GCE

Chemistry B

Advanced Subsidiary GCE **AS H033**

OCR Report to Centres June 2017

Oxford Cambridge and RSA Examinations

About this Examiner Report to Centres

This report on the 2017 Summer assessments aims to highlight:

- areas where students were more successful
- main areas where students may need additional support and some reflection
- points of advice for future examinations

It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the examination.

The report also includes:

- An invitation to get involved in Cambridge Assessment's research into **how current reforms are affecting schools and colleges**

- Links to important documents such as **grade boundaries**

- A reminder of our **post-results services** including Enquiries About Results

- **Further support that you can expect from OCR**, such as our Active Results service and CPD programme

- A link to our handy Teacher Guide on **Supporting the move to linear assessment** to support you with the ongoing transition

Understanding how current reforms are affecting schools and colleges

Researchers at Cambridge Assessment[1] are undertaking a research study to better understand how the current reforms to AS and A levels are affecting schools and colleges.

If you are a Head of Department (including deputy and acting Heads), then we would be very grateful if you would take part in this research by completing their survey. If you have already completed the survey this spring/summer then you do not need to complete it again.

The questionnaire will take approximately 15 minutes and all responses will be anonymous.

To take part, please click on this link: https://www.surveymonkey.co.uk/r/KP96LWB

Enquiry About Results

If any of your students' results are not as expected and University places are reliant on them, you may wish to consider one of our Enquiry About Results services. For full information about the options available visit: http://ocr.org.uk/administration/stage-5-post-results-services/enquiries-about-results/

[1] Cambridge Assessment is a not-for-profit non-teaching department of the University of Cambridge, and is the parent organisation of OCR, Cambridge International Examinations and Cambridge English Language Assessment

Grade boundaries

Grade boundaries for this, and all other assessments, can be found on Interchange.

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Supporting the move to linear assessment

This was the first year that students were assessed in a linear structure. To help you navigate the changes and to support you with areas of difficulty, download our helpful Teacher guide: http://www.ocr.org.uk/Images/345911-moving-from-modular-to-linear-science-qualifications-teachers-guide.pdf

Further support from OCR

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Active Results offers a unique perspective on results data and greater opportunities to understand students' performance.

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Advanced Subsidiary GCE Chemistry B (H033)

OCR REPORT TO CENTRES

H033/01 Foundation of chemistry

General Comments:

This paper allowed candidates of all abilities to demonstrate their knowledge and understanding. The vast majority of candidates had sufficient time to complete the paper and the level of "no response" to questions was very low and generally limited to the weakest candidates.

The multiple choice questions in section A allowed wide areas of the specification to be addressed. Centres need to provide guidance regarding the correct procedure when candidates change their mind. A number of candidates overwrote one choice with a second inside the box whereas it would be better for them to cross out their first choice and write their preferred answer alongside the box. A few candidates left some multiple choice questions unanswered. There was an encouraging increase in the number of candidates using the space adjacent to the question for rough working e.g. for writing formulae etc.

The majority of candidates were able to answer questions within the space provided with few making use of the additional blank page. Centres need to ensure that candidates use this space in preference to requesting additional booklets. When candidates do need to stray outside the allotted answer space they must clearly indicate where the rest of the answer is to be found whether this is on the additional page or in an additional booklet.

Candidates must also make sure that these extra responses are clearly labelled with the question number and sub-section.

The quality of response to "recall" questions was generally higher than the previous year. Calculations were reasonably well done although some candidates would benefit from a more structured approach to enable them to gain credit for partially correct responses or to guide them through the stages toward the correct answer.

Knowledge and understanding of practical procedures is often weak and candidates are sometimes unable to appreciate the differences between related procedures e.g. preparation of soluble and insoluble salts, measuring enthalpy changes of reaction and combustion.

Knowledge of the common ions/oxidation states of elements and writing balanced equations with state symbols needs to be improved.

Comments on Individual Questions:

Section A
Multiple Choices Questions: Q1–Q20

Overall the multiple choice questions catered for the full range of ability and allowed for good differentiation.

1) Over half of candidates answered this correctly. The majority of incorrect responses gave the number of atoms per molecule rather than per mole. It was clear that the vast majority of candidates knew the formula of methanol.

2) The vast majority of candidates correctly identified the properties of a metallic structure.

3) Two thirds of candidates answered correctly. The most common error was to refer to mass of useful products rather than M_r of useful products.

4) Generally only the more able candidates answered correctly. All incorrect responses were well represented.

5) Most candidates chose the correct answer although a number confused distillation with reflux.

6) The term "green chemistry" is becoming more widely understood as candidates generally performed well on this question.

7) This question was not well answered. The most common mistake was to assume a 20 degree rise in temperature caused a twenty fold increase in volume.

8) Two thirds of candidates answered correctly. Incorrect responses covered all other options.

9) Less than half of candidates answered correctly. The most common incorrect response was substitution by ammonia although a significant number of candidates incorrectly identified the product as an amide.

10) Almost half of candidates answered correctly. The most common mistake being to identify bond polarity as the most significant factor.

11) The reactivity of phenol was not well understood. Sodium hydroxide was the most common response but all other options were well represented.

12) Over half answered this correctly. The spread of incorrect responses suggests that there is confusion between the terms soluble and insoluble.

13) Approximately half gave the correct response. Very few candidates mistook cracking for elimination but a significant number chose removal of water of crystallisation.

14) The most able candidates almost always answered correctly. The vast majority of candidates sensibly used the blank space adjacent to the question for working but a significant number made the question more difficult than necessary by trying to use the gas equation rather than molar gas volume.

15) Although the majority of candidates answered correctly there is clearly some confusion about the three dimensional lattice and the relative size of ions.

16) Just over half the candidates answered correctly. A common misunderstanding of reactions is that the endothermic/exothermic nature is governed by the number of bonds broken and made.

17) This question proved to be a good discriminator. Methodical candidates used the space adjacent to expand the formula and these almost invariably chose the correct response.

18) This question was not well answered. Less than half the more able candidates gave the correct response. All possible responses were well represented although the most common response gave the ether as the highest boiling point. The link between intermolecular forces of attraction and boiling point was not well understood.

19) Less than half of all candidates answered correctly, although more able candidates did significantly better. Despite the majority of candidates being able to use electron pair repulsion to determine the bond angles round the carbon atom, they were often unable to translate this into situations in which the octet is incomplete or where there are multiple pairs of non-bonding electrons.

20) A large majority of candidates answered incorrectly. The majority of incorrect responses assumed that the radical nature of the NO molecule was the most significant factor.

Section B
Question 21
21(a)(i) The vast majority of candidates answered this question correctly.

21(a)(ii) The majority of candidates answered this question correctly. The most common mistake being to try to place thirty seven electrons rather than seventeen. Candidates need to be encouraged to use superscripts for the number of electrons in each sub-shell.

21(a)(iii) This question was very poorly answered. Most candidates where able to give the correct shape of a p-orbital, although a few gave a diagram of all three orbitals without clearly labelling it as such. Very few candidates stated that the orbital held two electrons.

21(b) Only a very small number failed to give the answer to the correct number of decimal places.

21(c) Despite parts (a) and (b) of this question being about isotopes, many candidates failed to use this information appropriately in section (c).

21(c)(i) Credit was given for candidates who recognised the significance of the chlorine isotope or those who remembered that mass spectrometry identified positive ions. Despite this, only about one third of candidates gained the mark.

21(c)(ii) Only about ten percent of candidates gained both marks available for this question. Few candidates explained the ratio with reference to the isotopes of chlorine although a number tried to explain it by invoking isotopes of carbon. Vague references to molecular ions were common.

21(c)(iii) Candidates were able to gain credit for either recognising that carbon-13 would be present or for recognising fragmentation and the removal of a single hydrogen from the chlorine-37 containing molecule.

21(d) This question was generally well answered by all but the weakest candidates. A small number did not attempt the question and an even smaller number produced answers which bore no relation to the information provided in the Data Sheet. Answers based on absorptions other than the CO or OH bond were extremely rare.

Question 22
22(a) This question discriminated well between the different abilities taking the paper. Most candidates recognised the result of the flame test for the cation but far fewer were able to correctly identify the sulfate anion.

22(b)(i) The appearance of an atomic emission spectrum is well known by candidates with only a minority describing absorption spectra.

22(b)(ii) The mathematical ability of candidates has been steadily improving and many now produce well-structured responses which lead them to the correct final answer. Less able candidates often failed to identify the steps in the calculation and therefore were unable to gain credit for partially correct answers. In this question the most common mistake was to fail to convert wavelength into frequency.

22(c)(i) This was a challenging question. The valency of lead ions is not well known but some candidates also failed to balance the equation and used incorrect species.

22(c)(ii) Knowledge of techniques for preparing and purifying an insoluble salt was very poor. Most candidates referred to recrystallisation.

22(d)(i) As stated previously, candidates ability to perform calculations is steadily improving. The majority of candidates produced answers to three significant figures as suggested by the supplied data. The most common partially correct response resulted from failure to understand the ratio shown in the equation.

22(d)(ii) Very few candidates gained full marks. The difference between precision and accuracy was not well understood.

22(e)(i) Very few candidates could provide both parts of the answer to gain the mark. Some knew the test required (sodium) hydroxide but could not remember the colour change. A significant number read the question to be about electrolysis. A very small number mistook cation for anion.

22(e)(ii) A minority of candidates gained this mark. Many failed to give an ionic equation or provided a half equation for the reduction of iron. Among those who wrote the correct equation only a small number remembered that a solid precipitate was formed.

22(f)(i) Many responses involved drying using a variety of techniques. This suggests that candidates are not confident with the concept of water of crystallisation and assume that anything containing water must be wet.

22(f)(ii) This calculation was well done by more able candidates but the weakest often did not appear to know how to begin. Structuring answers allowed some to gain partial credit.

Question 23
23(a) The name, skeletal formula and molecular formula were often correctly given but many candidates struggled with describing the compounds as aliphatic/aromatic and saturated/unsaturated.

23(b)(i) Candidates must be instructed to write down all the steps involved in a calculated answer. Many failed to score both marks because they failed to multiply for the numbers of moles involved.

23(b)(ii) Candidates who structured their work generally performed better than those who did not. Very few candidates recognised that, in this case, the appropriate number of significant figures was two.

23(c)(i) The majority of candidates recognised that the temperature change and mass of water (amongst others) needed to be measured, and most were able to produce the formula for calculating the energy. A significant minority stated that the mass of fuel should be used rather than the mass of water and a small number referred to measuring the "change in the mass of water".

23(c)(ii) Candidates understanding of practical procedures often appears to be weak. They are able to describe how to do things without being able to explain why. Many candidates described steps to improve precision rather than accuracy. Some candidates were clearly unable to distinguish between experiments to measure enthalpy change of combustion and enthalpy change of reaction.

23(d) Many candidates produced concise and correct answers. A number incorrectly stated that either the nitrogen or oxygen came from the fuel. A similar number referred to incomplete combustion. Very few candidates stated that the reaction happened in either the catalyser or exhaust.

Question 24

24(a) Most candidates gained this mark. Most incorrect responses either referred to the reactions being equal or the amounts being equal.

24(b)(i) Candidates found difficulty in describing electronegativity and frequently confused it with electron affinity. Candidates often referred to the ability of a nucleus to attract electrons and failed to indicate that it involved covalent/bonding electrons.

24(b)(ii) Few correct dot and cross diagrams were produced. Many candidates correctly placed electrons around the ester carbon but failed to put all the lone pairs on the oxygen atoms.

24(b)(iii) Many candidates produce clear and concise answers. The most common mistake was to reference pairs rather than groups of electrons or to talk about the repulsion being "as much as possible" rather than "as far as possible".

24(b)(iv) Only a minority of candidates scored this mark. References to hydrogen bonding were common even though neither caffeine nor ethyl ethanoate has hydrogen bonded directly to an electronegative atom.

H033/02 Chemistry in depth

General Comments:

The paper allowed candidates of all abilities to achieve success and included questions to challenge the most able and more straightforward questions to offer access to all. A very full range of marks was seen. Candidates had sufficient time to complete the paper.

The majority of candidates were able to answer questions using the space provided although a few did make use of the additional answer space at the end of the question paper. Candidates should be reminded that if they do use this additional space they should clearly indicate the question number, including part and any further sub-section, e.g. Q2(d)(ii), to which the additional answer refers. However, some candidates chose not to use this additional space and tried to squeeze answers in below the allocated lines. This can make it difficult to see such 'overflow' on the scanned paper. If candidates need to write more than they can fit into the allotted space they should be encouraged to make proper use of the additional answer space.

In the questions where candidates were required to draw a structure many, quite understandably, drew out a structure in pencil, possibly made corrections and then drew over this structure in ink, sometimes forgetting to rub out the rough working in pencil. Indeed even where an attempt was made to erase the rough pencil working, the scanned image can sometimes result in two structures superimposed and it can be very difficult to judge the intended answer. Candidates should be encouraged to ensure that any rough pencil working is fully erased.

Comments on Individual Questions:

Question 1

1(a) Most candidates were able to explain the meaning of the term *heterogeneous* but a surprising number, even amongst the higher-scoring candidates, did not include in the explanation of *catalyst* and the fact that it does not get used up in the process, focusing instead just on the fact that it speeds up a reaction or provides a route of lower activation energy.

1(b)(i) A large number of candidates did think that mass was the correct factor to control, and even where candidates thought that the statement was incorrect it was often thought that it was surface area that was relevant, even though the diagram had labelled the catalyst as being powdered. Not many candidates realised that it was the amount (number of moles) that was the crucial factor for valid comparisons to be made.

1(b)(ii) It was surprising here to note how many, even high-scoring candidates, did not score this mark because of the use of the word 'amount' instead of 'volume'.

1(c)(i) Most candidates were able to plot the points correctly and draw the lines of best fit to exclude the anomaly at (25, 55.0), though there were some candidates that did try to include the anomaly.

1(c)(ii) Most candidates realised that the manganese(IV) oxide is the most effective catalyst, though a surprising number referred to 'magnesium' or simply 'manganese'. However, fewer were able to score the mark by correctly linking this to producing most gas in the shortest time or in some other way linking it to rate.

1(c)(iii) Many candidates scored a mark for correctly calculating the rate in $cm^3\ s^{-1}$ but were unable to use the molar gas volume to convert to mol s^{-1}.
Answer: 5.6×10^{-5} (mol s^{-1})

1(d) Although this question was generally well answered there was evidence that more practice is required in drawing skeletal formulae.

1(e)(i) Although many candidates appeared to be familiar with the general outline of the four stages of heterogeneous catalysis, a significant number in Stage 2 referred incorrectly to breaking bonds *between* reactants.

1(e)(ii) The idea of a poison blocking the active sites on the surface of a catalyst was generally well known.

1(f)(i) Although correct answers were certainly seen, a considerable number of candidates did not seem to understand the significance of half arrow heads to show the movement of single electrons in a covalent bond to produce radicals.

1(f)(ii) Although some correct well set answers were seen, in this unstructured calculation too often candidates did not set out the calculation in a logical manner. In essence the three marks were awarded for dividing 346 by the Avogadro Number to work out the energy required to break a single C-Cl bond, then using $E = h\nu$ to work out the (minimum) frequency taking account of the need to convert kJ to J, and finally using $c = c/\lambda$ to convert frequency to wavelength.
Answer: 346 (nm)

Q1(g) In this Level of Response question, although the area of chemistry seemed to be familiar enough, there was a full range of marks, but with very few scoring Level 3 (6 marks). This often appeared to be due to candidates not reading the question carefully and as a result of this including irrelevant information. For example, many candidates explained the sources of radicals even though the question did not ask for this information. Usually the explanation of the role of chlorine atoms was described better than that of oxygen atoms (which was sometimes completely absent). Where both chlorine and oxygen were considered a description of the relative effects of the two was often done poorly or not at all.

Question 2
2(a) Many candidates answered this question correctly and apart from those that incorrectly kept the C=C double bond the other common way in which the mark was lost was by not extending single bonds on either side of the carbon atoms that were the C=C double bond in the monomer.

2(b)(i) Many candidates were familiar with pi and sigma bonds although a number did get them the wrong way round and some simply called them double and single bonds.

2(b)(ii) Whilst there were well explained, completely correct responses, a significant number of candidates incorrectly gave 109°, stating that there were four pairs of electrons around the carbon atom. Even where the correct answer of 120° was given some candidates lost marks through imprecise and incorrect explanations, for example referring correctly to ‘three groups of electrons' but not specifying 'around the carbon atom' (imprecise) and in other cases writing about 'atoms repelling' (incorrect).

2(c)(i) Too many candidates did not read the question here and simply stated 'turns colourless' without giving the original 'yellow/orange/brown' colour. Others lost the mark by including a reference to 'red' in the original colour or 'clear' instead of 'colourless' at the end.

2(c)(ii) A surprising number of candidates did not seem to know the correct name 'carbocation'.

2(c)(iii) Many candidates found this question difficult to answer with few referring to the attack of the carbocation by both the chloride and bromide ions. The relative reactivity of chlorine and bromine was referred to by some and others talked about displacement.

2(d) Most candidates correctly explained the lack of/limited rotation around the C=C double bond but did not go on to point out the other requirement, namely that each carbon must have two different groups bonded to it. Many simply described the arrangement of the E and Z isomers.

2(e)(i) Hydrogen bromide was simply known or not known.

2(e)(ii) There were a significant number of candidates that struggled with the conventional drawing of the three-dimensional tetravalent carbon atom. A common error was to have two bonds in the plane of the paper at 180° or 90°. The use of molecular model kits can help tremendously with the teaching of this aspect of the specification.

2(e)(iii) This question was generally well answered.

2(e)(iv) This question was not terribly well answered, with a common mistake being to put a hydrogen on the carbonyl carbon atom, usually making this atom pentavalent.

Question 3

3(a)(i) Many correct answers were seen here but where incorrect answers were given it was often because of the somewhat more unfamiliar units of tonnes.
Ans: 12500 (mol)

3(a)(ii) More candidates struggled with part (ii) than part (i) although ECF was certainly possible here.
Ans: 0.44 (tonnes)

3(a)(iii) This part proved even more problematic than (i) or (ii) with the volume units presenting a particular difficulty but also with some candidates incorrectly attempting a use of pV = nRT.
Ans: 150 (m^3)

3(b) Many candidates achieved the correct similarity, that is chlorine produced (at the anode), but failed to score the mark because of an incorrect difference, that is not recognising the formation of sodium instead of hydrogen (at the cathode).

3(c) Most candidates, including the higher-scoring ones, failed to score the mark here. It was obvious that most either mis-read or mis-interpreted the question. When asked to describe what would be **observed** candidates must describe what they would **see** at each electrode, with a yellow/orange/brown colour forming in the solution around the anode and gas bubbles at the cathode. An answer of iodine and hydrogen respectively is of course a correct deduction but not an observation. So few correct answers were seen here that Examiners were left wondering whether or not candidates had actually had a practical experience of the type that would have helped in answering this question.

3(d) In part (i) many candidates gave a correct half-equation for the formation of iodine rather than bromine, a case of not reading the question carefully, but in part (ii) many mistakenly thought that sodium would be formed and wrote the half-equation for this rather than for hydrogen which would of course be the product in aqueous solution.

3(e)(i) Colourless was a frequent incorrect answer here.

3(e)(ii) Candidates did struggle to recognise that the sodium halide referred to in this question was the iodide.

3(f)(i) Many candidates struggled to both see what was being oxidised in equation 3.1 and also to represent the oxidation as an ionic half-equation.

Answers to Q3(d), 3(e)(ii), and 3(f)(i) would suggest that candidates in general require more practice at writing ionic equations for redox reactions and ionic half-equations for both redox and electrode equations.

3(f)(ii) Even where 3(f)(i) had been answered incorrectly, many candidates obtained the correct answer of chlorine here. However, it should be noted that whilst Cl_2 scored the mark, Cl by itself did not.

3(g) Many candidates were able to state that the halogens get bigger going down the group or that shielding increases. However, fewer candidates correctly stated that this decreases the attraction between the nucleus and the outer electrons. Often there was a more vague reference to the attraction decreasing without the explicit reference to the nucleus and the outer electrons. That said, candidates did usually make the link to a decreasing readiness to gain an electron (hence to be reduced and so act as an oxidising agent).

Question 4

4(a)(i) There was a lot of information in this question and as such it tested candidates' ability to read the question very carefully and then to organise an answer to address all parts clearly. Many found doing both of these things quite demanding. For example, in the first statement, many candidates spotted that the element should be in the gas state but did not make it clear that the ion also should be in the gas state. The second statement, being correct and therefore requiring no correction simply required recognition of that fact. It was not necessary to explain why the statement is correct. The third statement was not dissimilar in the explanation required to correct the incorrect chemistry to the answer given in Q3(g) though the reference was to the removal of an outer electron from a Group 2 atom rather than the gain of an electron by a Group 7 atom. Essentially the greater distance of the outer shell electrons from the nucleus (in barium compared with calcium), or the increase in shielding, means that the attraction between the nucleus and the outer shell is less (in barium compared with calcium). Again it was that 'attraction' link that candidates seemed to find difficult to score.

4(a)(ii) Many candidates were able to calculate the amount of calcium, although there was no mark for simply doing this, but could proceed no further. Some that tried to do so, mistakenly tried to use pV = nRT. Even those that continued through to the correct answer often forfeit the mark for not recognising that the **appropriate** number of significant figures required was three. Answer: 754 (cm^3)

4(b) In this Level of Response question, unlike the previous example, the area of chemistry seemed to be less familiar, and although again there was a full range of marks, few achieved Level 3 (6 marks) and there was a larger number of candidates not offering any response at all. For those candidates that did offer a response many were able to give an outline method that would in essence work. However, the method was too often described sketchily, often with few reasons being offered for the experimental details, other than to carry out a 'fair test', and it was this that prevented many candidates from accessing Level 3 marks. Some confused thermal stability with a link to melting point and others seemed to this that the carbonates needed to be dissolved in hydrochloric acid. Examiners were left to wonder whether these candidates had ever had a practical experience of thermally decomposing Group 2 carbonates. Pleasingly, many that had chosen an appropriate outline method recognised that the carbon dioxide evolved in the thermal decomposition could be detected with limewater. In terms of the expected result, beyond the production of carbon dioxide, some thought, incorrectly, that the strontium carbonate would decompose more readily because 'strontium is the more reactive element'. However, some were able to relate the more rapid decomposition of calcium carbonate in terms of polarisation/distortion of the carbonate ion by the smaller calcium ion, and whilst not strictly required, was a sound explanation of the expected result and therefore worthy of some recognition.

4(c)(i) Most candidates were very familiar with the idea of concordant titres.

4(c)(ii) It was disappointing to note how many candidates did not realise that if a burette can be read to the nearest 0.05 cm^3, then since it is read twice in performing a titration the uncertainty in a titre will be $\pm$ 0.10 cm^3. A percentage of 0.24 was the most common incorrect answer.
Answer: 0.5 (%)

4(c)(iii) This was another example of an unstructured calculation and as such only the highest-scoring candidates tended to do well on this question. Like Q1(f)(ii), success required a logical setting out of the working. A significant number of candidates used 25.0 cm^3 as the volume of hydrochloric acid instead of 20.85 cm^3, and many were also unable to convert mol dm^{-3} into g dm^{-3}.
Answer: 1.54 (g dm^{-3})

4(d) A significant number of candidates failed to get this mark by not mentioning the nucleus or the atom of the element.

4(e) It appeared that many candidates struggled with the presentation of the data in this question.

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