CCEA GCE - Chemistry
(January Series) 2012

Chief Examiner's Report

chemistry

Foreword

This booklet contains the Chief Examiner's Report for CCEA's General Certificate of Education (GCE) in Chemistry from the January Series 2012.

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

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

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

Contents

Subject Code	1110
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GCE CHEMISTRY

Chief Examiner's Report

Assessment Unit AS 1 Basic Concepts in Physical and Inorganic Chemistry

Candidates generally performed well on this paper with few scoring very low marks.

There were very few blank spaces on the vast majority of papers.

As one examiner commented, "perhaps it needs to be emphasised that candidates should read questions/instructions very carefully in order to answer appropriately and to gain full marks". This was a notable feature of this examination.

Indeed, despite some comments with regard to some questions and despite the poor response to several questions the mean mark was higher than ever before.

Q11 The question stated that the shapes of the molecules should be drawn using their outer electrons. Furthermore, the shapes and the angles had to be explained. Despite the question being directly asked many candidates did not draw the structures of the compounds in the conventional sense, i.e. using bonds. There were 4x4 = 16 points to mention. Problems were experienced by those who wished to make a general statement with regard to electron repulsion. Although marks could be obtained via this approach, candidates had to be careful not to leave out essential detail. Those who detailed their answers, compound by compound, normally fared better. It was decided to mark the question by deducting a mark if two errors were made. The consequence was that a wide range of marks were obtained and on the whole high marks were obtained and there was notable discrimination.

Q12 **(a)** The majority of candidates wished to express their answers using oxidation numbers as well as electron gain or loss. This was acceptable if the electron gain and loss answers were correct. It was frequently seen that candidates wished to reverse the equation quoted e.g. in equation 1 it was said that iodine gained electrons but this, obviously, could not be accepted.

(b) The equation for the reaction of acidified iodide ions with oxygen was well done. Occasionally it was not balanced, this was often because the number of hydrogen ions did not balance the number of iodide ions which meant that HI was not used correctly. It was rare to see electrons in the equation.

(c) This question proved to be a good discriminator. Most candidates achieved one mark but very few indeed obtained both marks. Some comments were received in relation to the appropriateness of the question with regard to coverage of the specification. The problem arose because the specification states the reaction of halogens with iron. However, the reverse of these reactions can be used to elucidate the answers required. Also there is the fact that sodium halides react with concentrated sulfuric acid which is an oxidising agent. In the specification the reaction of halide ions with ammonia solutions is mentioned and the reaction of halogens with alkali is also mentioned.

(d) **(i)** This question proved to be far more difficult than expected. The only answer for this difficulty must have been the complexity of the equation presented. There were many species presented and many oxidation numbers to calculate. However, what was most surprising was the complete lack of success of the majority of candidates. Time and again the oxidation number of sulfur was presented as having changed. Indeed all of the elements in the equation were deemed to have changed. Consequently this question proved to be unexpectedly highly discriminating.

(ii) The introduction to part (d) stated that the reaction mixture was heated and this meant that the iodine had to be in the vapour state and consequently it had to be iodine vapour that was described. Many candidates incorrectly described solid iodine.

Q13 **(a)** The equation was very well deduced. Problems were experienced if the symbol P_4 was used despite the fact that P was stated in the introduction to the question.

(b) This question was extremely discriminating. It was surprising how many candidates failed at step one with the density calculation. But there were many opportunities to recover marks in the rest of the question and all candidates obtained at least one mark. A major problem for many candidates was deciding the value of the moles of bromine reacting, it was often different from the earlier value quoted. It was thought that providing two lines for the number of moles of bromine would emphasise to candidates that phosphorus was in excess and that the value of moles of bromine was the essential value to be taken. Despite the fact that this was italicised at the start of the question, many candidates were at a loss to appreciate this fact.

(c) The equation was correctly written by most candidates.

(d) This question proved to be impossibly difficult for all candidates. The reaction of bromine with phosphorus is in the specification.

(i) There were many answers that could not be accepted e.g. "allow for an even reaction time"; "to prolong the reaction as the phosphorus tribromide immediately decomposes"; "the bromine may react more quickly in small amounts"; "it is highly reactive". The mark scheme is quite specific. It is a question of "vigour" rather than speed.

(ii) This was the second best answered part of question (d). However, many answers were completely wide of the mark e.g. "reducing agent"; "it is a strong acid"; "it is a polar molecule".

(iii) This was the best answered part of question (d). Answers were either based on density or HCl being heavier or denser than air.

(e) A different answer was expected in this part compared to (d)(iii) but most of the answers seen were complete guesses. It was expected that knowledge of HX fuming in air would be answered here but there were many completely incorrect answers e.g. "because the HBr is breaking down and Br_2 is a coloured gas"; "reacts with chlorine in air"; "reacts with water"; "reacts to form bromine gas".

(f) Again, this part was very badly answered. There was no problem with deciding that bromine was responsible for the red-brown colour although a minority said "bromide". Again, there was little problem with saying that heated HI produced purple iodine vapour, although, despite the heat many wished to state the colour of iodine solid. But the big surprise was the vast majority (greater than 90%) of candidates who thought that a green gas would be produced. Whether this is done, or not done, practically the theoretical viewpoint is that decomposition occurs at 1700°C. Seeing as the maximum possible temperature of a Bunsen burner flame is not beyond 1000°C, the observation of green gas can not occur. In view of this incorrect observation, part (iv) was inevitably wrong because the question stated, "what do these observations indicate about the relative thermal stabilities of the hydrogen halides?"

Q14 **(a)** This type of question has proved relatively easy over the years and so it was this year, despite a small minority having difficulty with decimal points.

(b) **(i)** Although the great majority obtained the correct numbers of electrons, neutrons and protons there were often problems in obtaining the correct number of protons. A sizeable minority either gave six protons or eight protons. However, very few candidates lost both marks for this question.

(ii) Any error made in part (i) was carried through to part (ii) and consequently virtually all candidates gained the mark.

(c) **(i)** The purposes of mass spectrometry are listed in the specification and these are quoted in the mark scheme. A couple of other answers were also added. At first it was thought that both this question and part (ii) would be difficult to mark but in fact, candidates either demonstrated that they knew the answer or not.

(ii) The expected answer was that atomic masses, or molecular masses, were measured relative to the carbon-12 standard and this was seen, although the language used to explain this was often lacking. However, there was some infrequent mention of the use of the carbon-14 standard in measuring the Avogadro number.

(d) The definition of an isotope is a routine question and was answered extremely well and was usually based on neutron count.

(e) **(i)** The equation for the decomposition of sucrose was correctly given except for those candidates who provided C_{12} or $6C_2$ molecules. A very small minority included sulfuric acid despite the instruction not to.

(ii) The definitions of "hydrated" and "water of crystallization" were extremely well done. It was evident that either, previous mark schemes had been well learnt, or the current list of definitions had been well used. One reason for using the definitions together was the fact that these definitions are actually listed together in the specification.

(iii) This was not always an easy question to mark. Often it was said that the cane sugar was not hydrated but the answer certainly implied that it was! Consequently this question was demanding of candidates' knowledge of the true meaning of hydrated. The majority knew the answer but a very wide range of answers was provided.

(f) **(i)** Carbon dioxide was the most frequent response although carbon monoxide was mentioned.

(ii) Carbon monoxide was the most frequent response although a small number of candidates reversed their answers for parts (i) and (ii).

(iii) Quite a few candidates did not really understand the simple question asked in the introduction to the question in part (f). The answer "quartz" was seen far more than expected in parts (i) and (ii). This must have been based on structure rather than oxidation. The answer given in part (iii) was then completely irrelevant to the oxidation of carbon. However, what was more interesting was the candidates, who despite stating correct answers in parts (i) and (ii), said that graphite would not give the same products because of its bonding e.g. "No, it will not as graphite only has a C-atom bonded to 3 others whereas diamond is bonded to 4 others making it a stronger substance." This is strange because the reverse would have been expected i.e. graphite should react more readily.

(g) The really strongly observed feature of this examination was that candidates did not read the questions properly. No more was this true than in this question. The question asked for an oxygen molecule but a very large number of candidates used oxygen atoms and thus lost a mark and gained three marks rather than four.

Q15 **(a)** The equation for the reaction of copper with chlorine was well done.

(b) Although this question was well done on the whole, there was a problem when the formula of the crystals was written as $CuCl_2.2H_2O$. It was then common to balance the equation as follows:

$$2CuO + 4HCl \rightarrow 2CuCl_2.2H_2O$$

However, this was not correct as the number of water molecules did not balance i.e. two on the left and four on the right.

(c) The formula of the crystals was mostly correctly deduced but the formula was often written as $2CuCl_2.2H_2O$.

(d) Although the process of back titration is mentioned in the specification the question was extremely badly answered. It was not a question of minor errors; no knowledge was shown of the basic details. Often the nearest that candidates got to the answer was to titrate copper oxide with hydrochloric acid. Candidates thought that copper oxide was soluble in water. Full marks were very rare indeed for this question.

(e) **(i)** It was essential that concentrated hydrochloric acid was used rather than hydrochloric acid or dilute hydrochloric acid. In some cases concentrated sulfuric acid was quoted. Nichrome wire and the colours were usually correctly quoted.

(ii) The most common answer given was to clean the wire but the second answer was more difficult to find. Sometimes the expression was wrong e.g. "also that the acid would stick to the wire". But the results were encouraging.

(iii) The origin of flame colours produced by metal ions has been asked many times and is now a well answered question with nearly all candidates gaining maximum marks.

(f) **(i)** This question was expected to be relatively easy but it was quite surprising to see a sizeable number of candidates writing Cl_2^- for the chloride ion.

(ii)& (iii) Even more of a surprise was to see that the there was so much confusion between the terms anion and cation. They were continually reversed in the diagrams. The question said that the water molecules were polar and they needed to be drawn as polar and aligned appropriately. Unfortunately this was not always seen to be done. It was not a surprise because a similar situation had been seen on A2 papers some years before. There was a tendency to try and balance the $\delta+$ of the water molecule by writing $\delta+$ on the Cu^{2+} ion and similarly with the chloride ion.

(iv) This was routine well examined chemistry and of course was well answered. There was no need to use any "confirmatory" test with ammonia although this was often given, perhaps because of the way the question was asked.

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

This paper was generally well answered with candidates performing to a similar level as the previous January AS 2 paper.

As previously, the paper rewarded those who had learned the factual material and were able to apply this knowledge. The paper gave all candidates an opportunity to answer at least some of the questions; however questions 13(d), 13(e)(ii) and 14(c) proved to be particularly difficult.

Q11 This was a straightforward start to Section B with many candidates scoring 4 – 6 marks.

(a) The labelling of the axes was generally well done although some candidates labelled them as if on an energy level diagram.

(b) Most candidates gained both marks. The main errors were crossing the x-axis and crossing the line for 1500K.

(c) Most candidates obtained both marks although the explanations were somewhat convoluted on some occasions. The examiners simply required no particles (1 mark) with no energy (1 mark). Answers simply stated are often the best.

Q12 This question was generally well answered with many candidates gaining high marks.

(a) **(i)** No marks were awarded if candidates stated that the reaction was exothermic. The question was generally well answered with some excellent and comprehensive explanations.

(ii) This was generally well known although some of the answers were difficult to follow, again simple is best. A few candidates gave the answer the wrong way round.

(b) **(i)** This was again well answered with the main error being SrO formed in the reaction.

(ii) This equation was also well answered with the main error being incorrect balancing of the equation.

(c) The mark scheme for this question has appeared several times and had been well learned by many candidates and so they obtained full marks. The main errors were not mentioning concentrated hydrochloric acid, using a blue flame and describing the colour as apple green. The published acceptable colours state green and this is the only colour accepted by the examiners.

(d) **(i)** This equation was extremely well done with few mistakes.

(ii) A variety of answers were given with a few mentioning Van der Waals forces and so gaining no marks. Most candidates were able to relate the answer to cation size and polarising effect. Polarising on its own was not enough, rather requiring some explanation to gain the mark. Many excellent explanations were seen.

Q13 Some parts of this question proved difficult and so overall the marks were often poor.

(a) **(i)** This was extremely well done with few errors.

(ii) Candidates often knew the correct answer but failed to gain both marks because they did not consider both double bonds.

(b) This proved difficult for many candidates with the main error to omit the **di** in **diene**.

(c) **(i)** Many candidates added on H_2 to the isoprene and did not fully hydrogenate the product.

(ii) The catalyst was generally well known, although other metals such as platinum and iron did appear.

(iii) Again this was generally well known as it is straight from the specification. A few candidates did refer to the use of the nickel as a gas or liquid.

(iv) This was generally well answered with reference to intermolecular forces or Van der Waals forces. A few candidates did mention dipole-dipole attractions.

(d) This was very poorly answered with only a few candidates using the diagram above as a guide. Those who simply replaced the CH_3 group with Cl gained both marks.

(e) **(i)** This calculation was generally well done and most candidates gained at least 2 marks. The main error was in rounding the ratio 2.5:3.97:1 to 2:4:1 to give the formula C_2H_4Br.

(ii) This was very poorly answered with few candidates making use of the isoprene molecule shown earlier. When the isoprene was used the bromine was frequently added to the same carbon instead of across the double bond.

(f) Many candidates failed to recognise that isoprene is a hydrocarbon. Most gained a mark for carbon monoxide but then a great variety of products appeared including hydrogen and nitrogen.

Q14 Overall this question was poorly answered with very few candidates gaining more than 8 marks.

(a) Most candidates gained 3 or 4 marks out of the 5. Where marks are awarded for each step as shown then the correct answer should be given for that step. Too often the answer for step 4 appeared in step 5 and this cost the candidates a mark.

(b) Most candidates gained at least 1 mark but few gained all 3 marks. This question related to practical chemistry and few candidates were able to identify possible sources of error in the procedure.

(c) This was the most poorly answered question on the paper with very few candidates able to identify the making of bonds as exothermic and most suggesting breaking of bonds or overcoming of intermolecular forces as being exothermic.

(d) A wide variety of answers were given to this question. Those who used the definition of a catalyst were able to answer the question successfully.

Q15 Overall this question was poorly answered with many candidates showing a poor knowledge of the chemistry of the haloalkanes.

(a) **(i)** This equation was poorly answered with a variety of products given including hydrogen and carbon dioxide.

(ii) Errors from the equation were carried through and this helped some candidates. Even when ethene appeared in the equation it was not always given as the gas. Hydrogen bromide and bromine frequently appeared as possible gases.

(iii) Again candidates benefited from carry the error through from the equation. Some candidates who correctly identified the test for unsaturation described bromine water as red-brown as opposed to the colours given on the acceptable colours list.

(iv) Many candidates were able to achieve a mark although much of what was written was confused. The examiners accepted that the formation of an alkene was sufficient to indicate elimination.

(b) **(i)** This equation was well answered with the majority of candidates gaining the mark.

(ii) Many candidates simply restated the question as opposed to explaining the terms. The definition of substitution was better known than nucleophile. In future, the list of acceptable definitions will be of help in questions like this.

(iii) Many candidates lost marks for not including the intermediate in the flow scheme. Charges were often wrong or missing.

(iv) Many candidates lost a mark by referring to the polarity and bond enthalpy of chloroethane and bromoethane rather then the C-Cl and C-Br bonds. The comparison between polarity and bond enthalpy was generally well known.

Q16 This question was reasonably well answered with most candidates gaining a reasonable mark.

(a) **(i)** The vast majority of candidates gained this mark although Haber, Haber-Bosch and Contact Processes all appeared.

(ii) This was surprisingly poorly answered with the majority of candidates failing to realise that oxygen/air is needed for combustion.

(b) **(i)** This calculation was very well done. A few candidates used the wrong formula mass for potassium permanganate and some failed to use the 2:1 ratio.

(ii) The test for oxygen was extremely well known, although not all candidates gave the correct answer.

(c) **(i)** The purpose of the platinum was well known.

(ii) Most of the candidates recognised that the answer related to surface area but few realised that the gases could pass through the gauze and therefore increase the accessible surface.

(iii) Most candidates recognised that this was not a closed system or that the reaction was not reversible.

(iv) The usual mistakes appeared in the calculation and errors were carried through. The most common mistakes were not using the correct number of bonds, subtracting the reactants from the products or not dividing the final answer by 4. Some candidates lost a mark by failing to state whether the reaction was exothermic or endothermic.

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

Q11 **(a)** **(i)** The most common mistake in this question was to assume that $\Delta G = 0$ instead of -25. Most candidates calculated the value of ΔS correctly.

(ii) Many failed to state that the CO_2 removal process would decrease with a large majority stating that the rate would be decreased.

(b) **(i)** Only a few candidates achieved the mark for this equation with many giving an incorrect formula for ammonium carbonate, most frequently NH_4CO_3.

(ii) Explanations of the term spontaneous were weak and often showed misunderstanding. "Feasible at all temperatures" was a common response.

(iii) Few candidates referred to the size of $T\Delta S$ and ΔH.

(c) **(i)** This was answered reasonably well with many achieving the marks but a few gave the equation for the dissociation of ethanoic acid to ethanoate and hydrogen ions.

(ii) Many used the $H^+ + OH^- \rightarrow H_2O$ equation.

(d) Many candidates had difficulty writing this equation with many not including the equilibrium sign. The explanations were often of a poor standard.

Q12 **(a)** **(i)** This question was well answered.

(ii) The structures were well drawn by most but only the best candidates labelled them correctly. Most did not realise that O has higher priority than C.

(iii) Many made sensible suggestions and achieved the mark.

(b) **(i)** A large number gave AgO. Ag_2O_3 was also common.

(ii) Many gave correct answers. Some lost the mark for H_2 as a product rather than H_2O or some left it out completely.

(c) Most candidates gained a mark for A. Many suggestions for B were incorrect.

(d) Most candidates showed a lack of understanding of the term "flow scheme". Many achieved 1 mark for the correct structure of 2,2-dibromopropanoic acid. Most attempted a mechanism.

(e) In general this question was poorly answered. The most common mistakes were including an extra O atom in the product with PCl_5 and $SOCl_2$. Many did not reduce both groups with lithal and the central carbonyl group remaining unchanged with HCN.

(f) **(i)** A few gave a dissociation equation rather than an equilibrium expression and a few used $[H^+]^2$ rather than $[CH_3COCOO^-][H^+]$ for the numerator.

(ii) Most gained the 3 marks.

(iii) A lot of alternatives to the mark scheme answer were accepted here.

(iv) If marks were lost it was because the correct polar group in pyruvic acid was not identified as being able to form hydrogen bonds with water.

Q13 **(a)** Definitions were not necessary. Many candidates were unable to produce detailed definitions.

(b) **(i)** Well answered with a few errors in calculation.

(ii) Very poorly answered by most as candidates stated that lattice enthalpy was high but no explanation of what this meant in terms of the stability.

(c) Most gained the mark.

Q14 **(a)-(c)** Most gained marks for these equations but many lost marks in (a)(ii) for using SO_2 as a reactant rather than S.

(d) Mostly poorly answered with many losing marks for explaining the neutralisation rather than simply the pH of the salt solution. Many used the terms "stronger" and "weaker" rather than "strong" and "weak".

(e) **(i)** Very poor answers with many stating that pH of the acid decreased.

(ii) Good answers based on the graph with many discussing the "vertical portion".

(f) A very poorly answered question but the best candidates did it with ease.

Q15 The best answered question on the paper.

(a) Most gained marks and those who did not didn't explain the terms.

(b) Most gained marks but a few only drew one cis C=C and added the rest of the groups in any arrangement which seemed appealing.

(c) Well answered but some gave HI as a product and somehow removed hydrogen from the fatty acid.

(d) **(i)** Most knew the definition well with a few confusing it with saponification value. "Number of mg of iodine required to react with 1 g of the fat" was surprisingly common.

(ii) Most calculated this well but as expected a few chose linoleic acid instead of linolenic acid but consequential marking was applied.

(iii) Well answered by almost all except those who thought it was based on RFM of the fatty acid as in saponification value.

(e) The marking was generous for this part of the question. Very few candidates mentioned trans fats, LDLs, HDLs, essential fatty acids etc. Many argued themselves into a corner with stating that polyunsaturated fats lowered cholesterol but also increased it. The official mark scheme will no doubt provide guidance on the contribution of polyunsaturated oils or fats to the diet.

(f) Most gave finely divided nickel with an appropriate temperature.

Q16 **(a)** **(i)** A few used "δ–" rather than "–" on the oxygen or many gave the mechanism in full.

(ii) Many stated slow rather than **slowest**.

(iii) Many gave the equation with HCN rather than CN^- and some explained k rather than simply stating it was the rate constant.

(iv) Well answered with consequential marking from (iii).

(b) **(i)** Many candidates used H^+.

(ii) Most obtained at least one mark here.

(c) The arguments used here were often quite poor.

(d) **(i)** Many explained the term optically active instead of optically inactive.

(ii) Although most candidates scored both marks, the standard of 3D representations continues to be poor.

(iii) Many candidates did not explain the cancelling of the rotation well by simply stating "cancel each other out".

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