

CCEA GCE - Chemistry
(Summer Series) 2014

Chief Examiner's Report

chemistry

Foreword

This booklet outlines the performance of candidates in all aspects of CCEA's General Certificate of Education (GCE) in Chemistry for this series.

CCEA hopes that the Chief Examiner's and/or Principal Moderator's report(s) will be viewed as a helpful and constructive medium to further support teachers and the learning process.

This booklet forms part of the suite of support materials for the specification. Further materials are available from the specification's microsite on our website at www.ccea.org.uk

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GCE CHEMISTRY

Chief Examiner's Report

Assessment Unit AS 1 Basic Concepts In Physical and Inorganic Chemistry

This paper was accessible to all. Some of the questions discriminated between the more able and less able candidates. The mark scheme was easy to follow. Candidates appeared to have sufficient time to complete this paper.

- Q11**
- (a) This question was generally well answered. Some candidates misinterpreted the question and provided a graph showing the change in the 1st Ionisation Energy traversing a period. Another recurring error involved the misplacement of boron into Group (II). Candidates need to ensure that when they are drawing a graph like this that they do not show the increase in energy on entering a new sublevel as equivalent to the energy needed to break into a new inner shell.
- (b)
- (i) The dot and cross diagram was generally well drawn with the majority of candidates gaining two marks. The main errors were either omitting the electrons in the outer shell of the fluorine atoms or not distinguishing between the electrons within a dative covalent bond from those of the covalent bonds. The name of the shape and the bond angle was well known. Those candidates who had incorrectly drawn the structure of BF₃ attained the “carry error forward” marks for stating the correct shape and providing a bond angle of 107°.
- (ii) This question was answered well with most candidates gaining this mark.
- Q12**
- (a)
- (i) This equation was generally well known with the majority of candidates gaining maximum marks. A mark was deducted if phosphorus was represented in the equation as P rather than P₄.
- (ii) The explanation of the octet rule was very well known with most candidates gaining full marks. Candidates should make note of the fact that describing atoms as having a full outer shell is not the same as atoms having eight electrons in their outer shell.
- (b) This question was often poorly answered. Many candidates described silicon as a metalloid and described its structure in terms of metal cations and delocalised electrons. Another recurring error was to describe both silicon and sulfur as giant covalent structures. Candidates should note that the inclusion of incorrect chemistry in an answer is penalised. The majority of candidates gained both marks for the ‘Quality of Written Communication’.
- Q13**
- (a)
- (i) The quality of the diagrams provided varied. Many candidates ignored that the question asked for a labelled diagram. Many candidates did not provide an adequate description of a metallic bond.
- (ii) Most candidates recognised that aluminium had more delocalised electrons than sodium but many omitted stating that these electrons move and carry current.

- (b) This question was generally well answered.
- (c) (i) Most candidates attained two out of three marks. Candidates did not show the formation of the two chlorine atoms from chlorine gas.
- (ii) This question was well answered.
- (iii) The definition provided for the term 'lattice' was overall of a poor standard. Candidates should note that a mark was deducted for the use of the term 'atom' when referring to the lattice structure of an ionic compound such as sodium chloride.
- (iv) This question was well answered.
- (d) (i) The equation was generally well known with the majority of the candidates gaining the mark.
- (ii) The calculation proved more difficult than anticipated. Many candidates had difficulty working out the limiting reagent. Again errors made were carried forward and most candidates scored at least three marks.
- Q14** (a) (i) This question was generally well known with the majority of candidates gaining the mark.
- (ii) Where possible, any errors in the equation were carried through. The use of oxidation numbers was well known and the most common error was a failure to explain which was oxidation and which was reduction. The meaning of the term 'disproportionation' has been defined in the CCEA 'Clarification of Terms' booklet and answers were generally of a high standard.
- (b) This calculation was generally well answered.
- (c) (i) While generally well answered, candidates should note that a comparison between chlorine and bromine was required. Therefore a statement such as 'chlorine is a good oxidising agent' did not gain the mark.
- (ii) This calculation was very well done with the vast majority of candidates gaining both marks.
- (d) This question was generally well answered. While the question asked for the names of the products those candidates who provided correct formulae were awarded the marks.
- (e) Many candidates scored two of the possible scoring marks. Marks were lost as candidates did not indicate either addition of silver nitrate solution or concentrated ammonia solution.
- Q15** (a) (i) This equation was generally very well answered.
- (ii) The calculation was reasonably well done but many candidates provided incorrect units for the last part of the question and lost one mark.
- (b) (i) As expected most candidates gave the correct electron arrangement of the calcium ion.

- (ii) This question was not well answered and became a good discriminator. Many candidates provided an incorrect answer based on a difference in shielding. Candidates should refer to the mark scheme for this question and note that the second mark was only awarded if the criteria for the first mark had been met.
- (c) (i) This question was generally very well answered with many candidates gaining both marks.
- (ii) The calculation was very well done with the majority of candidates providing the correct answer to two decimal places.
- (iii) This was a straightforward question and was generally well answered with most candidates gaining full marks.
- (d) (i) Very well answered. Almost all candidates got this correct.
- (ii) While this question was generally well answered candidates did lose marks for the terminology they used. Candidates should note that an electron 'jumping' was not accepted as an explanation for electron movement between energy levels. Some candidates also lost a mark for not stating that energy in the form of light is emitted.
- (iii) This was well answered.
- (iv) This question proved to be very discriminating. Some candidates did not convert energy to joules. There did appear to be some confusion as to when and how the Avogadro/Planck constants are used. Again, marks were often lost by candidates for not providing the correct unit for frequency.

Assessment Unit AS 2 Further Physical and Inorganic Chemistry and Introduction to Organic Chemistry

Overall candidates found this paper more challenging than the paper last year. Candidates performed similarly in Section A, however in Section B the mean decreased by almost 12 marks. A large range of marks was evident from very low to very high marks, suggesting that the paper discriminated between candidates.

- Q11**
- (a) (i) The expression for percentage yield was well known with the majority of candidates gaining this mark.
 - (ii) A significant number of candidates ignored the 40% yield completely and performed a calculation based on 100% yield; those candidates who performed calculations using the 40% mostly did so correctly. A very small minority based their calculation on finding 40% of a calculated amount of butan-1-ol.
 - (b) (i) A large variety of answers were seen here, with very few candidates giving the answer in the mark scheme. Widening of the mark scheme allowed most candidates to get the mark.
 - (ii) This calculation was performed correctly by most candidates.

- Q12**
- (a)
 - (i) The most popular answer here was potassium thiocyanate; however a minority of candidates were not able to express the reagent correctly. The observations were usually correct if a correct reagent was given.
 - (ii) A number of candidates gave sodium hydroxide as the reagent here, a very small minority mentioned concentrated ammonia. A significant number of candidates gave the reverse of the correct answer; a minority did not express the fact that the precipitate is soluble in excess ammonia. As the stem of the question indicated that reagents were aqueous it was not necessary to state the reagent as being ammonia solution on this occasion.
 - (b)
 - (i) The observation was well known but a small number of candidates referred to a white precipitate.
 - (ii) The formula of the chromate ion was not well known by candidates and only a minority of candidates got both marks for this part.
- Q13**
- (a) The name was answered well by most candidates.
 - (b)
 - (i) A significant number of candidates were not able to label the isomers correctly.
 - (ii) The reasons for labelling the Z isomer caused problems for a number of candidates. Many candidates gave the wrong reason for a group having priority, mentioning RFM or molecular mass. This was penalised once. Most candidates wrote about the high priority groups being on the same side of the double bond, but only a minority gave the further detail of comparing the groups individually as would be required to decide which groups have priority.
 - (c)
 - (i) This was well answered by most candidates.
 - (ii) This was also well answered however, some candidates did not express their ideas clearly, for example, omitting mention of the C=C bond.
- Q14**
- (a) Similar questions have been asked before and this question was well answered with most candidates getting both marks.
 - (b) The flow schemes were well answered with only a minority of candidates neglecting to show both intermediates.
 - (c)
 - (i) This was well answered.
 - (ii) This question was not well answered by most candidates; many candidates did not give the idea of a comparison with known spectra which would be needed for identification.
 - (d) This question was an application of knowledge question where candidates were expected to utilise the structures of the intermediates they had drawn previously and recognise that one intermediate was primary and one was secondary and make a comparison based on stability. However this was not done by most candidates. As the question was a new question the mark scheme was widened to also accept answers based on the stability of the product on this occasion.
 - (e) The mechanism was well known.

- (f) The structures drawn produced a large variety of often incorrect polymer structures; many candidates were unable to provide a correct repeating unit to base their answer upon.
- Q15**
- (a) The definition of molar gas volume is provided in the ‘Clarification of Terms’ document. However, many candidates did not achieve both marks here as they did not mention the conditions were temperature and pressure, or they were too specific, suggesting that 1atm and 20^oC were the necessary/sole conditions.
- (b)
- (i) Many candidates scored one mark here due to making one mistake in their calculation. Common mistakes were to divide by 24 rather than 30 or to take the carbon monoxide to be two sevenths of the total volume as opposed to two thirds. Errors were carried through the rest of the question.
- (ii) Well answered.
- (iii) This was generally well answered but a number of candidates did not divide by one thousand to convert their answer into kilograms.
- (iv) A significant number of candidates multiplied the mass of propane by Avogadro’s constant rather than the number of moles.
- (c) Well answered.
- Q16**
- (a) This calculation posed some problems for candidates. Many incorrectly based their calculation on eight moles of carbon dioxide being the moles formed for 2876.5 kJ. This was less of a problem for candidates who followed a method similar to that shown in the mark scheme, but the use of incorrect rounding or the omission of the ratio between butane and carbon dioxide caused many candidates to lose marks.
- (b)
- (i) The definition is provided in the ‘Clarification of Terms’ booklet and was well known.
- (ii) The equation was well known but the most significant error was for candidates to give the state symbol of carbon as being either (g) or (gr).
- (iii) This was well answered but a minority of candidates lost marks as they did not use the standard enthalpy of combustion of butane in their calculation as was requested in the question.
- Q17**
- (a) The majority of candidates gave the name as ethan-1,2-diol rather than ethane-1,2-diol which was the expected answer. Both were accepted on this occasion.
- (b) The empirical formula was usually stated correctly.
- (c)
- (i) Most candidates achieved both marks here from a variety of observations.
- (ii) The type of reaction was not well known by a number of candidates.
- (iii) The structure of the product caused problems for most candidates with only a minority drawing the diester correctly, one mark was available for candidates forming a monoester.

- (iv) The test for hydrogen chloride was well known but a number of candidates lost a mark for omitting either the word 'concentrated' or 'solution' from the reagent.
- (d)
 - (i) Well answered.
 - (ii) The type of reaction was not well answered by many candidates with a variety of incorrect answers provided with no obvious pattern.
 - (iii) The organic product produced a range of answers, again without a discernible pattern in the incorrect answers. Some candidates produced structures which contained chromium. Incorrect structures were carried through into subsequent parts.
 - (iv) Well answered by candidates who had answered Part (iii) correctly.
 - (v) This question was well answered, however a minority of candidates made comparisons of hydroxyl groups rather than mentioning the C=O absorption.
 - (e) A range of equations were produced with many giving incorrect products such as water. A minority of candidates replaced one hydroxyl group.
 - (f) This was well answered with the majority of candidates scoring one mark. A minority however, did not mention that a hydrogen atom must be attached to the carbon to which the hydroxyl group is attached, only mentioning the methyl group present on the same carbon.
 - (g) A number of candidates provided answers based on Van der Waals and increased RMM of ethylene glycol. Those who did so, alongside making a comparison of hydrogen bonding, were able to score all three marks. A significant minority of candidates did not mention hydrogen bonding in their answer, even though its effect would be expected to be more dramatic than the difference in strength of van der Waals.

Assessment Unit AS 3 Internal Assessment

The change in format for this module received many positive comments from schools. Several centres forwarded issues/comments to CCEA. These comments were all noted and responded to and taken on board at the standardising meeting. In a number of cases, amendments were made to the mark scheme in view of these comments.

It was noted that the time allowance for Booklet A may need to be extended. The overall time allowed for both Booklets is 2hrs 30mins and any increase in the time for Booklet A must be matched by a decrease in the time for Booklet B. This will be considered in the light of this year's experience.

Booklet A

Q1 As in previous examinations this question was extremely well answered with many candidates gaining full marks. Marks were lost as follows:

- failure to calculate the average titre;
- failure to include units for the average titre;
- failure to record all readings on the table to at least one decimal place;
- units missing from the table;
- rough reading not greater than the accurate readings.

Q2 This question was also well answered with most candidates scoring highly. As in previous years the observations were often concise, clearly making use of previous mark schemes.

(a) Test 1 The most common error in this question was the omission of the colourless liquid in this observation.

Test 2 Well answered with few errors.

Test 3 Well answered with few errors.

Test 4 Most candidates identified the yellow precipitate but some failed to notice that it was insoluble in the concentrated ammonia.

Test 5 Almost all candidates answered this correctly.

(b) Test 1 Generally very well answered although some candidates included deductions such as 'no hydrogen bonding'.

Test 2 Very well answered with most candidates gaining both marks.

Test 3 Generally well answered although a few candidates either failed to notice the colour change or did not state the initial colour.

Test 4 This colour change was again well known but a few candidates failed to give a correct colour.

Booklet B

Q1 (a) Very well answered with few errors.

(b) (i) & (ii) Both of these equations were very well known. A few candidates did not balance equation Part (i) correctly, this error was carried through.

(c) This calculation was well answered. By supplying the titration figures it was much easier to mark and any errors were carried through. Most candidates gained at least 6 of the available marks. The main error was failure to divide the mass by two in Part (vii) and the answer was given for two tablets and not one tablet.

(d) (i) This was a useful discriminator with most candidates failing to recognise that the substances listed would not react with both the hydrochloric acid and the sodium hydroxide.

- (ii) This was generally well answered.
- (iii) This was reasonably well answered but accuracy was often confused with reliability.
- (iv) Again candidates often confused reliability and accuracy. Most candidates gained at least one mark for repetition of the titration.

Q2

This was the first year when candidates were supplied with the observations. This worked very well with candidates scoring heavily in both parts. The supplying of the observations meant that no additional marks were available and so questions were not marked to a maximum.

- (a) All tests in this part were very well answered with many candidates gaining full marks.

Test 1 Very well answered with few errors.

Test 2 Very well answered with few errors.

Test 3 Very well answered with the main error being to give the carbonate ion rather than the hydrogencarbonate ion.

Test 4 Very well answered with few errors.

Test 5 Very well answered with few errors.

The two salts were generally named correctly and any error in the deductions was carried through.

- (b) These tests proved slightly more difficult than the inorganic tests but overall most candidates scored well.

Test 1 Very well answered with few errors.

Test 2 Many candidates stated that a smoky flame indicated an alkene but this not sufficient on its own for a mark, a high carbon content was also required.

Test 3 Very well known with few errors.

Test 4 A number of candidates confused this test with the iodoform test.

When identifying the functional groups, any errors in deductions were carried through. Alcohols and carboxylic acids were sometimes given and appeared to be random guesses with no evidence suggested in the deductions.

Q3

- (a) This was very poorly answered and proved to be a good discriminator.

- (b) This was another good discriminator with only the more able candidates recognising that the reaction is reversible and that the water would therefore affect the yield.

- (c) (i) This was reasonably well answered with most candidates gaining at least one mark.

(ii) This was poorly answered as few candidates recognised the need to dissipate the heat evolved. Another good discriminator.

(iii) Most candidates were able to gain at least one mark and many gained both marks. The inability to write the correct equation appeared to hinder some candidates; however the reactants should have been a guide to answering the question.

- (d) (i) Very well answered with few errors.
(ii) Very well answered with few errors.
- (e) (i) The suitable drying agents were reasonably well known, although anhydrous copper sulfate still makes an appearance.
(ii) This was poorly answered. Many candidates stated that the solution went colourless instead of clear and some failed to recognise that the ester is a liquid despite it being distilled off.
(iii) This was reasonably well answered. It was decided that suction filtration would be unsuitable in this situation. A number of candidates incorrectly suggested distillation or the use of a separating funnel. A few candidates suggested refluxing.
- (f) **Part (i)-(v)** The steps were reasonably well known and most candidates were able to gain at least two or three marks. Any errors arising from the equation were carried through. The main error was a failure to correctly identify or use the limiting reactant.
(vi) The reasons for the reduction in the yield were well known, but not always expressed clearly. Most candidates gained at least one mark.
- Q4** (a) Few candidates recognised the need for the hydrated copper(II) sulfate to dissolve faster. The most frequent incorrect answers were that it 'dissolves easier' or 'the reaction speeds up'.
(b) Many candidates lost one mark by using the incorrect mass. Again any errors made were carried through.
(c) This was reasonably well answered with any error carried through from Part (b).
(d) Few candidates were able to identify the reaction as being endothermic. Most candidates suggested the use of a lid or suitable alternative but their explanation was incorrect; as a result most candidates gained one mark but few gained both marks.
(e) This was poorly answered with only the most able candidates recognising that the copper(II) sulfate must be hydrated and that this was an exothermic process. Explanations were often incorrectly given in terms of bond energy.
- Q5** (a) It was disappointing to note how poorly this equation was written despite the formula of the reactant and the names of the products being supplied. Many candidates lost a mark for incorrect balancing of the equation and some failed to get all the formulae correct.
(b) It is disappointing to note that some candidates, albeit a small number, still do not know the test for oxygen.
(c) Any error in the equation was carried through and this enabled some candidates to gain both marks. The most common error was the inclusion of water as a gas. Some candidates only calculated the volume of oxygen.
(d) The test for ammonia was well known. The most common error was to describe the fumes as 'misty' or 'steamy'. Some candidates described the use of damp indicator paper, however this is not an acceptable test for ammonia.

Assessment Unit A2 1 Periodic Trends and Further Organic, Physical and Inorganic Chemistry

On the whole the paper was answered well by a candidature that was deemed to be slightly stronger than last year. The paper turned out to be slightly more demanding than the January 2014 paper and the mean mark was lower than both January 2014 and Summer 2013.

The vast majority of candidates were able to attempt an answer to all questions and it was rare to see blank spaces left. Likewise, in the majority of cases, candidates seemed to have ample time to complete the paper.

The paper discriminated well between candidates with plenty of questions that were accessible to all but also some questions that only the very best candidates scored full marks on.

Q11 This question was almost all recall from topic 4.10 in the specification but many candidates struggled with it. Each error lost a mark and it was rare to see candidates scoring more than 6 marks out of 8.

Formula This column provided fewer problems than the others. Most candidates got 5 or 6 formulae correct out of 6. A frequently seen error was the symbol Si being used for sulfur (even though they had just written a formula for silicon dioxide).

Reaction with water Many candidates lost a mark here for being imprecise in their choice of terminology. The question asked for a description of the reaction with water and candidates were given guidance by the term “vigorous” being provided in the first row. However, many candidates went on to use rate-related terms (e.g. fast, slow) to describe the reaction with water. This was penalised only once. So, for example, a candidate could have filled in the column as “slow, none, none, fast, fast, fast” and would have only lost one mark as he/she showed clear understanding of the differences in reaction yet had used incorrect terminology in this context.

pH A range of 10-13 was accepted for magnesium oxide and most candidates did choose a value in this range. The three non-metal oxides all form strongly acidic solutions, hence only values in the range 0-2 were accepted. Candidates who knew the solutions of the non-metal oxides were acidic usually chose a value in this range. pH 3 was seen a few times but most candidates who got it wrong were a long way from the accepted range.

Bonding Candidates were asked to state the type of bonding, not the structure. Hence the answer “giant covalent” was not acceptable as a description of the bonding in silicon dioxide as the term “giant” describes the structure rather than the bonding. As before, this was only penalised once in the column so most candidates only dropped one mark in this column.

As is frequently the case, candidates apparently rushed this question whereas a little more time spent reading the column headings and the terms already filled in for sodium oxide would have reduced the number of simple errors being made.

Q12 (a) (i) The formulae in the equation were largely written correctly. The most frequent errors were these incorrect formulae: CaCN and NH_4CO_3 . Some candidates had separated the calcium carbonate in the products into calcium oxide and carbon dioxide and therefore they lost the

mark. The state symbols were very poor and once again highlighted failure on the part of the candidates to read the question carefully. The state symbols for the aqueous reactants were usually correct but a lot of candidates had given ammonium cyanide the state symbol(s). They had obviously come to this conclusion from the first line of the stem of Question 12 but had they read the whole stem carefully they would have realised that ammonium cyanide produced from two solutions would have to be aqueous. A surprising number of candidates did not know that calcium carbonate was a solid.

- (ii) Errors in Part (a)(i) were carried forward to the marking of Part (a)(ii) where possible. A very simple question was complicated by many candidates. They simply had to filter the product mixture and retain the filtrate. A lot of candidates were describing recrystallisation.
- (b) This was a straightforward question and was answered well by a majority of candidates. They could explain their answer in terms of the crystals forming on the cooler part of the tube. Or, they could simply observe that the forward reaction was endothermic as it required heat, thus the reverse reaction must be exothermic. Most candidates chose the latter.
- (c) (i) Very poor. The y-axis was usually correctly labelled as pH, however, candidates frequently made mistakes labelling the x-axis. Some candidates merely wrote “volume” without specifying ammonia or hydrocyanic acid and a lot of candidates had labelled the x-axis in a way that didn’t match the curve they had drawn. The curves themselves were also poor. The curve had to have no vertical portion whatsoever in order to score the mark. Only a handful of candidates scored full marks although the majority were able to score at least one mark.
- (ii) Incorrect terminology cost a mark here for a large number of candidates. There was unanimous agreement in both the senior examination team and the team of assistant markers that candidates had to refer to the absence of a “vertical portion/section/range” in order to score the mark. Reference to a point rather than a portion was commonly seen and was marked wrong. Choice of indicators for titrations is always explained with reference to a portion of the titration curve rather than with reference to a single point. To score the second mark candidates had to be precise in stating that no indicator would give a sharp colour change (due to the absence of a vertical portion). A lot of candidates simply stated that there was no appropriate indicator but this was not accepted.
- (d) Failure to present a correct equation in the answer to this question scored zero marks. One equation had to be written involving NH_4^+ and one involving CN^- (spectator ions were ignored where correct). The explanation did not need to be a definition of a buffer solution but candidates had to make clear reference to buffering (e.g. concentration of H^+ ions is unchanged) rather than just putting one of their equations into words.

- Q13**
- (a) What initially appeared to be a challenging list of unfamiliar compounds turned out to be quite an easy question as candidates simply had to look for functional groups, hence this was very well answered. In Parts (iii) and (iv) some candidates only wrote the names of two compounds possibly because they interpreted the two marks for the question to mean there were only two compounds required.
 - (b) Most candidates scored at least one mark for the equation. The most common error was failing to balance the equation with 2[O].
 - (c) The usual mistakes were seen here. Each error lost one mark. The correct answer is 2,3-dihydroxypropanoic acid. Most candidates remembered the comma and dash. The more common errors were to forget 'di' or to write 'hydroxyl' instead of 'hydroxy'. Occasionally candidates wrote "2,3-dihydroxypropan-1-oic acid" but this lost a mark as carboxylic acids don't require a number as the carboxyl group is always at the end of the chain. Another common incorrect answer was "1,2-dihydroxypropanoic acid" although this only lost one mark as the only error was to number from the wrong end of the carbon chain.
 - (d)
 - (i) Considering how often this type of structure is asked it is still not as well answered as might be expected. The main error is the arrangement of the oxygens in the ester group. Although it is not completely necessary, candidates should be advised that the best way to answer this question is to show the bonds in the ester group in order to clearly convey the arrangement of the oxygens and the carbons. It was not necessary to show the bonds in the $C_{17}H_{33}$ group on this occasion although a few candidates still chose to write the 99 hydrogens in the three groups.
 - (ii) This is pure application of knowledge and has been asked before. It was very rare to see a correct answer. Most candidates wrote NO_3 instead of ONO_2 .
- Q14**
- (a) This structure was poor. Many candidates failed to deduce that the bonds between the sulfurs and oxygens were double bonds. Others left out the single bond between the oxygen and hydrogen.
 - (b) This was well answered by most candidates. They didn't have to give the name of the strong base but any name given had to be correct (e.g. potassium hydroxide). Some candidates lost a mark because even though they had referred to a strong base they wrongly identified it as "potassium".
 - (c) This was a simple question from AS1 and most candidates scored full marks.
 - (d) (i) Various techniques could be used to monitor the rate of this reaction. Titrimetric analysis of iodine using standard sodium thiosulfate was common. Gravimetric analysis of iodide using silver nitrate solution was rarely seen. In both these cases candidates had to state that samples were being taken periodically and quenched. A third option, which was the most common answer, was colorimetric analysis of iodine. Candidates opting for this method had to mention the use of a calibration curve (although they were not required to explain how a calibration curve is initially produced). For all three methods candidates had to go on to state that a graph of concentration of a

named reactant/product against time was to be drawn and that the gradient of this graph had to be calculated at various concentrations. The question was well answered with most candidates scoring at least two marks. Common errors included failing to specify that the sodium thiosulfate was a standard solution or failing to state clearly that periodic sampling was taking place.

- (ii) This was very well answered.
 - (iii) The usual errors were appearing here. A few candidates omitted the rate constant in their equation. The most common mistake was to write 'R =' rather than 'rate ='.
 - (iv) Candidates were asked to use "this reaction" to explain what is meant by the overall order of a reaction. Hence, their answer had to clearly state that the overall order of this reaction was two/second as well as stating that overall order involved adding the individual orders.
 - (v) Well answered. The value was almost always correct. The units were occasionally wrong. Errors were carried forward from Part (d)(ii) and Part (d)(iii).
- Q15**
- (a) (i) Many candidates scored only one mark here because they failed to specify that "initial and final conditions are the same".
 - (ii) The calculations in Part's (a)(ii), (b) and (c) caused problems for a lot of candidates and it was very rare to see a candidate scoring full marks in all three. Failure to read the question and look closely at the equation meant that candidates did not realise that they had to divide their answer by 2 in order to obtain the "molar" values. Because almost all candidates failed to do this in all three calculations, the examining team opted to penalise failure to divide by 2 only once across the three parts. Units are always required in calculations regardless of whether the question specifically asks for units or not. A surprising number of students were incorrectly transcribing numbers from the tables to their calculation.
 - (d) (i) Almost universally correct.
 - (ii) Most candidates got this mark although a small proportion of them incorrectly stated that ΔG was less than or equal to zero.
 - (iii) Most candidates scored both marks here even though carrying errors forward meant some of them had negative temperatures in Kelvin.
 - (e) (i) The main error in this question was failure to specify that eutrophication involves the death of the same plants that have experienced an increase in growth because of the fertiliser. A lot of candidates scored the marks for increase in growth and decrease in oxygen levels.
 - (ii) Well answered.
 - (iii) Well answered. A large range of responses were accepted.
 - (iv) Again a large range of answers were accepted.

- (v) All candidates scored at least one mark here although not many mentioned the need to analyse or monitor the nitrate levels in the water.
- Q16**
- (a) (i) Most candidates realised that impurities were present.
- (ii) Candidates had to be precise that there was no cholesterol in the sample. Most candidates did state this but a few said cholesterol may be present “as an impurity” which was incorrect.
- (b) (i) The first mark was very easily obtained for linking “mono” with “one”. The second mark was for understanding “hydric” to refer to OH or hydroxyl (“alcohol” and “hydroxide” were not accepted).
- (ii) This was well answered although some candidates lost the mark for stating that the C bonded to the OH was also bonded to two “alkyl” groups but this is not the case in cholesterol.
- (c) (i) These reagents were not well enough known considering most of them would appear at some stage in AS. Candidates frequently had the correct reagents in the wrong order. The potassium/sodium dichromate had to be acidified. “Acidified dichromate” on its own (with no cation) was not accepted as it is not a reagent.
- (ii) This proved to be a very discriminating question with only the best candidates scoring all three marks (although most candidates scored at least one). Many questions have been set in the past about the solubilities of alcohols or ketones but candidates have not been asked to compare the two. Most candidates mentioned the long chain hindering the formation of hydrogen bonds. About half the candidates knew that both the alcohol and the ketone could form hydrogen bonds with water. To gain the third mark candidates had to deduce that a hydroxyl could potentially form more hydrogen bonds (using O and H) than a carbonyl group (only using O). Very good candidates were able to do this.
- (iii) This is a familiar question and candidates are still making familiar errors: leaving out the H₂O product, omitting the circle in the phenyl group, placing nitro groups on the wrong carbons and mixing up single and double bonds.
- (d) (i) Applying the knowledge of naming, candidates should have deduced that the ‘ol’ at the end of the alcohol becomes ‘yl’ in the name of the ester. However, very few candidates had the correct name, “cholesteryl ethanoate”.
- (ii) Most candidates scored at least one mark. A very common error was the omission of a double arrow.
- (iii) Again a common question brought out a common error – forgetting to specify that the sulfuric acid is concentrated.
- (iv) Most candidates got the equation correct. The name, ethanoyl chloride, was also well known.

Assessment Unit A2 2 Analytical, Transition Metals, Electrochemistry and Further Organic Chemistry

- Q11** The colours of the ions were well known with most candidates obtaining the maximum marks for this question. The only problems seen were when candidates wished to write two colours rather than one and did not use the correct method of indicating the colours or chose a colour that was wrong and mixed it with a correct one e.g. the chromium or copper ion were sometimes stated to be blue-green. The iron ion was often stated to be brown.
- Q12**
- (a) (i) The only answer accepted for the reason why the structure had a positive charge was the loss of an electron from the nitrogen atom. However, apart from this simple answer, there were many others that involved the structure of the nitronium ion itself e.g. “the electron structure clearly shows two covalent bonds between the nitrogen and oxygen atoms. This results in a positive charge. It was not sufficient to say that “there are less electrons therefore it makes the overall charge positive”.
- (ii) It was sufficient to quote the properties of an electrophile because the positive nitronium ion satisfied them; hence it was sufficient to say that it was positive and also that it was attracted to areas of high electron density. There were some examples where the answer was in terms of “electron deficient species”. This was not sufficient. A positive charge had to be said.
- (iii) The flow scheme for the mechanism of the reaction of electrophiles with the benzene ring is frequently examined and candidates always perform well as they did this year. The intermediate must have a broken circle. The use of a dotted line partial circle was not accepted, no current textbook uses it. The nitronium ion might have been shown with a lone pair but this was irrelevant as it does have a lone pair. The great majority of candidates obtained full marks.
- (iv) It was not possible to easily distinguish between the production of a hydrogen atom and a hydrogen ion, in terms of correctness of answer. Candidates used both in roughly equal numbers. Occasionally the answer was vague e.g. “substitution - as one molecule is substituted into the molecule in place of another”. This gained one mark for the word substitution. A small number of candidates explained substitution versus addition without mentioning that nitronium replaces H/H⁺ e.g. substitution because of the delocalised system which would be disrupted/destabilised if addition occurred etc. This was an alternative acceptable answer.
- (b) (i) Most candidates worked out the names of the benzoic acids but quite a sizeable minority insisted on changing the name of the nitrobenzoic acid; the most commonly seen example was to rename them as nitrobenzoates. However, there were many other strange names where the candidates wished to give an alternative systematic name for the nitrobenzoic acid e.g. aminohexanoic acid.

- (ii) This question proved to be far more difficult than expected. Very few candidates obtained both marks and a small minority obtained one mark. The answers were long and varied but seemed to concentrate on the idea that more space was needed e.g. “the delocalisation of the pi electrons and the increased number of hydrogen bonds as the nitro group moves further increases bond strength and so melting point increases”; “the further away the two groups allows them to form hydrogen bonds with separate atoms rather than the same atom, therefore greater bonding and increased melting point”; “the presence of the electrons from the nitro group disrupt and weaken the hydrogen bond in the –COOH group by withdrawing the electrons. It has decreasing effect the further away it is and so the bond with the hydrogen bonding in the carbonyl group is stronger”. The mark scheme explains that it is a question of intra versus inter hydrogen bonding although it was not expected that these words would be used.
- (iii) A few candidates said that tin was a catalyst. It is not, it is needed to form the hydrogen by reaction with hydrochloric acid. The mark scheme shows that concentrated hydrochloric acid was expected but hydrochloric acid was accepted. Sodium hydroxide was normally used to liberate the amine from the ensuing salt.
- (c) (i) There were two marks awarded for the equation and one mark for the explanation of decarboxylation. The one mark was easily obtained by the vast majority despite the fact that the equation told another story and only a small minority obtained the two marks. The major difficulty was that candidates expected more products than just carbon dioxide and aniline, such as hydrogen ions. Despite the fact that the anthranilic acid was distilled and no other reagents were present, candidates introduced hydrogen or oxygen as a reagent and frequently gave methanoic acid, HCOOH, as a product. Many answers were accepted for decarboxylation such as the removal of a carboxyl group or a carboxylic acid group.
- (ii) It was understood, by a minority, that anthranilic acid had to be an amino acid because it contained both an amino group and a carboxylic acid group but very few indeed were able to work out why it was not part of any protein. The simple reason was that it was not an alpha amino acid i.e. with the amino group and the carboxylic acid group attached to the same carbon atom. Many reasons were given for the benzene ring interfering with the formation of a protein. Others said that anthranilic acid was a single molecule. Many said that the acid group and the amino group were too close to form a polypeptide.
- (iii) Virtually all candidates stated that the condition necessary for the reaction was a temperature below 5 °C or 10 °C.
- (iv) The great majority obtained the available two marks for this question. The major problem was the location of the groups around the benzene ring. Problems with triple bonds between nitrogen atoms and other incorrect bonding were few.

- (v) The mark scheme was generous in accepting the word ‘unstable’ in all answers for one mark. The diazonium ion got the second mark. Candidates usually obtained a mark. Many answers were badly expressed when mention of the diazonium ion was omitted. It was remarkable how many answers gave extensive comment on the benzene ring and the stabilisation of the delocalised system but failed to comment on the situation with a butyl compound.
- Q13**
- (a) (i) The definition of the term ligand is given in the ‘Clarification of Terms’ document. It is a long definition but two marks were awarded for the answer. It is expected that definitions are accurately known. It is not expected that they be quoted word for word but all of the essential parts of the definition need to be quoted. The mark scheme was quite adamant that each error would be penalised. As a consequence only a minority of candidates gained both marks. Note that the definition states lone pair and not lone pairs. The ending of the definition states in a complex which was often omitted.
- (ii) The same principles were applied to the definition of ‘polydentate’ in this part as in Part (i). However, this part often gained one mark when Part (i) gained zero.
- (iii) There were many good answers for this question. The correct structure drawn with a lone pair on the carbon atom was acceptable for two marks. However, some candidates then said that the structure had 2 lone pairs because of the carbon atom. The mark was not then awarded for saying that the ligand has two lone pairs rather than one lone pair which is in the mark scheme. If the triple bond was correctly drawn between the carbon and nitrogen then everything else naturally followed. Even very obscure and completely incorrect electron structures still gained a mark if the deduction with regard to the lone pair was correct.
- (b) The question was directly and correctly stated and had similarities with a previous question on a CCEA past paper that referred to calcium citrate. In this case it was further complicated by the previously known formulae of sodium edta compounds which proved to be of little use. There was very little use of the strontium two plus ion and the ranelate ion was often four minus. Only a handful of answers were correct.
- (c) It was questioned what the denticity of ranelic acid actually was. It was not stated in the question and it was not necessary to know it. Whatever the candidate thought it had to be relevant to the denticity of the edta molecule which was known. Values of less than four for ranelic acid were not acceptable because of the presence of four carboxylic acid groups in the molecule. Candidates were very confused that the answer had something to do with entropy. However, entropy was not a factor and no answer relevant to entropy was accepted. Those that stated that edta was hexadentate and thus displaced ranelic acid which was tetradentate gained the marks. Those that stated that they were both hexadentate had a difficulty but gained a mark and usually lost it because their answer then went on to use an entropy based answer.

- (d) (i) This question was extremely well answered and seeing as it was a question which dealt with quality of written communication, six marks was the normal mark obtained. The most frequent mark lost was because there was no explanation for the change in the colour of the indicator.
- (ii) The calculation was very straightforward and provided an easy four marks for nearly all candidates. The remaining candidates made an error with what the question asked for which was the concentration of magnesium hydroxide and calculated for magnesium or some other magnesium species. A tiny number of candidates did not reach the end of the calculation.
- (e) Both parts were taken directly from the specification and were well answered. Although the specification mentions sequestering other expressions were readily accepted such as binds, removes, combines with etc.
- (i) The role of edta in treating blood produced one surprise when it was seen that a small minority of candidates wished to remove iron ions. This would have caused problems with haemoglobin levels. The removal of calcium ions was given but sometimes the explanation of coagulation or lack of coagulation was confused. A very popular answer was with regard to heavy metals. Answers had to be well explained and frequently were not. To remove heavy metal ions or a specific metal e.g. lead/mercury was acceptable. To prevent poisoning or toxic effects was acceptable for the second mark. However, harmful was not specific enough.
- (ii) Again, this question was well answered. Although the mark scheme says softens water, removing calcium ions that cause hardness was acceptable. 'Softens' was regarded as the equivalent of removing hardness. However, sometimes it was said that calcium ions are removed but no reason given.
- Q14 (a) (i) The explanation for the non-interaction of the CH₂ groups was well known. Stating that they were in the same environment or even identical was acceptable on this occasion as it was regarded as a new question.
- (ii) Although this question could have been regarded as relatively easy, a sizeable minority got it wrong.
- (iii) This type of question has been asked many times and whilst it is regarded as application of knowledge it should really be recall for many candidates. However, what was surprising in an answer was to regard peak X as a hydrogen atom which it clearly is not. Far too many candidates lost a mark for this basic mistake which could have so easily been avoided.
- (iv) This was a new question and therefore, as expected, was not well done. There were some good answers but there too many obvious errors. The most obvious was the integration curve actually going of the chart. Although the peak at X was often correctly integrated, the other peak had the integration curve not continuing through the height of the peak. Added to this were the expected errors of not having the correct

2:1 ratio for the integration. Even if the integration curve was a mess there was still a mark for the correct integration as shown in the mark scheme; two errors in the integration curve did not negate the ratio mark. However, better candidates coped very well with the demands of the question.

- (v) The responses to this question revealed that many candidates were following recently published texts which showed the TMS peak as rising above the line and then below it in a sinusoidal way. This is incorrect and was marked so. No other known texts refer to the TMS signal in this way. Of course, as this was a new question, there were many answers that gave a wide variety of peaks of various widths and various lengths. They were accepted if the signal was in the region of 0 ppm.
- (b) (i) The meaning of the term base peak is given in the 'Clarification of Terms' document. A variety of correct equivalent terms were accepted.
- (ii) Although the scale was difficult to interpret, as in previous years, an answer + or – 1 of the correct answer of 55 were accepted.
- (iii) The formulae for the fragment ions listed were well answered. Care was needed to quote the correct number of oxygen atoms in the fragment ion with a mass of 100.
- (c) (i) The writing of the polymer structure was well tackled but there were frequent errors. One polymer structure seen had greater than the repeating unit i.e. two alcohol units with succinic acid. This made the endings both $-O-CH_2CH_2-O-$. This was regarded as one error at one end and two marks were given. Sometimes a branched structure or a cyclic structure was given but it was difficult to then give the repeating unit of the polymer. However, the main error was to give an oxygen atom at one end which should have been at the other end. Looking carefully at the repeating structure will explain this anomaly.
- (ii) Almost without exception the name 'condensation' was given to this type of polymerisation.
- (iii) Interestingly this was a polymerisation that was without a catalyst. That means that the ends of the chains were not consumed by the catalyst and that the ends of the polymer consisted largely or not largely of carboxylic acid groups. However, carboxylic acid groups would remain and thus the polymer was acidic. This fact is quoted in most texts. Very few candidates realised this fact.
- (iv) Almost all candidates realised that the molecule could be hydrolysed but very few indeed realised it was because of an ester grouping in the molecule. The specification is very definite in saying that molecules that contain an ester or an amide group are capable of undergoing biodegradation. Some answers were spoiled when it was mentioned that the polymer could be hydrolysed by acid or alkali which missed the point of the question which asked why the polymer was biodegradable.

- (d) (i) There were many incomplete flow schemes e.g. with the ammonium salt being missed. Reagents were sometimes missing which was –[1] mark e.g. the ammonia. But the flow scheme did not have to be balanced, such is the nature of flow schemes. Heat was also not needed in the flow scheme. If a spurious reagent was seen, such as hydrogen, it was –[1] etc. Although water was supposed to be produced it could be left out. Normally it would feature over the arrow but seeing as heat is there or could be there, water would have been an additional burden. Normally it was given. Despite all these modifications to the mark scheme, the question was not that well answered. The major error was to give the charge on the ammonium ion but then to ignore the negative charge on the rest of the molecule. At the extreme there was no flow scheme, instead there were two equations.
- (ii) A variety of reagents were presented including nitrous acid, concentrated sulfuric acid, acidified sodium dichromate, ammonia and phosphorus pentachloride but the majority did state phosphorus pentoxide.
- (iii) The structure of the product after the reaction with lithium was correctly produced. There were hardly any structures that had only one of the nitrile groups reduced. Sometimes an amide was drawn.
- (e) (i) Answers to questions which deal with GLC continue to be weak. Although a minority of candidates realised that the ester was more volatile or boiled easily, they could not subsequently explain why this was an advantage. Many thought that there was an advantage in introducing the compound into the GLC apparatus but this was not the reason. It was also thought that it would produce a gas more easily but this was required for the first part of the answer. Speed through the apparatus was rarely given. Admittedly “advanced GLC” can deal with most situations but the specification simply states GLC.
- (ii) There was an obsession with retention time in answering Part (ii). But no answer could be solely accepted if only retention time was mentioned. It would appear that GLC data has not been seen nor examined. The specification states quite precisely to interpret GLC data in terms of the percentage composition of a mixture. In view of this statement in the specification it was expected that there would be better answers, but they were not seen.

Q15 The introduction to the question caused some confusion with some centres. First of all there was the question of the name vanadyl ions which was not the specific name for the species VO_2^+ . In most textbooks the name for this species is usually given either as the formula without the name or the oxidation number is given with the species. The whole point of the question was not to reveal which reaction was taking place. If so, it would have been relatively simple to write the equation and all the associated answers for the reaction quoted in the opening paragraph. The introduction did say to investigate the reaction. There is no standard way of writing cells quoted in the specification. However, both the cell systems quoted should have been familiar. Each of them provided sufficient information to work out the equations for the reactions occurring in the cells. Furthermore, the cells were written in the order of the more powerful oxidising agent being placed below the weaker

oxidising agent. No matter which reaction was chosen i.e. the reduction of permanganate ions or the oxidation of manganese(II) ions, it would have been possible to obtain full marks on the question. Any error made in one part of a question would have been carried through to the rest of the question(s).

- (a) The direction of flow of electrons should be from the negative electrode to the positive electrode. The flow of “electricity” is from the positive electrode to the negative electrode. For the reduction of manganate(VII) ions, the beaker situated on the RHS is the positive electrode. Indeed it is the convention when drawing a cell diagram such as shown in the examination paper that the positive electrode is situated on the RHS. Candidates in their explanation used descriptions such as the manganate(VII) ions receive electrons and was thus the positive electrode. This fits in with the theory and was thus accepted. If the candidate got their equations completely mixed up as shown in Part (c), then their explanation often did not make sense. However, they could still obtain one mark for the general theoretical statement of electrons flowing from negative to positive electrodes.
- (b) Part (b) was supposed to direct candidates to the answer expected in Part (c). However, a small number of candidates were still uncertain which way they had decided the reaction should go and could not decide which was reduction/oxidation and stated both changes to be either oxidation or reduction. Occasionally the wrong oxidation number was assigned to the vanadium species. This did not happen with manganese.
- (c) It was extremely surprising to see the equations from the cells so badly written whatever way the reaction was proceeding. The final equation written was often far better. Even so, the final equation frequently lost the available mark because many ions in the equation were not completely cancelled although the equation was essentially balanced. On the whole the question was badly answered. Only the stronger candidates obtained all three marks.
- (d) All candidates managed to obtain some marks and usually at least half marks because the colours the wrong way round were given half marks.
- (i) The colours for the vanadium ions were quite well known. Yellow and blue were the most frequent colours quoted with rarely a mention of any other colour.
- (ii) There was a major surprise seen when manganate(VII) ions were written in the equation in Part (c) on the LHS but the colour pink/purple was then given on the RHS for the colour change. This happened so frequently that there must have been a reason for it. Examiners thought that it might have been connected with titrations but there was no clear reason and it is still a mystery despite examiner thoughts.
- (e) Although one centre correspondent thought that the information as presented in the question led to the answer 0.00 V, no candidate presented such an answer. In the spirit of providing full marks for Q15, despite whichever way the reaction proceeded, 0.49V was accepted as being correct on this occasion.

- (f) This was the first time the purpose of a salt bridge and how it works has been asked. The major error made by candidates was to state that electrons were conducted along/through the salt bridge. Electrons are only conducted through wires in normal circuits. At times, with a new question such as this, it was difficult to ascertain what was meant by the candidate, for example when ions moved it was difficult to interpret whether the ions were in the salt bridge or in the reacting solutions.
- (g) There were four marks available for Part (g) and all candidates obtained some of these marks. Generally the actual description of a hydrogen electrode was poor with candidates simply stating that hydrogen was present rather than being passed over a platinum electrode. A description of the platinum electrode was completely lacking. The standard conditions were usually given but often the fact that hydrogen ions were present or even molar hydrogen ions was left out and the answer simply dealt with hydrogen gas.

Assessment Unit A2 3 Internal Assessment

Practical One

- Q1
- (a) (i) Most candidates recorded a mass which was “between” 7.80g and 7.90g. Only a relatively small number recorded a mass of exactly 7.80g or 7.90g.
- (ii) The calculation proved to be straightforward for most candidates. The most common error was the use of an incorrect RFM value. A small number of candidates felt the need to use both the 100cm³ and the 250cm³ values.
- (b) The tables were, in general, of a very high standard. Most candidates scored high marks. Incorrect subtractions, initial values of “0” and the absence of appropriate units were occasionally seen.
- (c) (i) The official mark scheme contains the two most common responses. Other answers, including appropriate rinsing of the apparatus, were accepted. Some candidates did not appreciate the distinction between accuracy and reliability.
- (ii) A very small number of candidates just included the final colour rather than the colour “change”.
- (d) (i) This half-equation was well known. It is clear that many candidates simply learn the half-equation rather than building it up or giving it much thought. A significant number of these candidates produced an almost perfect half-equation except for the charge on the manganate(VII) ion, which was given a charge of 2-. The half-equation was not balanced with respect to charge. Ions with a charge of 7+ also appeared.
- (ii) This half-equation was well known.
- (iii) This ionic equation was well known. A small number of candidates gave perfect answers in Parts (i) and (ii) but were unable to combine the two half-equations to produce a correct overall ionic equation.

- (iv) This proved to be challenging for some candidates. Common errors included using the number of moles of iron(II) in 250cm^3 rather than in 25cm^3 and incorrect calculation of the RFM for potassium manganate(VII). A significant number of candidates made no use of the average titre value from Part (b) and therefore seemed to miss the purpose of the titration exercise.
- Q2**
- (a) (i) Candidates scored well in this section. In Test 3, most candidates indicated that the solution turns green although some variations on green were accepted. In Test 4, most candidates indicated that the solution turned a dark blue but “purple” and “violet” were also accepted. A common error was the omission of the word “precipitate” or its equivalent in Tests 5(a) and 7.
- (ii) Very well answered. The vast majority indicated that the copper(II) sulfate was hydrated.
- (iii) The formulae given on the official mark scheme were those most commonly encountered. There was flexibility in the use of brackets and partial replacement of water ligands in Test 4 was acceptable. A small number of candidates seemed to treat the “en” ligand as hexadentate.
- (iv) $\text{Cu}(\text{OH})_2(\text{H}_2\text{O})_4$ was accepted in Test 5. CuSO_4 was often given for Test 7.
- (b) (i) Most candidates scored well in this section. In test 1, some candidates failed to describe the solution as colourless and others used the term “clear”. In Test 3, a small number of candidates only scored 1 mark since they did not include 2 observations.
- (ii) This was very well answered.
- (iii) The use of infrared spectroscopy to confirm the presence of the –COOH functional group was not well known/understood. The wavenumbers for the C=O and O-H absorptions were not required but the presence of both in the spectrum was expected for both marks. The best answers indicated that both absorptions would be present, gave the nature of each absorption and gave the approximate wavenumbers.
- (iv) The use of mass spectrometry to confirm the identity of a compound was not well known/understood. Only the best candidates made reference to the uniqueness of the fragmentation pattern. There were many examples of inappropriate terminology particularly references to the “RMM of the fragment”.
- Q3**
- (a) (i) The correct esterification equation was produced by most candidates.
- (ii) The percentage yield calculation produced many excellent answers. The main errors were to ignore the 60% completely or to scale the quantities down rather than up.
- (b) Although, in general, the method was well known, candidates tended to omit essential details such as the fact that the sulfuric acid used is concentrated or that anti-bumping granules would be added. Some candidates made reference to the purification of the product. The weakest answers included filtration and recrystallisation.

- (c) (i) The method was well known but some answers lacked detail. Reference to how the pressure is released was often missing. The best answers recognised that the density of the ester would suggest that the upper layer is retained.
- (ii) Most candidates failed to indicate that the filtering/decanting only occurs after the liquid has gone clear.
- (d) Candidates performed very well on the NMR spectrum. The most common errors were placing the quartet closer to TMS and/or not having the correct relative heights within the triplet or quartet. Incorrect relative heights in the integration curve were less common.

Practical Two

- Q1 (a) (i) Most candidates recorded a mass which was “between” 8.80g and 8.90g. Only a relatively small number recorded a mass of exactly 8.80g or 8.90g.
- (ii) The calculation proved to be straightforward for most candidates. The most common error was the use of an incorrect RFM value. A small number of candidates felt the need to use both the 100cm³ and the 250cm³ values.
- (b) The tables were, in general, of a very high standard. Most candidates scored high marks. Incorrect subtractions, initial values of “0” and the absence of appropriate units were occasionally seen.
- (c) (i) The official mark scheme contains the two most common responses. Other answers, including appropriate rinsing of the apparatus, were accepted. Some candidates did not appreciate the distinction between accuracy and reliability.
- (ii) A very small number of candidates just included the final colour rather than the colour “change”.
- (d) (i) This half-equation was well known. It is clear that many candidates simply learn the half-equation rather than building it up or giving it much thought. A significant number of these candidates produced an almost perfect half-equation except for the charge on the manganate(VII) ion, which was given a charge of 2-. The half-equation was not balanced with respect to charge. Ions with a charge of 7+ also appeared.
- (ii) This half-equation was well known.
- (iii) This ionic equation was well known. A small number of candidates gave perfect answers in Parts (i) and (ii) but were unable to combine the two half-equations to produce a correct overall ionic equation.

- (iv) This proved to be challenging for some candidates. Common errors included using the number of moles of iron(II) in 250cm^3 rather than in 25cm^3 and incorrect calculation of the RFM for potassium manganate(VII). A significant number of candidates made no use of the average titre value from Part (b) and therefore seemed to miss the purpose of the titration exercise.
- Q2**
- (a) (i) Candidates scored well in this section. In test 3, most candidates indicated that the solution turns green although some variations on green were accepted. In test 4, most candidates indicated that the solution turned a dark blue but “purple” and “violet” were also accepted. A common error was the omission of the word “precipitate” or its equivalent in Tests 5(a) and 7.
- (ii) Very well answered. The vast majority indicated that the copper(II) sulfate was hydrated.
- (iii) Very well known by most candidates.
- (iv) Some candidates used “curly brackets” to enclose the chloride ligands. This was not necessary but was accepted.
- (v) The fact that one bidentate ligand replaces two unidentate ligands was well understood and in most cases the replacement was complete.
- (vi) The fact that replacement of the water ligands is incomplete was well known. There were often errors in the overall charge of the complex produced.
- (b) (i) Most candidates scored well in this section. In test 1, some candidates failed to describe the solution as colourless and others used the term “clear”. In test 3, a small number of candidates only scored 1 mark since they did not include 2 observations.
- (ii) This was very well answered.
- (iii) The use of infrared spectroscopy to confirm the presence of the $-\text{COOH}$ functional group was not well known/understood. The wavenumbers for the $\text{C}=\text{O}$ and $\text{O}-\text{H}$ absorptions were not required but the presence of both in the spectrum was expected for both marks. The best answers indicated that both absorptions would be present, gave the nature of each absorption and the approximate wavenumbers.
- (iv) The use of mass spectrometry to confirm the identity of a compound was not well known/understood. Only the best answers made reference to the uniqueness of the fragmentation pattern. There were many examples of inappropriate terminology particularly references to the “RMM of the fragment”.
- Q3**
- (a) (i) Equations involving sulfuric acid and/or nitronium ions were common. Many candidates gave a mechanism.
- (ii) The RFM of the product was often calculated incorrectly. Some candidates counted five rather than four hydrogens on the benzene ring.

- (b) Although, in general, the method was well known, candidates tended to omit essential details such as the fact that both acids should be concentrated or that the temperature should be kept below 15°C. Weaker answers made reference to reflux and distillation.
- (c) (i) The method was well known but some answers lacked detail.
(ii) This was very well known.
(iii) The best answers recognised that the melting point (42°C) had been given in the introduction.
- (d) Candidates performed very well on the NMR spectrum. The most common errors were placing the quartet closer to TMS and/or not having the correct relative heights within the triplet or quartet. Incorrect relative heights in the integration curve were less common.

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