

GCE



Chief Examiner's and
Principal Moderator's Report
Chemistry

Summer Series 2018



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.

Contents

Assessment Unit AS 1	Basic Concepts in Physical and Inorganic Chemistry	3
Assessment Unit AS 2	Further Physical and Inorganic Chemistry and an Introduction to Organic Chemistry	8
Assessment Unit AS 3	Basic Practical Chemistry	10
Assessment Unit A2 1	Further Physical and Organic Chemistry	12
Assessment Unit A2 2	Analytical Transition Metals, Electrochemistry and Organic Nitrogen Chemistry	16
Assessment Unit A2 3	Further Practical Chemistry	20
Contact details		23

GCE CHEMISTRY

Chief Examiner's Report

Assessment Unit AS 1 Basic Concepts in Physical and Inorganic Chemistry

Although it might have been thought that the examination was a difficult one because of one or two new questions in Section B of the paper and a difficult question on testing the solubility of the gas chlorine monoxide the total mark for the paper was very similar to the previous year's examination. In fact Section B was the easier part of the paper and Section A had more demanding questions than for many years. The severity of the multiple choice questions was balanced by the relative easiness of Section B. The results of some of the multiple choice questions were surprising. For example, Question 5 which dealt with the planarity of molecules had a facility of 0.48 but was highly discriminating with a discrimination index of 0.43.

- Q11 (a) (i)** Most candidates knew that indicator paper was required to test for chlorine. The most frequent mistake was not to dampen the paper and there was also the mistake of stating that it went red and failing to mention that it was bleached. A variety of indicators were used including litmus and pH paper. Rarer mistakes were to use tests that could not be reasonably carried out such as making a solution of the gas. Tests such as using silver nitrate solution or the smell of chlorine were rarely used. It need not have been said where the test was carried out but it could not have been carried out in the U-tube
- (ii)** The colour of chlorine was well known and candidates handled the use of hyphens or oblique strokes very well.
- (iii)** This question dealing with an applied practical situation distinguished candidates well. There needed to be care in stating what the physical change was. Of course chlorine would not freeze to a solid but there were frequent comments that a temperature lower than -34°C would cause the chlorine to boil and "to ensure that the boiling point of chlorine is not reached. Whilst there might be some truth in stating that the boiling point is not reached the emphasis had to be placed on the gaseous chlorine turning into liquid chlorine. The emphasis was on the word condense.
- (iv)** Although this was a routine chemical test it was rare for candidates to obtain maximum marks. The essential step in carrying out a chemical test is to make sure that the substance to be tested is in solution. Many candidates failed to do this. The continual problem is that candidates do not adapt to the situation which is presented. They continue to repeat the test as it is classically carried out i.e. they add nitric acid and then the silver nitrate solution. However, it was essential that they convinced the examiner that a solution had been made. In this case there was no need to add dilute or concentrated ammonia solution because the identity of a halide was not being determined, it had been said that it was necessary to show that a chloride remained in the reaction tube. A test can be made for chloride using concentrated sulfuric acid but this was not frequently seen.

- (v) The question had been carefully written to say that mercury(II) oxide decomposes when heated to form mercury and oxygen. It had been expected that candidates would choose to test for oxygen in order to prove that there was no mercury(II) oxide left. Although this was the most popular choice the use of heat to decompose the oxide was rarely mentioned. Other methods involving weighing the residue were not far behind. The identification of mercury in the residue was rarely mentioned. It was often not realised that mercury(II) oxide was not left on its own it was mixed with mercury(II) chloride.
- (vi) There is no doubt that the chemistry behind this question is in the specification. In section 1.8.2 it states “compare the solubility and colours of the halogens in aqueous and non-aqueous solvents...” And on p26, “determine the solubility of chlorine and iodine in aqueous and non-aqueous solvents”. Only a handful of candidates gave answers approaching the one given in the mark scheme. Despite this many candidates gained two marks because of the generous mark scheme which allowed dissolving the gas in a known volume of water. Despite this there were a vast number of answers that tackled the problem from all sorts of angles. Use could have been made of the facts supplied in the question i.e. the colour of the solution would change, the pH of the solution changes as does the density, mass and volume as well as the amount of chloride ion generated. Many candidates confused chlorine oxide with chlorine itself.
- (b) (i) The systematic name of hypochlorous acid was known by about half the candidates.
- (ii) The term weak acid is defined in the specification and most candidates gave the correct definition with few resorting to quoting the pH value.
- (iii) The correct balanced equation was written, almost without exception, by candidates.
- (c) (i) The definition is mentioned in the specification and listed in the clarification of terms document. It was expected to be well known and it was. Because it was a long definition with several points to be mentioned the loss of any point was penalised which limited wholesale success.
- (ii) The electronic structure of chlorine monoxide was very well drawn. The vast majority of candidates obtained the two marks. The main error was not to give the lone pairs on the chlorine atoms.
- (d) (i) The shapes of molecules are listed in the specification and the term used is bent which is also given by the Northern Ireland textbooks. The term V-shaped was rarely seen and more often listed as an alternative.
- (ii) The question quite clearly stated how many lone pairs are there in a chlorine monoxide *molecule*. However, the answer “2” was the most popular by far. The numbers 7 and 10 were also seen.
- (iii) The answer to this question was very difficult to mark. Many candidates simply stated the order of repulsion of pairs of electrons and did not relate them to the question asked. It was often difficult to interpret exactly what candidates intended to say, but examiners had to mark exactly what was written. As a consequence the mark obtained was usually one rather than two.
- (e) The change in electronegativity across periods and groups was very well known.

- (f) The substances used in treating water are listed in the specification and they were well known. The usual incorrect answers such as fluorine and fluoride were seen.
- Q12 (a)** Although the question asked was for candidates to write the state symbols in the equation the actual equation given was frequently wrong with the number of water molecules often incorrect. Although the water given off was in the form of steam it was often listed as $4\text{H}_2\text{O}(\text{l})$. The introduction to the question had proved misleading for candidates who interpreted “lava” as implying that one of the substances in the equation was a liquid rather than a solid. The success rate was a lot lower than expected.
- (b) (i) This question asked for the answer to be given to 3 significant figures which was correctly interpreted by the vast majority of candidates.
- (ii) A similar result was found for Part (ii) as with Part (i).
- (iii) The test for ammonium ions was not as well-known as other tests for anions and cations. As has been stated these tests are well described in the CCEA literature. It is essential that reagents are used as they are described. Far too often candidates added sodium hydroxide without stating it was a solution; they might have said add a few cm^3 of sodium hydroxide but they did not say that it was a solution. Too often the litmus paper was added to the alkaline solution of the ammonium ions and naturally it turned blue. There were several points to mention for the three marks available. Many candidates failed to mention all of the points. There was another way to detect ammonia gas which was to use concentrated hydrochloric acid. Frequently, candidates stated that white *misty* fumes were produced.
- (c) (i) The explanation of the term *isotopes* have been asked many times and was well known.
- (ii) The relatively easy calculation to determine the percentage abundance of nitrogen-15 was very well done.
- (iii) The calculation of the relative atomic mass of nitrogen to three decimal places was very well done. The only problem was with incorrect rounding.
- (iv) The reason for the difference in the calculated RAM of nitrogen compared to the Periodic Table had not been asked before but it was tackled well with most candidates realising that the numbers in the table were whole numbers. The phrase “rounding up” was frequently used.
- (d) (i) Although this question appeared to be quite straightforward it caused problems in marking because of the way candidates expressed themselves. The old problem of stating that the oxidation number in the dichromate ion was +6 was seen far too frequently. Added to that it was often not clear that the oxidation number was for chromium. As a consequence this question was far more difficult than expected. It was clear that candidates were often quoting the phrase from the specification when they also included electrons in their explanation even though the question was only about oxidation numbers.
- (ii) Although often not well expressed because it was not clear what was gaining electrons, candidates obtained the correct answer more frequently than in Part (i).

- (e) Although the majority thought that chromyl chloride was covalent it was not a large majority. Candidates thought that the presence of a metal meant that it was ionic. Sometimes they said that the boiling point was close to water which was correct and was awarded. There was often confusion whether the boiling point was high or low.
- 13** (a) This question was taken directly from the specification i.e. Section 1.5.1. It was expected that candidates would lose marks because they used inappropriate terms such as ions when they should have said atoms and vice versa but this was very rare. Most candidates gained high marks. The major loss of marks was not to state that sodium chloride had a giant ionic structure.
- (b) The specification mentions four physical properties which are listed in the answers. However, the Northern Ireland text books have a more extensive list and these extra physical properties were added. Despite this candidates only obtained moderate marks because they often included other physical properties which were not acceptable.
- (c) (i) Candidates are very familiar with metallic bonding and the predominant score for this question was two marks.
- (ii) The reason for the greater electrical conductivity of magnesium was well known but not always fully expressed. Often it was said that magnesium had two delocalised electrons but then failed to mention how many sodium had.
- (iii) It was not expected that such a relatively simple question would produce such a variety of answers. There were so many different answers that a whole report could be written on what was seen. Some answers were extremely bizarre involving molten metals coming out of burettes and being deflected by charged ebonite rods. Candidates not only measured amps flowing and light bulbs glowing but used ammeters and voltmeters and measured resistivity of which there was no need whatsoever. Measuring the electrical conductivity of materials is a basic fundamental of science. It does reveal that the emphasis on electrical conductivity and batteries in the new specification has not yet been taken seriously enough.
- Q14** (a) (i) The shape of an s-orbital was very well known. Occasionally it was spoiled by drawing an axis through it; x plus y axes were acceptable but only one of the axes was not.
- (ii) The shape of the p-orbital was better drawn because there was no problem with the axes. If they were included, they were included correctly.
- (iii) The definition of an orbital was very well known, indeed it is defined in the specification. Weaker answers tended to describe it as a path that the electron takes in orbiting the nucleus.
- (b) (i) The explanation of electronegativity was very well done. The definition of electronegativity is given in the CCEA documentation. Some leeway was allowed in the definition because bonding and covalent bond are mentioned and could have been combined. A few answers tended to deal with the effect of electronegativity by describing the result of electronegativity e.g. the uneven distribution of the bonding pair of electrons.

- (ii) Candidates had to be careful with their answers. Although the electronegativities of hydrogen and carbon are very similar they are not the same; hydrogen has an electronegativity of 2.20 and carbon's value is 2.55. Answers such as carbon and hydrogen have similar electronegativities were allowed. But, "the electronegativity charges cancel each other out", was not allowed.
- (iii) There were two points in the mark scheme i.e. symmetry and the polarities cancelling each other out. Both had to be mentioned. Dipoles were accepted for polarities. But bonds cancelling each other out was not accepted.
- (c) (i) There is a difference between structure and bonding. It was acceptable to give a mark for a non-linear structure of ethyne which showed the C-H bonds either on the same side of the triple bond or on opposite sides. The majority of candidates obtained the mark.

(ii) Nitrogen is other only element which contains a triple bond and the vast majority of candidates stated this.
- (d) The test for carbon dioxide is a well-known one and candidates responded appropriately. The essential two statements for two marks were limewater and goes milky but candidates also needed to state that the carbon dioxide was bubbled through/passed through/added to in order to obtain the two marks.
- (e) The start of Question 14 gave a clue by stating that the average relative molecular mass of air was 28 although it was not necessary to state it in the answer to Part (e). However, it was necessary in giving a full explanation to calculate the RMM of the gas being collected. Simply stating that the gas was lighter or heavier than air was not sufficient.

(i) The method for methane was better attempted than chlorine but less than half of candidates were successful.

(ii) The method for chlorine was less successful than with methane; chlorine was often calculated as 35.5 if it was calculated at all.
- (f) Questions dealing with van der Waals' forces, despite the frequency with which they are asked constantly cause problems. In this question far too many candidates assumed that either the presence of the double bond produced more van der Waals' forces and did not explain why or stated that the double bond required more energy to break. Mention of hydrogen bonds was very rare; there were no other atoms apart from carbon and hydrogen. Dipolar forces were obviously more popular.

Assessment Unit AS2

Further Physical and Inorganic Chemistry and an Introduction to Organic Chemistry

The paper effectively assessed many of the topics in the specification for this unit. The cross-linking of topics within an individual question highlights the importance of being able to connect concepts within chemistry. The inclusion of questions that encompassed assessment objectives from AS1 should reinforce with candidates the synoptic nature of the AS2 paper. The paper provided an opportunity for candidates of differing abilities to respond positively to the questions posed. There were sufficient opportunities for accumulation of marks through recall of definitions and balancing equations. The paper also afforded an opportunity for stretch and challenge and therefore provided differentiation by outcome.

- Q11 (a)** This question was well answered.
- (b) (i)** Most candidates were familiar with this definition and it was well answered.
- (ii)** The standard of answers provided was extremely poor. A significant number of candidates provided an answer based on branching and did not score any marks. A significant minority of candidates who recognised that the difference in boiling point was due to different strength of intermolecular forces lost marks by not stating explicitly that H-bonds and/or van der Waals' forces are found **between** molecules.
- (c) (i)** This question on representation of a structure using a skeletal formula was well answered.
- (ii)** Overall this question was well answered. However a significant minority of candidates did not read the question thoroughly and provided the answer propanone rather than ketone.
- (iii)** This question was a good discriminator. Only the most able candidates realised that it was the absence of the O-H stretching frequency rather than the appearance of a C=O stretching frequency that indicated complete oxidation of the secondary alcohol.
- (d)** Overall the standard of responses were good. However, a significant minority of candidates lost a mark for the incorrect calculation of the RMM of isopropyl alcohol and/or propanone. However, error carried forward was applied for the remainder of the calculation.
- (e) (i)** The majority of candidates were awarded one mark for recognising that H-bonds formed between the alcohol molecules and the water molecules. The second mark required candidates to state that the alcohol contained an OH group.
- (ii)** This was a stretch and challenge question which only the most able candidates answered correctly.
- Q12 (a)** The lack of knowledge of both the structure and charges of the molecular ions was highlighted in the AS1 report for the 2017 summer examinations. It was therefore disappointing that a significant number of candidates did not know the formula of the phosphate ion.
- (b) (i)** Generally well answered although a significant minority produced an equation showing the formation of the oxide rather than the hydroxide.

- (ii) This question was discriminating with only the most able candidates recognising that the same mass of strontium would equate with less moles.
 - (iii) This question was well answered. Candidates could obtain the two marks for either comparing the reactivity of strontium in relation to calcium or comparing the solubility of both metal hydroxides.
- (c) (i) This question was generally well answered.
- (ii) This question was well answered.
- (d) This straightforward question proved to be discriminating. Many candidates provided incorrect answers based on solubility or toxicity. Candidates were also penalised for stating that magnesium oxide was an alkali.
- (e) (i) The majority of candidates obtained one mark for effervescence. Only the most able candidates recognised that calcium sulfate would form a white solid.
- (ii) Very well answered.
- (iii) The majority of candidates recognised that a subtraction of the numbers provided in the table was the mass of magnesium sulfate precipitated out. However, only the more able candidates could scale from grams to tonnes, even though this information is provided in the data leaflet.
- (f) This calculation was very well known by candidates and therefore the standard of responses was excellent. However, a minority of candidates provided the value of x without providing the formula of the hydrated salt and lost one mark.
- Q13** (a) (i) This definition was well known and the majority of candidates scored two marks.
- (ii) Few candidates scored full marks in this question. The use of curly arrows to represent the movement of electrons in an organic mechanism was poorly depicted by the majority of candidates. A significant number of candidate responses included the mechanism of propene with HCl rather than Cl₂.
- (b) This question was a useful discriminator. Only the more able candidates were able to apply their knowledge of the mechanism of free radical substitution to an unfamiliar structure.
- (c) (i) The majority of candidates provided a correct structure for molecule A but many interchanged structures B and C.
- (ii) The quality of responses varied. A significant number of candidates referred to the stability of B rather than the intermediate. A minority of candidates referred to Markovnikoff's rule which is not on the specification.
- (iii) This calculation was very well answered. However some candidates only provided an empirical formula and lost a mark.
- (d) (i) The majority of candidates attained one mark. Many did not show the O-H bond. This has been highlighted in previous examiner reports.
- (ii) This question was poorly answered with the majority of candidates naming the organic product from the hydrolysis reaction.
- (iii) This question was well answered although a minority of candidates labelled the isomers as trans and cis rather than E and Z and lost one mark.
- (f) (i) This definition was not known by the majority of candidates. The most common error was to state standard conditions rather than specified conditions.

- (ii) The majority of candidates correctly calculated the RMM of the gas but only the most able identified the gas correctly. The most common error was to state the gas was chlorine.
- Q14 (a)**
- (i) Most candidates gained one mark by stating a catalyst lowers the activation energy. Few included that this resulted in more successful collisions and therefore did not gain the second available mark.
- (ii) The standard of responses in this extended writing question was excellent with many candidates scoring 6 marks.
- (b)
- (i) This equation was not well known with only a minority of candidates providing the correct equation and state symbols.
- (ii) This question was a useful discriminator with only the most able students obtaining the mark.
- (iii) Many candidates struggled with the Hess's cycle and only a small minority of students gained three marks.
- (c)
- (i) This question was poorly answered. A significant number of candidates gave an incorrect number of moles for oxygen. Few candidates included state symbols. Candidates should be aware that state symbols must be included when providing an equation involving standard enthalpies of combustion, formation etc., even if they are not directed to do so in the stem of the question.
- (ii) This question could be considered to be GCSE standard rather than AS standard. Therefore it was very disappointing that the majority of candidates did not obtain the marks for this question.

Assessment Unit AS3 Basic Practical chemistry

Booklet A

The paper appeared to be straightforward with the vast majority of candidates able to attempt all questions. Candidates generally coped very well with the new format of the paper and all candidates were able to access marks, with a significant number scoring very highly.

- Q1 (a)** This part was answered well by candidates; a number gave additional, incorrect information and consequently did not get the mark.
- (b) The part was correctly answered by almost all candidates.
- (c) This part proved to be more discriminatory than expected. Given that it was not prescriptive, a range of responses were observed. A number of candidates described the use of a lighted/glowing splint, however the question asked candidates to select an appropriate reagent and neither a lighted or glowing splint are classed as such.
- (d) This part was answered well by candidates, with expected observations routinely noted. In Part (ii), examiners once again noted the response "precipitate redissolves". This has been discussed in previous reports and once again was not credited.
- Q2** This question was well answered with most candidates scoring highly.
- (a) Most candidates scored both marks, with common mistakes including not recording data to the nearest whole number, as asked in the question, and including a reading at two minutes.

- (b) Most candidates again scored both marks. The zinc was in excess and with continuous stirring, as directed in the question, all of the copper sulfate should have reacted leaving a colourless solution when the mixture was filtered. A range of colours were accepted for the residue.
- Q3** This question was generally well answered by candidates. The discrepancy between the length of magnesium given in the apparatus and materials list and that given on the question paper did not affect the marking of the question.
- (a) This part was well answered. Centres reported a range of colours and associated pH values and these were taken into account during marking, including identification of liquid C as acidic.
- (b) This part proved to be more discriminatory. A significant number of candidates had difficulties constructing a simple table, which is a key scientific skill. Common errors included: the table not being enclosed and units given in the main body of the table. The question asked candidates to record the times obtained to the nearest second; many candidates quoted times using minutes and seconds or recorded times to a particular number of decimal places. Candidates should be encouraged to read questions fully before answering. If a candidate identified liquid C as acidic in Part (a), they were expected to include it in this part and to indicate that no reaction with magnesium was observed. The question did not ask for repeats, although a number of candidates did repeat the experiment and averaged results. This was not penalised.

Booklet B

Booklet B proved to be more discriminatory than booklet A, as with previous years.

- Q1** (a) Only the most able candidates scored both marks in this part. Many candidates scored one mark for an equation in which the reagents react in a 1:1 ratio.
- (b) Generally well answered by most candidates. Some candidates did not score the mark in Part (ii) as they simply stated that the apparatus is inverted to mix the solution, rather than to mix the solution evenly.
- (c) A number of candidates lost at least one mark in Part (i), either for not doubling the value given in the question or not answering to the number of significant figures asked for. The calculations were well answered by most candidates; if there was an error in the answer to Part (a), this was carried forward into Part (iii). The most common incorrect answer was 630, obtained by using a 1:1 ratio and not scaling up by a factor of 10.
- Q2** (a) This part was well answered by candidates; the improvements to the method and definition were well known by most candidates. A noticeable number of candidates did not score both marks in Part (iii), which was surprising given the conditions are stated in the specification.
- (b) Part (i) was answered correctly by almost all candidates. Some candidates did not state two safety precautions in Part (ii), or did not explain the stated precautions in Part (ii). In Part (iii), a number of candidates did not scale down by a factor of ten and lost a mark.
- (c) This part proved to be discriminatory. A range of incorrect answers were given for Part (i). Many candidates had difficulty with the calculations, which was surprising. A number did not include the sign in their answer to Part (iii).
- (d) Whilst the test for the sulfate ion was well known by almost all candidates in Part (iii), answers to Parts (i) and (ii) were more wide ranging and these question parts proved to be poorly answered by many candidates.

- Q3**
- (a) Despite being mentioned in last year's report, most candidates did not include the oxidation state for potassium dichromate(VI) and so did not score the mark.
 - (b) Well answered by most candidates.
 - (c) The colour change was well known by almost all candidates.
 - (d) Generally well answered, with many candidates referencing the boiling point of ethanal as given in the question stem.
 - (e) The calculation was well answered by many candidates. A number of steps were required and in some cases candidates worked through the steps correctly but were penalised for not quoting their final answer to the correct number of significant figures. In other cases, candidates did not take account of the yield given in the question.
 - (f) Generally well answered, with most candidates scoring at least one mark.
- Q4** This question proved to be the most discriminatory in Booklet B.
- (a) Part (i) was well answered by most candidates. In many cases, candidates misinterpreted Part (ii) as asking for the test for hydrogen chloride gas. Only the most able candidates scored both marks in this part.
 - (b) The part was, surprisingly, poorly answered. Many answers referenced leaks in the apparatus which was not credited.
 - (c) This part was poorly answered by most candidates. Only the most able candidates recognised that the solubility of carbon dioxide is an issue with the method of collection described. In many cases, candidates confused accuracy with reliability and described repeating the experiment and taking averages of results in Part (ii).

Assessment Unit A2 1 Further Physical and 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 generally easy to follow. The candidates appeared to have ample time to complete the paper.

Candidates should be aware that the support materials are for information and help and as such are used by the examining team when compiling the mark scheme. It is advisable that candidates should be fully cognisant of the content relevant to each module.

Candidates frequently fail to explain their answers clearly, resulting in a loss of marks which could be easily avoided.

When performing calculations candidates should be aware that correct rounding is essential and that the examiners can only mark what is on the page and not what is in the calculator. Candidates often completed calculations correctly but failed to use the number of significant figures stated in the question and so marks were lost unnecessarily. Candidates should also be aware that it is good practice, and advisable, to always include units with their answer to calculations.

It should also be noted that names and terms which appear on the specification should be spelled correctly.

- 11**
- (a)** Parts (i) and (iv) were generally correct. Part (ii) was frequently incorrectly stated as being the second ionisation energy of barium instead of the first and second ionisation energies. Part (iii) was frequently incorrectly stated as the enthalpy of atomisation of chlorine instead of the bond dissociation energy.
 - (b)** The lattice enthalpy was well known. The common errors were to omit the one **mole** of an **ionic** compound and to state that **one mole** of ions are formed.
 - (c)** This was a straightforward calculation with most candidates gaining both marks. The most common error was not to double the electron affinity of the chlorine.
 - (d)** This was very well known, although Hess's Cycle and a few others did appear.
 - (e)** Any error in Part (c) was carried forward and most candidates gained at least one mark for the calculation. Any error within the calculation was also carried forward. The most frequent error was not to double the hydration enthalpy of the chloride ions.

The question stated that the answer to the calculation was to be used to explain why barium chloride is soluble in water. This was generally poorly answered, with the calculation answer only used by the more able candidates. If the answer obtained had a positive value the explanation could not be given.

- Q12**
- (a)**
 - (i)** This was generally well answered, with the most common error the omission of the O-H bond, especially on the alcohol group.
 - (ii)** Candidates frequently did not include the -e- in the butanedioic acid. This is in the specification for propane-1,2,3-triol and should be noted for future examinations.
 - (b)**
 - (i)** With PCl_5 the most common error was not to include the alcohol group in the reaction.
 With LiAlH_4 most candidates gave the correct formula. A small number gave the aldehyde instead of the alcohol.
 With $(\text{CH}_3)_2\text{CHOH}$ most candidates gave the correct answer; some candidates also formed an ester with the alcohol group.
 - (ii)** Any error was carried through from part (i). This was well answered - with the same issue with the aberrant -e- in the name.
 - (c)**
 - (i)** Candidates have difficulty in differentiating between intermolecular forces and intramolecular forces. The answer required hydrogen bonding between alcohol/acid groups of neighbouring molecules. Often the hydrogen bonding was within molecules or stated without appropriate explanation.
 - (ii)** This was well answered, although on occasion the significant figures caused the loss of a mark. A few candidates used 5.88 g instead of 5.58 g and a small number multiplied the mass by the RMM.
 - (d)**
 - (i)** Very well answered with few errors.
 - (ii)** Very well answered with few errors.
 - (iii)** Some candidates lost the mark for stating racemic instead of racemic mixture.
 - (iv)** Many candidates described the isomers as rotating the light in opposite directions but failed to explain the equal numbers. A small number of candidates stated it was a racemic mixture without giving this as the answer to Part (iii).

- Q13 (a)** This question proved to be a good discriminator. Most candidates were able to gain one or two marks but only the more able candidates gained five or six marks. The most common errors were:
- not measuring the pH;
 - not calculating the concentration of the hydroxide ions;
 - not calculating the gradient at a number of points;
 - stating that the shape of the concentration/time graph gave the order;
 - not plotting the rate/concentration graph
 - not stating that the shape of the rate/concentration graph gave the order.
- (b) (i)** This was a difficult rate equation to determine, however the performance of the candidates was better than expected.
- (ii)** Any errors from Part (i) were carried through and so most candidates gained at least one mark.
- (iii)** This was poorly answered as many candidates appeared to mistake the rate constant for an equilibrium constant. The candidates were required to state and explain, therefore without the correct statement the explanation could not be marked.
- (c) (i)** As expected, this proved to be a very difficult calculation. The most common errors were the omission of the initial concentration of water and giving the initial concentration of the alcohol as X instead of (X - 0.5). Any errors were carried through which allowed many candidates to gain one or two marks; few gained full marks. Significant figures were again an issue for some candidates.
- (ii)** This was generally well answered with most candidates gaining both marks.
- (iii)** This was reasonably well answered.
- (d) (i)** This proved to be more difficult than expected, the answer was generally zero or two marks, with zero being more common. The ester bond was frequently incorrect and there was often no alcohol.
- (ii)** This is a new definition and was reasonably well answered.
- (iii)** These two uses are directly from the specification. This, again, was new to the specification and reasonably well answered. A number of candidates stated biofuel instead of biodiesel.
- Q14 (a)** Reasonably well answered, with the usual problems with numbers, commas and hyphens as well as the aberrant -e-.
- (b) (i)** Reasonably well answered. Marks were lost for no water being present or for the equation not being balanced.
- (ii)** Most candidates gained a mark for heat but most failed to correctly state potassium dichromate(VI) i.e. the (VI) was missing. This was reported upon last year and is as per the specification.
- (iii)** This proved to be a difficult question. Many candidates gained one or two marks but few gained five or six marks. It was a good discriminator. The most common errors were:
- wrong boiling point range;
 - no appropriate collecting vessel;
 - recrystallisation and drying between filter paper;
 - incorrect drying agent;
 - liquid going colourless on drying;

not comparing the IR spectrum with that of a pure sample;
IR spectrum same as pure sample.

- (c) (i) This reaction is well known and many candidates gained both marks. The most common errors remain the absence of water and the carbon to nitrogen bond.
- (ii) This was very well answered.
- (iii) Candidates continue to confuse intermolecular forces and covalent bonds when explaining melting points. A number of candidates referred to boiling points and many attempted to answer the question without clear reference to which melting the explanation referred. Most candidates gained one mark but few gained both marks.
- Q15 (a) (i)** This definition is directly from the support materials and most candidates gained at least one mark. The most common error was the inclusion of an atom in the definition.
- (ii) This was very poorly answered with most candidates failing to refer to the reaction as asked. Those who did refer to the reaction frequently incorrectly stated that a H^+ ion was removed from the benzene ring. Only a small minority of candidates gained the mark.
- (b) (i) Reasonably well answered, although a sizeable minority of candidates used HCl instead of PCl_5 .
- (ii) This was very poorly answered, with only the most able candidates able to recognise the reaction of PCl_5/CH_3COCl with water.
- (c) (i) This is new to the specification and was reasonably well answered.
- (ii) Again this was new to the specification and was answered better than anticipated. The most common errors were:
the + in the wrong place on the ion;
the arrow not beginning on or inside the circle;
the arrow not going to the carbon with the + charge;
the arrow not going from the bond between the H and the benzene carbon;
the catalyst not being regenerated.
- Q16 (a) (i)** It was anticipated that this would be straightforward, however that was not the case with few candidates giving the correct oxidation number.
- (ii) This was well answered with most candidates gaining both marks.
- (b) (i) This was an awkward equation to balance and a majority of candidates failed to do so correctly. A small number of candidates had O_2 on both sides of the equation.
- (ii) Any error in Part (i) was carried through and so most candidates gained at least one mark. The most common error was the omission of water followed by hydrogen chloride. Again some candidates lost a mark for the incorrect use of significant figures.
- (c) (i) The term buffer solution was well known and explained by the majority of candidates.
- (ii) This was poorly answered by most candidates. Most frequently the correct equation was given for the removal of H^+ ions but only the most able candidates were able to explain the removal of the OH^- ions and give the correct equation.

- (d) (i) This was generally well answered.
- (ii) This was generally well answered with the most common error being the use of -46.2 instead of 2(-46.2). Any error in Part (i) was carried forward.
- (iii) Again, any errors were carried forward and so many candidates gained both marks. A small number of candidates failed to include the correct unit or gave no unit for the temperature.
- (iv) Only the more able candidates recognised the answer to be activation energy.

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

Both Section A and B were of a similar standard of difficulty. The facility indices of the multiple choice questions were of a similar difficulty to those of last year.

- Q11 (a)** The colours of the aqueous solutions were well known, suggesting that candidates have been making use of the Acceptable Colour Changes and Observations document available on the microsite.
- (b) (i) The electronic configuration was well answered by almost all candidates; however, a significant number did not obtain the second mark in this question as they did not make it explicit they were talking about the copper ion rather than an atom of copper.
- (ii) The term ligand was well answered however several candidates lost the mark because of simple omissions, a significant proportion of candidates wrote about how a lone pair of electrons would form covalent bonds as opposed to a covalent bond. Candidates are advised to learn definitions from the Clarification of Terms document.
- (iii) Some candidates simply stated that the number of ligands changed without giving the reason that the chloride ion was larger. A significant proportion of candidates lost the mark by talking about chlorine atoms or chlorine ions.
- (iv) The equation was well known; however, several candidates lost a mark due to placing the chloride ions within the tetrachlorocuprate(II) complex inside curved brackets in the equation.
- (v) The colour change was answered correctly by the vast majority of candidates.
- (vi) The majority of candidates got both marks in this question, with the vast majority of candidates correctly stating that entropy was increased.
- (c) Most candidates correctly identified ethylamine as the stronger ligand and the reason for it being so was often correctly given.
- Q12 (a)** (i) The definition of standard electrode potential was well known.
- (ii) Most candidates gave this equation correctly.
- (iii) The emf was correctly calculated by almost all candidates.
- (b) The set-up of the standard hydrogen electrode was well known with few candidates making errors. Any marks lost were most commonly lost for the omission of a condition such as temperature or pressure. The quality of communication was generally good.

- Q13 (a)**
- (i)** The responses to the question with regard to the advantages of ethanoic anhydride in preference to ethanoic acid were generally not of a high standard. The synthesis of aspirin is a new topic on the specification and many candidates wrote about ethanoic anhydride being less corrosive or the reaction being easier to control. This question seemed to create confusion as evidenced by the mixed responses.
 - (ii)** The equation was well answered.
 - (iii)** The vast majority of candidates correctly identified concentrated phosphoric acid's use as a catalyst.
 - (iv)** The reason for adding water was understood by most candidates.
 - (v)** The reason for sucking air through the apparatus was correctly answered by the vast majority of candidates.
 - (vi)** The question about the use of TLC to determine whether or not the reaction was complete caused problems for the vast majority of candidates. Very few candidates realised that if the reaction was incomplete salicylic acid would remain in the mixture and that this would need to be checked for specifically. Additionally, very few candidates suggested a suitable vessel in which to perform the TLC procedure. Candidates are reminded that although the AS and A2 practical support documents are available they should always consider the context of a specific question when providing a method.
- (b)** The majority of candidates were able to follow a correct method for the calculation, but many candidates lost marks due to errors in rounding or errors in the number of decimal places used.
- (c)**
- (i)** This question, which was a new question, produced a variety of responses. Many candidates were able to obtain one mark but only a minority of candidates expressed their reasoning in a manner sufficient for two marks; as the answers were varied there was no particularly common error.
 - (ii)** This equation proved to be discriminating, the majority of candidates obtained one mark as they showed the sodium hydroxide solution reacting with the carboxylic acid group. However, only a minority of the candidates also showed that it would react with the hydroxyl group. The question offered support in Part (i) by informing candidates that the group was acidic and asking for an explanation for this behaviour; yet, it was surprising how few candidates then incorporated this information into the equation they provided.
 - (iii)** The advantage of the sodium salt was well known.
- (d)** The catalyst for the reaction with benzene was well known.
- Q14 (a)**
- (i)** The reagents for the reactions were well known, the most common error was to omit the term concentrated when describing the various acids.
 - (ii)** The structure of the diazonium ion was well presented with very few candidates making errors in the position of the charge or also showing the Cl^- ion.
 - (iii)** The structure of the azo dye was given correctly by most candidates, errors from Part (ii) were carried through and not penalised if repeated in Part (iii).

- (iv) The reason for colour in azo dyes was asked many times in the previous specification and the mechanism was well understood. The question did provide discrimination as many candidates wrote about reflection and transmission rather than simply the absorption of light. Additionally, many candidates were unable to explain in terms of delocalisation why the colours produced would be different.
- (b) The equation for the esterification of 2-hydroxybenzoic acid was performed correctly by most candidates. A minority of candidates did not provide water as a product.
- (c) (i) This was answered very well, very few candidates were unable to give a suitable use for PET.
- (ii) The vast majority of candidates understood that PET is susceptible to hydrolysis.
- Q15** (a) (i) Most candidates were able to correctly identify that solvents containing hydrogen would produce a signal, however very few were able to apply this to enable them to name a suitable solvent. Any liquid which did not contain hydrogen was accepted. The most common error here apart from not naming any solvent was to suggest tetramethylsilane, despite the fact that those candidates would often talk about tetramethylsilane producing a peak in Part (iii).
- (ii) The standard for nmr spectroscopy was very well known.
- (iii) The reasons for using tetramethylsilane as a standard were well known.
- (b) (i) The answers to this question were of a high standard, most candidates described the ethyl group correctly with few problems.
- (ii) This style of question was unfamiliar to candidates with only a minority realising that a singlet with an integration ratio of nine could only be three methyl groups all attached to a single carbon.
- (c) The question asked that candidates give a structure based upon nmr data, but again only a minority of candidates were able to do this sufficiently. Very few candidates got both alkyl groups correct, and of those who did a significant proportion attached the ethyl group to the carbonyl group. If the ethyl group was connected to the carbonyl group one mark was awarded.
- Q16** (a) (i) The ionic equation for the reaction of bromate(V) with sodium hydroxide was a synoptic element from AS1 and was not known by the vast majority of the candidature with only a handful of correct answers given. Candidates are reminded that there are synoptic elements in GCE Chemistry papers.
- (ii) Very few candidates were able to give a correct colour change for the reaction in Part (a) (i).
- (b) (i) The half-equation for the reaction of bromate(V) forming bromide was not answered well. The most common error was to give five electrons, but surprisingly some candidates gave the incorrect formula of the bromate(V) ion despite the formula being given in the stem of the question.
- (ii) The half-equation for the oxidation of iodide to iodine was well answered by most candidates.
- (iii) The errors produced in Part (b) (i) were carried through which allowed most candidates to get the mark for the overall equation.

- (c) (i) The addition of starch was considered a simple question which required what was believed to be a simple answer. However very few candidates made it clear that starch would make the end point easier to see.
- (ii) The calculation of the concentration of bromate(V) caused a number of problems. Many candidates lost marks by not rounding their numbers correctly, or by not giving the correct number of significant figures for the final answer. A number of candidates did not incorporate the ratio of thiosulfate ions to iodine. These problems meant only a minority of candidate achieved full marks in this question.
- Q17 (a)** The question stem stated that aspartame is the methyl ester of the dipeptide of phenylalanine and aspartic acid. Despite this guidance the vast majority of candidates gave the structure of the methyl ester of phenylalanine rather than phenylalanine. The response to the structure of aspartic acid was given correctly much more frequently.
- (b) (i) The vast majority of candidates circled the correct chiral centre.
- (ii) The structure of the zwitterion was mostly well answered; the most common errors were to either include the sodium ion in the structure or to remove both protons from the two carboxyl groups.
- (iii) The equation was very well answered, and most candidates handled the glutamic acid structure correctly, the most common error was to incorrectly balance the equation.
- Q18 (a)** The means by which cisplatin acts as an anticancer drug was a new question and this knowledge was very well known with the vast majority of candidates getting this answer correct.
- (b) The molecular formula of carboplatin was very well answered. Candidates handled the skeletal parts of the structure very well, with only a minority of candidates giving an incorrect number of hydrogens, which was the most common error.
- (c) (i) Deducing the oxidation number of transition metals is section 5.5.6 in the specification and is an integral part of unit A2-1. Despite this a large number of candidates did not include any reference to oxidation states in their answer to Part (c) (i). Those candidates who did answer in terms of oxidation state usually got the answer correct, however a small minority gave +6 and + 4 as the oxidation stats of A and B respectively.
- (ii) This question on shape and co-ordination number was very well answered. The majority of answers got four marks. The most common incorrect answer got three marks due to incorrectly giving the shape of B as tetrahedral.

Assessment Unit A2 3 Further Practical Chemistry

Section A

Overall, candidates performed very well in section A of the paper.

- Q1**
- (a) Despite the clear instruction given step 3, a significant number of candidates did not include the temperature of the sodium hydroxide solution before addition of the sulfuric acid.
 - (b) The responses to this question were, in general, very poor. It was not necessary to quote the uncertainty in a burette reading but many of the candidates quoted an incorrect value. $\pm 0.5 \text{ cm}^3$ was common, giving an overall uncertainty of $\pm 1.0 \text{ cm}^3$.
 - (c) Despite the clear instruction to plot a graph of “temperature change” against volume, a significant number of candidates plotted the highest temperature reached against volume.
- Q2**
- (a) A colourless solution was added to a black solid in a boiling tube. Many candidates described a “black solution” as having formed initially. Gentle heating of the boiling tube would result in some bubbling which was often described as “effervescence”.
 - (b)
 - (i) “Blue” and “precipitate” were both required and most candidates scored the one available mark.
 - (ii) Variations of the “copper” colour were accepted. All of the observations were common in the answers given although many candidates only provided 2 or 3 out of the 4. “Exothermic” was considered to be a deduction rather than an observation. A few candidates described a pungent smell.
 - (iii) Green, yellow and combinations of the two were accepted to describe the resulting solution.
 - (c)
 - (i) This worked well and the vast majority of candidates scored the mark. A small number of candidates did not include a colour “change”.
 - (ii) Most candidates scored the one mark here.
 - (d)
 - (i) In this test, a colourless solution was added to a white solid. Most candidates scored the one mark by stating that the “white solid disappeared”. The word “dissolved” was also accepted. A small number stated the white “precipitate” disappeared. Those who made reference to the solution needed to give a clear indication that a colourless solution had “formed”.
 - (ii) Due to the sodium hydroxide solution being in excess and the variation in “half a spatula measure”, there were a variety of possible observations. All involved a white precipitate. The word “redissolves” should not be used when precipitates disappear/dissolve.
- Q3** In the first test, the formation of a brown solution (or solid) was the most common response for Y. Both were accepted. The colours obtained with Universal Indicator were a cause for concern in many centres. However, only the pH was required. Those candidates who tested the contents of the test tubes after Test 1 had been carried out were not penalised. A small number of candidates failed to provide colours for the flames obtained in the third test. Some candidates indicated that Z “extinguished” the flame. Most candidates provided perfect responses for the fourth test. Overall candidates scored very well in Question 3.

Section B

- Q1** Many candidates were very familiar with the chemistry involved in these tests and had learnt the material thoroughly. The word precipitate was often missing for iron(II) and a few candidates thought that the precipitate dissolved on addition of excess ammonia solution. The “II” was sometimes missing for cobalt. The final blue solution for nickel(II) was often “green”. Candidates should not use the word “redissolves”.
- Q2**
- (a)**
- (i)** A mathematical definition was expected but a definition in words was acceptable. Some candidates had “solvent front” on the bottom line. This should have been “distance moved by the solvent front”.
- (ii)** Overall the answers to this question were poor. The solvent fronts were often not clearly labelled. The third mark, for the positions of the amino acids after running with the second solvent, was dependent on the second mark which was for the positions of the amino acids after running with the first solvent. This concept was, in general, not well understood.
- (b)**
- (i)** Many candidates included absorption ranges would not be common to both amino acids and as a result lost at least one mark. There are six ranges which would be common to both and only three were required for full marks.
- (ii)** A significant number of candidates gave the correct range but not the “associated bond”.
- (c)**
- (i)** Many candidates gave concentrated nitric and concentrated sulfuric acids. Heat and/or reflux as well as sodium “nitrate” rather than sodium “nitrite” were common errors.
- (ii)** Many candidates gave the observation for sodium carbonate and made no reference to nitrous acid. An incorrect gas for the nitrous acid reaction was often quoted.
- Q3**
- (a)** Most candidates scored the mark with only a relatively small number not quoting to one decimal place or making a mistake when calculating the temperature rise.
- (b)** Again, most candidates scored the mark but a few did not include the units.
- (c)** Many candidates used the same volume for both the metal nitrate and the sodium hydroxide solutions. Failure to actually give the formula was reasonably common even when the ratio had been calculated. A few candidates gave specific metal hydroxides such as aluminium and chromium(III) hydroxides.
- (d)** Many candidates realised that the temperature rise would be smaller but only a small number included the idea that the peak would have shifted to the left.
- Q4**
- (a)** A surprisingly large number of candidates only scored one mark in this question. The most common error was a failure to mention the “hydrogen ion” concentration. An incorrect temperature of 293K was less common.
- (b)** There were many impressive diagrams with lots of candidates scoring 2 or 3 out of 4. The most common omission was the concentration of zinc ions in solution.
- (c)**
- (i)** This was not well known by a large number of candidates. Many continued on the theme of cells and half-cells.
- (ii)** Many candidates scored full marks here.
- Q5**
- (a)**
- (i)** The systematic name proved to be a problem for most candidates. The colours suggested were mostly sensible ones based on knowledge of other manganese ions and compounds. Some candidates were familiar with the compound and knew the colour.

- (ii) Overall, well understood but easy marks were lost due to an incorrect RFM or an answer which was not quoted to “two significant figures”.
 - (b)
 - (i) Most answers were perfect. Some had the colours the wrong way round and some did not have a “colour change”.
 - (ii) Only a relatively small number had the incorrect value although a significant number did not include the unit.
 - (c) Most candidates combined the half-equations correctly.
 - (d) Most candidates made a very respectable attempt at this calculation. Carrying errors forward within this question and from Part (b) (ii) was significant in many cases. Each error was only penalised once. Common errors included not scaling by ten and use of the incorrect RFM. Candidates had to read the question carefully and give their answers to “two decimal places”.
- Q6**
- (a) Very few candidates scored the mark. All that was required was the idea that the conditions were the same for both gases.
 - (b)
 - (i) Only a small minority failed to calculate the correct values. More failed to include units for both values.
 - (ii) When marks were lost in this part of the question it was normally due to incorrect or missing units. Quite a few candidates converted from cm^3 to dm^3 and scored both marks for correct values and units.
 - (iii) This proved tricky for many. Lots of candidates felt the need to use 24 and/or 24,000 in their calculation. Errors were carried forward.
 - (c)
 - (i) There were very few convincing definitions.
 - (ii) The many candidates who obtained the correct answer for Part (b) (iii) were able to deduce the number of carbons and hydrogens in the molecular formula by subtracting 71 from the RMM. Some candidates gave a structural formula. In some cases an incorrect response in Part (b) (iii) did give a feasible dibromoalkane.
 - (d)
 - (i) Many suggestions were incorrect. This area was not well known.
 - (ii) Although there were references to silver nitrate, many candidates did not link the outcome of the test back to the answer given in Part (c) (ii). If the candidate had deduced a dichloroalkane, this would be confirmed by the formation of a white precipitate.

Contact details

The following information provides contact details for key staff members:

- **Specification Support Officer: Nuala Tierney**
(telephone: (028) 9026 1200, extension: 2292, email: ntierney@ccea.org.uk)
- **Officer with Subject Responsibility: Elaine Lennox**
(telephone: (028) 9026 1200, extension: 2320, email: elennox@ccea.org.uk)



INVESTORS
IN PEOPLE

