GCE

Rewarding Learning

Chief Examiner's Report

Chemistry

Summer Series 2017

Foreword

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

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

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

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GCE Chemistry

Chief Examiner's Report

Assessment Unit AS 1 Basic Concepts In Physical and Inorganic Chemistry

The paper provided an opportunity for candidates of differing abilities to respond positively to the questions posed. The paper included a suitable number of both definition questions and questions that required recall of factual information. The paper was accessible to all candidates, however, the quality of the answers provided ranged widely in standard. Only a very small percentage of candidates scored 90% and above. It was apparent that candidates were not fully prepared for the new content/format as outlined in the new specification and Specimen Assessment Materials. Not all candidates were familiar with the definitions as provided in the 'Clarification of Terms' booklet. In addition, the quality of responses provided in Question 11(c) and Question 13(c) would suggest that candidates were not expecting practical type questions. The unstructured mathematics question in Question 15 (b)(iv) was also very poorly answered and proved inaccessible to all but the most able candidates.

Q11 (a) (i) This should have been a straightforward question to start this section of the paper. It was expected that candidates would know that the ionisation of $H_2S_2O_3$ would give rise to $S_2O_3^{2-}$ in the same way that SO_4^{2-} is formed from the complete ionisation of H_2SO_4. However, this question was very poorly answered with only the most able candidates obtaining two marks.

(ii) Overall this question was well answered. A large minority of candidates gave an incorrect charge for the hydrogensulfate ion as 2-.

(b) (i) This question was well answered.

(ii) Few candidates scored two marks in this question. Many candidates described the bonding between the ammonium ions and the sulfate ion as covalent and were not awarded any marks. Some candidates correctly stated that the bonding was ionic but were then penalised for including incorrectly that this was brought about by the transfer of electrons from the ammonium ions to the sulfate ion.

(c) Only the most able candidates scored all four marks in this question, with most candidates only achieving half of the available marks. The test for the ammonium ion was not well known and many of the responses provided lacked the practical detail needed and expected at AS level. In the test for the ammonium ion many candidates omitted the first step which involves heating with sodium hydroxide solution. In the test for the sulfate ion, many responses did not state the addition of a solution of barium chloride.

Q12 (a) The standard of responses provided was very good with many candidates scoring both marks.

(b) This question was a useful discriminator with only the most able students obtaining both marks. While many candidates recognised that aluminium had more delocalised electrons than sodium, few discussed the greater positive charge on the aluminium ion in comparison to the sodium ion.

(c) (i) Well answered with the majority of candidates achieving both marks.

(ii) This question was very well answered by most candidates.

(iii) A significant number of candidates were not familiar with this definition even though it is described clearly in the new specification (1.2.9).

(d) (i) The definition of a covalent bond is outlined in the 'Clarification of Terms' booklet and in the new specification (1.3.3). Despite this, the standard of candidates' responses was poor. The mark scheme was extended to include the 'old' definition of a covalent bond but this may not be done in future examinations.

(ii) The octet rule was well known with many candidates achieving all three scoring points. Candidates were penalised for not stating explicitly that an atom shares/loses/gains electron(s) on reaction/forming a compound. Candidates also were penalised when they did not discuss how both the aluminium and chlorine atoms disobeyed/obeyed the octet rule. The inclusion of incorrect chemistry was also penalised. For example, some candidates referred to the chloride ions in $AlCl_3$.

Q13 (a) Despite this being a familiar question on an AS1 paper it was very disappointing to see the number of candidates who provided a covalent diagram for the bonding in $ZnCl_2$. The use of zinc confused many candidates. The zinc atom was frequently shown with four electrons in the outer shell. Another common error was to show the zinc ion with eight electrons in the outer shell.

(b) (i-iv) This question was structured and enabled most candidates to achieve all four scoring marks. Any errors given, such as rounding errors, were carried through.

(c) It was expected that AS chemistry students would be very familiar with all the practical steps required to prepare a standard solution. The standard of the responses provided was extremely disappointing with only the most able of candidates scoring 5/6 marks.

Q14 (a) This question was well answered.

(b) (i) Only the most able candidates were able to balance the equation correctly.

(ii) Most candidates gained all three marks.

(iii) As with Part (ii) the standard of the answers provided was high and most candidates achieved all available marks.

(c) Few candidates achieved full marks. The presence of Van der Waals' forces in addition to H-bonds between molecules of ammonia was omitted by most candidates.

(d) (i) Very well answered.

(ii) The standard of the diagrams provided by a significant minority of candidates was poor. Diagrams of PH_4^+ and PH_3 that did not look tetrahedral and pyramidal respectively were penalised.

(iii) The structure of this question required an answer which provided a comparison between PH_3 and PH_4^+. Few candidates provided this to the standard expected at AS level.

(e) This proved to be a discriminating question. Many candidates did not answer the question asked. Many diagrams did not include all partial charges and lone pairs. As a result, few candidates gained all four marks.

Q15 (a) (i-iii) This question challenged many candidates. In general, candidates had difficulty moving between the three reactions.

(i) The most common error was a failure to convert Kg to g when working out the moles of ammonia. Errors made here were carried through.

(ii) Many candidates did not realise that nitrogen(IV) oxide was NO_2. Answers were provided based on the moles of NO.

(iii) Only the most able candidates used the correct ratio when calculating the moles of HNO_3 from NO_2. However, many candidates correctly carried out the next two steps and achieved two of the three marks available.

(b) (i) Very well answered. Candidates who gave an incorrect indicator were awarded two marks if the correct colour changes for this indicator were provided.

(ii) Very well answered. Some candidates lost this mark for not including the units of volume.

(iii) This was a new question and was very well answered. Candidates who provided an answer based on percentage uncertainty were awarded the mark this year. This may not happen in future examinations.

(iv) This unstructured maths question was extremely poorly answered. Many candidates did not show clearly each step in their calculation. As a consequence of this it was often difficult to ascertain how an answer had been derived and how to award marks.

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

The mean mark in Section A was slightly lower than for the corresponding paper in 2016 (previous specification). In Section A, Question 3 and Question 4 proved to be the most challenging with D the most popular incorrect response for Question 3 and A the most popular incorrect response for Question 4. Question 6 and Question 9 proved to be the least challenging. In Section B the mean mark was slightly higher than for the corresponding paper in 2016. There was a wide spread of marks obtained in Section B ranging from single figures to the high seventies.

Q11 (a) (i) The standard of the diagrams was poor. When drawing these diagrams, a cross-section should be used and candidates should avoid blocking the delivery tube. It should be clear that the delivery tube passes through the bung. Each end of the delivery tube should be open and, in this case, one end needed to be below the surface of the limewater. When heating is involved, there needs to be some way in which a pressure build up can be prevented. Many candidates used elaborate methods for gas collection involving beehive shelves and gas jars. Gas collection was not required. A significant number of candidates heated mineral wool which had been soaked in water and passed the steam over the magnesium carbonate. Others heated magnesium rather than magnesium carbonate.

(ii) Most candidates scored the one available mark.

(iii) The strongest candidates scored both marks. Some candidates gave a general explanation of the trend within the group. The question required specific reference to magnesium and calcium carbonate. Others made reference to “atomic” radius, “electron” density, carbonate “molecules” and “Van der Waals’ forces”. Many answers did not mention the anion/ carbonate ion.

(b) (i) Surprisingly poor. Sodium nitrate was a very popular response.

(ii) Many of those candidates who had given the correct answer in Part (i) were unable to provide a balanced equation. The absence of a “2” in front of the hydroxide ion was a common mistake. It was also surprising how many candidates decided to ignore the question and included state symbols.

(c) (i) Barium sulfate was a more popular choice than potassium nitrate but potassium nitrate appeared quite often.

(ii) Many of those candidates who had given the correct answer in Part (i) did not include state symbols.

(d) (i) Most candidates scored both marks.

(ii) This was very well answered.

Q12 (a) Many candidates reproduced the definition given in the CCEA support material and scored both marks. It was surprising how many did not score both marks.

(b) Skeletal representations are new to the specification. The skeletal representations were well known and understood. Unfortunately too many candidates were unable to provide the correct names. There were problems with the use of commas, hyphens and absence of “di” when “dimethyl” was required.

(c) Many candidates scored both marks and the idea that there is a greater area of contact between the molecules leading to more Van der Waals' forces was well understood.

(d) **(i)& (ii)** Many candidates scored full marks here. If marks were lost, it was normally for incorrect balancing.

Q13 **(a)** **(i)** The strongest candidates scored both marks. Square brackets are essential in these expressions. A significant number of candidates gave a general expression involving the concentrations of A, B, C and D and many worked out the correct units but did not give the expression.

(ii) This was well known, especially by those who scored both marks in Part (i).

(b) **(i)** There were some excellent answers here. However, too many candidates used rates of reaction arguments which were not relevant.

(ii) A simple statement on the rate of production was all that was required. Too many candidates used equilibrium arguments on yield which were not relevant.

(iii) Again, there were some excellent answers here. However, as in Part (i), too many candidates used rates of reaction arguments which were not relevant.

(iv) Although many candidates correctly identified cost as the issue, they did not provide any explanation in terms of the thickness of the pipes.

Q14 **(a)** Overall, the answers to this question were very disappointing. The two spectra would be very similar since the molecules contain the same bonds. Only a comparison with the spectra of known compounds would allow a match in the fingerprint region and therefore allow the molecules to be distinguished.

(b) **(i)** The replacement of the hydroxy group with a chlorine atom was well known. However, other incorrect products resulted in the loss of both marks. Mistakes in the structure of the organic reactant and product were common.

(ii) The naming of the product was disappointing. "Chloro" comes before "methyl" alphabetically and the numbers should be separated from the letters using hyphens.

(c) Most candidates scored well on this question. When marks were lost it was usually for not acidifying the potassium dichromate, not heating and/or not explaining the chemistry in terms of the oxidation/non-oxidation of the alcohol. It should be noted that the new specification refers to acidified potassium dichromate(VI). On this occasion no penalty was exacted for the omission of the oxidation number but this will not be the case in the future. Most candidates scored the higher mark within their band for their written communication skills. However, candidates would be well advised not to take this higher mark for granted. Sentences should begin with capital letters and finish with full stops and the spelling of scientific terms should be correct.

Q15 **(a)** Many candidates reproduced the definition given in the support material and scored both marks. It was surprising how many candidates had not made the effort to correctly learn these definitions.

(b) **(i)** Burette was the preferred answer. Candidates should make an effort to spell this term correctly.

(ii) This was well known.

(iii) Overall, very well answered. An ionic equation was acceptable. $NaCl_2$ appeared in a few answers.

(iv) Very well answered. Some candidates used 50 rather than 100. Others gave a negative sign.

(v) Proved difficult for a few but they could still score marks in Part (vi) by carrying the error through.

(vi) The most common error was to leave out the negative sign.

(vii) There were quite a few weak suggestions involving average bond enthalpies.

Q16 (a) Most candidates scored both marks. A minority of candidates used the percentages, rather than the number of moles, to generate a ratio.

(b) (i) It was anticipated that this question would be very well answered. The reality was very different as the answers were very poor. All that was required on the left was two p-orbitals and on the right the two p-orbitals overlapping sideways.

(ii) Most candidates focussed on the pi bond as a region of high electron density which would be prone to electrophilic attack. Some also pointed out that pi bonds are weaker than sigma bonds.

(c) (i) Almost all candidates scored the one available mark.

(ii) Many candidates scored both marks but “electrophilic substitution”, “nucleophilic addition” and “nucleophilic substitution” appeared frequently.

(iii) Again, alphabetical order and the use of hyphens proved a problem here. Those who gave the minor product could carry the error through into Part (iv).

(iv) This was the first time that “curly arrows” were required in a mechanism. Only one of the four marks was for curly arrows. Many candidates used the curly arrows in the correct way. The arrows should be curly not straight. Curly arrows should start on a bond or a lone pair. There were three curly arrows required. The first should have started on one of the bonds in the C=C and finished between the end carbon and the hydrogen. It is very helpful, in this case, to position the H (of the H-Br) where it ends (attached to the end carbon). The second curly arrow should have started on the H-Br bond and finished on the Br. The third curly arrow should have started on a lone pair (on the bromide ion) and finished at the positive charge on the carbocation. The remaining three marks were for the rest of the mechanism including the structure of the reactant, the structure and charge on the carbocation, the charge on the bromide ion and the structure of the product.

(v) The strongest candidates gave very convincing answers and scored both marks. Some candidates were suggesting that the major product was more stable than the minor product rather than focussing on the relative stability of the two possible carbocations.

Q17 (a) Many candidates reproduced the definition given in the CCEA support material and scored both marks. It was surprising how many candidates had not made the effort to learn this definition.

(b) (i) Most candidates gave a sensible location for the activation energy.

(ii) There were many excellent answers here. It was important that the curve started at the origin, that the peak was to the left and higher and that there was only one position where the curves crossed (ideally to the left of the peak in the higher temperature curve). A small number of curves began rising upwards at high kinetic energies.

(iii) Some candidates gave an explanation without stating the effect on the rate. The explanation needed to make reference to the fact that fewer ions have energy greater than the activation energy.

(c) Most candidates were able to state that 1-iodopropane reacts more rapidly than 1-bromopropane. Fewer were able to give a convincing explanation. Some made reference to a weaker bond without stating which bond(s) they were referring to.

Assessment Unit AS 3 Basic Practical Chemistry

Paper A

The standard for this exam was high, with candidates responding well to the format.

Q1 **(a)** Almost all candidates scored a mark for this question, a small number of candidates described the appearance as clear rather than colourless, the term clear was ignored.

(b) **(i)** Most candidates got the mark here, however a number did not observe the fizzing.

(ii) A range of colours was accepted for the precipitate and this enabled most candidates to achieve the mark.

(iii) Most candidates obtained the mark here with no pattern detected in incorrect answers.

(iv) The majority of candidates correctly gave the observation as a white precipitate.

(v) Again, most candidates obtained the mark here with no pattern detected in incorrect answers.

(vi) The observation of a yellow precipitate was correctly given by the majority of candidates.

Q2 **(a)** The table was one that many candidates might have been unfamiliar with however most candidates responded very well to this question. Unfortunately, some candidates lost a mark because they omitted units or did not seal their table within a box. Some candidates did not clearly give a reading for zero cm^3 of hydrochloric acid added, and some did not give a second set of temperature readings or made mistakes in calculation of the mean. These errors however tended to be isolated with most candidates obtaining at least three marks.

(b) **(i)** The axes were usually correctly labelled, the most common error being the omission of the term 'average' or 'mean' on the y-axis.

(ii) The majority of candidates got two marks for this question. Some candidates lost a mark for not drawing a correct line of best fit when they opted to do so whilst some candidates plotted points but did not add a line of any description.

Q3 **(a)** Descriptions of smells is a laboratory skill that can be used to determine information about many chemicals. It was anticipated that the smells of E and F would be well described with G being less well described and a range of smells was accepted for G. However, the smell of G was often described better than either E or F and although this question was well answered, often candidates gave additional information that contradicted their initial phrases which led to a loss of marks.

(b) This question was usually well answered but again some candidates would list additional incorrect information in addition to correct observations, which resulted in marks not being obtained.

(c) The description of the flames was of a very high standard and the vast majority of candidates got both marks here.

Paper B

The standard of this paper was of a much broader range than Paper A.

Q1 (a) (i) This question dealt with a standard laboratory technique. The question was asked many times in the previous specification and the generic method is available via a CCEA support document on the chemistry microsite. Despite this the majority of answers did not score all the marking points, in fact most candidates obtained two marks or less for this question. Answers were often muddled in their sequencing and many answers did not mention weighing 2.79 g of the hydrated sodium carbonate in a named container or failed to dissolve the sodium carbonate in a stated volume of water.

(ii) The indicator question was well answered. A significant number of candidates gave phenolphthalein as the indicator but error carried forward marks were available for the colour change.

(b) The structured calculation was very well answered by both candidates who performed well on the rest of the paper and those who did not. The candidature appears to cope very well with structured calculations.

(c) (i) The diagram is a relatively simple diagram and most candidates obtained at least two marks. Common errors were to omit a label or to use a gauze in place of a pipe-clay triangle.

(ii) Many candidates did not obtain the mark for this question as they did not suggest leaving the apparatus to cool before handling it.

(iii) This calculation was well performed by most candidates.

Q2 (a) (i) There was evidence in this examination that many candidates are not using the CCEA Clarification of Terms document to inform their definitions. Being a short definition, it was better answered than the other definition required in Question 3(a)(i).

(ii) This question was answered well by only a minority of candidates. Very few candidates gave a suitable container despite being asked for practical details. A significant number of candidates suggested performing the procedure in a separating funnel suggesting they were confused with the washing of non-aqueous liquids. Furthermore, many candidates indicated that the anhydrous sodium sulfate is added until the liquid is no longer cloudy when in fact it would be added prior to swirling or stirring until the cloudiness is removed.

(b) This unstructured calculation was poorly answered. Many candidates obtained zero credit because they did not attempt any calculation based upon moles and stoichiometric relationships. These candidates simply calculated the mass of reactant and divided the mass of product by the mass of reactant.

(c) Although candidates understood this question and gave answers based upon the spectra, often they were let down by ambiguous language. Despite being told to use the spectra, candidates often did not indicate which spectrum they were referring to or did not identify functional groups as was requested. Candidates should be aware that the infrared frequency ranges are now included on the Data Leaflet which is issued with the examination as many candidates gave wave number values that were outside the ranges indicated on that leaflet.

(d) This question was surprisingly poorly answered. The oxidation of alcohols was taken straight from the specification, but many candidates gave answers based upon the idea that the boiling points would be too similar and did not think about the consequences of aldehyde and potential carboxylic acid formation.

Q3 **(a)** **(i)** This definition was not well answered. Many candidates omitted key information such as burning or oxygen, or they replaced the term 'enthalpy' with 'energy'. Candidates should base their answers upon the Clarification of Terms document which is supplied on the Chemistry microsite.

(ii) The reactants and the products for the equation were well answered but many candidates were unable to balance it correctly, often omitting to include the oxygen present in the propan-2-ol in their balancing and giving an incorrect value for the oxygen gas.

(iii) The use of a copper can was well understood, but, a significant minority incorrectly suggested that copper is an insulator.

(iv) The stirring of water was well answered by most candidates.

(b) **(i)** This calculation was well answered but a minority of candidates did not perform any mole calculation.

(ii) Many candidates incorrectly suggested that data books would give average values rather than thinking about experimental error such as heat loss.

Q4 **(a)** This question was very well answered by most candidates.

(b) This question was very well answered, although it should be noted that a small minority of candidates drew molecules with two oxygen atoms and one hydrogen atom.

Q5 **(a)** This equation was very well answered.

(b) Many candidates were able to describe A as being a U-tube, although a number of other answers were given with no clear pattern in the incorrect answers.

(c) The purpose of the anhydrous copper sulfate was very well understood.

(d) The observation in A was very well answered.

(e) The fact that ammonia caused the indicator to turn blue was well understood and answered correctly by many candidates, but, some candidates were penalised for incorrectly suggesting the ammonia would condense.

(f) The fact that nitrogen would be formed in the reaction between ammonia and copper oxide was not well answered. This suggested candidates did not think about what the products of the reaction between copper oxide and ammonia would be as well as not recognising the fact that a liquid (water) formed in B. It was considered this question would be difficult but it was expected that the response would be better and that candidates would think about the reactions likely to occur to give the stated product.

Q6 The procedures to test for the calcium and carbonate ions were well known and well answered. Candidates often gave sufficient practical detail for the answer, this being true for a number of candidates who had not done so elsewhere on the paper. The most common error was to omit that the hydrochloric acid in the flame test is concentrated, to not mention that it is a blue Bunsen burner flame that is used or to attempt to react calcium carbonate with sulfurc acid.

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)

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COUNCIL FOR THE **CURRICULUM, EXAMINATIONS** AND **ASSESSMENT**
29 Clarendon Road, Clarendon Dock, Belfast BT1 3BG
Tel: +44 (0)28 9026 1200   Fax: +44 (0)28 9026 1234
Email: info@ccea.org.uk   Web: www.ccea.org.uk

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