External Assessment Report 2010

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 similar to last year. Section A of the paper was easier than in 2009 and similar to the standard of Section A in 2007 and 2008. All questions in Section A functioned as expected.

Section B of the written paper was slightly more demanding than in 2009, as expected, but it was satisfying to note that no markers reported that any candidates had difficulty completing the paper in the allotted time. As in previous years, in parts of the paper where the candidates were asked to 'suggest' or 'explain', a fair number of candidates lost marks due to their inability to express themselves clearly in writing.

Compared with 2009, the average marks were up by 3.1 in Section A (Multiple choice), but down by 2.2 marks in Section B (Written) and there was no significant change in the average mark for the Investigation Report which was 15.3 out of 25.

Almost all candidates submitted a very well presented, wordprocessed Investigation Report.

In Section B, Question 5 (b) did not function as intended. It was worth 2 marks and this was taken into account in determining the grade boundaries.

The same was true for Question 12 (b) which was an A-type question worth 1 mark.

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.

Q 1 Electronic configuration of iron
Q2 Aufbau principle
Q3 Trend in ionisation energies of a Group 2 element
Q7 Lattice structures
Q8 Ionic hydrides
Q11 Factors affecting equilibrium position
Q12 Partition coefficient
Q13 Definition of acid
Q14 Indicators
Q18 Bond enthalpy
Q19 Hydration enthalpies
Q21 Born-Haber cycle
Q22 ΔG^{o} and E^{o}
Q23 Species reduced in electrochemical cell
Q25 Nucleophilic substitution reaction

Q26 Realisation that no addition reaction involved in reaction of methane with chlorine
Q27 Solubility of organic compounds
Q28 pi bond
Q32 Hydrogen bonding
Q35 Problem solving question on enamines
Q38 Isomers
Q40 Infra-red absorption

Section B

In general, calculations were well done.

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) Calculation of energy from wavelength

Q2 (a) Calculation of oxidation number of chromium

Q3 (a) and (b) Calculation of ΔH^o and ΔS^o (Calculation of ΔG^o not so well done because many candidates did not appreciate that standard temperature is taken to be 298 K and this value had to be used in the calculation)

Q4 (b) Calculation of the % of manganese in steel

Q5 (a) Resonance structures

Q6 (a) (ii) Calculation of number of moles of oxalate ions
Q6 (a) (iv) Calculation of mass of potassium in sample

Q9 All parts of this question were well done. In part (d) a large number of candidates calculated the correct value for the rate constant but gave the wrong units. However there was a marked improvement in working out the correct units compared to previous years.

Q10 (d) Calculation of % yield

Q12 (d) (ii) Structure of an optical isomer

Q13 (a) Alcohols and ethers

Areas which candidates found demanding

Section A

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

Q15 Only 49% of candidates were able to recognise the correct equation for the standard enthalpy of formation of magnesium bromide

Q24 Only 33% of candidates calculated the emf as 0.23 V. 38% of candidates chose option D (2.88 V) which meant they were using equations $K^+ + e^- \rightarrow K$ and $Fe^{3+} + 3e^- \rightarrow Fe$.

Q30 Only 49% of candidates managed to select option A correctly. This was an A-type question and it worked well.

Q34 Only 48% selected option B correctly. This would have been easier had the candidates recognised the reaction of ammonia and ethanoic acid as neutralisation.

Q39 Only 42% correctly selected a magnetic field (option A) as causing the separation of ions in a mass spectrometer whereas 48% chose option D (electron bombardment).

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.

Q1 (b) and (c) The question is about electron pairs (bonding + non-bonding pairs). Many candidates considered only the bonding pairs and some did not seem to realise that the 8 outer electrons in Ar had to be considered.

Q2 (b) It was disappointing that only 34% of the candidates managed to name the complex ion correctly. Many chose to end the name with –ate despite it not being negatively charged and some did not include the oxidation number of chromium in the name.

Q4 (a) Parts (i) and (iii) were particularly poorly done but no surprises here since these were based on a PPA and PPA questions are notoriously badly done.

Q5 (b) Very poorly done to the extent that this was considered to be a non-functioning question. Only 13% got the answers correct but the question was not discriminating since those who got full marks were a cross-section of the ability range. Candidates did not read the question properly and seemed to use the number of lone pairs rather than the number of lone pair **electrons**. The example given that atom (a) had formal charge +1 was intended to point candidates in the right direction. The correct answers are atom (b) has formal charge 0 and (c) and (d) have formal charge -1.

Q6 (a) (i) Most candidates had the colour change the wrong way round. The colourless oxalate solution is in the conical flask and the colour change at the end-point is when the colourless solution changes to a permanent pink or purple colour.

Q7 This question was poorly done. In part (a) the equilibrium arrow was necessary in the chemical equation and so many candidates lost the mark. In part (b) (i), only 29% of candidates appreciated that equilibrium is not reached in an open system when gases are able to escape. Part (b)(ii) was an A-type question and performed as such.

Q8 This also performed as an A-type question but 48% did get part (a) correct and 56% of candidates got part (b) correct.

Q10 (a) and (b) Again a question based on a PPA. Answers are given in the information that goes along with the PPA instructions. Acceptable answers for (a) were to give a higher yield or to reduce side reactions or to prevent charring. Sodium chloride solution was the answer to (b).

Q11 (a) Some candidates are aware of the correct answer but are unable to express themselves well enough to be awarded the mark. Reading over their answers afterwards and making obvious corrections would have helped.

Q11 (b) An A-type question and performed as such. Many candidates chose to draw a cyclic ion intermediate which is wrong and a fair number had bromine as part of the intermediate which is also wrong.

Q11 (c) Most candidates realised that an alkali such as KOH was required here but spoiled their answer by stating that the KOH should be in alcohol which would lead to an elimination reaction rather than the substitution reaction in the question.

Q12 (a) and (b) Both A-type questions. Correct answer to part (a) is ethanal. Most common answer was ethanol. Candidates should know that H-CN adds across the C=O carbonyl bond in aldehydes and ketones. Only 10% got part (b) correct. Answer given in the arrangements document is cyanohydrins but cyanoalcohol was also accepted. First time this has been asked in the SQA AH exam and many candidates wrote ‘nitrile’ as their answer.

Advice to centres for preparation of future candidates

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 last year, it might be worthwhile for centres to produce a summary of the PPAs which highlights the important points in each experiments.)

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 gain that mark.
- In Unit 3, there are only five different types of reaction mechanisms which candidates need to know and they must try not to confuse the carbocation mechanism and the cyclic ion intermediate for addition across the C=C double bond.
- 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.

A new Candidate's Guide for the AH Chemistry Investigation is available for 2010–11 and is available to download from SQA's website. Candidates should be encouraged to follow the information it contains. This is especially true for the acceptable method of citing references in the text and of listing the references at the end of the report. This guide is available for centres and candidates to download from SQA's website. It is very important that all candidates are given access to the most up-to-date Candidate's Guide.

Chemical Investigation

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

2 More teacher guidance 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 have been given the guidance document but have, unfortunately, chosen to ignore it.

Copies of the Chemical Investigation Guidance Document can be downloaded from SQA's website and a new one has been prepared for the 2010–11 session. 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 which 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 is now only stated in the abstract/summary then it is important that the aim is or aims are written clearly and are easy to understand. Conclusion(s) 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 not stated clearly at the beginning.

3 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 2 or 3 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.

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

5 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.

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

7 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.

8 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.

9 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.

10 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.

11 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.

12 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. The evaluation is worth 4 marks and is very discriminating. Most candidates get only 2 out of 4 here.

13 Candidates are expected to keep an up-to-date day book with entries being checked regularly by their teacher. This is a requirement if the centre is selected by SQA for verification of the Investigation Unit and is very helpful to the candidate — keeping him/her in the right direction, making sure they are using controls, carrying out duplicates etc and very useful when writing up the Investigation report.

Statistical information: update on Courses

Number of resulted entries in 2009	2183
Number of resulted entries in 2010	2225

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	27.6%	27.6%	613	85
B	26.7%	54.3%	595	72
C	22.3%	76.6%	496	60
D	7.5%	84.1%	167	54
No award	15.9%	100.0%	354	–

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.