External Assessment Report 2012

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 as expected with mean marks in Section A and in the Investigation very similar to 2011. Section B of the paper proved to be more difficult than in 2011.

Most questions in Section A functioned as expected with the exceptions of Question 4, in which more than 50% of the candidates chose the incorrect option B, and Question 37 in which only 20% of the candidates correctly chose option D. Question 31 also caused problems with only 20% choosing the correct option and 57% choosing option A. However, it was expected that this question would be difficult for many candidates. There were some new questions in Section A but many had been used before, albeit with minor changes for this year's exam.

Section B proved to be more demanding than in 2011 with the mean mark working out at 30.9 out of a maximum of 60. Very few candidates appeared to have difficulty completing the paper but many probably did not leave enough time to go back over their answers. 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.

The mean mark for the Investigation was 15.6, very similar to 15.7, which was the mean mark in 2011. Most candidates are submitting very well-presented Investigation reports with some new titles appearing this year.

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.

Question 1: Knowing that α radiation is not a form of electromagnetic radiation

Question 3: The electrons with the highest energy in $Co^{2+}(g)$ are in 3d orbitals

Question 8: Effect of adding a product to a system in equilibrium

Question 13: Choosing the correct indicator for a strong acid/weak base titration given the pH range of four indicators

Question 14: Hess's law calculation

Question 15: Graph of temperature against volume of acid added for NaOH/HCl titration

Question 18: Steps in a Born–Haber cycle

Question 19: Ionisation energy calculation

Question 20: Calculation of boiling point given ΔH and ΔS values

Question 24: Propagation step in a chain reaction

Question 25 The molecule most likely to form a stable carbocation

Question 26: Knowing that butanoic acid will have a higher boiling point than other compounds containing four carbon atoms

Question 28: Application of Markovnikov's rule

Question 30: Number of sigma and pi bonds in CO_2

Question 33: Molecular formula for a ketone. Much higher facility value than when this question had been used previously.

Question 34: Amine dissolving in water to give an alkaline solution

Question 38: Definition of wavenumber

Question 39: Infrared spectroscopy dependent on vibrations within molecules

Question 40: Pharmacophore

Section B

As in previous years, calculations were generally done well. Questions on prescribed practical activities (PPAs) were better done than in previous years.

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.

Question 1 (a): Calculation of energy from wavelength

Question 1 (c): Knowing that positive holes are the main current carrier in silicon doped with boron

Question 2 (a): Calculation of oxidation states of nitrogen in two species

Question 4 (a): Shape of a BH_3 molecule

Question 6 (b): Calculation of partition coefficient

Question 7 (a): Formula for the conjugate base of ethanoic acid

Question 9: Calculation of cell voltage from free energy

Question 11 (a): Knowing the gases produced when $LiAlH_4$ and PCl_5 react with water

Question 14 (a): Electrophilic substitution

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.

Question 2: Appreciating that if X^{3+} has 55 electrons, X must have 58 electrons and so is an f-block element

Question 4: Realising that in absorption spectroscopy, if the concentration decreases then the radiation transmitted increases in intensity

Question 7: Being able to select a bidentate ligand from given formulae

Question 9: Only 22% got this question on solubility product correct but it was an A-type question and performed as such.

Question 10: Calculation of equilibrium constant. Again an A-type question and performed as such but was better done that it had been when used previously.

Question 11: Only 49% got this correct which meant that 51% of the candidates did not realise that a buffer solution cannot be made from a strong acid and salt of the strong acid.

Question 17: Calculation of the standard enthalpy of formation of HCl(g) from bond enthalpy values

Question 21: Enthalpy and entropy changes when steam condenses

Question 31: Planar molecules. Most realised that chlorobenzene is planar but not that chloroethene is also planar.

Question 37: Empirical formula calculation. Most candidates calculated the empirical formula correctly as C_2H_5 but the question asked for the **molecular** formula which cannot be C_2H_5.

Section B

The following questions in Section B proved to be difficult, 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.

Question 2 (b): Writing a balanced ion–electron equation. This type of question was done poorly last year.

Question 2 (c): Naming a complex ion. This was an A-type question and performed as such. The correct answer is dicyanocuprate(I), not dicyanocopperate(I), and perhaps this is something that needs to be emphasised to candidates.

Question 3 (a) and 3 (b): Many candidates did not give full answers to these questions and since there are no half marks then these candidates lost 1 mark per question. Giving only ionic radius as an answer to part (a) is not acceptable. Candidates will have been taught that the correct answer is the relative radii of the ions and this is what Markers were looking for. In part (b) an acceptable answer is that each sodium ion is surrounded by six chloride ions and each chloride ion is surrounded by six sodium ions, but giving only half the answer again meant no mark awarded.

Question 3 (c): Although most candidates realised that the correct answer here is potassium fluoride, it is worth pointing out that a large number of candidates wrote 'flouride' or 'fluorine' instead of fluoride. This is an error which should not be made at Advanced Higher level.

Question 3 (d): This was an A-type question and performed as such. Slightly more than 30% of candidates got the correct answers to both part (i) and (ii).

Question 4 (c): The answer for the class of organic compounds to which tetrahydrofuran belongs is cyclic ethers, but ethers was also accepted. Another A-type question which performed as such.

Question 5 (b): The expected answer here was use distilled/deionised water instead of tap water. Other correct answers were accepted. Some candidates may not have spotted 'tap water' in the question, through not reading the question carefully.

Question 5 (c): Again candidates may not have read the stem of the question carefully enough. However, it was an A-type question which performed as such with 29% of candidates getting the correct answer.

Question 7 (b): Another A-type question but 45% of the candidates got the mark here. The shorter stem was probably read more carefully.

Question 8 (a): Only 48% of the candidates got this correct. The fact that the word 'range' was in bold type may have confused some candidates rather than helping them. This was done so candidates would not just give 2000 K as the answer.

Question 8 (b): Another A-type question which performed as such. 31% got the mark here.

Question 10 (a): This was another A-type question. Candidates should have met a straight-line graph of concentration against time in PPA 5 from Unit 2. More than 50% of candidates got parts (b) and (c) correct which was good since they were designed as A-type questions.

Question 11 (b): Part (i) was an A-type question answered correctly by 34% of the candidates and so performed as such. However, only 41% of candidates managed to draw the correct structural formula in part (ii) which was disappointing.

Question 12 (a): Another A-type question performing well with 33% of candidates getting the correct answer.

Question 13 (b): Only 42% realised that this was a hydrolysis reaction.

Question 13 (c): An A-type question which could only be answered by candidates who had carried out the PPA. An encouraging 33% got the correct answer.

Question 13 (d): Another A-type question based on the PPA. Only 26% got this correct with some candidates getting mixed up and answering that the mixture becomes cloudy rather than the cloudiness disappearing. The setters were really looking for 'the oily layer disappearing' but 'cloudy to clear' was also accepted.

Question 14 (a) (ii): The question asked candidates to identify the organic base and was worded in this way so they could either give its name or formula. A disappointing 33% of candidates got this correct.

Question 14 (b): Both parts of this question were very poorly answered, particularly part (ii) with only about 10% of candidates getting the mark.

Question 15: Although all three parts were designed as A-type questions, candidates did better than expected here. In fact, 54% of candidates got the correct answer for part (a). Questions on transition state are always poorly done but 36% of candidates got the mark for part (b) which is very encouraging. Part (c) was worth two marks and many candidates managed to get 1 mark here with a fair number achieving both marks. This was very encouraging since this was the last question so very few candidates did not reach the end of the paper.

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 six significant figures will be acceptable. Candidates should be taught about significant figures and not to confuse significant figures with number of decimal places.)
- go over past paper questions, especially the multiple-choice questions but also Section B questions as well

  (There is probably no better way to study to pass examinations.)

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 cannot be awarded the mark
- 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 who writes it up poorly is likely to score fewer marks than a candidate who carries out 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.

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, all the aim(s). 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 assigned 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.

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 as a result of experience or doing a control experiment

When giving raw data, candidates 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. 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 and uncertainty but also show how these affect the final result. Candidates can point out the uncertainty 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.

Statistical information: update on Courses

Number of resulted entries in 2011	2,472

Number of resulted entries in 2012	2,496

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	27.9%	27.9%	696	84
B	25.8%	53.7%	645	71
C	24.3%	78.0%	607	58
D	9.9%	87.9%	246	51
No award	12.1%	100.0%	302	-

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.