_2O)_6]^{3+}(aq) + H_2O(l) \rightleftharpoons [Cr(H_2O)_5(OH)]^{2+} + H_3O^+$

(ii) The pH of an aqueous solution of $[Cu(H_2O)_6]^{2+}$ is higher than that of an aqueous solution of $[Cr(H_2O)_6]^{3+}$ of the same concentration. Suggest why this is so.

(2)

The charge on copper ion is +2. The size of cu^{2+} is bigger than cr^{3+} ∴ its charge density is less. As a result it is less capable of polarising the bonded ligand H_2O. ∴ concentration of $[H^+]$ is less.

ResultsPlus

Examiner Comments

This example clearly shows that the candidate has linked the pH to the concentration of H^+ ions, as well as explaining why the chromium complex has resulted in a greater concentration of these ions.

ResultsPlus

Examiner Tip

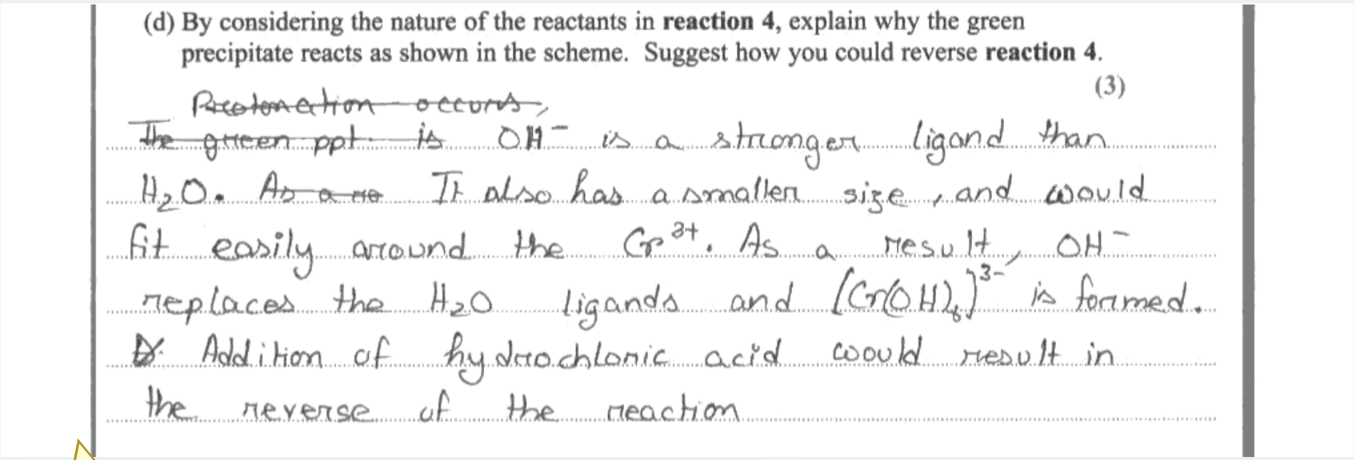
Remember a lower pH has a greater concentration of hydrogen ions than a higher pH.

Question 17(c)

Less than half of the candidates could suggest a correct formula for the green precipitate, with many of the incorrect answers assuming the precipitate was a charged complex with either ammonia or hydroxide ions.

Question 17(d)

The responses seen seem to indicate that the difference between ligand exchange and deprotonation / hydrolysis is poorly understood. Many assumed that the hydroxide ions simply replaced the water molecules. This also made access to the third mark difficult as they then assumed simply adding more water would reverse the reaction. A number attempted to explain the reaction in terms of the amphoteric nature of the chromium(III) hydroxide. Whilst this was an acceptable approach, many used vague references such as 'chromium is amphoteric' and so did not score this mark. A few otherwise good answers did not refer to the nature of sodium hydroxide's role in the reaction, so missed the first mark.



(d) By considering the nature of the reactants in **reaction 4**, explain why the green precipitate reacts as shown in the scheme. Suggest how you could reverse **reaction 4**.

(3)

~~Protonation occurs,~~
~~The green ppt is~~ OH$^-$ is a stronger ligand than H_2O. ~~As a re~~ It also has a smaller size, and would fit easily around the Cr^{3+}. As a result, OH$^-$ replaces the H_2O ligands and $[Cr(OH)_6]^{3-}$ is formed. ~~D~~ Addition of hydrochloric acid would result in the reverse of the reaction

ResultsPlus
Examiner Comments

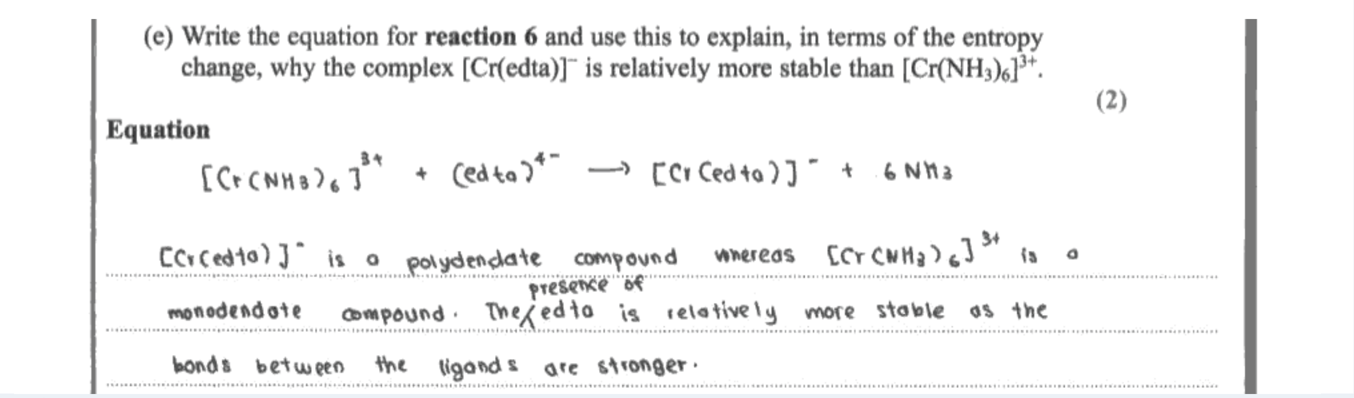
This example illustrates a common misconception that the hydroxide ion behaves as a ligand in this process. Despite this the candidate did salvage one mark for the use of acid to reverse the reaction.

ResultsPlus
Examiner Tip

This is a difficult one as it is easy to assume the reaction is ligand exchange. Remember however, that sodium hydroxide is a strong base so is likely to deprotonate amphoteric hydroxides.

Question 17(e)

The correct equation was common and at least one candidate drew a complete structure of edta^{4-}. However, a number of candidates, whilst recognising a positive entropy change of the system, tried to justify this by simply stating that the formation of complexes with hexadentate ligands give rise to such a change, rather than the underlying reason for the increase in disorder.



(e) Write the equation for **reaction 6** and use this to explain, in terms of the entropy change, why the complex $[Cr(edta)]^-$ is relatively more stable than $[Cr(NH_3)_6]^{3+}$.

(2)

Equation

$[Cr(NH_3)_6]^{3+} + (edta)^{4-} \longrightarrow [Cr(edta)]^- + 6NH_3$

$[Cr(edta)]^-$ is a polydendate compound whereas $[Cr(NH_3)_6]^{3+}$ is a monodendate compound. The presence of edta is relatively more stable as the bonds between the ligands are stronger.

ResultsPlus

Examiner Comments

Here the equation is correct but there is no discussion of entropy in the explanation, so only one mark is scored.

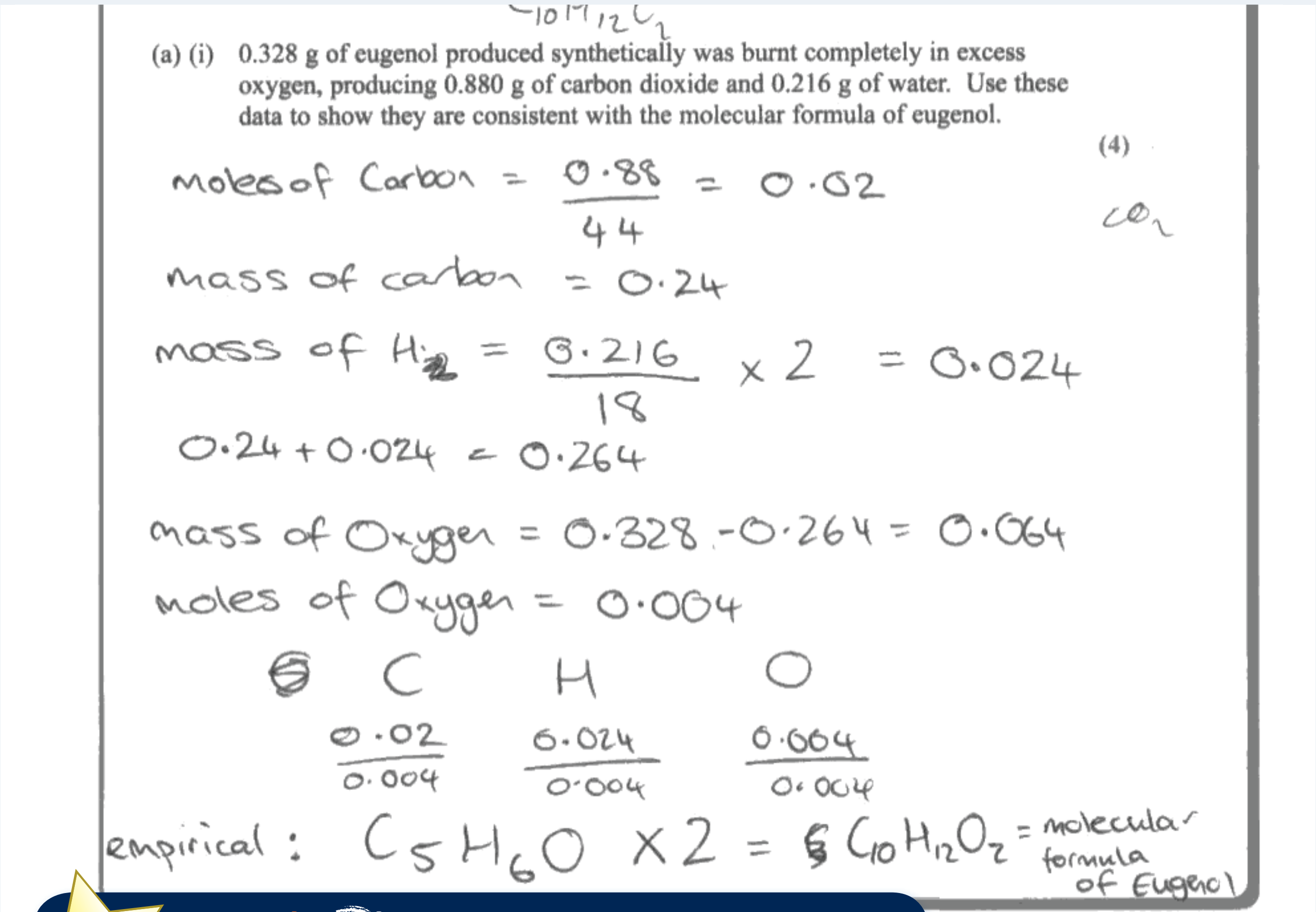
ResultsPlus

Examiner Tip

Justify the stability of complexes containing hexadentate ligands by comparing the number of reactant particles to the number of product particles and then linking this to the entropy change of the system.

Question 18(a)(i)

Having praised candidates for the clarity of presentation in 16 (a) (iii), it is fair to say that this skill was seen less often here. The key was the appreciation that the amount of oxygen needed to be deduced. Evidence suggests that the more able candidates realised this and generally went on to score full marks by a variety of different methods. However, those that didn't, often calculated the amount of carbon dioxide and water but only occasionally used these to justify even the C:H ratio.



$C_{10}H_{12}O_2$

(a) (i) 0.328 g of eugenol produced synthetically was burnt completely in excess oxygen, producing 0.880 g of carbon dioxide and 0.216 g of water. Use these data to show they are consistent with the molecular formula of eugenol.

(4)

CO_2

moles of Carbon $= \frac{0.88}{44} = 0.02$

mass of carbon $= 0.24$

mass of $H_{\cancel{2}} = \frac{0.216}{18} \times 2 = 0.024$

$0.24 + 0.024 = 0.264$

mass of Oxygen $= 0.328 - 0.264 = 0.064$

moles of Oxygen $= 0.004$

~~6~~	C	H	O
	$\frac{0.02}{0.004}$	$\frac{0.024}{0.004}$	$\frac{0.004}{0.004}$

empirical : $C_5H_6O \times 2 = \cancel{8}\ C_{10}H_{12}O_2$ = molecular formula of Eugenol

ResultsPlus

Examiner Comments

Each step in this example is clearly described and the candidate has spotted that they have to deduce the amount of oxygen, as combustion analysis gives data about all the elements in the molecule except oxygen.

ResultsPlus

Examiner Tip

Remember in combustion analysis to find the amount or mass of each element except oxygen. Subtract this from the total mass or amount of the molecule to find the mass or amount of oxygen.

Question 18(a)(ii)

The most straightforward two marks question on the paper, with excellent recall shown by the vast majority and very little evidence of ‘clear’ rather than ‘colourless’. A small number perhaps hastily read the question and suggested a test for a carbonyl group.

Question 18(a)(iii)

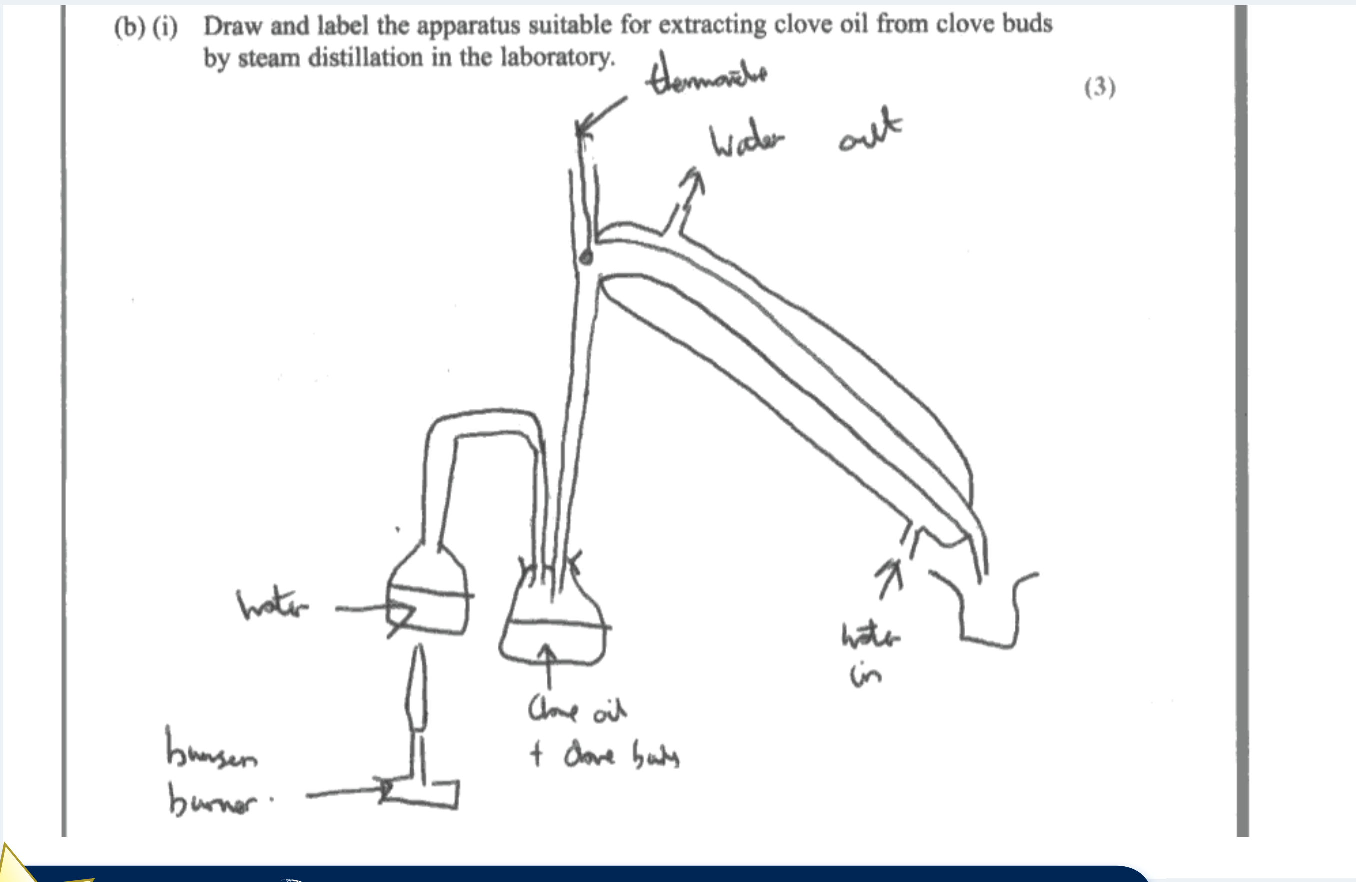
Most candidates recognised the need for reflux but a few thought avoidance of the naked flame, for instance by use of an electric heater, was sufficient and so did not score.

Question 18(a)(iv)

Often candidates deduced correctly that step 4 was an esterification but suggested using only ethanoic acid. A number of those who realised ethanoyl chloride could be a more effective reagent confused the process with acylation and suggested use of an $AlCl_3$ catalyst. Such answers did not score.

Question 18(b)(i)

The quality of apparatus diagrams is an area where many candidates could significantly improve. Too often diagrams appeared to be one continuous piece of glassware and when joints were shown, significant gaps would often have allowed escape of all the steam / oil. Candidates are not expected to produce text-book quality diagrams but there is an expectation that to score full credit the apparatus must work if used in the way shown by the candidate. Only rarely was this the case.



(b) (i) Draw and label the apparatus suitable for extracting clove oil from clove buds by steam distillation in the laboratory.

(3)

ResultsPlus

Examiner Comments

This example, whilst not having too much artistic merit, did have enough chemically correct diagrams to score two marks. This candidate chose to use a separate steam supply, which here was (just) acceptable even though the diagram did not directly pass the steam through the cloves. The condenser and collecting vessel were present and the system has at least one ‘joint’ from the flask to the rather elongated still head. However, the top of the still head is open to the atmosphere, hence most of the mixture would escape and so one mark was lost.

ResultsPlus

Examiner Tip

Practice drawing standard equipment set-ups relevant to this unit, such as this one.

Question 18(b)(ii)

As indicated in the introduction application of practical skills to novel contexts is an underdeveloped skill. Few candidates recognised the need to use solvent extraction, though some of the better answers at least suggested the use of a separating funnel to remove the oily layer, followed by use of a suitable drying agent, scoring two of the three marks. A significant number of often accurate, though inappropriate, descriptions of recrystallisation were seen.

Question 18(c)

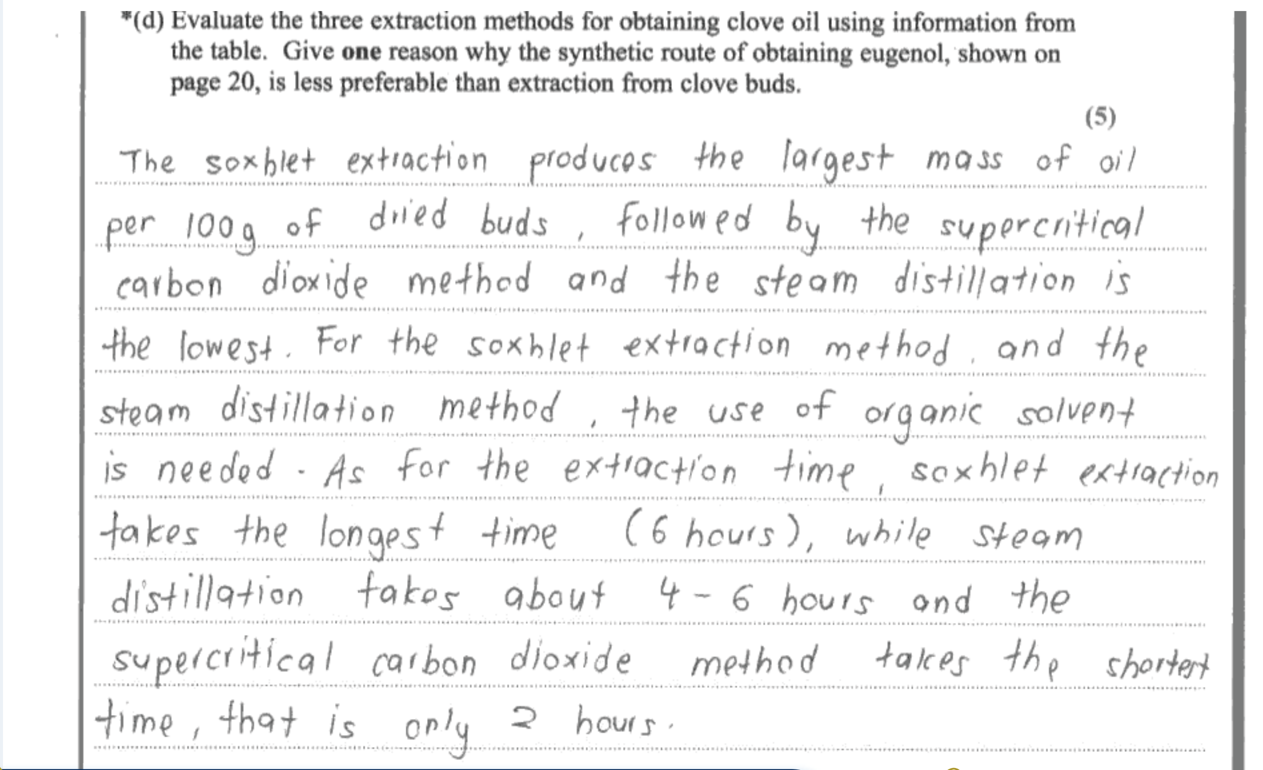
The best answers paid careful attention to the context of the question and therefore were able to argue against animal testing by virtue of the long-standing use of small amounts of clove oil. However, the majority of answers were based on generic observations or arguments, both pro and anti-vivisection, but these failed to score.

Question 18(d)

Very little real evaluation of the data and information was seen in the answers to this question. Too often comments were simply a repetition of the question and as such, failed to score. The best answers showed clear evidence of processing the data before making a judgement or comparison. For instance, many noted the lack of need for an organic solvent when using $ScCO_2$, but only a few considered the potential benefits of this. In addition, the colour of the products was often noted, but the significance of this on the purity, despite the clear inference from the stem of the question, was rarely understood.

Some excellent answers calculated a yield of eugenol / eugenol ethanoate, using the mass of oil per 100 g of clove buds and the % of eugenol / eugenol ethanoate and so could present a valid evaluation of the three processes in terms of overall yield.

However, this approach was rare and far more prevalent were the statements that either $ScCO_2$ or Soxhlet gave the best yield depending on which columns in the table the candidate chose to compare. Ironically when considering the synthetic route candidates often used the data to calculate an overall yield of around 2% and used this to justify the extraction from cloves.



*(d) Evaluate the three extraction methods for obtaining clove oil using information from the table. Give **one** reason why the synthetic route of obtaining eugenol, shown on page 20, is less preferable than extraction from clove buds.

(5)

The soxhlet extraction produces the largest mass of oil per 100g of dried buds, followed by the supercritical carbon dioxide method and the steam distillation is the lowest. For the soxhlet extraction method and the steam distillation method, the use of organic solvent is needed. As for the extraction time, soxhlet extraction takes the longest time (6 hours), while steam distillation takes about 4 - 6 hours and the supercritical carbon dioxide method takes the shortest time, that is only 2 hours.

ResultsPlus

Examiner Comments

This example shows illustrates a common approach by many candidates. Information is simply repeated from the question and used to make simple, often invalid, comparisons between the four processes. To improve the answer would need to show evidence that the data or information had been processed to make a valid comparison. For instance discussing the mass of oil per hour rather than simply stating that $ScCO_2$ took less time could have scored credit as could considering the benefits of not using a chlorinated solvent.

ResultsPlus

Examiner Tip

This type of question is not a simple comprehension exercise so simply repeating information from the stem is unlikely to score highly. Be prepared to look deeper into the data in order to make valid judgements.

Revision Tips

Practice drawing apparatus such as that needed for distillation accurately.

Use the question stem as a checklist when answering less structured questions to ensure you do not miss out key information.

Use sub-headings if necessary to help you structure your answer.

Briefly describe each step of a lengthy calculation in words to remind yourself what you are doing. This will help embed understanding as you revise.

Make sure you understand what is happening at each stage of a mechanism as you revise, rather than trying to memorise it as an image. Describing each step in words as you revise, whilst not required in a question such as 15 (c) (iv), will help you understand and apply the mechanism, rather than just recall it.

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