

CCEA GCE - Chemistry
(Summer Series) 2011

Chief Examiner's Report

chemistry

Foreword

This booklet contains the Chief Examiner's Report for CCEA's General Certificate of Education (GCE) in Chemistry from the Summer Series 2011.

CCEA's examining teams produce these detailed reports outlining the performance of candidates in all aspects of the qualification in this series. These reports allow the examining team an opportunity to promote best practice and offer helpful hints whilst also presenting a forum to highlight any areas for improvement.

CCEA hopes that the Chief Examiner Reports will be viewed as a helpful and constructive medium to further support teachers and the learning process.

This report 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 on Physical and Inorganic Chemistry

Q11 The structure given was that of diamond. There was a tiny number of candidates that described the structure as that of graphite. Consequently those candidates lost all of the marks for Q11. Those who did answer the question correctly faced the greatest difficulty with part (c). Although virtually every candidate said that diamond did not conduct electricity a very great number stated that this was because diamond did not have any free ions or charged particles. It was felt that this was a premeditated answer and that candidates were not applying their answer to the question asked. This was a common misconception. In part (b) candidates correctly stated that diamond was hard because of the strong covalent bonds.

Q12 (a) (i) Answers to part (a) produced a variety of wrong answers. Naturally the formula of barium nitrate was written as BaNO₃ but what was more surprising was the formula of silver chloride which was often given as AgCl₂. The question proved to be unexpectedly discriminating.

(ii) It was exceedingly disappointing to see the formula of silver chloride repeatedly written incorrectly often as AgCl₂ or even AgCl₃. This meant problems for examiners later in the paper when section (b) was marked.

(iii) Virtually without exception candidates gave the correct answer of a white precipitate. No other answers were seen.

(b) This question proved to be exceptionally discriminating with only the most able candidates being able to obtain the correct answer. Nearly all of the candidates were able to obtain the answer 0.002 for part (i). For the vast majority of the candidates this was the only mark obtained apart from the mark for part (iv) which followed through any error made in part (iii).

Very often the errors made were with regard to incorrectly written equations in part (a) when equations such as:

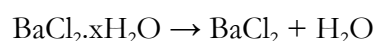


In part (iv) it was expected that candidates would calculate the relative formula mass of barium chloride from the relative atomic masses but this was not always so. It was quite surprising how often a value of 226 was obtained in part (iv) which conveniently led to a value of x of 1.

(c) Even when the value of x was known the equation was incredibly badly written with a vast variety of species written which included the decomposition of water itself. The value of x had a wide range of values depending on the calculation which carried errors through.



Many other answers were simply careless and did not balance the number of molecules in the equation.



- Q13**
- (a) (i) The definition of the term isotope was exceptionally well known. Scarcely an incorrect answer was seen. A variety of definitions used was seen but the most common was that involving protons and neutrons.
- (ii) Again, the names and numbers of the sub atomic particles was known. Surprisingly a few candidates actually gave the electron structure of astatine which was not expected.
- (b) The calculation of the number of astatine atoms was well done. Occasionally either the 30g or the atomic mass 210 was omitted.
- (c) The properties of astatine were expected to be the same as those of iodine or indeed similar to them. The publication of the list of colours of compounds in the specification helped to determine the mark scheme in this question and in other questions. Either the colours of iodine were accepted or a 'darker' version of the same colours. There were problems with the use of grey and black and the mixture of them. However, the colours listed in the mark scheme had to be followed and the colour grey on its own was incorrect. The question provided a range of marks with most candidates obtaining half marks or more.
- (d) The equation was well tackled. Most of the problems seen involved incorrect balancing. If a problem was seen with the molecular formula of astatine it was followed through into this part. Some candidates thought that the formula of an astatine molecule was At.
- (e) Many interesting and lengthy answers were seen trying to explain how the relative atomic mass of astatine could be calculated but they all missed the essential point which was to state the reason was a peak and that this peak occurred either at 210 for atomic astatine or 240 for molecular astatine.
- Q14**
- (a) This question has been asked many times before and there was a similar response although it was thought that the correct answer, producing NaHSO_4 , was more popular than had been seen before.
- (b) (i) A similar question has been asked before involving ammonia gas collection. A better response was seen with hydrogen chloride. The vast majority of answers were correct. Occasionally atomic numbers were used but this was a rare mistake. It was strange to see an answer of 36.8 for the RMM of hydrogen chloride.
- (ii) Most candidates were able to state that hydrogen chloride was heavier than the other gases in air and to further state that the gas would sink compared to the other gases. However, there were a few interesting answers that thought the combined masses of nitrogen and oxygen were heavier than that of hydrogen chloride. Often candidates would have stated that hydrogen chloride was either heavier or denser than air but then failed to explain why it was collected by downward delivery and restated the question

being asked. Sometimes there was mention of diffusion but this was not relevant to relative mass.

- (c) (i) The responses to this question were intriguing. Many candidates put the emphasis on the word dry and elaborated the fact that sodium hydroxide produced water! Often it was not said if the sodium hydroxide reacted and it was further not said what it reacted with. This caused difficulties with the evaluation of the answers and also to provide examiner self-examination because answers which were accepted, although a reaction took place the reason was that water was produced. But what was wanted was the fact that the sodium hydroxide reacted with the hydrogen chloride! It was difficult to distinguish in what direction the answers were going.
- (d) Many answers thought that the reaction with sulfuric acid would be acceptable and even gave the equation for the reaction. Others confused whether bromide was an oxidizing agent or a reducing agent. The question proved to be very discriminating. It proved essential that candidates should either decide that a reaction had taken place in detriment to the normal one or 'impurities' were produced. Naming such an 'impurity' would have been sufficient. But, too often, the impurity named was that provided by iodide reduction i.e. hydrogen sulfide, sulfur etc.
- (e) This question provided a simple choice and the majority choice was hydrogen iodide.
- (f) This question proved to be a major problem with regard to the guidance concerning testing substances. In the published paper on acceptable colours it was stated that concentrated ammonia solution was required. Unfortunately, either the word concentrated or the word solution was left out of the answer. This led to almost all of the candidature obtaining one mark when, formerly, they might have obtained the two marks available. There was no problem with white smoke or fumes. If a gas was mentioned the mark was lost.
- Q15** (a) The grammatical problem of metal or metals having an electron or electrons in the outer s shell was ignored. Consequently the greater majority of candidates obtained the mark.
- (b) The simple answer to this question was the fact that the number of shells increased. However this was expressed in a very convoluted way most of which were incorrect.
- (c) (i) On the whole this was a very well attempted question with the majority of candidates following their way through to a correct result. However, there were a very significant majority that thought the answer would be the ionisation energy for an atom of sodium rather than a mole of sodium. Consequently many answers stopped at calculating the ionisation energy for an atom rather than for a mole. This was revealed by the incorrect use of units which stated a value of kJ mol^{-1} for the atomic value rather than for the molar value.

- (ii) This question was extremely well answered. A small minority of candidates left out the state symbols and an even smaller minority supplied the incorrect symbols.
 - (iii) The reasons for the lower first ionisation energy of potassium were well known although they were often badly expressed. Shielding was straightforward but candidates do need to relate the atomic radius to the ionisation energy more directly. Many times it was accepted but occasionally there was some obfuscation with many answers.
 - (iv) Many answers were provided that might have been credited but there was only one answer provided in the mark scheme. Shells nearer to the nucleus and the fact that an electron had to be removed from an already positive ion were discussed but had to be rejected. Many concepts are taught and there can be many answers as seen here.
- (d)
- (i) Questions concerning delocalised electrons have been asked many times before but on this occasion it was necessary to give an explanation of metallic bonding of which delocalised electrons were a part and this was often the mark lost. The positive ions and the delocalised electrons were essential for the labelled diagram. Sometimes the positive ions were labelled as positive particles but that was not sufficient.
 - (ii) The question regarding the variation in melting points down a group has not been asked before but the answers seen were very impressive. The mark was more often obtained than lost with many creditable efforts being made to use the theory of metallic bonding which had just been answered previously.
 - (iii) The major problem seen in the answers to this question was the inability to state that the greater number of electrons were in the valence shell or were delocalised. Simply stating that calcium had more electrons was not sufficiently clear.
- (e)
- This question was better answered than in previous years. There were far fewer covalent structures presented for caesium chloride and the use of dot and cross electrons was carefully managed. What was not foreseen was the ability of candidates to write a structure for CsCl_5 rather than CsCl .
- (f)
- (i) The carrying out of a flame test is well known. More and more candidates are using a blue flame and the use of concentrated hydrochloric acid is almost without exception the acid used. The only problem seen with this question was the fact that candidates wished to carry out the flame test on an actual Group I element rather than a compound.
 - (ii) It would have been acceptable to quote either the colour of sodium or the colour of potassium. However, almost the whole of the entry gave the colours of both elements even to the extent of quoting the colour of potassium through blue glass. Hence it was unfortunate when a mistake was made with this last colour.

- Q16**
- (a) It is still surprising that some candidates manage to write a full and concise answer yet fail to obtain any marks. The word octet must be defined as 8 electrons and the outer shell must also be stated. Definitions which are based on noble gas structures need to mention these essential points. It is not sufficient to state that elements obtain the electronic structure of a noble gas.
 - (b) It has been mentioned before that the definition of electronegativity is printed in the specification. Despite this fact the definition is still often based on a molecule rather than a bond.
 - (c)
 - (i) The electronic structure of carbon dioxide was well known. Occasionally the outer electrons of the oxygen were missing and a mark was lost. A very small minority drew single bonds for the carbon oxygen bonds.
 - (ii) A handful of candidates thought that carbon dioxide was bent but the mark for the shape was easy to obtain. The mark for the name of the shape was given by the great majority as linear but linear planar was not a commonly seen term and was rejected.
 - (iii) Over the years the reason for the shapes of molecules have been readily accepted as involving the electron structure and very few indeed mentioned the repulsion of oxygen atoms and it was more often implied than stated. The minor error was not to state directly that it was the bonding electrons which were responsible. Repulsion is the expected word to use but there should be a qualification of the word rather than simply stating that the bonding electrons repel.
 - (d) The most commonly seen answer was 'the dipoles cancel out' which was the exact answer on the mark scheme. Candidates tried to state that it was charges cancelling out or arguments were based on electronegativities. But the only answer acceptable had to be based on dipoles.
 - (e) The question stated that carbon dioxide had 'extreme' solubility. The reason for the use of this term was to emphasise the fact that the dipoles were still present even though they 'cancelled'. The polarity of the bonds explains the more than expected solubility. Either an explanation based on hydrogen bonding or on dipole interaction was acceptable. The majority of answers were based on hydrogen bonding. Because the emphasis was on the polar bond explanation basic answers using 'like dissolves like' were not acceptable.

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

Overall the performances in this paper were disappointing. The mean mark for this paper was significantly lower than normal.

- Q11** Poorly answered. Few recognised the thiocyanate ion and the formula of potassium dichromate was not well known. The spelling for triiodomethane

frequently had only one letter 'i' and hyphens often appeared. Many candidates did not even guess a formula for thionyl chloride.

- Q12**
- (a) Only about 50% of candidates gave all the products from the incomplete combustion of hydrocarbons. Carbon and/or water were frequently missing.
 - (b) Many candidates gave long detailed answers looking at one aspect e.g. spillage in too much detail and gave little or no detail on the other aspect e.g. combustion. There were five scoring points for combustion and four scoring points for spillage. To score full marks, candidates had to score 3 points for one aspect and 2 for the other. Many answers lacked sufficient detail e.g. stating that 'oil kills birds' without an explanation did not score the relevant mark.
- Q13**
- (a) Most answers correctly referred to reactivity.
 - (b) Most used s, p, d notation although a few still gave 2.8.8.2.
 - (c)
 - (i) Many answers referred to shielding as the cause of atomic radius increase.
 - (ii) There were only slightly more giving the correct answer 'larger' than the incorrect 'smaller'.
 - (iii) Most answers were well outside the acceptable range.
 - (iv) Very poorly answered. The clue, in the table, that the units of density were gcm^{-3} was not used by candidates. Many linked an increase in mass to an increase in the number of electrons. Many candidates also indicated that if the volume increased that the density would also increase.
 - (d)
 - (i) Generally well known.
 - (ii) The definitions of first ionisation energy were frequently partial definitions. Key aspects of the definition were often left out e.g. reference to one mole.
 - (iii) The equation was well answered.
 - (e)
 - (i) This was reasonably well answered.
 - (ii) Candidates need to distinguish between an observation and a conclusion e.g. heat given off/container warms up is an observation which leads to the conclusion that the reaction is exothermic.
 - (iii) The full equation showing the formation of calcium hydroxide was given by many candidates. Credit was given if the equation showing the formation of calcium oxide was given i.e. the reaction of calcium with steam.
 - (iv) This question elicited some of the most creative answers. There were many new pieces of apparatus in evidence. Many, if they existed, would not have allowed the gas to be collected. Many answers did not include a test tube and/or a beaker. A significant number of candidates gave simple diagrams involving the relevant

apparatus and scored full marks – the use of an inverted funnel was common.

- (f) This question was answered well. The majority of candidates calculated the atom economy correctly and scored full marks.
- Q14**
- (a) Overall, Q14 was the most discriminating question. The signs were often the wrong way round. The mass used in the calculation was often incorrect as were the units quoted.
- (b) The definition of Hess's Law was well known.
- (c) Many candidates had difficulty applying Hess's Law. The number of moles involved was frequently ignored and the equation used was incorrect. Those candidates who calculated and used the number of moles in part (a) were given full credit (provided the values were correct and used appropriately).
- (d) Many candidates knew the test for copper (II) ions and used the colours indicated in the support material available via the CCEA website. Candidates should use the colours given in the support material and avoid variations of those colours.
- Q15**
- (a) Most candidates scored both marks here.
- (b) Again many creative answers here. However many candidates scored the mark.
- (c) The marking was generous here. 'Endothermic since heat is needed' was sufficient for both marks.
- (d)
- (i) Not well answered. The test was, in general, not known. Candidates should learn the tests as they appear in the support material.
- (ii) Much better knowledge than for (i). The most common error was not indicating that the silver nitrate was in solution.
- (e) Very well answered. The majority of candidates scored full marks.
- Q16**
- (a) Many encountered difficulty in providing the systematic name. The inappropriate use of commas was frequent.
- (b)
- (i) The general formula for chloroalkanes was well known.
- (ii) The molecular formula for chlorobutanes did not cause many problems for candidates.
- (iii) The vast majority of candidates demonstrated sound knowledge and understanding in answering this question.
- (iv) Well known by most.
- (v) Surprisingly few correct responses for the meaning of 'sec'.
- (c) The practical aspects of the preparation were well answered, as was the percentage yield calculation.
- (d) This question required candidates to draw upon their knowledge to explain some chemistry with which they were probably not familiar. The

best candidates coped very well and gave convincing arguments based on practical knowledge of the primary halogenoalkanes and theoretical knowledge including reference to C-Cl bond enthalpy and the difference in structure and hence mechanism. Others correctly identified the difference in speed but their explanations lacked credibility.

Assessment Unit AS 3 Internal Assessment

Candidates were generally well prepared for Q1 and Q2 in both papers and the marks were correspondingly high. The identification tests in the final question on both papers were also well answered. The remaining questions provide some discrimination between the candidates. The use of the 'Acceptable Colours' booklet appears to have helped those who have prepared carefully for the papers.

Examiners took on board feedback from centres when compiling the finalised mark schemes for both papers. This feedback is both welcomed and invaluable and will be useful when preparing future papers. When centres are marking the papers it is important that they adhere to the mark scheme provided rather than the responses they think should be accepted. Any suggestions will be discussed at the standardising meeting and the mark schemes are then adjusted accordingly. This allows for a much more consistent standard when the papers are being marked in the various centres and then remarked by the examining team.

Paper 1

Section A

- Q1**
- (a) Revision of the mark scheme allowed for a greater range of marks which benefitted the candidates. There was a clear lack of understanding amongst many candidates concerning the difference between accuracy and reliability.
 - (b) The tables were generally very well done with marks mainly being lost through lack of agreement with the supervisor's titre. A few candidates are still losing marks for not including the units when calculating the average titre. Candidates should clearly indicate which titres they are using to calculate the average when they have obtained three (or more) values in addition to the rough value.
 - (c) This colour change is well known from the acceptable colours booklet.
 - (d) This equation was well known, although some candidates gave the NaHSO_4 . The examiners allowed one mark for the equation when this appeared. The error was also carried through to the calculation.
 - (e) The calculation was generally well answered with most candidates gaining at least four or five of the available marks. Any errors were carried through to the benefit of the candidates.
- Q2**
- (a) (i) Descriptions of **X** were generally good. Too many candidates referred to 'not a transition metal' or 'a Group 1 or 2 metal' without recognising the presence of the ions or compound.

- (ii) This was well answered. Candidates were given credit for recording both temperatures even if they had not calculated the temperature change.
- (iii) Most candidates correctly identified the white precipitate and recognised it as chloride ions. However a few candidates are still incorrectly referring to chlorine ions.
- (iv) This was well answered by the vast majority of candidates.
- (v) This was well answered by the majority of candidates with many gaining full marks. Some candidates referred to the UI paper turning blue-green which was unacceptable, it was agreed to accept purple. The acceptable pH range was taken as 9 – 11 as this is the limit of the UI paper used, therefore values which included 12 were incorrect.

Most candidates were able to correctly identify the two salts. Names are asked for in the question so if formulae are given instead they must be correct.

- (b) (i) This was well answered by the majority of candidates. A few described the solution as sweet smelling and this was unacceptable.
- (ii) It was agreed to accept red as a correct answer and the acceptable pH range was extended to 1 – 4.
- (iii) This was well answered by the majority of the candidates with many gaining full marks.
- (iv) This was well answered by the majority of the candidates with many gaining full marks. It was agreed to accept 'heat given out' and the deduction that the reaction was exothermic.

The carboxyl group/carboxylic acid was identified by many candidates. However only the most able candidates were able to give the correctly balanced equation.

Section B

- Q3**
- (a) (i) This was well answered by the vast majority of the candidates.
 - (ii) Poorly answered by many candidates. Most candidates failed to recognise the concept of requiring the mass of ethanol used by taking weighings before and after the experiment. Also many candidates failed to recognise that the actual mass of the water was needed not the mass of the water and its container.
 - (iii) Only the more able candidates were able to give the correct definition of specific heat capacity.
 - (b) (i) This was well answered by the more able candidates with the more common errors being the use of 0.35 instead of 300, wrong units and the minus sign being omitted. Some candidates used 4.2 for the calculation despite being given 4.18 in the question.

- (ii) Most candidates gained a mark for heat being lost to the surroundings. Only a few candidates recognised that the combustion may be incomplete.
- (c) (i) Disappointingly a number of candidates were able to complete this equation correctly despite it being from GCSE chemistry.
- (ii) This was another question well answered by the more able candidates. Errors in the equation were carried through. The most common errors were the omission of O=O values and the use of 360 (C – O) instead of 740 (C=O) when calculating the values for CO₂.
- (iii) This was poorly answered by the majority of the candidates with few recognising the pattern involved.
- (iv) This was well answered with carbon monoxide most commonly given.
- Q4** (a) It was agreed to accept that the concentrated sulfuric acid may also be acting as a catalyst and this favoured many candidates.
- (b) (i) Many candidates simply repeated the information in the question and so gained no marks. The marks awarded were for loss of material by evaporation (due to the low boiling point) and the fire risk (due to the flammability).
- (ii) This was well answered by the majority of candidates.
- (c) (i) The use of sodium carbonate to remove acid impurities is well understood by candidates.
- (ii) It was agreed to accept that diethyl ether is non-polar and so does not mix with water, this favoured the candidates.
- (iii) The use of anhydrous magnesium sulfate as a drying agent is well understood by candidates.
- (iv) This was reasonably well answered but a disappointing number of candidates referred to distilling as a means of removing the magnesium sulfate.
- (v) This was poorly answered with only a few candidates recognising that this was satisfactory due to the difference in the boiling points.
- Q5** (a) The majority of the candidates correctly identified the formation of the white precipitate in both cases. Candidates lost marks for errors such as ‘the magnesium/magnesium nitrate does not dissolve in the excess NaOH whereas the aluminium/aluminium nitrate does’. This was penalised as one error.
- (b) The iron(II) test was generally well known although some candidates did not refer to the solution turning blood red or the formation of a blood red solution. The use of thiocyanide ions and thiosulfate ions also appeared in some answers.

The flame test for sodium was very well answered. If the flame test was described some candidates failed to state that a blue flame should be used and were marked down accordingly.

Paper 2

Section A

- Q1**
- (a) The tables were generally very well done with marks mainly being lost through lack of agreement with the supervisor's titre. A few candidates are still losing marks for not including the units when calculating the average titre. Candidates should clearly indicate which titres they are using to calculate the average when they have obtained three (or more) values in addition to the rough value.
 - (b) This colour change is well known from the acceptable colours booklet.
 - (c) This equation was very well known with the vast majority of candidates gaining both marks.
 - (d) The calculation was generally well answered with the majority of candidates gaining at least four or five of the marks available. The calculation of the percentage of ethanoic acid in the vinegar proved to be the most difficult step.
 - (e) This was well answered by the vast majority of the candidates with many gaining full marks. The range of acceptable answers in the mark scheme was increased and this favoured the candidates. Many candidates referred to the washing of the glassware in meticulous detail.

- Q2**
- (a)
 - (i) Descriptions of **A** were generally good. Too many candidates referred to 'a transition metal' or 'not a Group 1 or 2 metal' without recognising the presence of the ions or compound.
 - (ii) This was generally well answered. A number of candidates referred to the formation of a white solution instead of a white precipitate. Only a few candidates confirmed the presence of both chloride and copper ions in part (c).
 - (iii) This was well answered with the majority of the candidates correctly identifying the presence of the sulfate ions.
 - (iv) This was very well answered with many candidates gaining full marks.
 - (v) This was well answered. Many candidates gained the marks for the absence of carbonate/hydrogencarbonate ions from earlier observations.
 - (vi) This was generally well answered. The mark scheme was extended to include condensation as an observation and the colour change from green to white/brown.

Most candidates were able to correctly identify the two salts. Names are asked for in the question so if formulae are given instead they must be correct.

- (b) This was well answered by the majority of the candidates. It was agreed to accept that the precipitates indicated the presence of chloride, bromide or iodide ions as well as chlorine, bromine or iodine present. Candidates lost marks for not including the 1- when naming the samples and also frequently not giving the correct order of reactivity despite having effectively recorded it in their observations.

Section B

- Q3**
- (a)
- (i) Many candidates failed to state that the water is bonded into the structure, instead referring to it being trapped.
 - (ii) Many candidates incorrectly referred to water or steam given off as opposed to condensation or a vapour given off. The use of water or steam is a deduction not an observation.
 - (iii) This had been asked previously and was well answered by the vast majority of the candidates.
- (b)
- (i) This was well answered by the majority of the candidates.
 - (ii) This was well answered by the vast majority of the candidates.
 - (iii) This was well answered by the majority of the candidates. Some candidates lost a mark by incorrectly rounding the value to 0.06 instead of 0.07.
 - (iv) This was very well answered by the vast majority of the candidates.
 - (v) This was well answered by the majority of the candidates. Rounding in part (iii) gave an answer of 7 and this was accepted, if done correctly, by the examiners.
 - (vi) This was not well answered by the majority of the candidates. Many candidates simply referred to water having evaporated as a viable explanation.
 - (vii) This was poorly answered with only the most able candidates referring to the possibility of thermal decomposition.
- (c)
- (i) This was very well answered by the vast majority of the candidates.
 - (ii) This was poorly answered by many candidates. Many referred to recrystallisation and often those who referred to reducing the volume of the solution simply evaporated it to dryness.
 - (iii) This was generally well attempted by the majority of the candidates. The most common error was the use of 120 for the RFM of the hydrated crystals instead of 246.
- Q4**
- (a) Most candidates stated that volatile meant reactive.
- (b)
- (i) This was generally well answered although some candidates suggested that the sodium dichromate was to show that oxidation had occurred and was therefore acting as an indicator.

- (ii) This colour change is well known by the vast majority of candidates.
 - (c) (i) This was generally well answered by the majority of the candidates. The most common error was to suggest that the ethanol would evaporate off.
 - (ii) Many candidates gave inorganic substances as possibilities e.g. CO₂ and sulfuric acid.
 - (iii) This was well answered by the majority of candidates, with many gaining both marks.
- Q5**
- (a) The majority of the candidates correctly identified the formation of the white precipitate in both cases. Candidates lost marks for errors such as ‘the aluminium does not dissolve in the excess ammonia solution whereas the zinc does’. This was penalised as one error.
 - (b) The flame test for sodium was very well answered. If the flame test was described some candidates failed to state that a blue flame should be used and were marked down accordingly.
- The use of iron(II) ions to test for thiocyanate ions was well known although some candidates did not refer to the solution turning blood red or the formation of a blood red solution.

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

Overall, the performances in this paper were very encouraging. The mean mark for this paper was significantly higher than normal. Statistics suggest that candidates coped well with the Multiple Choice questions with 3 and 4 being the most discriminating.

- Q11** In general, candidates performed very well in this question. Typical Grade A candidates scored 5 or 6 whereas a typical Grade E candidate scored 1 or 0. The most common mistakes were to ignore the fact there was an excess of ethanoic acid and an excess of the oxidising agent. Candidates could score in (a) (ii) by carrying an error through from (i). Many did not include units.
- Q12** Typical Grade A candidates scored 9 or higher whereas a typical Grade E candidate scored 5 or less. State symbols were often missing in the cycle. In the calculation, many candidates did not double the atomisation enthalpy of chlorine or divide the enthalpy change on the top right of the cycle by two to obtain the electron affinity. The electron structures were very well done, however, a small number of candidates gave the structure for the atoms. The definition was not well known.
- Q13** Typical Grade A candidates scored 23 or higher whereas a typical Grade E candidate scored in the low teens. It is now clear that centres are teaching the E-Z nomenclature very well and the responses were very impressive. Distinguishing between aldehydes and ketones proved to be very easy for most candidates. It was remarkable the number of candidates who wanted to distinguish between ‘keytones’ and aldehydes. The 2,4-dinitrophenylhydrazine

presented very few difficulties for most. Candidates should be encouraged to 'match the melting point with that of a known 2,4-dinitrophenylhydrazone using tables of data'. Too many talked about matching to the melting point of butanone rather than its derivative. The use of [O] and/or [H] in equations requires some attention in many cases.

- Q14** Typical Grade A candidates scored in the high teens or low twenties whereas a typical Grade E candidate struggled to reach double figures. The most common incorrect answer for (a)(iv) was 0.70 since many candidates did not use 0.40 as the concentration of hydrogen ions. Elsewhere part (a) was reasonably well done. Some candidates did not give the full expression for the acid dissociation constant. The expression involving the square of the hydrogen ion concentration was common. The calculation in part (b) was well done by the vast majority of candidates. Part (c) proved to be much more discriminating with many candidates struggling with the buffer calculation and the explanations in (iii) and (iv).
- Q15** Typical Grade A candidates scored close to full marks whereas a typical Grade E candidate struggled to score half the available marks. In general, candidates seemed to be very 'tuned in' to the significance of the structure of a fat/oil and the calculations in (a)(iv) were very impressive. Covalently bonded potassium atoms appeared in (a)(i).
- Q16** Typical Grade A candidates scored in the mid to high teens whereas a typical Grade E candidate struggled to reach double figures. Most candidates coped well with part (a) although the explanation in (ii) was often unconvincing. Even some of the better candidates struggled to link the rate equation with the mechanism. This is an area which may need attention. It was clear in part (b) that the understanding of the terms was in many cases quite poor. Parts (b)(iii) to (b)(v) produced very good responses in most cases.

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

Most candidates made a successful attempt at completing the majority of the questions. The range of questions 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.

In a small number of cases the legibility of the candidates writing was poor and made for difficult marking. If answers are illegible then they cannot be rewarded by the examiners and candidates may lose marks needlessly.

- Q11**
- (a) (i) The word 'plane' was occasionally misspelt, disappointing at this level. Two marks were available for the answer so candidates were expected to use the word 'plane' twice in the answer i.e. rotate the **plane** of **plane** polarised light.
- (ii) A number of candidates failed to draw an acceptable 3D structure, a few did not attempt to do so. The asymmetric carbon was generally shown correctly.

- (b) Many candidates discussed hydrogen bonding and lost marks accordingly. When the zwitter/ionic nature was identified candidates often did not include the attraction between the oppositely charged ions.
- (c) This was generally well answered and when the sodium salt was given examiners accepted this as long as the correct charges were shown.
- (d) Many excellent answers were given and most candidates received both marks. A small number of candidates drew a structure using hydrogen bonds which was unacceptable.
- (e) (i) The concept of R_f value was well understood.
(ii) Few candidates obtained both marks in this question. A reasonable number of candidates recognised that the amino acid was not very soluble in the solvent but failed to note that it was more soluble in the stationary water phase within the paper.
- (f) It was disappointing that many candidates were unable to complete this simple empirical formula calculation, which should be within the scope of able GCSE candidates. The majority of candidates did obtain full marks.
- Q12** (a) The electronic configuration was generally given correctly. However many candidates referred to both the half filled d and s subshells when explaining the stability.
- (b) Many candidates used the Cr_2O_3 as the limiting reactant and so lost a mark. Most candidates did manage to obtain at least 3 out of the 4 marks.
- (c) This was generally well answered.
- (d) (i) This was very well answered by the vast majority of candidates.
(ii) This was very well answered by the vast majority of candidates.
- (e) (i) The suitable reducing agent, ethanol, was reasonably well known but candidates did give responses such as lithal, hydrogen peroxide and conc. sulfuric acid.
(ii) The colour of the chrome alum was better known than the formula although many candidates did obtain both marks.
- (f) (i) The majority of the candidates were able to give the correct empirical formula. A number of candidates gave the molecular formula instead of the empirical formula.
(ii) A range of reagents were given including conc. sulfuric acid and conc. hydrochloric acid and tin and hydrochloric acid. Candidates often lost a mark for using conc. hydrochloric acid with the sodium nitrite.
(iii) The correct temperature range was given by the majority of the candidates. Many did not refer to the stability of the diazonium ion for the second mark.
(iv) This was generally well answered. Candidates lost marks for failing to include both $-NH_2$ groups on the dye or by coupling the diazonium ion with phenol.

- (v) Most candidates gained some marks here but few were able to gain full marks. Marks were lost for describing the colour as due to the emission of light when electrons fell back to their ground state, failing to explain that the energy levels were closer together, or failing to mention the conjugation/delocalisation of the electrons.
- Q13**
- (a) This was generally well answered although a number of candidates did give the negative ion by mistake.
- (b) (i) This was poorly answered as candidates failed to apply the peak integrations to the ethyl ethanoate molecule.
- (ii) Again this was poorly answered as the candidates failed to apply the chemical shifts to the ethyl ethanoate molecule.
- (iii) The splitting pattern was well understood with most candidates gaining a mark.
- (iv) The source of the singleton was again well understood by candidates.
- (c) (i) This equation was generally well answered, with most candidates gaining the mark.
- (ii) This equation was again well answered with most candidates gaining the mark.
- (iii) The hydrochloric acid product was poorly answered with a number of candidates giving the acyl chloride as the product. The salt formed with the sodium hydroxide was well answered. A small number of candidates named the products instead of giving the formulae and lost marks accordingly.
- (d) (i) A number of candidates again used names instead of formulae. Many candidates used NaCN for A, which was generally poorly answered. LiAlH_4 was better known as B.
- (ii) This equation was reasonably well known. The most common mistake was the formation of RCl instead of HCl.
- (iii) Many candidates began by giving details of recrystallisation which were unnecessary. Most candidates were able to gain some, if not all of the marks, for then describing the taking and use of the melting point. A few candidates described the use of boiling points and other inappropriate chemical tests and failed to gain any marks. The vast majority of candidates who gained marks for the description also gained both marks for QWC.
- (e) (i) Candidates often gained one mark by describing two lone pairs or two co-ordinate bonds but frequently failed to give both answers as required by the mark scheme.
- (ii) This equation was generally well answered.
- (iii) The understanding of entropy was generally good but candidates often failed to give the increase in the number of molecules and failed to gain the second mark.

- Q14**
- (a) A surprising number of candidates failed to get both electronic configurations correct, Fe^{2+} being more frequently incorrect. A disappointing number of candidates failed to gain any marks.
 - (b) Chemisorption was generally well understood although a small number of candidates still refer to **absorb** instead of **adsorb**. Only a few candidates gained full marks as many did not refer to the weakening of the bonds in the reactants or the lowering of the activation energy.
 - (c)
 - (i) The mechanism for the bromination was generally well known with many candidates gaining full marks. The most common error was the use of Br^- in the first step or the incorrect use of charges in the other steps. Some candidates failed to include the H^+ in the final step. The use of arrows, although not necessary, should be correct if included in such mechanisms.
 - (ii) The name of the product was generally correct. The most common mistake was the use of 3-bromo instead of 2-bromo.
 - (d)
 - (i) The role of the iron in 'binding' the oxygen was reasonably well understood. The role of the haemoglobin was rarely given.
 - (ii) Few candidates recognised the irreversible nature of the carboxyhaemoglobin complex.
 - (e) Generally well answered although candidates lost a mark for the use of -3 instead of 3- when giving the charge of the ion.
 - (f)
 - (i) Many candidates failed to give correct colours even though these are available on the acceptable colours list. Examiners will use these colours and descriptions only to allow for consistency when marking papers.
 - (ii) Few candidates recognised the 3:5 ratio and so lost one mark. The majority of candidates were able to gain three out of the four marks.
- Q15**
- (a)
 - (i) The conditions were not well known even though they have appeared on recent mark schemes.
 - (ii) The explanations of the flexibility and softening temperatures were generally good but often candidates failed to state both the flexibility and softening temperature of the HD polythene and so lost a mark.
 - (b) The structure of Perspex was poorly drawn with few candidates gaining both marks.
 - (c)
 - (i) The term condensation polymer was well known and the vast majority of candidates gained this mark.
 - (ii) Candidates frequently lost marks for drawing this as a dimer instead of a repeating unit. The peptide link was often vaguely and incorrectly indicated.
 - (d) It was widely recognised that polyesters are biodegradable but few candidates stated that this was because they are hydrolysed and so, few candidates gained both marks.

- (e) (i) This was very well known with the vast majority of the candidates gaining the mark.
- (ii) Most candidates recognised the 'lock and key' mechanism/active site or that the activation energy was lowered but often did not give both and so only gained one mark.

Assessment Unit A2 3 Internal Assessment

Paper 1

- Q1** (a) The practical papers at both AS and A2 produced a lot of comments from centres with regard to the titrations and the subsequent questions. Problems have been created in the past with the award of marks for answers which involved cleaning and drying titration glassware when it was stated in the question that the apparatus was clean and dry. In response to centres comments marks were restored in the A2 3 papers for correctly cleaning and drying and this certainly increased the marks awarded for Q1(a). As in previous examinations it was felt that most, if not all candidates would use a pipette filler to fill a pipette. This has been common practice for many years but it was omitted by many candidates. Some centres wished to comment on the difficulty of performing permanganate titrations and the ways that these difficulties could be voided. However, in view of the essential procedures to be carried out for a total of six marks these could not be accepted. Following comments from centres the average mark rose for virtually all candidates and the majority of candidates obtained five or six marks.
- (b) The presentation of a suitable table was correctly carried out by all candidates. It was essential that units were given and that the correct headings were presented. There does appear to be an increased number of candidates who are presenting three accurate titrations rather than the expected two. This leads to a need to give clear advice on how average titres should be calculated if multiple titre results are presented. The vast majority of candidates obtained maximum marks for the calculation of the average titre, the number of significant figures, and titration consistency.
- (c) The list of acceptable colour changes states that the change is from colourless to pink and these were the exact words used by candidates. If candidates stated that the colour was pale pink or even permanent pink, these colours were accepted because they did not influence the actual colour seen.
- (d) For whatever reason, equations always seem to be better written in the first half of practical papers compared to those asked in theory papers or in the latter sections of practical papers. Consequently this equation was universally correctly written.
- (e) The calculation of the molarity of the iron(II) ammonium sulfate solution was variably tackled. The first step in the calculation was usually performed correctly but there were often problems with the second step which involved scaling up from 25 cm³ to 1000 cm³ (i.e. x40). It was frequently omitted.

- (f) Part (f) was of course more challenging than part (e) and could be calculated in several different ways. Although all of the answers involved decimal places they were all rounded off to the nearest whole number. Although the majority of candidates obtained the correct value of $n=6$ it was a case of either candidates knowing the correct procedure or not.

Q2

- (a) (i) Candidates are familiar with the type of questions asked in Q2 and the standard answer of the pink solid being a transition metal ion or compound was given. Very few candidates made the error of stating that a transition metal was present. Although a purple colour is incorrect, solid cobalt chloride can be a darker colour than pink, although this was the most popular answer. Such colours were accepted. It was correctly considered that only the colour of aqueous cobalt ions is listed in the acceptable colours publication and that there is no definite ruling on the colour of the solid.
- (ii) It should be noted that even though soluble appears in both the observation and deduction column it could not be awarded twice. Most candidates developed the argument that the test confirmed the presence of cobalt ions.
- (iii) The test with silver nitrate proved to be relatively easy. The two essential points for the observation were that a white precipitate was formed. Two marks were stated for this question and hence those who stated that a pink solution was left could not be rewarded.
- (iv) Although the mark scheme originally stated that an insoluble hydroxide was formed i.e. cobalt hydroxide there were arguments that this was the first positive chemical test for cobalt ions and consequently a far wider range of answers involving various aspects of cobalt chemistry were accepted. The blue colour had to be associated with a precipitate. Occasionally it was not.
- (v) When concentrated ammonia solution was added to the cobalt chloride solution three observations were needed and they were usually given.
- (vi) When concentrated hydrochloric acid was added to the cobalt chloride solution, one observation was needed which was usually given. In addition, it was frequently stated that heat was produced.
- (vii) A range of variations on cobalt chloride were accepted i.e. cobalt(II) chloride, hydrated cobalt chloride etc. However, if an incorrect formula was also given the mark was lost.
- (b) The featuring of glycine as an unknown posed one or two difficulties! All practical examinations are pre-tested as indeed was this one on more than one occasion. Initial results with the melting of glycine posed no problems. However, it was discovered that differently aged samples produced quite different experimental results. Consequently, in the interests of safety, the examination paper was altered.

- (i) Some controversy continued with the marking of the paper. It could be argued that glycine is the only white solid in A2 of the chemistry specification apart from alanine. Other solids are few and coloured or indeed crystalline. Hence it was acceptable to directly state that substance B was an amino acid. Stronger candidates added amides, but care was needed. If incorrect amides were introduced the mark could be lost. A few candidates thought that B might be an organic salt but the introduction stated that it was organic.
- (ii) Care was needed in stating that ammonia gas was produced. For example, some candidates stated that B contained ammonia or the ammonium ion. Ammonia being given off was acceptable. Naturally, it was also acceptable to say that the compound contained nitrogen or it was a nitrogen-containing compound.
- (iii) It was expected that a pH value would be given because it was asked for. However, a small number of candidates wished to state that the solution was neutral but this was not the question asked. Dark green was not accepted, pH 6 was acceptable but pH 7 or 8 was not.
- (iv) Virtually without exception candidates stated that the solution turned blue. The difficulty was in stating why. A complex of glycine would be expected rather than a glycine salt. Very often formulae were written that were dubious with bonds that neither indicated a complex nor a salt. Mention was made of ligands which was vague but acceptable.
- (v) Candidates correctly observed that there was no change in the colour of the potassium dichromate(VI). A variety of answers were produced for the deduction involving either redox or presenting a list of compounds. A fairly frequent error was to include aldehydes and ketones as one group when they would, of course, act independently.

There were comments on the n.m.r and infra-red spectra presented. These were the 'real' spectra although not completely perfectly reproduced. The only confusing issues for candidates were the very small peaks around the singlet in the n.m.r spectrum and the integration which was for the protonated species. However, candidates were not distracted by these issues.

Glycine was deduced by greater than 99% of the candidates. There were occasional incorrect answers such as phenylamine and alanine.

- Q3**
- (a) The equation was correctly written but the state symbols were often incorrect.
 - (b) Similar questions have been set in previous papers on the earlier specification and this question was well done despite its demanding nature.

- (c) Although it was usually stated that sodium or sodium peroxide reacts with water, the actual reason for the use of dry oxygen was often wrong. The formation of hydrogen was mentioned but also the formation of sodium hydroxide. Both substances are irrelevant to the actual yield of sodium peroxide.
- (d) The drawing of labelled diagrams is a regular feature of CCEA chemistry examinations. The use of a U-tube was illustrative in the mark scheme despite a comment that they were not used in GCE chemistry! A test tube with a small hole at the end was accepted as a combustion tube. Very few 'good' diagrams were seen. The major problem was with pieces of unrecognisable apparatus and the lack of glass tubing and bungs. There was also the problem of not drying the oxygen or not using a suitable method. Consequently very few diagrams, indeed, obtained the maximum of four marks.
- (e) (i) The introduction to part (e) had been carefully prepared with the formula of disodium hydrogenphosphate given and that of phosphoric(V) acid was deducible. Despite the help, the question was demanding and discriminating.
- (ii) A similar comment is applicable to part (ii) which although might be thought cumbersome supplied the necessary information. The essential point of 'water removal' was missed by the majority of candidates. So, the question was again demanding and discriminating.
- (f) It was apparent that many candidates were unfamiliar with GLC. What was expected to be a relatively easy question proved to be quite demanding. Quite a few candidates used a glowing splint despite the insistence on GLC. Others seemed to think that all you needed to do was pass the oxygen through and then use known data in a similar way to that used with melting points e.g. 'Pass products of the reaction through the GLC machine, once results are obtained compare them to published data to prove that O₂ was produced?.'

Others thought that the process was similar to that of mass spectroscopy.

'The particles would be propelled through a GLC. The particles that have less charge would make it to the end of the column. A spectrum would be produced and compared with official published spectra to identify the gas'.

Quality of written communication was not just for part (f), it was for the whole of Q3.

Paper 2

- Q1 (a) The practical papers at both AS and A2 produced a lot of comments from centres with regard to the titrations and the subsequent questions. Problems have been created in the past with the award of marks for answers which involved cleaning and drying titration glassware when it was stated in the question that the apparatus was clean and dry. In response to centres comments, marks were restored in the A2 3 papers for

correctly cleaning and drying and this certainly increased the marks awarded for Q1(a). As in previous examinations it was felt that most, if not all candidates would use a pipette filler to fill a pipette. This has been common practice for many years but it was omitted by many candidates. Some centres wished to comment on the difficulty of performing permanganate titrations and the ways that these difficulties could be voided. However, in view of the essential procedures to be carried out for a total of six marks these could not be accepted. Following comments from centres the average mark rose for virtually all candidates and the majority of candidates obtained five or six marks.

- (b) The presentation of a suitable table was correctly carried out by all candidates. It was essential that units were given and that the correct headings were presented. There does appear to be an increased number of candidates who are presenting three accurate titrations rather than the expected two. This leads to a need to give clear advice on how average titres should be calculated if multiple titre results are presented.

The vast majority of candidates obtained maximum marks for the calculation of the average titre, the number of significant figures, and titration consistency.

- (c) The list of acceptable colour changes states that the change is from colourless to pink and these were the exact words used by candidates. If candidates stated that the colour was pale pink or even permanent pink, these colours were accepted because they did not influence the actual colour seen.
- (d) For whatever reason, equations always seem to be better written in the first half of practical papers compared to those asked in theory papers or in the latter sections of practical papers. Consequently this equation was universally correctly written.
- (e) The calculation of the molarity of the iron(II) ammonium sulfate solution was variably tackled. The first step in the calculation was usually performed correctly but there were often problems with the second step which involved scaling up from 25 cm^3 to 1000 cm^3 (i.e. $\times 40$). It was frequently omitted.
- (f) Part (f) was of course more challenging than part (e) and could be calculated in several different ways. Although all of the answers involved decimal places they were all rounded off to the nearest whole number. Although the majority of candidates obtained the correct value of $n=6$ it was a case of either candidates knowing the correct procedure or not.

- Q2**
- (a) (i) Candidates are familiar with the type of questions asked in Q2 and the standard answer of the solid being a transition metal ion or compound was given. Very few candidates made the error of stating that a transition metal was present. The problem of alternative colours did not occur on paper 2 compared to paper 1.
- (ii) It should be noted that even though soluble appears in both the observation and deduction column it could not be awarded twice. Most candidates developed the argument that the test confirmed the presence of nickel ions.

- (iii) The test with silver nitrate proved to be relatively easy. The two essential points for the observation were that a white precipitate was formed. Two marks were stated for this question and hence those who stated that a green solution was left could not be rewarded.
- (iv) Although the mark scheme originally stated that an insoluble hydroxide was formed i.e. nickel hydroxide there were arguments that this was the first positive chemical test for nickel ions and consequently a far wider range of answers involving various aspects of nickel chemistry were accepted. The green colour had to be associated with a precipitate. Occasionally it was not.
- (v) When concentrated ammonia solution was added to the nickel chloride solution two observations were needed and they were usually given i.e. the green precipitate dissolves to form a blue solution.
- (vi) When edta solution was added to the nickel chloride solution one observation was needed which was usually that the blue colour stayed. In other words it was difficult to state that a reaction occurred and this was accepted.
- A range of variations on nickel chloride were accepted i.e. nickel(II) chloride, hydrated nickel chloride etc. However, if an incorrect formula was also given the mark was lost.
- (b) The featuring of glycine as an unknown posed one or two difficulties! All practical examinations are pre-tested as indeed was this one on more than one occasion. Initial results with the melting of glycine posed no problems. However, it was discovered that differently aged samples produced quite different experimental results. Consequently, in the interests of safety, the examination paper was altered.
- (i) Some controversy continued with the marking of the paper. It could be argued that glycine is the only white solid in A2 of the chemistry specification apart from alanine. Other solids are few and coloured or indeed crystalline. Hence it was acceptable to directly state that substance B was an amino acid. Stronger candidates added amides, but care was needed. If incorrect amides were introduced the mark could be lost. A few candidates thought that B might be an organic salt but the introduction stated that it was organic.
- (ii) Care was needed in stating that ammonia gas was produced. For example, some candidates stated that B contained ammonia or the ammonium ion. Ammonia being given off was acceptable. Naturally, it was also acceptable to say that the compound contained nitrogen or it was a nitrogen-containing compound.
- (iii) It was expected that a pH value would be given because it was asked for. However, a small number of candidates wished to state that the solution was neutral but this was not the question asked. Dark green was not accepted, pH 6 was acceptable but pH 7 or 8 was not.

- (iv) Virtually without exception candidates stated that the solution turned blue. The difficulty was in stating why. A complex of glycine would be expected rather than a glycine salt. Very often formulae were written that were dubious with bonds that neither indicated a complex or a salt. Mention was made of ligands which was vague but acceptable.
- (v) Candidates correctly observed that there was no change in the colour of the potassium dichromate(VI). A variety of answers were produced for the deduction involving either redox or presenting a list of compounds. A fairly frequent error was to include aldehydes and ketones as one group when they would, of course, act independently.

There were comments on the n.m.r and infra-red spectra presented. These were the 'real' spectra although not completely perfectly reproduced. The only confusing issues for candidates were the very small peaks around the singlet in the n.m.r spectrum and the integration which was for the protonated species. However, candidates were not distracted by these issues.

Glycine was deduced by greater than 99% of the candidates. There were occasional answers such as phenylamine and alanine.

- Q3**
- (a) (i) The equation was not always correctly written because of the confusion over the name sodium sulfate(IV), apparently because of the different methodology at GCSE but this should not have been such a problem at GCE. The state symbols were often incorrect.
- (ii) The formula of the pentahydrate was correctly deduced by the great majority.
- (b) Similar questions have been set in previous papers on the earlier specification and this question was well done despite its demanding nature.
- (c) The drawing of labelled diagrams is a regular feature of CCEA Chemistry examinations. It was expected that the use of vacuum filtration would be well known and indeed it was, but very few 'good' diagrams were seen. The major problem was the location of the side arm to the conical flask. It should have been near the top but it was frequently drawn half way down or towards the bottom. The funnel should have been attached through a bung but frequently it was just lying on the top of the flask. Often, when it did have a bung the glass tube did not pass through. Consequently very few diagrams, indeed, obtained the maximum of four marks.
- (d) There were two possibilities for using the ethanol to wash sodium thiosulfate. Either it was to remove water and thus help to dry the sodium thiosulfate or it was to remove impurities which were not soluble in water. The introduction to part (d) had tended to remove the former answer as it was said that the crystals were dried using filter paper. However the answer '*Removes any impurities insoluble in water*' was seen and was awarded two marks.

- (e) (i) It has been said many times that the equation for the reaction of iodine with sodium thiosulfate should be well known, especially at A2 level. Although the majority obtained the correct result, it should have been a greater number.
- (ii) Naturally, there were problems with this question as to whether I or I₂ was used depending on the interpretation of the equation written in part (i). Although the majority deduced the correct answer it was not a substantial majority. The question was demanding and discriminating.

Quality of written communication was not just for part (e), which was somewhat impossible, it was for the whole of Q3.

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