

CCEA GCE - Chemistry
(Summer Series) 2015

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

Overall candidates performed very well in this paper. The multiple choice section proved to be very accessible. Section B of the paper was more challenging than section A. Questions 11 and 13 were the most challenging and question 14 was the least discriminating. There was no evidence that the candidates were unable to complete the paper in the allocated time.

- Q11**
- (a) This was well answered by the vast majority of candidates.
 - (b) Generally well answered although a few candidates gave the wrong formula for beryllium chloride despite it appearing later in the question.
 - (c)
 - (i) The shape was well known. Some candidates lost marks for including the lone pairs in the chlorine atoms in their explanation or failing to mention the repulsion was between the bonding pairs.
 - (ii) This was very poorly answered. Many candidates thought that the sodium chloride would react with the water to produce sodium hydroxide and/or hydrochloric acid. In addition quite a number of candidates did not make use of the equation provided when discussing the pH after beryllium chloride had been reacted with water. Some good explanations involving the neutralisation of the hydrochloric acid with beryllium hydroxide were given and accepted.
 - (d)
 - (i)&(ii) The octet rule was well known although some candidates failed to gain a mark by not stating that six electrons are around the beryllium in part (i).
 - (iii) The explanation of the coordinate bond was well known.
 - (iv) Most candidates gained at least one mark. A number of candidates stated that the structure was ionic despite it being shown as covalent. Some described the increase in van der Waals forces as being enough to cause a high melting point despite these being weak forces.
- Q12**
- (a)
 - (i) The vast majority of candidates gained full marks in this question.
 - (ii) This was very well answered, although a few candidates lost a mark for giving the answer to two decimal places.
 - (iii) It was disappointing to note that many candidates were unable to relate the chemical properties to electronic structure or to the number of electrons remaining the same.
 - (b)
 - (i) This was not well known and proved to be a good discriminator. Many candidates gave $3d^5, 4s^1$ as the outer electronic structure rather than $3d^6$.

- (ii) This question was poorly answered and proved to be a good discriminator. Many candidates gave the correct formulae but failed to balance the equation and so lost a mark.
- (iii) Many candidates recognised that the answer was related to the stability of a half-filled subshell but failed to give a correct explanation or tried to explain it in terms of iron(II) having a half-filled 4s1 subshell.
- Q13** (a) (i) This question was well answered.
- (ii) This was poorly answered with few candidates showing how they deduced the formula and many giving an incorrect formula.
- (b) Most candidates gained at least some marks in this calculation with very few gaining no marks. Marks were lost for failing to convert the kJ to J, not using the Avogadro number, not using Planck's Constant or incorrect conversion to nm.
- (c) (i) This equation was generally correct.
- (ii) A small, but significant, number of candidates were unable to give the electronic configuration of the nitride ion.
- (iii) The shape of the amide ion was reasonably well known but many candidates only showed one lone pair of electrons.
- (iv) The shape of the amide was generally correct.
- (v) Many candidates stated the VSEPR theory but failed to give any explanation and so did not answer the question. This proved to be a useful discriminator.
- Q14** (a) (i) This was generally answered correctly. The main error was failing to convert the kg to g when deducing the number of moles. Carry error forward marks were awarded.
- (ii) This was generally well answered. The main error was using sodium hydrogencarbonate instead of sodium carbonate. A few candidates did not use the correct 2:1 ratio.
- (b) (i)–(vi) Generally very well answered with many candidates gaining full marks
- (c) (i) A significant number of candidates failed to answer this question, however virtually all of those who did gained full marks.
- (ii) This was well answered. A small number of candidates said that the polarities cancelled each other instead of the dipoles.
- (iii) Most candidates were able to state that hydrogen bonds were involved but many failed to explain that there was enough energy to overcome the hydrogen bonds at this temperature. A small number of candidates described the breaking of the bonds between the hydrogen and the oxygen.
- Q15** (a) (i) The definition of electronegativity was well known.
- (ii) The reason for the trend was well known but answers frequently did not refer to the bonding electrons for the second mark.

- (iii) This was answered very well with most candidates gaining both marks.
 - (iv) This was generally well known, although some candidates did refer to the strength of the fluorine-hydrogen bond.
 - (v) This was poorly answered by many candidates. Frequently the order was not stated, although the explanation was correct, both parts were needed for the mark.
- (b)
- (i) This was reasonably well known. Red-brown frequently appeared, clearly mistaking bromine water for bromine.
 - (ii) Disproportionation was well known and generally well explained.
 - (iii) This equation was very poorly answered, with many candidates gaining no marks. When the reactants and products were known it was frequently incorrectly balanced.
- (c)
- (i) Many candidates gave silver iodide as the answer which suggests that they did not read the question correctly.
 - (ii) O and P were answered reasonably well. However many candidates struggled with naming Q and R.

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

The paper was successful in allowing candidates of differing abilities to respond positively to the questions posed. The level of language used in the examination was considered to be appropriate for the candidates sitting the examination and the evidence suggests that candidates had sufficient time to complete the paper.

- Q11**
- (a) Most candidates scored full marks here. Errors included missing dots to represent the free radical and inclusion of a 2 as part of the formula for the methyl radical.
 - (b) Again, most candidates scored full marks. The most common errors were to classify Q as an initiation step or to leave one or more of the steps unclassified.
- Q12**
- (a)
 - (i) This question proved to be straightforward for most candidates. When a structure is required the answer should be unambiguous e.g. $\text{CH}_2=\text{CHC}_4\text{H}_9$ can represent various structures whereas $\text{CH}_2=\text{CH}(\text{CH}_2)_3\text{CH}_3$ cannot.
 - (ii) Again, this proved to be straightforward for most. Some candidates drew the structure of trichloromethane. It should be stressed to candidates that the chemical symbol for hydrogen is a capital "H" and for chlorine a capital "C" followed by a small "l".
 - (iii) Most candidates scored both marks here. Molecular formulae were accepted. A small number of candidates had the bromine atoms in the wrong positions.

- (iv) This question proved to be one of the most challenging on the paper. The strongest candidates simply indicated that when hex-1-ene is added until present in excess that the colour of the bromine disappears completely. Some also indicated that the bromine colour will not re-appear even when the product is heated. Only a very small number of candidates used the idea that the reaction is exothermic. The question indicated that the solvent was TCE and therefore the use of bromine water was considered to be inappropriate.
- (b) (i) A relatively small number of candidates scored the full 5 marks. Marks were lost for missing units, incorrect signs or incorrect rounding. Where appropriate, the importance of including units with quantities should be stressed to candidates. Many candidates used 100g on the fourth line rather than the 133g calculated on the third line. The energy received by the TCE should be a positive quantity whereas the molar enthalpy should be negative. A mistake early in the calculation could still score the later marks by carrying the error through.
- (ii) A significant number of candidates did not use the value calculated in (b)(i) and indicated by their calculations that the energy required for bond breaking = the energy released on bond formation. A significant number got their signs the wrong way round i.e. bond breaking negative and bond forming positive. Some mixed Joules with kilojoules. An incorrect answer in (b)(i) could still score full marks in (ii) if the error was carried through correctly.
- (c) (i) Most candidates replaced both bromines with –OH groups. A small number only replaced one group. Candidates should be encouraged to use the correct symbols for each element, ensure that all the carbons are involved in four bonds and show that the oxygen of the –OH group is bonded to the carbon.
- (ii) Those candidates who repeated the replacing of “just one bromine” were not penalised again. The best answers showed that each carbon atom was involved in four bonds and that the nitrogen atoms of the amino groups were bonded to carbon atoms.
- (iii) It was not considered to be essential that the triple bond was shown. However, a clear indication that the nitrogen atoms were involved in single or double bonds was penalised. Some candidates gave structures in which the –CN groups were attached to the same carbon.
- (d) This question proved challenging. It was pleasing to see that a significant number of candidates recognised that a “double” elimination would occur and arrived at one of the correct structures.
- Q13** (a) (i) This proved to be straightforward for most candidates.
- (ii) The trend was well known. Many candidates included BeCO_3 and RaCO_3 although this was not essential.

- (iii) This was well handled by most candidates. Use of the terms “atomic radius”, “electron density” and “depolarised” were common. Some candidates included van der Waals’ forces in their arguments. It should also be stressed to candidates that it is bonds within the carbonate ion which are weakened as opposed to the ionic bond between the cation and anion.
- (b) (i) This question proved challenging. Many candidates gave equations in which the carbonates reacted with water.
- (ii) The solubility trend for the hydroxides was well known.
- (iii) The answer could be expressed as a percentage. The most common error was to use 58 instead of 116.
- (iv) Despite the introduction, some candidates misinterpreted the term “calcinaton” and gave an equation involving calcium.
- (c) (i) This question was poorly answered for magnesium. Many candidates suggested that the magnesium disappears, there are lots of bubbles, a white precipitate forms and lots of heat is produced. The observations for calcium were much more likely to be correct.
- (ii) For magnesium, many candidates suggested a “pop”.
- (iii) The exaggerated ideas about the reaction between magnesium and water were often carried through into this answer. Explanations were often missing.
- Q14** (a) (i) Most candidates scored this mark. Errors were carried through in (a) and (b).
- (ii) The vast majority of candidates scored both marks. If a mark was lost it was normally for incorrect balancing of oxygens. A 1:12.5:8:9 ratio was accepted.
- (iii) This question was well handled. However, a significant number of candidates had a methyl group at the end of carbon chain in the belief that this was branching.
- (b) There were four main steps involved in this calculation and the units had to be included/correct. Each error lost a mark. The most common error was to give a volume of oxygen rather than the volume of air.
- (c) (i) This was well known.
- (ii) Nitrogen was essential in this answer. The name of the second gas was often either missing or incorrect.
- (iii) There was evidence that a significant number of candidates were unable to translate the name “nitrogen(II) oxide” into the correct formula.
- (d) (i) The emphasis was on the products of complete and incomplete combustion of hydrocarbons. Many candidates gave very detailed descriptions of how carbon dioxide contributes to global warming. A lot of the detail was unnecessary. There was much less emphasis on problems associated with incomplete combustion of hydrocarbons, particularly the production of soot in an urban environment. Many

candidates focused on the problems associated with the combustion of impurities which may be present in hydrocarbon fuels. In a small number of answers there was confusion about the impact on the ozone layer.

- (ii) The question indicated that equations (plural) were required. Most candidates scored at least one mark. There were many examples of poor balancing.
- (iii) A detailed description of chemisorption was often given. Reference to poisoning of the catalyst was sufficient.
- Q15** (a) (i) Many candidates did not appreciate the role played by potassium.
- (ii) Poorly answered by many candidates who then gave perfect answers in (c)(i).
- (iii) Well known by most candidates.
- (iv) Again, well known by most candidates.
- (b) In general, this question was well handled by candidates. Reference on van der Waals' forces was essential for the second mark. There were only a small number of references to hydrogen bonding. Despite the question, some answers explained why chloroform is a gas.
- (c) (i) The introduction indicated that there are four butanols. Many candidates only classified butan-1-ol and butan-2-ol.
- (ii) There were some perfect answers here – even from candidates who failed to score in (a)(ii). Some candidates gave the correct answer without an explanation.
- (iii) Most candidates were able to link the shape of the molecule to the area of contact between neighbouring molecules and van der Waals' forces.
- (iv) The chlorinated and brominated product was well known but suggestions for the product with sodium were disappointing with sodium often involved in a covalent bond.
- (d) (i) Most candidates referred to the vibration of bonds. The term “molecular vibration” as used in the specification was also accepted.
- (ii) This was well understood.
- (iii) Many candidates gave excellent answers which involved matching of the fingerprint region of the unknown butanol with that of the known butanol. It was not essential to refer to the fingerprint region but it was essential to indicate that the spectra would be identical.
- (e) Many candidates gave an incorrect structure for the ester and many equations did not include water.

Assessment Unit AS 3 Practical Assessment

Booklet A

Candidates had adequate time to complete the paper. It was extremely rare to see any blank spaces on the scripts.

Q1 Candidates have become very proficient at constructing and filling in a titration results table. The vast majority scored 7 or 8 marks. A mark was deducted if the table was not completely enclosed but only a tiny minority of candidates lost this mark. The most common errors were, as usual, to record “0” instead of “0.0” and to omit units from the average titre. The solutions provided were 0.1 mol dm^{-3} sulfuric acid and 0.1 mol dm^{-3} sodium hydroxide which should have yielded a titre value of approximately 12.5 cm^3 . Bizarrely some candidates were recording titres as low as 8.0 cm^3 and as high as 35.0 cm^3 . Some candidates also reported titres in the usual region of 20.0 to 25.0 cm^3 .

Q2 (a) Solution A was zinc sulfate.

Test 1 (a) The vast majority of candidates reported a white precipitate or white solid when drops of sodium hydroxide solution were added to solution A. Some referred to the precipitate as ‘gelatinous’ and this was acceptable.

Test 1 (b) Again there was a very high success rate here with most students seeing the white precipitate disappear on the addition of excess sodium hydroxide solution.

Test 2 Almost all candidates got both marks here for white precipitate on the addition of barium chloride solution.

Test 3 The majority of candidates correctly recorded that there was no change here (i.e. the solution remained colourless) on the addition of silver nitrate solution. A few centres observed a very faint cloudy appearance and this was accepted. However, “white precipitate” was not accepted as the faint cloudiness that could be observed was very different from the white precipitate observed, for example, in Test 2. A very small number of centres contacted CCEA to report that “all” their candidates had observed a white precipitate in this test and, after discussion amongst the senior examination team, it was decided that “white precipitate” would be accepted for those centres but all other answers for Test 3 would be marked incorrect for those centres.

(b) Solid B was hydrated sodium carbonate.

Test 1 Most candidates were able to describe the solid B as a white solid.

- Test 2(a)** Fizzing/effervescence/bubbling was essential for the first mark when solid B was added to dilute ethanoic acid. The second mark was awarded for either recording that the solid disappeared or that a colourless solution was formed. Any mention of heat was ignored as the temperature change would have been indiscernible with these amounts of reagents. Most candidates scored at least one mark here but some candidates lost a mark for writing additional incorrect observations, for example, steamy fumes.
- Test 2(b)** Again most candidates correctly observed a cloudy/milky appearance when the gas produced was brought into contact with limewater. Delivery tubes were optional on the Apparatus & Materials List but the simplest way to carry out the limewater test in these circumstances is to simply hold the test tube in which the reaction is occurring almost horizontally above a test tube that is almost filled with limewater. As the carbon dioxide drops into the limewater the top portion of the limewater goes milky.
- Test 3** This test (heating a hydrated solid) has appeared frequently in recent years and has been mentioned in the Chief Examiner's Report before yet candidates are still performing very poorly in it. "Condensation" was not accepted as it is a change of state rather than being something that is observed. The more precise, yet rarely seen, description is that a colourless liquid has been formed on the walls of the boiling tube. To record water as the observation was not accepted. Some candidates recorded that the crystals were melting or bubbling but this was not accepted. There was only one mark for this test and it was only awarded for colourless liquid formed on the walls of the boiling tube.
- Test 4** All candidates scored the mark here for observing a yellow flame or an orange flame.
- (c) Liquid C was ethanol.
- Test 1** Both liquids mix completely when water is added to ethanol and most candidates reported this in various ways. The most common correct answer was that one layer forms. Some candidates wrote deductions (e.g. C is soluble in water) instead of observations and these were ignored if correct but were not credited.
- Test 2** The flame formed when ethanol burns is predominantly blue and sometimes has a yellow or orange tip. If a colour was mentioned for the flame it had to involve blue (i.e. orange flame was incorrect but blue flame with orange tip was acceptable). Noting that there was no soot or smoke was also acceptable.
- Test 3** Again most candidates scored at least one mark here. The final colour of the mixture of C and acidified potassium dichromate was essential and a range of colours were accepted as this is what is observed (e.g. green, blue or brown). The second mark was for stating the initial orange colour of the acidified potassium dichromate or for noting the change in smell.

Booklet B

Again candidates had adequate time to complete the paper. It was extremely rare to see any blank spaces on the scripts.

- Q1** As is frequently the case with questions such as this, it was clear that many candidates did not take the time to thoroughly read the introduction to the titration exercise and the method given before attempting to answer the questions. Consequently many candidates dropped two very straightforward marks on the very first page.
- (a) (i) The majority of candidates wrote about dissolving the toothpaste but the method makes it clear that the toothpaste does not dissolve (filtration is required). A reaction is taking place between the calcium carbonate in the toothpaste and the dilute hydrochloric acid that is added. The purpose of heating is to speed up the rate of this reaction.
- (ii) Again, many candidates incorrectly wrote about all the toothpaste disappearing but, again, the need for filtration in the method should have alerted them that this does not happen. The answer is simply that there will be no more fizzing.
- (b) (i)&(ii) It was not surprising to see that the vast majority of candidates had no problem with these two simple equations. The presence of H_2CO_3 (instead of H_2O and CO_2) as a product in the equation in part (i) lost one mark. Some candidates were careless when it came to writing distinct upper case and lower case letters in chemical symbols and were penalised accordingly.
- (c) Candidates were able to select methyl orange or phenolphthalein and most knew the colour change well. Occasionally the initial and final colours were mixed up but most candidates scored all three marks here.
- (d) Few candidates were able to secure all six marks in this calculation in spite of it being broken up into clear steps. Again, examiners got the impression that candidates had not thoroughly read through the method and consequently struggled with some aspects of the calculation. However, most candidates were able to score at least three marks. There were six marks available with eight steps involved – one mark was deducted for each error. One of the most common errors was on the third line of the calculation where candidates did not use the 1:1 ratio from the equation but instead used the 40.0 cm^3 of 0.5 mol dm^{-3} hydrochloric acid initially added to the toothpaste. Having not read the introduction carefully, candidates simply searched for a volume and concentration of hydrochloric acid and assumed it was to be used for this part of the calculation. Other less common errors arose later in the calculation such as failing to use the 2:1 ratio on the sixth line or using an incorrect RFM for calcium carbonate on the seventh line. Consequential marking was applied throughout the calculation.
- Q2** (a) Surprisingly, a lot of good candidates appeared to be thrown by the fact that they were given deductions and asked for observations instead of being given observations and asked for deductions.

- Test 1** Candidates are very familiar with the appearance of barium chloride solution as they regularly use it to test for sulfate ions in the laboratory. Most candidates correctly described the solution as colourless although a few thought it was green.
- Test 2 (a)** This question was well answered with most candidates knowing that chloride ions would give a white precipitate with silver nitrate solution.
- Test 2 (b)** Again, well answered. Various terms were used to indicate that the precipitate disappeared on the addition of excess silver nitrate solution and most were acceptable.
- Test 3 (a)** The test for barium ions using potassium chromate solution was not as well known. Most candidates knew that a precipitate was formed but many of them guessed incorrectly that it was white rather than yellow.
- Test 3 (b)** Even fewer candidates knew what happened when excess potassium chromate solution was added. There was some discussion as to the correct colour of the final solution. If this test is carried out on a test tube scale (as it was in this question) the final solution is yellow. If more solution is used in a beaker the equilibrium shifts and an orange colour is observed. Some candidates confused potassium chromate with potassium dichromate and subsequently wrote about a colour change from orange to green and a change in smell. This was quite common.
- Test 4** Very well answered. The vast majority of candidates knew that the flame was green. Any additional shades of green were penalised.
- Test 5** Many candidates did not recognise this as simply the white precipitate for a solution of sulfate ions with a solution of barium ions. Quite a few candidates wrote white precipitate but also wrote additional incorrect observations (e.g. fizzing), which led to a mark being deducted.
- (b)** The format of this question was more familiar to candidates and they tended to answer part (b) better than part (a).
- Test 1** This was well answered with the most common correct answer being the inability to form hydrogen bonds.
- Test 2** Candidates had to make mention of high carbon content (or similar) to get the mark for the combustion of the organic liquid, Y. A lot of candidates wrote about unsaturation and this was ignored if it was written in addition to a statement about high carbon content. However, unsaturation on its own did not get credited as, although unsaturated compounds do burn with a smoky flame, the presence of a smoky flame does not prove conclusively that a compound is unsaturated.
- Test 3** This very familiar test was well answered by almost all the candidates.

Test 4 A lack of precision led to many candidates losing the mark in this question. It was common to see deductions like, “not an alcohol”, but in order to get the mark candidates had to specify that it was not a primary or secondary alcohol. Some candidates also correctly noted that it could be a tertiary alcohol.

Identification of the functional groups was generally very good and consequential marking was applied if candidates had made an error in their deductions.

Q3 This question was based around the enthalpy change for a simple displacement reaction. As with question 1 however, candidates who didn't take time to read the method carefully found themselves in difficulty at various points in the question.

- (a) (i) Most candidates scored at least one mark in this question. The most common error was to fail to divide by four or omission of units. Occasionally candidates also used the RFM of anhydrous copper(II) sulfate (160) rather than the RFM of the hydrated copper(II) sulfate (250).
- (ii) This was surprisingly poorly answered. Many candidates did not reference the mass of hydrated copper(II) sulfate they had calculated in the previous question. It was also common for candidates to not mention what vessel they were using to make the initial solution (a beaker). Shaking by inversion was also frequently omitted. Most candidates were able to score at least two marks.
- (b) Various pieces of apparatus could be used to measure out 50 cm³ of copper(II) sulfate solution and this was reflected in the mark scheme. Very well answered.
- (c) Again, this was well answered with most candidates knowing that the polystyrene cup would provide insulation.
- (d) This was very poor considering that this reaction would have been observed by candidates from GCSE and earlier. Also, they were given the equation with state symbols at the start of the question and should have been able to deduce observations from it. The first mark was for a colour change from a blue solution to colourless. The second mark was for the formation of a solid (the colour of which was required and the mark scheme here was very flexible).
- (e) (i) This was poorly answered. A lot of candidates simply calculated the number of moles of copper(II) sulfate and assumed that the number of moles of magnesium was the same. It was also common to see the number of moles of magnesium written incorrectly as 0.83 instead of 0.083.
- (ii) Again, this was poorly answered. A mark scheme was devised that allowed error to be carried forward from (e)(i). A lot of candidates simply did not realise that magnesium was in excess.
- (f) (i) Candidates had to multiply the mass by the specific heat capacity and the temperature change then convert their answer into kilojoules. A lot of candidates were able to calculate the amount of heat energy correctly but they either could not convert it into kilojoules or they

incorrectly inserted a negative sign. No negative sign is required here as they are asked to calculate the amount of heat energy given out rather than being asked to calculate an enthalpy change.

- (ii) Candidates had two things to do in this part of the calculation: first they had to divide the heat energy calculated in (f)(i) by the number of moles of copper(II) sulfate calculated in (e)(i) (consequential marking was applied), then at this point they had to insert a negative sign as here they were asked to calculate the enthalpy change for the reaction. Not many candidates scored the mark on this part.
- (g) Candidates were not awarded the mark for simply stating that more insulation was required. They had to specify what that insulation was e.g. using a lid on the cup or surrounding the cup with cotton wool. This was well answered with most candidates opting for the lid on the cup.
- (h) This was very poorly answered. Many candidates lost marks here for a lack of precision or for getting confused between observations for dilute ammonia solution and for dilute sodium hydroxide. Some candidates did the initial part of the test with sodium hydroxide solution then completed the test with dilute ammonia solution. This is poor practice but if the candidates stated the correct observations they were awarded the marks. Ideally candidates should have used dilute ammonia solution and initially observed a blue precipitate then a dark blue solution upon excess. Some candidates opted for a flame test and if it was described correctly they were able to attain all three marks.
- Q4**
- (a) Candidates had to specify that bromine was toxic/poisonous to get the mark. A lot of candidates simply wrote that toxic fumes were involved without specifying bromine. Others did specify bromine but simply stated that it was harmful rather than toxic.
- (b) The mark scheme was fairly generous at this point allowing candidates a mark for anything to do with the reaction being very vigorous or producing a lot of heat.
- (c) The usual errors appeared in the definitions of reflux. Candidates are still commonly referring to heating/evaporating instead of boiling and some are forgetting to use the word 'repeated' (or similar).
- (d) Most candidates knew that anhydrous calcium chloride is a drying agent.
- (e) (i) This was poorly answered. A lot of candidates were trying to prove the presence of water using Universal Indicator or anhydrous copper(II) sulfate.
- (ii) The majority of candidates answered this question well.
- (f) The calculation was generally well answered and it was clear that most candidates understood what they were doing. A mark was deducted for the omission of units on the third line of the calculation. Rounding errors were common but most candidates still scored at least three marks here.
- Q5** Students were instructed in the question that they had to use sodium hydroxide solution and the vast majority did so.

Ammonium ion Most candidates scored the two marks for the production of a gas that gave white fumes with a stirring rod dipped into concentrated hydrochloric acid (or similar). However, very few candidates knew that the initial mixture of ammonium ions and sodium hydroxide solution had to be heated.

Magnesium ion This was not as well answered as the test for ammonium ions. The first mark was for the need to dissolve the solid salt in water. Most candidates knew that a white precipitate would be formed on the addition of drops of sodium hydroxide solution but when it came to the excess sodium hydroxide solution a lot of candidates got confused between the observations for magnesium ions and those for zinc and aluminium ions. A lot of candidates wrote a correct answer involving sodium hydroxide solution then went on to describe the test for magnesium ions using dilute ammonia solution. This was unnecessary but it wasn't penalised as long as it was correct. Unfortunately some candidates lost marks having written a perfectly good answer involving sodium hydroxide solution but then went on to write additional incorrect statements about the test using dilute ammonia solution.

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

The paper was regarded as ‘quite wordy’ with many questions requiring longer than average answers. Many years ago papers were set with regard to the first question judged by examiners to be the most accessible. After some fruitless years when the most difficult question was found to be the easiest and vice versa the practice was abandoned. However, there was no doubt that this year the first question was the most difficult but this was never anticipated. This question carried much fewer marks than the other questions on the paper. The paper certainly discriminated. The performance of candidates, in the face of such challenging questions, was extremely commendable. Those candidates who obtained marks greater than 60%, of which there were many, displayed good ability in chemistry.

- Q11**
- (a)** The atomisation energy is the energy needed to atomise an element in its standard state. The halogens were listed in their standard states at the start of the question. Although iodine has the lowest bond energy it is a solid. Any reasoned argument was acceptable. Even fluorine would have been acceptable if the argument between bond energy and physical state was correctly reasoned but none were seen. Although iodine has the largest atomic radius which leads to lower bond energy this answer on its own was not sufficient. Despite the answer requiring an explanation few candidates provided one.
- (b)**
- (i)** Although the question was written in a convoluted sense the essential question being asked was, in a new way, “why are lattice enthalpies positive?” or it was another attempt to ask candidates to define what was meant by the term lattice enthalpy. It was not sufficient to interpret that all of the lattice enthalpies had a positive sign or indeed to say that they were endothermic “reactions”. Some candidates tried to argue that “when forming a compound the enthalpy of the reactants was less than the enthalpy of the products”. Answers which said that bonds were being broken were acceptable. There was no need to say that the bonds being broken were ionic.
- (ii)** There were two approaches to answer this question. Either a candidate could argue that the size of the halide ions increases or that the bond energies of the halogens become less. Unfortunately, candidates seemed to take completely divergent views. What was surprising was the fact that many candidates completely abandoned the correct use of the language of chemistry and used words such as atoms, ions and molecules without discrimination in this part question and in the rest of Question 11. Indeed, many wrong answers were given with “shielding” being extremely popular e.g. “Ions are more unstable-takes less energy to form bonds larger radius, electron further from nucleus”; and “ionic radius of group VII decreases as descend (sic) but charge stays the same therefore decreasing charge density and less electrostatic attraction”; “the bonding pair of electrons is further away from the nucleus with increased shielding, therefore requiring less energy to break the bond”.

- (c) (i) As might be anticipated, with a slightly more complex calculation for the Born-Haber cycle there were more erroneous answers. One examiner listed 30 different answers! However, the majority of candidates did produce the correct answer. The major error was not to multiply the standard enthalpy of atomisation of chlorine and the electron affinity of chlorine by three.
- (ii) As with earlier questions it was not sufficient for candidates to state that the value of the enthalpy of formation was positive. Many candidates correctly said that enthalpies of formation should be negative or they stated that too much energy was needed to form CaCl_2 . However, statements such as “not energetically feasible” were not sufficient explanations. Some candidates correctly deduced that the ΔG value was positive because the value of ΔS was negative and the ΔH value deduced was positive. Candidates who obtained a negative value for ΔH found it impossible to carry a logical argument through in part (ii).
- (iii) Although it was expected that candidates would simply refer to the increasing positive charge on the calcium ions many answers referred to the increasing charge density of the ions. A very common answer was to say that “there are more halide ions bonded to the calcium, this requires more energy to break them”. Sometimes candidates were not specific enough about their answers e.g. “the charge on *calcium* increases which increases the lattice enthalpies”.
- (iv) The calculation for the disproportionation of calcium (I) chloride was well done as might have been expected although weaker candidates did have problems in deciding which numbers to deal with.
- (v) Although it would be expected that there would be a very small entropy change very few candidates deduced this but most did say that there was no entropy change. Some candidates mentioned that because there were no gases being produced that there would be no entropy change which was again acceptable. There were contradictory answers such as “ ΔS is negative as there is no entropy increase”. Attempts were made to relate ΔG to the answer but such attempts had to state that there was no change in entropy.
- Q12 (a) The name for methacrylic acid was well tackled. Apart from the correct name listed in the mark scheme other answers seen were 2-methyl-propen-2-oic acid, 2-methyl-prop-2-enoic acid and 2-methyl-2-propenoic acid. Although the number 2 in the name 2-methylpropenoic acid was not obligatory it was not omitted.
- (b) (i) The mechanism for the reaction of hydrogen cyanide is now very well known and the errors made in the past are now rarely made such as partial charges and incomplete polarised bonds. Of course there are a small minority of candidates who have not learnt the mechanism which is now routine knowledge.
- (ii) The major error made by candidates was to quote sodium hydroxide without the presence of water. It is essential that candidates state exactly what the catalyst used is. In the case of the acid there was not a problem as the word acid conveys the fact that the substance is in

solution. Consequently most candidates obtained one mark rather than two marks. The question asked for the names of the substances. Candidates are taking an unnecessary risk if formulae are used.

- (iii) Omitting the word concentrated lost the mark for the acid. Candidates had little trouble in deducing that the reactant was methanol.
 - (iv) Esterification was the only acceptable answer. However, condensation was sometimes given and most frequently with esterification. The latter combination was acceptable.
- (c)
- (i) The industrial sources of methane and ammonia were not known. A further problem was that candidates did not identify, in their answers which answer corresponded to which question. The synthesis/manufacture of ammonia is listed in the specification in section 2.9.4. The source of hydrogen in the Haber process is methane which is obtained from natural gas. Candidates stated that methane could be obtained from the fractional distillation of crude petroleum but this is not correct. There might be traces but this is not an industrial source. A mark was given to those candidates who implied that methane was obtained from petroleum and either did not state how or said that it was obtained by cracking. Most answers referred to obscure sources of ammonia or methane often based on biological situations.
 - (ii) Bond energy calculations are normally a good source of marks for candidates and they were in this question. The correct value was $+217 \text{ kJ mol}^{-1}$ but there were quite a few who gave a negative value and then did not transfer the value through to part (iii). But generally answers were good. Candidates should be advised to present all of their calculation so that examiners can spot any error that is made. A few candidates presented answers that were impossible to interpret and were heavily penalised.
 - (iii) The calculation was a simple follow on from part (ii). As expected the most common error was to not convert from J to kJ or vice versa. Careful candidates were rewarded with full marks. But there was often the tendency to forget about the need to suggest why the entropy change was positive. When the question was tackled there was often a reluctance to use the word entropy and instead “disorder” was frequently used saying there was an increase in disorder. But there needed to be a reference to the equation stated in the question which showed that the number of molecules was going from two to four.
- (d) Questions have been set before on these aspects of the specification. Initially they were new questions and a wide variety of answers were accepted. This time the list of acceptable answers was narrowed. The treatment of domestic and industrial waste continues to change and is often subject to both political and economic factors.
- (i) In the past there were fairly simplistic ideas for waste disposal. Often landfill was regarded as cheap and convenient but the situation has changed. Convenient sites have been used and few remain. It was acceptable for candidates to say that empty quarries could be used and

that land could be re-created but it was rare for them to say this. Even now landfill often occurs above ground. The most common answer for waste incineration was to generate electricity. This is the current situation although heat generation can be an alternative answer.

- (ii) Candidates often gave confused answers for the disadvantages of landfill and waste incineration. Quite often they said that waste incineration produced greenhouse gases such as methane. Quite often they said that toxic gases were produced but failed to name them. Times have changed and industry does not and cannot release toxic gases in any significant quantity. There is far more control. Yet candidates continue to use the word toxic and harmful without discrimination. Greenhouse gases and ozone depleting gases were often mentioned in the same sentence, again without discrimination. All statements had to be backed up with hard, correct facts. Unsightly landfill sites were frequently mentioned and were accepted.
- (iii) Candidates were well drilled with regard to strategies to control reduce and manage the amount of polymer waste. The mantra “reuse, recycle and reduce” was frequently seen and if explained gained the two marks available. The vast majority of candidates gained maximum marks. All ideas were promulgated whether they were chemical, political or economic.

- Q13**
- (a) The question asked for both the conjugate acid-base pairs to be identified. Quite a few candidates failed to point out the acid and base parts of the acid-base pair. The question asked for the acid-base pair and if they were given in that order it was acceptable. Although the correct answers were given by more than 50% of the candidates a higher percentage was expected.
 - (b) This question proved to be quite challenging and had a low success rate. The key issue was to interpret diluting as adding water and thus driving the equilibrium to the RHS. There was then the difficulty of expressing the decrease of pH as an increase in the concentration of the hydrogen ion. Candidates became tied up in a convoluting series of arguments which were well short of the answer.
 - (c)
 - (i) This question was expected to be extremely straightforward. Basic kinetics with a gas produced should have been relatively easy. But quite a few candidates were distracted by the presence of bromide ion. Whilst there was a small minority who thought that colorimetry was the answer here it had risen to an overwhelming majority by the time that part (vi) had been reached. Candidates did not deal well with the basics of kinetics. Far too often candidates, having measured the volume of oxygen given off, plotted graphs of the concentration of oxygen against time. It was rare for candidates to obtain four marks. The average was two or three.
 - (ii) Although the question was quite explicit in stating that the answer should be related to the relative speeds of step 1 and step 2 a small number of candidates wished to refer to rate determining steps without mentioning the steps. Apart from this the question was very successfully answered.

- (iii) Virtually all the candidates correctly identified the reactive intermediate as OBr^- .
- (iv) The success was continued with this question where, again, all candidates obtained the correct answer of second order.
- (v) Although there were different ways of expressing the answer most candidates stated that the bromide ion was a catalyst because it was regenerated or “not used up”. Some candidates correctly said that bromide was regenerated at the end of step 2. Other information was sometimes presented in relation to the principles of catalysis but they were ignored if the essential argument had been presented.
- (vi) As mentioned the commitment to colorimetry was extremely strong in answering this question. This was a surprise because it had been expected that candidates would simply add silver nitrate solution, filter off the silver bromide produced and then weigh it. In fact no candidate gave this full explanation although a very small number actually added silver nitrate solution. The most common answer was as follows: “Bromine ions form a brown solution use a colorimeter to determine the light transmission and compare to a calibration curve”. Whilst candidates appear very happy to use aqueous silver nitrate to test for halides they cannot apply this knowledge to its use in gravimetric analysis.
- (d) All candidates obtained the two marks available for stating the orders of reaction for X, Y and Z.
- Q14** (a) The great majority of candidates obtained the correct answer of vegetable oil but despite the question asking for the oil or fat a small minority of candidates actually gave the answer oleic acid. A smaller minority actually stated marine oil or animal fat.
- (b) Most candidates realised that bromine or rather bromine water was the reagent needed to test whether an oil or fat was unsaturated. A few candidates, using the idea of iodine values, tried to set up an iodine value type experiment. The major problem was that candidates wished to do the test on the oil/fat without it being in solution which would have proved difficult. Examiners adopted a compromise and accepted shaking as an alternative. Despite this the average mark was two rather than three.
- (c) Candidates had considerable trouble trying to work out an answer with few answers seen that provided a completely satisfactory account. Crude petroleum is in the specification and is a mixture of alkanes. Olive oil is a triglyceride which reacts with either alkali or acid. Initially the question was written for the use of alkali (sodium hydroxide) rather than acid but it was thought that the question would be criticised because the sodium salt produced would act as soap and dissolve the petroleum. The major problem appeared to be that candidates wanted the petroleum to react with a reagent. The method adopted should have been to heat/reflux the mixture with hydrochloric acid and then separate out the petroleum. It was not anticipated that this question would cause the response that it did.

- (d) The calculation proved to be very discriminating and indeed challenging. Most candidates were able to make a start although often it was down a wrong path of trying to calculate the RMM of the oil/fat. But many candidates did put the correct numbers together and obtained a value of 4 for the answer. A few more went a step further, realised that this was the value for the glyceride and needed to divide this value by three to get the answer required for the question asked.
- (e) (i) Almost without exception candidates gave the name glycerol for the common name of propne-1,2,3-triol.
- (ii) In a previous year a question had been asked which referred to the optical activity of triglycerides which should have paved the way to answering this question. In the end the question proved to be very discriminating. A frequent unexpected answer was to write two structures one consisting of the triglyceride with oleic acid i.e. R_1COOH and another one with stearic acid R_2COOH . In such cases neither of the structures was optically active and very often no asterisk was provided. Another representation was to draw the structures as mirror images of each other, in this case only rare examples were correct. Yet the majority of candidates were able to provide the correct structures with the correctly labelled asymmetric centre.
- (iii) Although this question has been asked innumerable times there is always a small minority who fail to give a complete answer e.g. "this oil can be hydrogenated by adding hydrogen atoms onto the molecule". But candidates normally obtained the three marks.
- (f) Over the years candidates have been carefully instructed on answering questions which deal with the determination of melting points. Such is their accuracy in response that noting when the substance starts to melt and when it has finished melting now gets one mark when it used to receive two. Melting point apparatus used to be described in terms of a metal block or the use of an oil bath. Now the mark is given for stating melting point apparatus. All of this was known by candidates. However, the sting in the tail was the novel new question which was quite simply to determine whether the substance was an oil or fat at 25 °C. Some candidates carried out a separate experiment to determine this fact which was acceptable. It was perfectly feasible to determine the fact during the melting point determination but quite a few candidates wished to consult data tables which in view of the melting point (softening) ranges and the variety of oils/fats and the purity of them was not really feasible and in this case not the correct procedure to follow.
- Q15 (a) There are several structures of nitric acid in the literature. The structure presented in the examination paper was one of them. Whatever the structure drawn it was essential that the number of electrons was correct and that they were arranged as octets apart from hydrogen. This was mainly accomplished. The major error was to have an incomplete octet in the single-bonded oxygen next to the nitrogen. It was difficult to always assign the correct number of dots and crosses in certain situations but some lee way was given in this respect.

- (b) (i) The calculation of the pK_a value was correctly done by the majority of candidates although sometimes candidates applied the equation for a weak acid and worked out a different dissociation constant.
- (ii) The calculation of the pH of a 2.0 M solution of the acid was well done as might have been expected.
- (iii) This calculation was the most complicated of the three that were set. Most candidates were able to work their way through to the final solution but a small minority stopped at a concentration of the hydrogen ion as 8.94.
- (iv) This question was the summation of the reasons for the previous questions. It was set to see if candidates understood why two calculations were asked for and what the validities of the answers were. High level answers were not seen such as saying that nitric acid was being treated as a weak acid when in reality it was a strong acid and candidates, if they were able, simply distinguished between the two methods of calculation. Often this was done by trying to explain the answer in terms of pH values but not the reasons for the pH values e.g. “in solution, nitric acid fully dissociates giving a higher pH”; “when it is fully ionised there are more H^+ so it has a lower pH.”. The most frequently accepted answers were along the following lines with each calculation being explained i.e. “in part (ii) the nitric acid fully dissociates but in part (iii) the nitric acid only partly dissociates” and “in part (ii) the solution was fully ionised. In part (iii) we used the dissociation constant K_a which means the solution was only partially ionised”.
- (c) The equations were taken directly from the specification and provided a range of candidates with four marks. The best known answer was given for part (iv) where all candidates were able to explain the term ‘amphoteric’. The most difficult was the equation for the reaction of ammonia with nitric acid. The other equations were problematic for some with the need to balance. Weaker candidates gave products which were not nitrates.
- (d) These equations were expected to be very difficult apart from the reduction of nitric acid to ammonia which was sometimes the only mark that candidates obtained. Part (i) discriminated well between candidates and only a handful of candidates were able to correctly balance the equation in part (iii). In the case of this question it was known in advance that it would be discriminating.
- (e) This question did not have to provide a perfect answer. As expected candidates knew the reasons for the acidic and the neutral salts but had difficulty with explaining the third slightly acidic salt. All that was needed was to say that the alkali/base from which the salt was made varied in alkalinity/basicity. However, in their search for an answer candidates sometimes thought that the acid was changing in strength which was not possible. They also homed in on the fact that aluminium oxide was amphoteric as mentioned in (c)(iv). A very small number commented on the hydrated aluminium ion producing hydrogen ions by polarisation of water molecules but the explanation was not correct or thorough enough. Naturally the question discriminated a great deal.

- (f) (i) Candidates were well versed in their answers to the advantages and disadvantages of nitrate fertilisers. They needed to be careful in not using the opposite answer in part (ii) and expecting maximum marks e.g. it was not sufficient to say that the composition of the artificial fertiliser was known in part (i) and then say that the composition of the natural fertiliser was unknown in part (ii). Known composition was the most frequent answer for the advantage in part (i) and eutrophication, or its description, was the most frequent answer for the disadvantage.
- (ii) Continuing the good answers in part (i) the most popular answer for the advantage was to improve soil structure and the disadvantage was smell. Any answers which referred to toxicity or greenhouse effect had to specifically mention the chemical involved.

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

The paper was successful in giving all candidates an opportunity to answer at least some of the questions. It also discriminated between the more able candidates and the less able candidates. The mark scheme was easy to follow. The candidates appeared to have ample time to complete the paper.

There continues to be concern over the poor use of English by candidates resulting in them losing marks. A clear simple unambiguous explanation is often all that is required, as can be seen in the mark schemes provided. It also appears that on some occasions candidates are not reading the question fully and are, instead, answering the question they would have preferred to have seen rather than the actual question on the paper.

- Q11** (a) This was reasonably well answered. Many candidates lost a mark for not including the metal atom/ion in their answer.
- (b) (i) This was answered very well by all but the weakest candidates.
- (ii) This was well answered by the great majority of candidates. The most common error was the omission of the (aq) in the formula of the VO_2^+ .
- (c) (i) This definition was very well known.
- (ii) Most candidates gained at least one or two marks. A few candidates referred to absorption instead of adsorption. Many neglected to mention the weakening of the bonds in the reactants and/or the orientation of the molecules. The weakening of bonds without reference to the reactants was not awarded a mark.
- (iii) This was poorly answered with many candidates attempting to write ionic equations.
- (iv) The catalyst for the formation of ammonia was reasonably well known but few knew the catalyst for its oxidation. Platinum and rhodium was required for the mark.

- Q12**
- (a)** It is disappointing to note how many candidates were unable to give the correct reagents. In Step A concentrated hydrochloric acid was required; hydrochloric acid or HCl did not receive a mark. In Step B a solution of sodium hydroxide/potassium hydroxide was required so sodium hydroxide/potassium hydroxide on its own did not receive a mark nor did NaOH or KOH.
 - (b)** As in part (a) the reagents were poorly known. Hydrochloric acid was required and again a solution was needed and so HCl did not receive a mark. The temperature was reasonably well known.
 - (c)** This was quite well answered with the usual errors of omission i.e. the chloride in the benzenediazonium chloride and the HCl in the equation.
 - (d)**
 - (i)** This was very well answered.
 - (ii)** Most candidates were able to gain at least one mark. There are four asymmetric centres and three were required for two marks and two for one mark.
- Q13**
- (a)**
 - (i)** This was generally well answered although nucleophilic addition did appear with the weaker candidates. A few candidates described the reaction as bromination.
 - (ii)** The catalyst was well known. Iron bromide appeared in a few answers and was not accepted.
 - (iii)** This was poorly answered. The candidates were asked for the mechanism of the catalysed reaction and so $[\text{FeBr}_4]^-$ was required at some point as was Br^+ . Partial charges often appeared on the bromine molecule and the intermediate.
 - (iv)** The name of the mechanism was reasonably well known.
 - (b)**
 - (i)** This was well answered with the most common error being the incorrect representation of the benzene ring.
 - (ii)** This was reasonably well answered. The most common error was the omission of concentrated in the naming of the acids. The equation was well known.
- Q14**
- (a)**
 - (i)** This was very well answered.
 - (ii)** This was reasonably well answered. The most common error was the omission of oxygen at one end of the structure. Some candidates included a benzene ring in the structure, presumably mistaking hexanedioic acid for benzenedioic acid.
 - (b)** This was generally well answered. The most common error was the incorrect number of bonds around the nitrogen.
 - (c)** This was reasonably well understood with most candidates recognising that the carbon monoxide binds with the haemoglobin. Some stated that this causes suffocation rather than preventing the transport of oxygen.
 - (d)** Whilst most candidates recognised that polyurethanes could be hydrolysed, few stated that it was the ester/amide group which could be hydrolysed. As a result this was poorly answered.

- Q15**
- (a) (i) The name was reasonably well known. A few candidates did use butyl which was not accepted. Some candidates gave six carbons in the name.
- (ii) Some long descriptions of hydrogen bonding when all that was required was a simple statement that it could form hydrogen bonds with water.
- (b) (i) This equation was reasonably well known. The most common errors were only one of the functional groups reacting and ammonia appearing as a product.
- (ii) This equation was better answered than the previous one. Again the most common error was the reaction of only one functional group.
- (iii) The use of the melting points of amides for identification purposes was well understood.
- (c) (i) The definition of a zwitterion was well understood. The most common error was the omission of the word 'permanent' in the definition.
- (ii) The structure of the zwitterion was very well known.
- (iii) The isomers were generally well drawn. The use of dotted lines and wedges, although not required, were helpful on many occasions but could also be very confusing if poorly drawn.
- (d) The structures of proteins were reasonably well known and the definitions from the Clarification of Terms document were frequently seen. Candidates often failed to include hydrogen bonding in the primary structure. At least two of disulfide bridges, ionic interactions and hydrogen bonding were needed to gain the mark in the tertiary structure.
- (e) (i) This was reasonably well answered. The most common error was the omission of the term 'active site'.
- (ii) Most candidates were able to gain a mark by stating that the enzyme became denatured. Few candidates were able to explain why the enzyme would be denatured.
- Q16**
- (a) (i) It was disappointing to note the large number of candidates who did not know the chemical name for TMS, with silane often appearing instead of silane.
- (ii) Most candidates were able to give one reason for the use of TMS, with only the more able candidates giving two reasons.
- (b) This was either done extremely well or very poorly. Many candidates appeared intimidated by the concept of nmr. The splitting was generally correct, however it was often in the wrong order or not labelled at all. The integration trace was often poorly done.
- (c) (i) This was very well answered.
- (ii) This was very well answered.
- (iii) This was reasonably well answered.

- Q17**
- (a)** It was disappointing how few candidates were able to use the information supplied in the stem of the question to complete these equations.
- (i)** Many candidates failed to include oxygen or formed carbon monoxide.
 - (ii)** The best answered of these three equations, although carbon dioxide frequently appeared as a product.
 - (iii)** Candidates often attempted to write an ionic equation, many did not know the formula of aluminium oxide and often when the formulae were correct, the equation was not balanced.
- (b)** This colour change was well known. The most frequent error was to give green to orange.
- (c)** This was a good discriminator, with the more able candidates gaining both marks. Some candidates lost a mark for failing to show the 3D arrangement whilst getting the bonding correct. If charges were shown they had to be correct, as did the use of double and single bonds.
- (d)**
- (i)** This equation was very well known and was seldom incorrect.
 - (ii)** This calculation was extremely well done with many candidates gaining full marks. The most common error was not dividing five to get the mass in one tablet. Any incorrect rounding was penalised once.
- (e)**
- (i)** The term ligand was well known from the 'Clarification of Terms' document. Each omission from the definition given in the document was penalised once. Most candidates gained at least one mark.
 - (ii)** There is a poor understanding of E-Z isomers. Many candidates gained one or two marks by explaining the answer in terms of cis-trans isomerism. Only the more able candidates were able to gain the final mark by explaining the answer in terms of priority.
- (f)**
- (i)** This was very well answered with hexadentate being accepted in addition to chelate and polydentate.
 - (ii)** This was very well answered by most candidates. The most common error was an incorrect charge on the complex ion.
 - (iii)** This was very well answered with most candidates gaining both marks. The most common error was incorrectly stating the number of species on each side, even when the equation was correct.
- (g)** There were some excellent answers which demonstrated use of the Practical Support Booklet. However some candidates appeared to have confused some of the methods given and this resulted in lost marks.

Assessment Unit A2 3 Practical Assessment

Booklet A

- Q1** The titration question was very well answered with almost all candidates scoring full marks. Some concerns were raised by centres about the change in method and how it may affect precision of titre values. The mark scheme was adjusted to allow for this, however almost all candidates produced accurate titres within $\pm 0.1 \text{ cm}^3$ and the most common reason for not obtaining full marks was an incomplete table.
- Q2 (a)**
- Tests 1&2** Candidates performed well on the observation. There were some issues raised with some candidates observing the crystals or solution as being blue. Adjustments were made to accept some of the suggestions made by centres.
- Test 3** The concentrated ammonia produced some observations that candidates would not be familiar with. Candidates who carefully wrote down what they observed performed well here, however a wide range of answers were produced and the mark scheme was adjusted to allow for some of the feedback from centres.
- Test 4** The sodium hydroxide produced observations that candidates would be more familiar with and candidates performed well in this section.
- Test 5** The addition of barium chloride was well known and answered well.
- Tests 6&7** Most candidates responded well to the change in colour and also the production of a colourless liquid (condensing or similar terms being considered a deduction rather than an observation). However, a number of candidates lost marks because they indicated white crystals had formed, when the solid formed after heating would not have been crystalline.
- (b)** The organic tests were well known and candidates performed well in this section, acidified potassium dichromate produced a range of colours and the mark scheme took this into account.

Booklet B

- Q1 (a)**
- (i)** The ionic equation was well known.
- (ii)** The colour observed was well known and almost all candidates got this mark.
- (iii)** The species responsible for the pink colour was not well known by candidates and a small minority of candidates correctly identified $\text{MnO}_4^- (\text{aq})$ as the ion concerned. Most candidates suggested Mn^{2+} .
- (iv)** Only a minority of candidates obtained 2 marks for this question. Most candidates suggested adding dropwise before the end point, but very few identified the need for a rough titration or that they should repeat for titre values within $\pm 0.1 \text{ cm}^3$.
- (b)** This question was well answered, and the method was well known.

- (c) This calculation was answered well with many candidates following the correct steps. Common errors were incorrect rounding of values or the failure to incorporate the ratio of manganate to iron ions in the calculation.
- (d) (i) The observation was well known.
(ii) The ionic equation was not well known and this question caused problems for a number of candidates, with only a minority achieving both marks.
- Q2**
- (a) The inorganic deductions were well understood and given correctly by the majority of candidates.
- (b) (i) **Test 2** This was well answered by candidates.
Test 3 This was well answered, but some candidates had problems as they did not give a sufficient number of species when they gave a negative answer. It was necessary to state that the unknown was not a primary or secondary alcohol or aldehyde when identifying species that the unknown would not be.
Test 4 This was well answered, however some candidates lost marks for stating that the unknown was an alcohol, when the test only confirms the presence of a hydroxyl group and the unknown could have been an alcohol or carboxylic acid.
Test 5 The formation of an ester was a deduction correctly made by most candidates.
Test 6 The deductions for the addition of sodium carbonate were very well made by most candidates, with the vast majority of candidates including the necessary detail that the gas produced was carbon dioxide.
- (ii) The homologous series was correctly identified by the majority of candidates. Errors made in the deductions were carried through to this part.
- (iii) The correct structure was given by the majority of candidates. The most common error was not including the covalent bond between oxygen and hydrogen.
- (iv) Most candidates correctly identified the ion that was responsible for the base peak.
- Q3**
- (a) The reason for ammonia not reacting with benzene was not well answered, and a range of answers were accepted to enable candidates to obtain a mark. Most candidates missed the key idea that ammonia being a nucleophile would not be attracted to the electron rich benzene.
- (b) (i) The definition of reflux was well known and was correctly given by the vast majority of candidates.
(ii) Overall the standard of diagrams was disappointing in this examination. Very few candidates obtained full marks for the diagram and a range of mistakes were produced. The most common errors were to include water flowing in the condenser when the stem of the question indicated that no water flowed in the condenser. For many

candidates the condenser and round-bottomed flask looked like one continuous piece of glass with no clear indication of a join or an attachment in the diagram itself.

- (c)** The calculation was well performed by many candidates, however a significant number of candidates had problems with rounding numbers and this cost a number of candidate's marks on this question. This also led to situations where the final answer did not match correctly the values given on the page by the candidate.
- (d)** The removal of acidic impurities was well known and most candidates got full marks for this question.
- (e)**
 - (i)** The structure of the benzenediazonium ion caused problems for a significant minority of candidates. The most common error was placing the positive charge on the wrong nitrogen or giving an incorrect number of bonds between the two nitrogen atoms.
 - (ii)** The reagents and conditions for the conversion to iodobenzene was not well known, with only a minority of candidates getting both marks. Many candidates did not specify that the potassium iodide needed to be aqueous or that the mixture needed to be warmed.

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