External Assessment Report 2013

Subject(s)	Chemistry
Level(s)	Advanced Higher

The statistics used in this report are pre-appeal.

This report provides information on the performance of candidates which it is hoped will be useful to teachers/lecturers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding. It would be helpful to read this report in conjunction with the published question papers and marking instructions for the examination.

Comments on candidate performance

General comments

In general, candidates performed slightly better than in 2012. This was to be expected since their average prior attainment was higher.

The mean mark in Section A (multiple choice) was 28·0 out of 40 compared to 25·8 in 2012. Almost all questions in Section A functioned as expected with the A-type questions scoring significantly lower facility values than the other questions. In question 37, only 28% of candidates managed to get the correct answer (D) with 30% and 32% going for options A and B respectively. This was not totally unexpected as candidates are known to find this difficult, however the question is valid and its discrimination factor was acceptable suggesting that most who did get it correct had worked it out rather than just had a lucky guess.

The mean mark in Section B was 33·5 out of 60 compared to 30·9 in 2012. Most candidates seemed to have enough time to complete the paper. As in previous years, many candidates still appear to have difficulty expressing themselves clearly and, again, this was most evident in questions where candidates needed to give an explanation.

However there was a slight drop in the mean mark for the Investigation which was 15·2 out of 25, compared to15·6 in 2012. Most candidates are submitting very well-presented Investigation reports and, again, some new titles appeared this year.

Areas in which candidates performed well

Section A

The following questions in Section A produced high facility values, ie in which 70% or more candidates got the correct answer. The number in brackets is the percentage of candidates getting the correct answer.

Q1 Selecting the correct equation representing the 2^{nd} ionisation energy of a diatomic element (90%).

Q2 Knowing the types of electromagnetic radiation in order of increasing frequency (77%).

Q3 Choosing the correct metal salt which would emit radiation of highest frequency when placed in a Bunsen flame (74%). This question was answered much better than expected and candidates certainly did better than the pre-test results had predicted.

Q5 Hund’s rule (70%).

Q9 Knowing that a dative covalent bond is present in the ammonium ion (78%).

Q10 Identifying the molecule with the largest number of electron pairs (79%).

Q12 Appreciating that the electrical conductivity of a semiconductor increases with temperature (82%).

Q13 Knowing that hydride ions are present in calcium hydride (76%).

Q18 Shifting the position of equilibrium in phosphoric acid (80%).

Q19 Knowing that the value of the partition coefficient is temperature dependent (91%).

Q20 Calculating a value for the partition coefficient (85%).

Q21 Knowing that $[H^+]$ decreases when ethanoic acid is diluted (72%).

Q22 Appreciating that ethanoate ions react with hydrogen ions (71%).

Q23 Selecting the appropriate indicator (81%).

Q24 Getting the activation energy for the reverse uncatalysed reaction (76%).

Q27 Selecting the reaction in which there is an increase in entropy (89%).

Q29 Realising that butanoic acid going to butan-1-ol is reduction (82%).

Q30 Selecting correct types of reactions in an organic reaction sequence (87%).

Q31 Choosing the correct intermediate in the reaction between propene and bromine (79%).

Q32 Initiation step in a chain reaction (93%).

Q33 Knowing that alcohols have higher boiling points (77%).

Q34 Matching general formulae with homologous series (79%).

Q40 Knowing that receptors are usually protein molecules (93%).

Section B

As in previous years, calculations were generally done well. Candidates' performances on questions on PPAs continued to improve but are still not well done.

There were high levels of performance in the following questions in Section B, ie parts of questions in which the mean mark of the candidates was at least 70% of the maximum mark for that part of the question.

Q1(a) Naming a dopant added to germanium to make a p-type semiconductor. (82%)

Q1(b) Knowing the charge carrier in a p-type semiconductor (83%).

Q2(a) Calculating ΔS^{o} from a table of values (71%).

Q3(b) Electron affinity of Cl (72%).

Q3(c) Identifying lattice enthalpy (84%).

Q4(d) Converting a wavelength value into energy in kJ mol^{-1} (77%).

Q6(a) Calculating the pH of 0.10 mol l^{-1} propanoic acid (78%).

Q8(a) Calculating order of reaction (82%).

Q8(b) Writing the rate equation (77%).

Q8(c) Calculating a value for the rate constant including the units (72%).

Q9(a) Co-ordination number (73%).

Q10(d) Realising that KOH in ethanol causes an elimination reaction to take place (73%).

Q 11(b) Functional group in a primary amine (90%).

Q14(b) Using the data booklet to find the bond responsible for the peak at 1140 cm^{-1} in the infra-red spectrum (87%).

Areas which candidates found demanding

The following questions in Section A produced low facility values, ie fewer than 50% of the candidates got the correct answer.

Q16 Calculating the total number of moles of ions in a salt solution, given its formula (46%).

Q25 Bond enthalpy calculation (46%).

Q37 Product of reaction between phenylamine and hydrochloric acid (28%).

Section B

The following questions in Section B proved to be demanding, ie parts of questions in which the mean mark of the candidates was lower than 50% of the maximum mark for that part of the question.

Q3(d) Calculating the value of lattice enthalpy in a Born Haber cycle (49%).

Q4(a) Data required for a calibration curve in a PPA (31%).

Q5(a) Predicting the colour of a solution from an absorption spectrum (49%).

Q6(b) Calculating the pH of a buffer solution (42%).

Q7(c) Explaining whether zinc or aluminium should be used to extract chromium from chromium oxide using the information provided from an Ellingham diagram (10%).

Q8(d)(i) Realising that the isomer most likely to have been used was the tertiary one (21%).

Q8(d)(ii) Giving an acceptable explanation why the tertiary isomer was the one used. The answer markers were looking for was a correct explanation in terms of the stability of the carbocation (8%).

Q9(b) This calculation proved to be very demanding for most candidates (30%).

Q10(b) Realising that light was the experimental condition required (34%).

Q11(a) A surprisingly low number of candidates (31%) were able to identify correctly one of the amide functional groups present in caffeine.

Q11(c) This was an A-type question, looking for the third bond to be shown on the N atom (29%).

Q12(a) A PPA question, only 18% of candidates knew that the dehydrating agent used was phosphoric acid.

Q12(b)(i) Only 22% of candidates were able to give an acceptable answer for why saturated sodium chloride is used in the PPA. Both parts (a) and (b) were A-type questions.

Q13(a) 47% of candidates were able to name and draw the structures for the geometric isomers of compound B. This was probably better than expected.

Q13(b) Only 41% of candidates could name compound D correctly as pentan-2-one.

Q13(c)(ii) Drawing the structural formula for the cyanohydrin (19%). This was an A-type question.

Q13(d) Drawing the structural formula for compound F (33%). Again an A-type question but correct follow through from wrong answers to (c)(ii) were accepted.

Q14(a) A difficult empirical formula calculation but nevertheless it was disappointing that only 38% of candidates managed it.

Q14(c) 49% of candidates correctly deduced the molecular formula as $C_4H_{10}O$.

Q14(d) Deducing the structural formula for compound A (34%). Too many candidates treated each part of this question as if it were a different compound A each time.

Advice to centres for preparation of future candidates

General

Advise candidates to:

- Read each question carefully including the stem.
- Try to get through Section A in about 45 minutes so that they have enough time to complete Section B and go back over any questions that they were unsure about.
- Do all the PPA experiments and take notes on each experiment not just the one which has to be written up to pass Outcome 3. (As stated previously it might be worthwhile for centres to produce a summary of the PPAs which highlights the important points in each experiment. However again markers commented that there had been an improvement in the performance of candidates in questions on PPAs.
- Consider the number of significant figures in the final calculated answer. For example, it is highly unlikely that a numerical answer to 6 significant figures will be acceptable. Candidates should be taught about significant figures and not to confuse significant figures with number of decimal places.
- For questions such as Q14 in Section B of this year's exam paper, candidates need to be able to firstly calculate the C and H content then the oxygen content by subtraction before calculating the empirical formula. The molecular formula will either be the same as or a multiple of the empirical formula. The final answer must be consistent with answers to earlier parts of the question.
- Go over past paper questions, especially the multiple-choice questions, but also Section B questions.

Candidates should be reminded that:

- There are no ½ marks awarded. So if a question is worth 1 mark and the candidate's answer is only partially correct then he/she is not awarded the mark.
- Candidates should be reminded that approximately 6 out of the 60 marks in the Section B of the examination paper are based on PPA experiments and to revise the PPAs when studying for the AH examination.
- Up to 10 marks in the AH exam can be on work covered at Higher.

Chemical Investigation

The comments from previous years are still very relevant and are repeated below. The first comment is, again, the most important.

More teacher involvement at the planning/designing stage would be very beneficial to many candidates. Candidates also need better advice on writing up the Investigation Report. It would appear that not all have seen copies of the very useful Candidates' Guide. A candidate who does a good Investigation but writes it up poorly is likely to score fewer marks than a candidate who does a poor investigation but writes it up according to the advice given in the Candidates' Guide. It is obvious that candidates from some centres are being disadvantaged because they have not seen copies of this guidance document. It is also true that some candidates may have been given the guidance document but have chosen to ignore it. Copies of the *Advanced Higher Chemistry Investigation Guidance* can be downloaded from SQA's website. Candidates should be told to follow exactly the methods of citing and listing references.

New additions to the Candidates' guide in 2012–13 included:

In Underlying Chemistry, 'Downloading directly from the internet or copying directly from books may suggest to the marker that you have not understood the chemistry involved and may be considered as plagiarism. It is always best to put things into your own words'.

In Procedures part (c), *For example, you may have had to dilute a solution to get better titration results. In this and in similar situations you should give the original raw results, where practicable, as well as the results after the modification. It will not count as a modification if you are carrying out the procedure wrongly to begin with and the modification involves carrying out the procedure the way it should have been done to begin with. For example, measuring out a volume for titration using a measuring cylinder then changing to using a pipette when you should have been using a pipette to begin with.*

In the Results section, *if you are using a weighing bottle when measuring out the mass of reactant, you should record all the masses. If you tare the balance to zero when weighing you should state this in your report so that the marker appreciates that you have done so and will not be looking for raw results but just the mass of reactant used.*

Other important points include:

- There is no need for a hypothesis in the AH Chemical Investigation report. No mark is given for the hypothesis.
- The abstract that follows immediately after the contents page and which contains the aims and summary of main findings should cover all the main points. If the main aim is to determine, say, the vitamin C content of different fruit juices, then the summary of main findings should include the values obtained.
- Since the aim(s) is/are now only stated in the abstract/summary it is important that it is/they are written clearly and is/are easy to understand. Conclusions at the end of the

report need to be based on and cover the aim/all of the aims. This is much harder to do if the aim(s) is/are not stated clearly at the beginning.

Many candidates do their Investigation experiments without proper controls or replicates. Although time is a factor, ideally, experiments should be repeated completely. This is much more than doing a titration until two or three results are concordant. For example, if the Investigation involves determining the fat content of different types of cheese, then each experiment should be carried out at least twice for each type of cheese. If the Investigation involves determining the vitamin C content of orange juice then the method selected should be tested with a control which should be a solution of ascorbic acid of known concentration to find out how accurate the method is. Results of this could then be discussed in the Evaluation part of the report.

Raw results should be given. For example, the results of a titration experiment should include initial and final burette readings, not just titre values.

If the Investigation involves the determination of one or more compounds, then it is not really acceptable to take it to the nearest university and get IR, UV, NMR etc spectra carried out. It may seem old-fashioned but the analysis should be done chemically giving the results, observations and conclusions plus reasoning at each stage. If the candidate does get different spectra run then the report should show that the candidate has interpreted the different absorptions correctly and should assign the main peaks correctly.

Unless the centre is presenting a large number of candidates for AH Chemistry there is no reason for two candidates from any one centre to be doing the same or similar Investigations.

The second category is for underlying chemistry. There is no need to re-state the aim here. Up to 4 marks are awarded for underlying chemistry. Very few candidates get all 4 marks. Candidates should use this opportunity to show how much chemistry they have found out. Appropriate formulae, equations etc should be given here, especially if relevant to Advanced Higher Chemistry or something covered in Higher Chemistry. It is important that candidates do not simply cut and paste from websites but attempt to write in their own words to show their understanding of the chemistry involved. As stated above, the underlying chemistry is worth 4 marks out of the total of 25 marks for the Investigation.

Procedures should be clearly described so that they could be repeated by another AH Chemistry student from the information given. Diagrams or photographs often help here. The method used should not be listed as a set of instructions but must be written in the past tense and impersonal voice. The procedure should take into account the need for controls and each experiment should be replicated to eliminate rogue results. Candidates should be aware that any modifications made to original design/method, etc should be reported. This may simply be diluting the titrant to get higher titre values with lower percentage error. However, it is not good enough just to state that a modification has been carried out. The modification should have been made as a result of experience and markers want to see evidence of this. For example, a table of low titre values showing why it was necessary to dilute the titrant.

Many centres appear to be under the impression that candidates need to use more than one technique. This is not so. It is just one way of gaining the mark in category 2(c) of the marking instructions. Other ways of getting the same mark include making a modification as a result of experience or doing a control experiment

When giving raw data, students should ensure that they are recording values with the correct number of significant figures and/or decimal places. Tables should have appropriate headings and correct units should be given. Graphs should also be set out correctly, taking care when using EXCEL and other software that the scales are the most appropriate and that lines/curves of best fit are produced. Final calculated results must be calculated to the appropriate number of significant figures. It is easier to understand and therefore better for markers if the results are given after each experiment rather than listed in an Appendix at the back of the report.

Observations should be recorded, for example, colour changes, precipitates, shapes and colours of crystals, etc. It is most unlikely that any candidate will carry out an Investigation in Advanced Higher Chemistry without observing something that can be mentioned in the report.

The conclusion(s) at the end must relate to all the aims given earlier and the conclusions should be given under a separate heading near the end of the report.

The evaluation should also be given under a separate heading near the end of the report. During the evaluation the candidate should not only identify the main sources of error but also show how these affect the final result. Candidates can point out the error values in the measuring equipment used and therefore the uncertainties in each raw and processed result. They can then work through their raw results and calculations to get the uncertainty in their final calculated result. It may then be possible to compare their final result with the manufacturer’s stated value in some Investigations. The evaluation is worth 4 marks and is very discriminating. Most candidates get only 2 out of 4 here.

To get the final bonus mark, candidates must produce a very good report and have scored at least 3 out of 4 marks in both underlying chemistry and evaluation categories.

Candidates are expected to keep an up-to-date day book or record of work, with entries being checked regularly by their teacher. This is a requirement for the internal assessment of the Unit and will need to be available if the centre is selected by SQA for verification of the Investigation Unit. It is also very helpful to the candidate: keeping him/her in the right direction, making sure they are using controls, carrying out duplicates, etc. It is also very useful when writing up the Investigation report. It is very evident that some candidates are given a great deal of support in their centres compared to candidates from other centres.

Statistical information: update on Courses

Number of resulted entries in 2012	2496

Number of resulted entries in 2013	2545

Statistical information: Performance of candidates

Distribution of Course awards including grade boundaries

Distribution of Course awards	%	Cum.%	Number of candidates	Lowest mark
Maximum Mark 125				
A	31.6%	31.6%	803	87
B	26.6%	58.1%	676	74
C	21.4%	79.5%	545	61
D	8.3%	87.8%	211	54
No award	12.2%	100.0%	310	-

General commentary on grade boundaries

- While SQA aims to set examinations and create marking instructions which will allow a competent candidate to score a minimum of 50% of the available marks (the notional C boundary) and a well prepared, very competent candidate to score at least 70% of the available marks (the notional A boundary), it is very challenging to get the standard on target every year, in every subject at every level.

- Each year, SQA therefore holds a grade boundary meeting for each subject at each level where it brings together all the information available (statistical and judgemental). The Principal Assessor and SQA Qualifications Manager meet with the relevant SQA Business Manager and Statistician to discuss the evidence and make decisions. The meetings are chaired by members of the management team at SQA.

- The grade boundaries can be adjusted downwards if there is evidence that the exam is more challenging than usual, allowing the pass rate to be unaffected by this circumstance.

- The grade boundaries can be adjusted upwards if there is evidence that the exam is less challenging than usual, allowing the pass rate to be unaffected by this circumstance.

- Where standards are comparable to previous years, similar grade boundaries are maintained.

- An exam paper at a particular level in a subject in one year tends to have a marginally different set of grade boundaries from exam papers in that subject at that level in other years. This is because the particular questions, and the mix of questions, are different. This is also the case for exams set in centres. If SQA has already altered a boundary in a particular year in, say, Higher Chemistry, this does not mean that centres should necessarily alter boundaries in their prelim exam in Higher Chemistry. The two are not that closely related, as they do not contain identical questions.

- SQA's main aim is to be fair to candidates across all subjects and all levels and maintain comparable standards across the years, even as arrangements evolve and change.