External Assessment Report 2011

Subject	**Chemistry**
Level	**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

Candidate performance was slightly better than last year. Section A of the paper was more difficult than in 2010. All questions in Section A functioned as expected with the exception of Question 40 where the correct answer was D, but 34% of the candidates chose option C. This compound would have shown two peaks in the proton nmr spectrum but had the wrong molecular formula. Centres are reminded that there are no half marks for partially correct answers.

Section B was certainly as demanding as in previous years and it was encouraging to see that the mean mark was 34·4 out of a maximum of 60. This was an improvement on recent years. No Markers reported any evidence of candidates having insufficient time to complete the paper. Many candidates still appear to have difficulty expressing themselves clearly and this is evident in questions where candidates are asked to 'explain'.

The mean mark for the Investigation Report was 15·7 out of 25, which was also slightly up on previous years. Almost all candidates submitted a very well presented word-processed Investigation Report.

Two candidates scored a very impressive 121/125 and fewer than 3% scored lower than 40/125.

In Section B, Question 4 (c) was very poorly done — to the extent that it did not function properly. This was taken into account when setting the grade boundaries.

Areas in which candidates performed well

Section A

The following questions in Section A produced high facility values, ie in which more than 70% of the candidates got the correct answer.

Q1 Ionisation energies of a Group 3 element

Q2 Colorimetry

Q3 Lone pairs

Q6 p-type semiconductor

Q9 Properties of sodium hydride

Q12 Changing the position of equilibrium

Q13 Calculating the equilibrium concentration

Q14 Altering the partition coefficient

Q16 Conjugate acid/conjugate base pairing

Q20 Bond enthalpy

Q23 Entropy

Q26 Recognising that 1-bromopropane being converted to propene is elimination

Q28 Bonding in ethane

Q31 Application of the Markovnikov's rule

Q33 No hydrogen bonding between molecules of a tertiary amine

Q35 Electrophilic substitution on to benzene

Q38 Mass spectrum parent ion and empirical formula

Section B

In general, calculations were well done as in previous years.

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

Q1 (a) Superconductivity

Q2 (a) Realisation that red is at the low frequency end of the visible spectrum

Q2 (b)(ii) Calculation of wavelength from energy value

Q3 (a) Calculation of oxidation states

Q3 (b) Drawing of resonance structure

Q4 (a) Electronic configurations of Fe^{3+} and Mn^{3+} ions

Q4 (b) Calculation of yield

Q5 (b)(ii) Octahedral shape of complex ion

Q6 (a) Using the graph to deduce temperature at which reaction becomes feasible

Q7 (a) Overall order from rate equation

Q7 (b) Graph from zero order reaction

Q7 (c) Calculating the value of the rate constant

Q8 (b) Calculation of standard free energy change

Q10 (a) Realising that the structural fragment is known as the pharmacophore

Q11(b)(ii) Using the Data Booklet to find the wavenumber range for O-H in the infra-red

Areas which candidates found demanding

Section A

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

Q11 Calculation of volume of calcium nitrate required to make a more dilute solution

Q15 Gas liquid chromatography

Q21 Enthalpy of atomisation of bromine

Q22 Calculation of the enthalpy of solution

Q34 Recognition that diaminoethane reacts with HCl in a 1:2 ratio

Q39 Realising that proton nmr spectra are due to absorbance of radio waves

Q40 Using molecular formula and information from proton nmr spectrum to identify a compound

Section B

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

Q3(c) Writing an ion-electron equation. Poorly done since this is covered at Higher rather than Advanced Higher.

Q4(a)(iii) Explaining why Fe^{3+} is more stable than Mn^{3+}. Most candidates knew the answer but couldn't express themselves properly, tending to use the word orbital or orbitals rather than stating that the 3d subshell is half-filled. This could have been answered correctly by writing the electronic configurations in orbital box notation.

Q4(c) This question was very poorly done. Had the question asked the formula for the tetrachlorocuprate(II) ion, then it may well have been answered better. The fact that the question asked for the formula for **ammonium** tetrachlorocuprate(II) certainly threw most candidates. Definitely a teaching point for the future.

Q5(a) This PPA question was poorly done. Unfortunately, PPA questions are usually poorly done. It is quite difficult to get both parts correct for one mark and, since no half-marks are awarded, getting only one part correct meant zero marks. However 28% did get this correct which is fairly good for this A-type question.

Q12(a) Only 48% of the candidates got this part correct which, again, was very good for an A-type question. A bit of chemical arithmetic is required to realise that the other product formed is water and so it is a condensation reaction.

Q12(c)(i) Only 19% got this correct. Performed as an A-type question, as intended.

Q13(a)(ii) Structure of the carbocation. 47% did this A-type question correctly.

Q13(b)(i) Although a large number of candidates usually get this question wrong, it is nevertheless disappointing that only 43% of candidates knew that sodium ethoxide is prepared in the lab by reacting sodium with ethanol.

Q13(b)(ii) Methoxyethane was the answer expected and although both methyl ethyl ether and ethyl methyl ether were accepted, only 36% of candidates were awarded the mark. An A-type question.

Q14(c)(i) Acceptable reagents were KCN, NaCN or HCN (or their correct names), but only 39% came up with an acceptable answer. Again an A-type question.

Q14(c)(ii) Hydrolysis or acid hydrolysis were the acceptable answers and 41% got this A-type question correct.

Q14(c)(iii) A difficult A-type question and only 15% of candidates realised that the nitrile functional group is reduced to an amine group and that the rest of the molecule is unaffected.

Advice to centres for preparation of future candidates

General

Candidates should:

- 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 that 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, there was an improvement in the performance of candidates in the PPA questions in the 2011 exam.)
- go over past paper questions, especially on Unit 3 since questions on organic chemistry were poorly answered in 2011

Candidates should be reminded that:

- There are no half marks awarded. So if a question is worth one mark and the candidate's answer is only partially correct, then he/she cannot gain that 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.
- Work covered at Higher can also be assessed in the AH examination.

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 *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.

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(s). This is much harder to do if the aim(s) are 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.

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.

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 are under the false 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 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.

Any 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.

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 2010	2,225

Number of resulted entries in 2011	2,472

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	32·2%	32·2%	795	86
B	25·0%	57·1%	617	73
C	21·1%	78·2%	522	61
D	7·9%	86·2%	196	55
No award	13·8%	100·0%	342	-

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, therefore, SQA 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 Head of Service 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.