

CCEA GCE - Chemistry (Legacy)
Summer Series 2017

Chief Examiner's Report

chemistry

Foreword

This booklet outlines the performance of candidates in all aspects of CCEA's General Certificate of Education (GCE) in Chemistry (Legacy) 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 Introduction to Organic Chemistry	5
Assessment Unit AS 3: Internal Assessment	9
Assessment Unit A2 1: Periodic Trends and Further Organic, Physical and Inorganic Chemistry	11
Assessment Unit A2 2: Analytical, Transition Metals, Electrochemistry and Further Organic Chemistry	15
Assessment Unit A2 3: Internal Assessment	21
Contact details	24

GCE CHEMISTRY

Chief Examiner's Report

Assessment Unit AS 1 Basic Concepts In Physical and Inorganic Chemistry

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

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.

- Q11 (a)** This was very well answered with most candidates gaining at least one mark. The most common error was to refer to the outer shell instead of the outer sub-orbital/orbital.
- (b) (i)** This was answered well by the vast majority of candidates. The most common error was to give $3d^2$ instead of $4s^2$ as the outer configuration. Not all candidates used the superscript notation for the number of electrons in the outer subshell, this was accepted by the examiners.
- (ii)** Virtually all candidates gained both marks in this question.
- (c) (i)** Many candidates had not learnt this definition and so gained either no marks or one mark. Those who had learned the definition gained both marks.
- (ii)** This calculation was done extremely well with the vast majority of candidates gaining both marks. The most common error was failing to give the answer to two decimal places.
- (d) (i)** The flame colour of calcium ions was very well known with few mistakes.
- (ii)** Candidates are well acquainted with this type of question and it was answered correspondingly well. A few candidates lost a mark for failing to describe the energy emitted by the electron on returning to a lower level as light, rather giving the colour.
- Quality of written communication. Most candidates gave a full answer to the question and so were able to gain both marks.
- Q12 (a) (i)** The diagram of metallic bonding was generally well known. Marks were sometimes lost because of poor labelling.
- (ii)** The explanation of electrical conduction was very well known by the majority of candidates.
- (iii)** While the concept of magnesium having more outer electrons was well known, it was often poorly explained. Reference was often made to magnesium simply having more electrons.
- (b) (i)** It was disappointing to note that some candidates at this level drew diagrams of covalent bonding. Carelessness with charges and the number of outer electrons also cost marks. A few candidates failed to use the dot and cross notation.

- (ii) The properties expected were those listed on the specification and these were the only ones accepted.
- (c) (i) The concept of delocalised electrons in graphite was well known and well explained by the majority of candidates. The most common error was to state/imply that all of the outer electrons were delocalised.
- (ii) Again the concept of all the outer electrons of the carbon atoms being involved in bonding was well known. However some candidates lost the mark by incorrectly stating that all of the carbon electrons were involved in bonding.
- Q13** (a) The explanation of a standard solution was well known by the majority of candidates. A small number of candidates still included the volume in the explanation and accordingly lost the mark.
- (b) Candidates have become extremely good at this type of calculation and so the standard of answers was excellent with many candidates gaining full marks. The most common errors involved scaling and rounding. Candidates should be aware that incorrect rounding will be penalised and examiners can only mark what is on the page not what is on the calculator.
- (c) Only the more able candidates gave the correct answer to this question and it proved a useful discriminator. Many candidates stated that there were no impurities present.
- Q14** (a) (i) This was frequently poorly answered. Either candidates did not know the correct colours or failed to understand the convention on the support materials of using – and/when giving their answers. The use of the – means both colours are required and the / means either colour may be used.
- (ii) This was generally well explained. Marks were lost when candidates stated/suggested that more energy was needed to break the bonds, implying the covalent bonds. This again was an example of a poor explanation costing the candidates marks.
- (iii) This explanation was also generally well known. The most common error was failing to refer to the outer electrons, rather referring to electrons in general.
- (b) (i) This equation was a good discriminator, with only the more able candidates gaining the marks.
- (ii) Again this was a good discriminator, with only the more able candidates gaining the marks.
- (c) Weaker candidates were unable to assign the correct oxidation numbers and so were unable to explain why this was a redox reaction. Some candidates explained the answer in terms of electrons and so lost the marks. This style of question has been asked before and it was expected that the standard of answers would have been better.
- (d) (i) This equation also proved to be a good discriminator with only the better candidates gaining the mark.
- (ii) Many candidates were able to give the initial colour but failed to recognise the presence of the iodine when giving the second colour.
- (e) Frequently the observations given were too general and so not worthy of a mark. These observations are given in the support materials and so they were expected and the only ones accepted by the examining team.
- (f) (i) Most candidates described fluoridation as the addition of fluorine rather than fluoride to the water.

- (ii) Again poor explanations cost candidates marks. Any reference to teeth and gums or teeth and bones was not accepted. Frequently 'freedom of choice' was given as a disadvantage without any explanation.
- Q15 (a)**
- (i) The explanation of isotopes was well known. Many candidates lost the mark by referring to an atom instead of atoms.
- (ii) This table with very few exceptions was completed correctly.
- (iii) The relationship between electrons and chemical properties was well known but candidates often lost the mark by including protons in their answer.
- (b) (i) Many candidates appeared to confuse the period with the group, whilst others simply guessed an answer.
- (ii) While this was better answered than the previous part, there was still confusion between period and group and also some guessing.
- (c) (i) This equation was generally well answered. Some candidates used Fl instead of Fl as the symbol for flerovium. This error was carried through.
- (ii) This equation was generally well answered. Some candidates include water in the equation instead of hydrogen.
- (iii) This was the poorest of this group of equations with only the more able candidates gaining the mark.
- (iv) These diagrams were quite discriminatory. The usual lack of electrons on atoms and not using dot and cross notation cost marks. FlF_4 was more often correct as many candidates failed to recognise the need for dative bonding in the FlF_6^{2-} ion.
- (v) The shapes of both species were well known. The most common error was the use of square planar to describe FlF_4 .
- (e) (i) The equation for the first ionisation energy was well known. The most common error was the omission of state symbols.
- (ii) This calculation was a good discriminator with the more able candidates gaining full marks. The most common errors were the misuse of either the Avogadro Number or Planck's Constant or both.

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

The question paper as a whole discriminated well between candidates. There were a few new questions which candidates tend to find difficult. The major weakness in the paper, as seen in other examination papers, was the drawing of diagrams.

- Q11 (a) (i)** This question was based on a question that was set some years ago. It was badly answered then and it was badly answered again. A large number of candidates guessed completely inappropriate answers which were not based on the organic chemistry of fractional distillation. For example "l" gave rise to lithium, limestone and lead; "n" gave rise to nitrogen, napalm and nitroglycerine. The answers for "n" were often close to the answer e.g. naphtha, naphtha, naphtha, naphthatha, naphla and naphthol. Some of these were accepted. Answers for "g" were often accurate but the use of gasoline was a frequently wrong answer. Gas (refinery) was accepted but gas oil and gas residue was not. Whilst lubricating oil was the accepted answer it was not possible to accept lubricant.

- (ii) It was important for candidates to state one property otherwise “listing” would have lost the mark. Hence those candidates who stated that relative molecular mass and boiling point were responsible lost the mark. But if candidates carefully explained their answer they gained the mark. However, the vast majority of candidates easily obtained the mark available.
- (b) The term organic was well known but there was a considerable number of answers that stated “they are hydrocarbons and contain carbon and hydrogen”. Even when candidates stated that they contained carbon they said it was in the form of chains. Sometimes candidates challenged examiners when they said that “they are made naturally from carbon” but it was not accepted.
- (c) The answer given, almost without exception, was fractional distillation.
- (d) The products from the combustion of organic chemicals were universally given as carbon dioxide and water. Formulae were accepted instead of names despite the question asking for names.
- (e) Whilst Part (d) was relatively easy, this question posed problems. The majority of answers stated carbon monoxide and water and omitted to mention carbon. Hence the most common mark awarded was one. Despite arguments that could be made about soot being a form of carbon it was accepted. Coke was not accepted. Some candidates stated unburnt hydrocarbons which were not accepted.
- Q12** (a) (i) All candidates were able to state three observations. A few lost a mark if they said that there was a hissing noise, or that a gas was given off (because it is not an observation). Stating that the reaction is exothermic or that the temperature increases is not an observation.
- (ii) The equation for the reaction of magnesium with sulfuric acid was well done. Hardly any candidates wrote an incorrect answer.
- (iii) Answers that dealt with the solubility of barium sulfate gained the marks but answers which concentrated on polarisation and electronic configuration and the reactivity of the group two metals did not. Whilst barium sulfate was quite well done the answer for barium hydroxide frequently omitted stating that the barium hydroxide was soluble in water.
- (b) There were four marks for this diagram but all of them were very rarely awarded. The drawing of diagrams in chemistry examinations has been a frequent weakness as it was on this occasion. There were no quickfit diagrams drawn. The major omission was the addition of the sulfuric acid through a dropping funnel or some other appropriate method. The quantity of sulfuric acid used was 20 cm³ which is more than a test tube will hold so either a boiling tube or a conical flask should have been used. It is important that the way is clear through tubes and that the apparatus is not sealed. There were diagrams which simply had the magnesium in acid and the gas was collected using a filter funnel and a test tube. Such diagrams received no marks.
- (c) The answer to this question was not known. There was a wide variety of answers e.g. the nitrate ion is smaller than the carbonate ion; the nitrate ion has a smaller charge density; nitric acid dissociates fully. Although it was often stated that metal carbonates are very soluble in nitric acid, this was not an explanation.
- (d) (i) It was expected that the introduction to this question would supply the information for candidates to fully answer the experimental problem stated. Almost without exception candidates used routine chemical methods of analysis. This proved difficult if not impossible because the method used had to be appropriate for each of the carbonates. Hardly any candidates had

success using this approach. The expected answer was to heat the carbonates but then candidates omitted testing for carbon dioxide or the mass lost by the carbonate. Strangely a sizeable number of candidates wished to determine the melting points of the carbonates and gave a fully detailed account of using capillary tubes and a correct melting point method. They compared their result with tabulated data.

- (ii) This question with regard to thermal stability has been asked often and appropriate mark schemes have been produced and well learnt. Most candidates obtained the three marks available but marks were lost when atomic radius was quoted and the effect on the carbonate ion was not mentioned and the polarising effect of the metal ion was preferred.
 - (e) (i) The colours of the barium precipitates were well known.
 - (ii) It was anticipated that the equations given would simply include the necessary ions i.e. barium ions and either sulfate or chromate ions. However, the question did mention that barium chloride was being used and the majority of candidates felt duty bound to use barium chloride in the equation. This led to the production of chloride ions but for many candidates it led to the production of chlorine instead which was unfortunate as it lost both marks.
- Q13**
- (a) (i) Although the great majority thought that copper(II) chloride was a catalyst a fair minority thought it was a drying agent. The idea of copper(II) chloride as a drying agent was strangely reproduced in Part (c)(ii) when it was used as a test for water.
 - (ii) This was a straightforward question and was answered well. As soon as candidates said high pressure they had realised that there were more molecules on the left than the right and proceeded to obtain the two marks.
 - (iii) There were some interesting answers to this question. Those candidates that went completely astray thought that using oxygen was dangerous because the reaction would be too vigorous. Those who concentrated on the equilibrium sometimes made the mistake of quoting the reactants when only oxygen was meant to be commented on. Sometimes the answers had to be interpreted e.g. “oxygen is more concentrated than air”; “if oxygen was used it would increase the concentration of one of the reactants”; “oxygen is more pure”; “shift to right-hand side adding oxygen molecules to left-hand side so equilibrium would shift to the right to counteract change and reduce them”.
 - (iv) Most candidates had a good idea what the answer should be e.g. “air can easily be obtained”; “air is more readily available”; “air is free”; “air is abundant”; “air is less expensive” etc. What was not accepted was: “easier method than with compressed oxygen”; “oxygen reacts too violently”.
 - (v) Questions such as this have been set regularly and candidates are well prepared for them. Although answers were long, they arrived at the correct answer in the vast majority of cases. There was a minority which wanted to argue that operating the oxidation at a high temperature would incur extra costs.
 - (b) This was possibly the most accessible question ever set on bond energy calculations or that candidates were exceedingly well prepared. Candidates often reproduced the answer -216 kJ. Even the tiny minority that did not obtain this number inevitably obtained one or two marks.
 - (c) (i) It might be expected that the vast majority obtained six marks for the analytical tests but it was lower than expected although it was still, naturally, a sizeable number. Candidates were advantaged by the fact that “concentrated ammonia”

was accepted. This was accepted to fit in with other papers this year which had accepted this nomenclature. However, a strict procedure with regard to “solutions” will be exacted in the future. The documents in support of the specification should be studied with care because they will be used with regard to marking but the specification is the ultimate guide.

The errors made in this question were as expected. It was usually omissions which cost marks such as not stating that the indicator paper was damp. Sometimes it was extras such as misty with the test for hydrogen chloride. The use of silver nitrate as a test for chlorine was rare but was seen.

- (ii) When this question was set it was realised that few candidates would realise that it was necessary to condense the water in order to test the water by physical or chemical methods to prove that it was indeed water. Only a handful of candidates did this. However, it was decided to allow candidates to test for water despite not converting the gas to water. As mentioned earlier it was completely surprising that so many candidates used copper(II) chloride as a test for water and stated that it would turn from white to blue. Many candidates used UI which was not accepted.
 - (d) (i) The structure of 1,2-dichloroethane was well deduced by virtually every candidate. One structure was seen with two chlorine atoms on the same carbon.
 - (ii) There was a dispute with thermal cracking with a question on a previous paper in a different context. In this case the context was clear. Yet far too many candidates wished to say that it was the cracking of a hydrocarbon or as an alternative the cracking of a long chain hydrocarbon. As a consequence the question discriminated and many candidates only obtained one mark for “heat”.
 - (iii) There were very few errors in drawing the structure of polyvinylchloride. The usual error made was to place a number 3 or the letter n outside the square brackets (which were not needed).
- Q14** (a) A wide variety of answers were provided for the systematic name of octenol. There were two parts to the name i.e. the double bond and the alcohol together with the fact that it had eight carbon atoms. It was possible to give a mark for each part. Hence if candidates had given a name such as 3-hydroxyoctene it was awarded one mark because the location of the double bond was not given.
- (b) This was a new question which was answered well by candidates. The general formulae of alkenes and alcohols were well known and the general formula for the alkenol was correctly deduced by the majority of candidates.
 - (c) Virtually all candidates correctly deduced that the octanol had no E/Z isomers but many failed to correctly explain why there were no isomers e.g. “it doesn’t because it has two hydrogens bonded to the same carbon. It was important to state that the hydrogens were bonded to carbon atoms of a double bond. Sometimes general answers were given and the term group was introduced which clouded the issue when the groups were actually hydrogen atoms.
 - (d) (i) The reactions of octenol were well known. It was unfortunate that candidates insisted on putting brackets round the chlorine atom. This was penalised once but brought the mark down from three to two.
 - (ii) It was thought that this question would prove to be very difficult for candidates. It was not easy but the number of successful candidates was far greater than expected. A few candidates misinterpreted the question and there

was a sprinkling of water molecules and even hydrogen molecules. Some other candidates constructed different variations of the carbon chain. The question proved to be highly discriminating with marks from zero to three being obtained.

- (e) (i) Although potassium dichromate was well known the most common mistake was to miss out the word acidified and the mark was lost in a one mark question.
- (ii) Although the majority of candidates obtained the correct answer of a ketone there were many answers that simply removed a hydrogen atom and created an aldehyde. Other candidates had problems balancing the number of oxygen atoms in the equation and used $2[\text{O}]$ on the LHS or they left out the water molecule on the RHS. Those candidates who substituted molecular formulae for structural formulae had a problem if one of the formulae was incorrect which meant both marks were lost. This was frequently the case.
- (iii) Distillation or fractional distillation was the most popular answer although there were many answers which used a separating funnel.
- (f) Bromine water was well known in the chemical test for the presence of $\text{C}=\text{C}$ double bonds. The major problem was that candidates did not shake the mixture. This has been part of mark schemes from previous papers. There were candidates that wished to bubble octenol through the bromine water or even bubble bromine through the octenol.

Assessment Unit AS 3 Internal Assessment

Booklet A

The paper appeared to be very straightforward with the vast majority of candidates able to attempt all questions and score highly. Centres are clearly very familiar with the format and so the vast majority of candidates attained high marks.

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

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

(b) This part was correctly answered by almost all candidates.

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

(a) Test 1: Most candidates scored this mark, although the mark was not awarded for 'white powder'.

Test 2: Well answered with most candidates scoring full marks. As noted in previous reports, the observations that the 'white precipitate redissolves' upon addition of excess ammonia solution is not correct and so some candidates lost this mark.

Test 3: Well answered with almost all candidates correctly identifying the flame colour.

- (b) Test 1: Well answered with few errors.
Test 2: Well answered. The main error, once again, was that the 'blue precipitate redissolves'.
- (c) Well answered with few errors. Some candidates noted a colour change of orange to brown and only scored one mark out of the possible two.

Booklet B

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

- Q1** (a) Well answered by most candidates. Some candidates average all titres, including the rough value and so lost the mark. Other errors were not including the unit or stating 20 cm^3 .
- (b) Most candidates correctly identified the indicator and associated colour change. A small number stated phenolphthalein but were credited with a correct colour change if it was given.
- (c) The equation was well answered by candidates.
- (d) The structured calculation was well answered by most candidates; few problems were noted. The most common error was not including the appropriate unit for mass of sodium carbonate or mass of water.
- (e) A surprising number of candidates did not score this mark. Some simply stated that the sample should be heated, without reference to obtaining constant mass. Others gave a more detailed explanation and were often penalised for incorrect chemistry.
- Q2** (a) This part proved to be discriminatory, although most candidates correctly identified the two salts.
- Test 1: Well answered, although a significant number of candidates did not score the mark as they did not refer to the presence of an ion/compound. 'Does not contain a transition metal' was the most common error.
- Test 2: Well answered by candidates.
- Test 3: Generally well answered. 'Iodine ion' was the most common error. A number of candidates listed several sulfur-containing compounds and did not score the second mark as a result.
- Test 4: Well answered by candidates.
- Test 5: This part was not well answered. A significant number of candidates did not give an observation. In other cases, it was clear that the chemistry was not understood.
- (b) Test 1: Well answered.
- Test 2: A significant number of candidates did not score full marks. Listing caused many candidates to lose marks. It should be noted that litmus paper turning red simply indicates the presence of an acidic gas and not specifically hydrogen chloride.
- Test 3: Well answered, with most candidates suggesting a correct structure in Part (ii).
- Q3** (a) This question proved to be much more problematic than anticipated. The introduction to the question stated that the reaction was endothermic, however most candidates answered this part assuming the reaction was exothermic. Candidates should be encouraged to fully read all question parts.
- (b) The error in Part (a) was carried forward to this part which resulted in more candidates scoring this mark than the previous mark.

- (c) Almost all candidates only score scored two marks in this part. The volume of sulfuric acid is given to one decimal place and so a measuring cylinder was incorrect. Very few candidates identified the correct piece of apparatus.
- (d) Well answered by most candidates.
- (e) Well answered by most candidates.
- (f) This part was well answered by most candidates; the procedure was well known. The most common error was referring to the highest temperature obtained. A large number of responses did not include a reference to stirring the mixture.
- (g) As with Question 1, the calculation was well answered by most candidates. The most common error was adding the temperature change to the initial temperature, rather than subtracting this value.
- (h) Well answered by most candidates.
- Q4** (a) Part (i) was well answered by most candidates. The diagram in Part (ii) was very poorly attempted with very few scoring full marks, which was surprising. The main errors were missing labels, blockages in the apparatus and apparatus incorrectly labelled. In Part (iii), many candidates did not realise that the question asked for more than one precaution and so did not score the mark.
- (b) This part was, surprisingly, poorly answered. The most common incorrect answer was '1-methylethanol'.
- (c) Well answered by most candidates.
- (d) Generally well attempted, although a significant number of candidates incorrectly made reference to the speed of the reaction or distribution of heat.
- (e) Well answered by most candidates.
- (f) A significant number of candidates assumed the organic layer was the upper layer, despite the question stating the opposite. Most candidates correctly stated that water should be added, although fewer scored the second mark as they did not appreciate the fact that the organic layer was more dense than the aqueous layer in this case.
- (g) Well answered by most candidates.
- (h) Despite being a straightforward percentage yield calculation, it was surprising how many candidates did not score full marks. Candidates often used the wrong RMMs or did not account for the yield given in the question. A significant number of candidates did not give a unit with their final answer and so lost a mark.

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

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

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 on the calculator.

- Q11** (a) Most candidates gave the correct bonding but few did give covalent for Al_2O_3 . The pH values were less well known and this was where marks were lost, minus one for each error.
- (b) Performance in these equations was often erratic, with only the most able candidates getting them all correct.
- (i) Disappointingly, a surprising number of the candidates did not know the formula of nitric acid.
- (ii) This proved to be the most difficult of this group of equations, with only the most able candidates getting it correct.
- (iii) This equation was reasonably well known, incorrect balancing was the most common error.
- (iv) This was the best answered of these equations.
- (c) (i) This was a basic definition from the support materials and a disappointing number of candidates lost at least one mark. The most common errors were: energy change, failure to mention an ionic compound and failure to mention gaseous when describing the ions. A large number of candidates also stated that the compound would form one mole of ions.
- (ii) Candidates perform well in this type of calculation and the standard of answering was very high. The most common error was failure to divide by two, followed by the wrong sign.
- Q12** (a) (i) This equation was answered extremely well, with most candidates gaining both marks. The most common error was the use of H_2CO_3 , which lost one mark.
- (ii) Most candidates got the shift in the equilibrium correct, however some of the explanations were poor. Most candidates failed to recognise that the sodium hydroxide would neutralise the hydrochloric acid and if they did they explained the shift in terms of the water formed rather than the hydrochloric acid removed. This was accepted by the examiners.
- (b) This was a discriminating calculation. The more able candidates gained full marks, weaker candidates got some marks for error carried forward and the correct units.
- Q13** (a) (i) The natural processes expected were those stated on the syllabus and this was generally what was given. Explanations were usually good and the questions well answered.
- (ii) The examiners simply wanted the candidates to state that these gases absorbed infrared radiation. There was much confusion in the answers, resulting in marks being lost by the inclusion of incorrect information. Candidates frequently incorrectly stated that the gases reflect infrared radiation from the sun instead of remitting some of the infrared radiation absorbed after it had been reflected from the earth.
- (b) Candidates needed to state that there is more methane in the atmosphere. This was often accompanied by detailed explanations as to why this is the case. This was unnecessary.
- Q14** (a) This was very well answered by all candidates.
- (b) (i) This was well answered by most candidates. Weaker candidates failed to recognise that iron and hydrogen are both elements.
- (ii) This was very well answered with most candidates gaining both marks. The most common errors were an incorrect sign or incorrect units.
- (iii) This was also very well answered with most candidates gaining both marks. The main error was incorrect units.

- (iv) Again this was very well answered with most candidates gaining both marks. The use of error carried forward also allowed some candidates to gain both marks. The most common was the omission of units.
- (v) This was a good discriminator with only the most able candidates recognising the high activation energy.
- Q15 (a)**
- (i) This was well known and very well answered by the most candidates.
- (ii) This was also very well known with most candidates gaining both marks. The most common error was the omission of the word plane when referring to the polarised light.
- (iii) Reasonably well answered by most candidates. Weaker candidates appeared to place a random circle on the diagram.
- (b) (i) This was a difficult question and proved a good discriminator with the most able candidates getting the correct answer.
- (ii) Most candidates gained both marks by carrying the error forward from the formula given. A small number of candidates multiplied by the RMM instead of dividing.
- (c) (i) The examiners required a reference to the two carboxyl groups present and only a few candidates gave this answer.
- (ii) Many candidates gained full marks for this calculation. Others gained some marks by carrying any errors forward.
- Q16 (a)**
- (i) This structure was generally well drawn.
- (ii) The correct answer was given by only the most able candidates. This was often blank or candidates attempted to give a systematic name. Only the correct spelling of salicylate was accepted.
- (iii) This was not as well answered as the previous structure. The main errors were attaching the ethanoic acid to the carboxyl group or attaching $\text{CH}_3\text{CH}_2\text{CO}$ to the OH group.
- (iv) The better candidates recognised the use of ethanoyl chloride, although the spelling did prove problematic for some. Most candidates were able to give a satisfactory explanation for its use.
- (b) Most candidates gained at least two or three marks and many gained full marks. Those who gained four marks generally failed to explain that the drying agent left the solution clear, colourless was often incorrectly used.
- Quality of written communication: most candidates were able to gain both marks.
- (c) (i) This was generally correctly answered by most candidates. The most common error was the appearance of water as a product instead of hydrogen chloride.
- (ii) This not as well answered as the previous equation. The most common errors were the reduction to the aldehyde or incorrect balancing.
- Q17 (a)** Only the more able candidates gained both marks. Many candidates identified the van der Waals' forces but gave an incorrect explanation. RMM was often incorrectly stated as being greater for palmitic acid.
- (b) (i) Most candidates did not mention the addition of hydrogen across a $\text{C}=\text{C}$ and thus they lost the mark.
- (ii) The catalyst was very well known, with few candidates giving the wrong answer.

- (iii) Most candidates gained full marks in this calculation. Those who did not gain full marks did gain marks by carrying errors forward. The most common error was not using six iodine molecules.
- (c) Most candidates gained at least one or two marks. The main error was mixing up LDLs and HDLs. Also some candidates mixed polyunsaturated and polysaturated fats.
- Q18** (a) (i) This was generally well known with the main response dilution followed by cooling.
- (ii) The question specified an acid-base titration but candidates opted for the use of thiosulfate. Marks were generally gained for the correct use of the results. Most candidates gained one or two marks. Only the most able candidates gained full marks.
- (iii) This was very well answered with few mistakes.
- (b) (i) The rate equation was generally correct and any errors in the equation were carried through. The omission of charges was the main error.
- (ii) Very few mistakes were made when the error was carried through.
- (iii) The value of the rate constant was generally correct but the units proved difficult for most candidates with very few gaining the second mark.
- (c) Two disadvantages were required and also some clarification as to why they were disadvantages. It was not enough to state eutrophication without mentioning run off nor was it enough to state more expensive without saying what it is more expensive than. Most candidates gained at least one mark.
- Q19** (a) The systematic name was poorly answered. Only a few of the most able candidates gained the mark.
- (b) Most candidates recognised that this was related to hydrogen bonding, however some of the explanations were poor. Some candidates suggested the presence of -OH groups on the gluteraldehyde or that all the hydrogens on gluteraldehyde could hydrogen bond with the water.
- (c) (i) This very well known with most candidates gaining the mark. The most common error was the use of brick red to describe the precipitate.
- (ii) Not as well answered as the previous part, however the majority of the candidates did gain the mark. The most common error was the use of Cu or the formula of only one ion given.
- (d) (i) Generally not well answered, with incorrect balancing was the main error. Other errors included the wrong alcohol.
- (ii) Warm or heat was all that was required. Some candidates went on to incorrectly state refluxing. Most candidates gained the mark.
- (iii) This colour change is rarely wrong and that continues as the case in this question.
- (e) (i) This mechanism is very well known and was answered extremely well. The main error was the hydrogen ion missing followed by no charge on the cyanide ion.
- (ii) This reaction is also well known and was generally well answered. The most common errors were no water as a product and hydrogens missing from the nitrogens of the 2, 4-DNP and the hydrazone formed.
- (iii) Many candidates described how to carry out a melting point and then how to use it to identify the raspberry ketone. Most candidates gained the mark.

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

As is usual with chemistry examinations the results of some questions were as anticipated and others were completely unexpected. The paper as a whole discriminated well and following the pattern of previous years one of the A2 papers usually proves to be more difficult than the other one. This year it was the A2 2 paper which had a mean mark considerably lower than the A2 1 paper. This paper contained some questions which had not been asked before and these, as usual, proved to be difficult to answer.

Q1- The questions in Section A worked well. Question 3 proved to be the easiest question in Section A. The most difficult question was Question 5. All of the questions in Section A performed well.

Q11 It was not initially expected that there would be such success with this question as questions requiring the filling of tables in previous years had not been successfully done. However, the response to this question was excellent but it was also discriminating. A sizeable number of candidates gained full marks. The colours of precipitates and solutions were correctly reproduced from the lists provided in the supplementary materials for the specification. Shades of colour were acceptable but had to be exact in the case of the copper compounds. The precipitate with nickel ions was occasionally described as green-blue which was incorrect. The colour of pink is often associated with cobalt compounds and this was one of the most frequent errors in completing the table. The other most frequent error was to state that no reaction took place with several of the reactions. The question was marked on the basis that each incorrect answer had a mark deducted from the total of eight.

Q12 (a) It was not thought that this question would prove as difficult as it did for candidates. The most common error was to place two double bonds together which is not possible in a Kekulé structure. Often, the structure presented on the question paper was given. This was apparent if there was a vertical double bond on the bond joining the two six-membered rings. Incorrect structures showed 6 double bonds rather than the 5 double bonds needed. There were a number of structures that did not include bonds but gave p-orbitals or showed carbon and hydrogen atoms in the structure.

(b) (i) The problem with answers to this question was the fact that delocalisation features in more than one place in the specification. It occurs in describing the structure of metals but is also listed in the specification in Section 5.12.1 which defines delocalisation in arenes. Hence the definition which had to be accepted was: “ π electrons, spread over several atoms”. This could have been amended to include carbon atoms and the number could have been stated as 10.

The usual definition of delocalisation for metals does not apply in this situation. The electrons are not free they are actually bonded within the structure. In marking the question it was appreciated that candidates might say many atoms or multiple atoms; such equivalent words were accepted.

(ii) The definition of a π bond is the overlap of p-orbitals but several times the orbitals were called shell or sub-shell. It was better simply to say overlap rather than linear overlap which was incorrect. Sideways overlap would have been accepted.

- (iii) The reason for naphthalene being a solid and benzene a liquid was correctly given based on van der Waals' forces. Although delocalised electrons were accepted as simply being electrons there were many occasions when it was said that the extended delocalised electron system was the reason for the difference in properties. Sometimes the answer was very simplistic e.g. naphthalene has two delocalised rings of electrons and benzene has one or naphthalene has more double bonds. These answers were distractions from the essential argument of "more electrons". Another argument that strayed further from the correct answer was to say that naphthalene was a more stable molecule and had stronger bonds, not stating which bonds were being referred to.
- (d) (i) The structures of the two phthalic acids were well drawn and the vast majority obtained the two marks. The major error was to draw the carboxylic acid group the wrong way round so that the hydrogen was joined to the benzene ring. A handful of candidates reproduced the original phthalic acid which meant that the error could not be carried through.
- (ii) Success in Part (i) led to success in Part (ii).
- (iii) The structure of the polymer was correctly drawn by the majority of candidates although many candidates put brackets around the structure and the letter n outside. The brackets were acceptable but the letter n was not. Surprisingly, a sizeable number of candidates received no marks because they introduced nitrogen into the structure. The polymer structures had to be carefully examined because it is possible to draw four different structures all of which are correct depending whether the molecule is back to front. There were few errors involving too few oxygen atoms or too many.
- (e) (i) The structures of the two reactants which couple to give Orange 1 were well drawn. Many of the problems seen with drawing diazo structures in previous years were not seen this year. The charge on the diazonium ion was nearly always in the correct place and both the naphthol and the diazotised sulfanilic acid were correctly drawn. Sometimes the diazonium ion was drawn as the chloride salt which was acceptable.
- (ii) The means of carrying out a diazotisation should be well known but was not. It was frequently confused with nitration and the conditions and reagents for nitration were given. The one fact that candidates usually knew was that the temperature must be kept low. There were not too many instances of using sodium nitrate rather than sodium nitrite. A frequent error was to add phenylamine rather than an amine or the sulfanilic acid.
- (iii) The reason for compounds being coloured has fluctuated between three marks and four marks over the years. On this occasion a lot of information had to be provided in the third line of the mark scheme i.e. light energy raises electrons to higher energy levels which removes/absorbs (a) colour (from the light). Naturally there were occasional gaps and the mark was lost. Very often it was said that visible light was absorbed but only part of it was absorbed. There was use of the term "chromophore" but this term is long gone from the specification. Some candidates said that the molecule was very conjugated but the specification says extensively delocalised. Other words were used for extensively such as "high degree" and even "increased" and accepted. Inevitably, the argument of electrons being raised to higher energy levels and then falling down and giving out light was often seen.
- (iv) Although the sulfonic acid group was presented as $-\text{SO}_3\text{H}$ the dash was usually missing in the answer provided but if it was correct the answer was accepted. The question proved to be quite discriminating and there were many incorrect formulae given such as Na_2SO_4 , NaSO_4 , $-\text{ONa}$, and SOONa etc.

- (v) The reason why the solubility of Orange 1 was increased as a sodium salt was not known. A very similar question was set last year and was completely misunderstood then. In this case it was a sodium salt but it was an ionic salt. It has been discussed in the past and it was discussed this year whether an ionic salt is polar or not. The conclusion again was that an ionic salt is not polar. Yet this was the most popular answer i.e. the salt is polar and so is water and like dissolves like. Also popular was the idea that hydrogen bonds could form between the ions and water. Although it was asked why the sodium salt was soluble most candidates focussed on the sodium ion and ignored the anion. Their answer was wrong but even a correct answer would have been disregarded if only one ion was commented on.
- (f) (i) The catalyst was well known as either iron or iron bromide or iron(III) bromide. Iron(III) tribromide was incorrect. Although aluminium and aluminium bromide were rarely seen they would work and were accepted. Formulae or words were accepted.
- (ii) The specification mentions catalysed bromination and the question asked for catalysed bromination. Hence uncatalysed bromination was not accepted even if it was correctly drawn. There were problems whether equations for the use of the catalyst were accepted or whether the catalyst was incorporated into the flow scheme. Either method was accepted. Curly arrows were not expected and rarely seen. Problems were often seen if the opened ring with the positive charge was not facing where the bromine ion had been added. It was interesting to contemplate whether the carbon atom which was connected to the bromine atom should have full bonds, i.e. full lines drawn or should have dotted lines drawn. Both were accepted.
- (iii) Whilst there are good reasons for the lack of reactivity of the benzene ring to bromination the reasons for the greater reactivity of ethene are not as clear. Benzene is unreactive because of the stability of the delocalised electron system. Candidates had difficulty in expressing their ideas fully and clearly. They might say “because of the delocalised electron system” but fail to mention the associated stability. There were many answers that referred to the “openness” of structures implying that the electrons in ethene were more exposed or open. This was difficult to accept because both structures are flat and the electrons are available for reaction. Although not entirely happy with the phrase “readily available” this is often used to explain the reactivity of ethene and was frequently used by candidates and was thus allowed. Some candidates said that “the benzene ring withdraws electrons so they are less available for reactions”.
- Q13 (a)** (i) Without exception, candidates gave starch as the indicator. Indeed, no other indicator was seen.
- (ii) The addition of starch was continually given when the colour of the solution had gone yellow or straw yellow or straw colour or yellow straw colour. One answer said to add the starch when it was “strawed”. Near to the end point was seen but was rare; at the end point was rarer still.
- (iii) Success in Part (a) was continued with the change of colour from blue-black to colourless. Occasionally candidates fell foul of the colour rules and quoted blue/black rather than blue-black. The reverse of the colours was acceptable for one mark if they were correctly given. However, this was very rare the colours were so well known.

- (iv) The calculation was very acceptable to nearly all candidates who managed to score some marks. There was a large number of candidates who managed to get the correct answer of 8.1 cm^3 .
- (b) This question was very problematic. There was one query to ask whether this was part of the specification. This was quite a legitimate question in view of what was said in the specification with regard to colorimetric methods. However, in previous years many questions have been set which deal with following reactions in kinetics. The major reaction which is studied in kinetics is the reaction of iodine with propanone. This is followed, without exception, using the change in colour associated with the decrease in concentration of iodine in aqueous solution. Last year there was a question which dealt with the determination of a formula using colorimetry. Unfortunately the vast majority of candidates treated this question in the same way i.e. they added orthotoluidine to solutions of chlorine in water and varied the concentrations of each chemical. They then went on to state that transmittance/absorption was measured and curves/straight lines were drawn to determine where there was a peak. In such circumstances the only mark that could usually be obtained was the selection of the appropriate filter. If the filter was stated it was usually stated as a blue filter and sometimes as violet. Even if the filter was stated to be appropriate it was accepted. Calibrating the colorimeter was not regarded as producing a calibration curve.
- Q14** (a) The question with regard to isomers was synoptic and extremely well known. All candidates knew that isomers had the same molecular formula and continued to explain that there were isomers because of different structures.
- (b) (i) This question proved exceedingly difficult for candidates. The major problem was that they were led astray by the structure of trimethylamine. As printed on the examination paper it appeared as though the trimethylamine molecule was branched. Candidates failed to realise that the molecule was not planar and that it would appear, in three-dimensions as almost spherical. This led to answers such as “it is more branched so molecules can’t make as much contact with each other decreasing the number of van der Waals’ forces”. Most candidates did not realise that propylamine formed hydrogen bonds and even fewer realised that trimethylamine would form dipole-dipole forces. Very few candidates obtained two marks and most obtained one mark.
- (ii) Although the majority of candidates were lured into using fractional distillation to separate milligram quantities of a mixture of liquids a sizeable minority realised that a chromatographic method had to be used. Although GLC was the most popular other chromatographic methods were used and accepted. Two marks were available and once the chromatographic method had been chosen the second mark tended to be awarded virtually automatically e.g. for retention time or just stating that the compounds separated. It should be borne in mind that the compounds did not have to be obtained they just had to be separated. Although candidates might have used the term developing agent and used 1D or 2D chromatography none of these terms were essential and were not needed. Candidates appeared to be guessing at various methods and some initially wanted to dissolve the mixture in water and then distil.
- (c) (i) The question asked for the formation of the salt of the amine and many candidates did not read this carefully enough and gave the formation of the amine plus hydrogen chloride and consequently lost a mark.
- (ii) Nearly all candidates stated that sodium hydroxide should be used but only a small percentage of those gained the mark by saying that it should be sodium hydroxide solution. Heat was ignored and whether the sodium hydroxide was in excess or whether it was dilute or concentrated. These did not usually matter because solution was usually omitted.

- (d) The explanation for the classification of the amines into primary, secondary or tertiary amines was exceedingly well done. Both arguments were used i.e. whether the nitrogen was attached to one two or three carbons or whether the group was NH_2 , NH or N .
- (e) The systematic name for isopropylamine was given as 2-aminopropane for two marks but there were several alternatives accepted for one mark such as 1-methylethylamine, 1-methylethanamine, propan-2-amine and propane-2-amine. But, propyl-2-amine was not accepted.
- (f) Questions on mass spectrometry fragments have proved relatively simple in the past but this question posed problems for candidates. There were four possible ions which had an m/e ratio of 43 which could have been accepted as answers i.e. C_3H_7^+ , $\text{CH}_3\text{CH}_2\text{CH}_2^+$, $(\text{CH}_3)_2\text{CH}^+$ and $\text{CH}_3\text{CH}_2\text{N}^+$ or $\text{C}_2\text{H}_5\text{N}^+$. It was agreed by examiners that although the ion containing nitrogen would be accepted the second mark could not be awarded because this ion is not produced from the amines. Candidates needed to state which amine the ion had possibly come from. If the general ion C_3H_7^+ was stated then both the amines propylamine and isopropylamine needed to be mentioned which was not always the case. Similarly, candidates often mentioned both amines when $\text{CH}_3\text{CH}_2\text{CH}_2^+$ was quoted.
- (g) (i) The specification quotes TMS and either TMS or its formula were accepted. However, many candidates wished to name TMS and were usually successful but there were names such as tetramethylsilurane seen. If both name and formula were given and one was wrong the mark was lost.
- (ii) Candidates got themselves into difficulties if they tried to talk about carbon atoms next to carbon atoms which did not contain hydrogen. The great majority of candidates realised that the hydrogen atoms were chemically equivalent or in the same chemical environment.
- (iii) Although integration curves are a dominate feature of nmr spectra and have occurred in all nmr spectra in all chemistry examinations this was the first time that candidates had to explain how to use integration curves to identify hydrogen atoms. Only a handful of candidates gave an acceptable answer. Very few indeed actually quoted the full integration curve ratio or any part of it. The integration curve gives ratios and it is wrong to quote an actual value of the curve as being equivalent to a certain number of hydrogen atoms.
- (iv) Although nearly all candidates realised why the triplet and quartet were formed there were often problems with expressions which lost one or both marks. The mark scheme allowed fairly loose answers to succeed.
- (v) It was expected that candidates would identify the amine relatively easily but around 90% of candidates being successful was lower than expected.
- (vi) Although many questions have been asked with regard to the use of infrared spectroscopy there is still a problem with candidates supplying the correct answers. Despite many examiners reports which state what is expected correct answers are rarely seen as was the case with this examination. Quite simply all that candidates needed to have done was to obtain a spectrum of the real amine and compare it with a spectrum of the suspected amine. If the spectra are the same then the amines are the same. Candidates did not express their answers as simply as this. They wanted to compare the fingerprint regions which would have been acceptable if they had stated this simply and directly. Most of the time they wanted to compare "peaks" and their favourite "peak" naturally was that associated with an amino group. The only problem was that IR cannot distinguish between NH and NH_2 groups or rather that GCE chemistry candidates would not know how to distinguish between them. An alternative was to resort to data bases which would not resolve the problem.

- Q15 (a)** The oxidation numbers were correctly deduced by virtually all candidates.
- (b) (i)** The iron was correctly described as Fe^{3+} or iron(III). Very occasionally candidates stated that it was hexaaquairon(III).
- (ii)** Blood red was the answer and blood red was seen without exception. It was rarely described as a solution or as a solid both of which would have been accepted in this particular case.
- (iii)** The equation written had to be based upon the one mentioned in the specification which most candidates responded well to. However, there were often problems with missing out a water molecule on the right-hand side of the equation or missing out charges. Yet, there were too many equations given which were based on historic equations which are no longer accepted e.g.



- (c) (i)** A very similar question to this one was set in previous years. The response was poor then and a similar response was seen this year. It would have been simpler if the original mark scheme had been adhered to which required candidates to refer to step 1 and step 2. However, so few candidates did this that the mark scheme had to be revised and what was substituted posed many problems in trying to accurately mark the responses. Candidates needed to indicate that rhodanase took part in the reaction and was regenerated. Of course this was extremely difficult to interpret without referring to steps 1 and 2. This meant that some extremely vague statements had to be carefully interpreted. With so many statements referring to the general properties of enzymes this was not easy. As a consequence it was rare to award two marks and only the better or the more eloquent candidates succeeded in this task.
- (ii)** The term “biological catalyst” is in the specification and was well known. For the few candidates that did not use this term they had to explain what biological was and what a catalyst was. Biological tended to be a protein and catalyst tended to lower activation energy.
- (iii)** Denatured was accepted as a term that needed no explanation. If this had not been so then many marks would have been lost although many candidates tended to give supporting evidence of denaturation with regard to structure. What was essential was the use of the term “active site” because this is mentioned in the specification. Care was needed with expressions such as the “substrate does not fit into the active site” it could have been either the substrate or the active site that was at fault.
- (iv)** There was wide variation in the success of candidates with the equations. The current rule of the examining team is that if any formula in an equation is incorrect then the mark(s) for that equation are forfeited. In this case it applied to both organic and inorganic formulae. As a consequence NaCO_3 and HNO_3 caused the loss of marks for the relevant equations. The question was technically not well phrased because the $-\text{SH}$ group is actually part of the amino acid but there was no effect on candidates. Candidates had more success with the first equation although they had to be careful to balance it. The second equation had candidates writing nitro groups and amine groups in the resultant structure. Occasionally candidates had problems reproducing the original amino acid structure either adding hydrogens or leaving them out. The question proved to be quite discriminating.
- (v)** The $-\text{S}-\text{S}-$ structure was well known either as a disulfide bridge or link or bond. Its function in maintaining the 3D structure of a protein was well known although there was a wide variety of ways seen of expressing this function.

- (d) (i) The term ligand was well known. Apart from the very rare use of complex ion no other answer was seen.
- (ii) Although the shape of the complex ion was known to be octahedral it was very badly drawn. Examiners were looking for symmetry in drawing the structure and it was often lacking. There was no predominant use of the “dot and wedge” structure which often helps the interpretation of the structure written. In order to resolve this issue questions will be phrased in the future which insist on the use of dotted lines and wedges and answers which do not include the convention will not gain marks. Although it appears logical to accept the ligand as $-\text{CN}$ the alternative of $-\text{NC}$ was still acceptable although very few were written. Only a small minority of candidates stated that the cyanide ion was small which resulted in the complex forming the octahedral shape.
- (iii) It was very sad to see so many candidates correctly deduce that the charge on the ion was “one” but predominately write it as +1 rather than $1+$ and lose the mark. The rule of the examination, which has frequently been stated, is that oxidation numbers are written as $+X$ and charges are written as X^+ .
- (iv) It was thought that this question would prove to be extremely difficult but candidates adapted their answers very well. They realised that at least one of the structures was capable of forming one bond with a central metal ion and sometimes said both. A common error was to think that one of the structures could form two bonds and be bidentate. Having said this there were many answers where candidates could only guess, e.g. “they are optical isomers and can rotate the plane of polarised light as both isomers are non-superimposable”; “alters how many coordinate bonds it can form so it alters the shape of its complexes; “ the different structures will alter the shape of the complexes and single, double and triple bonds will push electrons further apart, however triple bonds will push them furthest away from each other”.

Assessment Unit A2 3 Internal Assessment

Booklet A

The paper appeared to be very straightforward with the vast majority of candidates able to attempt all questions and score highly. Centres are clearly very familiar with the format and so the vast majority of candidates attained high marks.

- Q1 (a)** As in previous examinations this question was extremely well answered with many candidates gaining full marks. A wide range of titre values were noted across centres. Marks were lost as follows:
- failure to calculate the average titre;
 - failure to include units for the average titre;
 - failure to record all readings on the table to at least one decimal place;
 - units missing from the table; and
 - rough reading not greater than the accurate readings.
- Q2** As expected, this question was well answered with most candidates scoring highly.
- (a) Test 1: Most candidates scored the first mark, although ‘green-blue’ was stated by a number of candidates for the colour of the precipitate and this was not credited. Some candidates noted that “the precipitate does not redissolve” which did not score the mark.

Test 2: Well answered with few errors.

Test 3: Part (a) caused issues for some candidates and centres. The expected observation, purple to colourless, was noted by most candidates however the mark scheme was widened to allow for other acceptable final colours. A number of candidates made reference to two layers forming, suggesting the mixture was not mixed even though candidates were asked to shake the mixture. Parts (b) and (c) were well answered by most candidates.

- (b) Test 1: Most candidates noted a temperature increase, although some candidates simply stated a temperature change. Almost all candidates listed a second, correct observation.

Test 2: The difference in temperature was less than that in Test 1 and it appears that some candidates did not shake or stir the mixture as in some cases the initial and final temperatures were the same. As with Test 1, almost all candidates listed a second, correct observation.

Booklet B

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

- Q1 (a)** It was surprising how many candidates did not score full marks for the equation in Part (i). In many cases, candidates did not interpret oxidation states correctly and gave incorrect formulae for copper(II) nitrate and nitrogen(IV) oxide. Writing balanced symbol equations is a key skill in chemistry and it was disappointing that so many candidates had difficulty with the equation. Many candidates did not score the mark in Parts (ii) or (iii) as their answers were not specific. For example, the response “it is toxic” was seen several times as an answer in Part (ii). Almost most identified the need for gloves in Part (iii), a significant number of candidates did not explain why or simply stated that the acid was harmful.
- (b) Part (i) caused the most difficulty for candidates in the paper. Whilst most correctly stated that hydrogen ions are removed, the majority of candidates did not explain that this allows the buffer solution to perform its basic role in this equilibrium – to maintain a constant pH. A large number of responses discussed the position of equilibrium which was not credited. In other cases, answers made reference to the hydroxide ion and this was penalised as it was not stated anywhere in the question that the buffer solution contained hydroxide ions. In Part (ii), the colour change was answered correctly by most candidates, however candidates had difficulty applying the knowledge that a solution of copper(II) ions is blue and did not score the second mark. Many interesting, but incorrect answers were given!
- (c) The calculation was well answered by almost all candidates.
- (d) There are two possible tests for copper(II) ions and both were accepted. A number of responses referred to addition of sodium hydroxide solution to form the precipitate, followed by addition of ammonia solution to form a deep blue solution. This scored full marks. In many cases, candidates did not indicate the sodium hydroxide was in solution and lost a mark. Some candidates described a flame test which scored no marks.

- Q2 (a)** This part was generally well answered by candidates.

Test 1: Well answered, although some candidates simply stated the final outcome, for example, a brown precipitate and scored two marks.

Test 2: Well answered by candidates, although reference to the precipitate redissolving was once again seen and not credited.

Test 3: Generally well answered. Given the deduction indicated that the solid was hydrated, the mark was also given for “water” or “condensation”.

(b) This part proved to be discriminatory.

Test 2: A number of correct deductions were credited, although in many cases candidates stated that glycine was present. This suggested that candidates did not read the introduction fully which stated that the unknown contained three carbon atoms. In other cases, candidates stated the “NH₂” was present but were not awarded the mark as the bond from the nitrogen atom was missing.

Test 3: Generally well answered. In some cases candidates stated that “optical isomers were present”. This was not credited as the stated observation would not be seen.

Test 4: Well answered, although some candidates stated that “COOH” was present. As with Test 2, this was not credited due to the missing bond.

Test 5: Well answered by most candidates. Given that Y was an amino acid, the answer “strong intermolecular forces” was credited.

Most candidates answered Parts (ii) and (iii). The error was carried forward from Part (ii) to Part (iii). For example, some candidates stated that Y was a carboxylic acid. This was marked wrong, but if propanoic acid was drawn in Part (iii) this was credited.

- Q3**
- (a)** A variety of answers were given in Part (i). There needed to be an indication that the reaction was occurring in the reaction vessel to score the mark and in some cases this was not explicit. Part (ii) was well answered, though some candidates did not indicate that the acids were concentrated and did not score the first mark. This question has been regularly asked in past examinations and it was surprising how many candidates needlessly lost a mark. Part (iii) posed no problems for candidates.
- (b)** Part (i) assessed basic knowledge and most candidates scored both marks. A significant number of candidates did not correctly answer Part (ii). Many answers made reference to a practical procedure such as distillation. This was disappointing given that formation of amines from their respective salts is A2 knowledge. The calculation in Part (iii) was well answered by most candidates. The most common errors were multiplying by the density in the final step rather than dividing, or using 11.6 g of phenylamine rather than 11.16 g as stated in the question.
- (c)** A straightforward recall question, however sodium nitrate was often seen in place of sodium nitrite.
- (d)** This was very discriminatory. Many candidates had difficulty with the equation in Part (i), giving incorrect products. The full equation, rather than the ionic equation, was often seen and was awarded one mark. Very few candidates scored full marks in Part (ii). Most identified the use of a gas syringe to measure the volume of nitrogen gas released. Some described how to calculate the average rate at this point. Only the highest scoring candidates realised that the graph obtained would be a curve and so tangents would need to be drawn, the gradients of which gave the rate of reaction at those points. The fact that nitrogen was a product was missed by many candidates, as many answers described how to determine the order of reaction with respect to nitrogen. Lack of detailed understanding of the context cost many candidates marks.

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