External Assessment Report 2014

Subject(s)	Chemistry
Level(s)	Advanced Higher (Traditional)

The statistics used in this report are prior to the outcome of any Post Results Services requests

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

The order of questions in Section A (multiple choice) was largely Unit 1, followed by Unit 2 and then Unit 3 questions. In Section B the setters decided to make a deliberate policy change by putting the most difficult questions at the end of the paper. This was the reason why the last two questions were on a difficult PPA and on buffer solutions. As expected, the facility values for these questions were low. The reasons for this change in order included the hope that less well prepared candidates would not be put off by these questions compared to if they had been placed earlier in the paper; and the fact that, in the past, some candidates haven't managed to reach the final questions, where they may have gained easy marks.

In general, markers commented that candidates' performance in Section B of the written paper was poorer than in previous years. Markers stated that there did not seem to be so many outstanding candidates this year and that calculations were more poorly done than in previous years.

The mean mark in Section A (multiple choice) was 29.1 out of 40, which was slightly better than in 2013 when the mean mark was 28.0. All questions in Section A functioned as expected, with the A-type questions scoring significantly lower facility values than the other questions.

The mean mark in Section B was 27.7 out of 60 and this was much poorer than in 2013 when the mean mark had been 33.5. This confirmed what markers had stated in their reports. A large majority of candidates managed to complete the paper in the required time.

The mean mark for the Investigation Report was 15.1 out of 25, which was very similar to the mean mark in 2013 (15.2). Again most candidates are submitting well-presented Investigation reports, but still too few use the candidate's' guide to their advantage.

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	Knowing that the energy of electromagnetic radiation is proportional to the frequency (78%)
Q2	Converting wavelength 501 nm into energy in kJ mol^{-1}. (76%)
Q3	Knowing the electronic configuration of a vanadium atom in its ground state. (80%)
Q4	Knowing that the intensity of radiation absorbed in absorption spectroscopy increases as the concentration increases. (76%)

Q5 Working out that PH_3 has the least ionic character from a list of compounds. (86%)

Q7 Working out that BF_3 does not have a pyramidal structure. (70%)

Q8 Working out that the highest oxidation state of chlorine is in $HClO_4$. (82%)

Q10 Selecting the property required for a primary standard. (79%)

Q11 Knowing that in dynamic equilibrium the rates of the forward and reverse reactions are equal. (86%)

Q12 Calculating the equilibrium concentration. (78%)

Q15 Bond enthalpy calculation. (77%)

Q16 Another bond enthalpy calculation. (71%)

Q18 Recognising the enthalpy of atomisation in a Born-Haber cycle. (94%)

Q19 Recognising the lattice enthalpy in a Born-Haber cycle. (87%)

Q20 Selecting the correct half-cell to produce 1.03 V when connected to a silver metal/ion half-cell. (94%)

Q21 Calculating ΔG^o for a cell given the emf. 80%)

Q25 Knowing that 1-bromopropane changing to propene is an elimination reaction. (86%)

Q26 Knowing that the end-on overlap of two atomic orbitals leads to a sigma bond. (86%)

Q28 Selecting the statement that would not be true for both an alcohol and its isomeric ether. (71%)

Q32 Knowing that Fehling's solution can be used to distinguish between an aldehyde and a ketone. (76%)

Q33 Realising that a tertiary amine shows no infra-red absorption between 3300 and 3500 cm^{-1}. (83%)

Q35 Selecting the correct substance which has a geometric isomer. (86%)

Q38 Selecting the correct compound from its mass spectrum. (75%)

Q39 Knowing that infra-red spectroscopy depends on vibrations within molecules. (80%)

Q40 Selecting the correct active antibacterial agent from its structural formula. (81%)

Section B

Unlike previous years, calculations in Section B were not done well. Significant figures are still an issue. Generally speaking the number of significant figures in the answer should be the same as the quantity in the question with the least number of significant figures. Markers are slightly more generous and will generally accept an answer with one significant figure less up to two significant figures more than the 'correct' answer.

Candidates' performances on questions related to PPAs continue 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(b) Knowing that $SiCl_4$ and PCl_3 both react with water producing white fumes of hydrogen chloride. (73%).

Q1(c)	Knowing the meaning of 'amphoteric'. (83%).
Q2(a)	Drawing a resonance structure for the sulphite ion.(90%)
Q3(a)(i)	Calculating ΔH^o. (81%)
Q3(b)	Using $T = \Delta H^o / \Delta S^o$ to calculate the maximum temperature above which the reaction would no longer be feasible. (78%)
Q5(a)	Drawing the structural formula of oxalic acid given its molecular formula. (73%).
Q5(b)	Calculating the value of x in $CaSO_4.xH_2O$. (73%)
Q6(c)	Knowing that electrophilic substitution is the name of the type of reaction when benzene reacts to form methylbenzene. (73%)
Q7(b)	Drawing the structural formula for compound **A**. (81%).
Q8(a)	Circling the chiral centre in ibuprofen. (75%)
Q10(a)	Determining the order of reaction with respect to $CH_3CHIC_2H_5$ (82%) and OH^- (74%).
Q10(b)(i)	Writing the rate equation for the reaction. (76%)

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. Only two questions came into this category:

Q14	Adding more of one solvent to 2 miscible liquids in equilibrium. (49%)
Q37	Working out which fragment in mass spectrometry has a mass/charge ratio of 92. (46%)

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

Q1(a)	Knowing that NaCl and Al_2O_3 would not affect the pH of water. Only 28% got this correct. Some candidates gave only one answer therefore zero marks.
Q1(d)	The shape of a PCl_3 molecule (31%). Answer required was trigonal pyramidal. Candidates lost the mark if only pyramidal was given. This was taken into account when deciding the pass mark since it affected a large number of candidates.
Q2(b)	Lewis diagram for the sulphite ion (36%) .
Q4(a)	Co-ordination number (47%). Should have been a fairly easy question, but too many candidates were mixing this up with oxidation number. Maybe they thought the question was too easy or didn't understand what the co-ordination number is.
Q4(c)(i) & (ii)	(31% and 30%) Candidates are never good at writing answers to 'explain' type questions. In part (i) often a good answer was ruined when the candidate discussed emission rather than absorption.
Q4(e)	Electronic configuration of chromium(I) 48%). The chromium(I) was in bold to highlight that it was this rather than chromium(III), however too many candidates are still not remembering that the 4s electrons are lost before 3d electrons when transition metal atoms change into ions.
Q4(f)	Calculation in 3 parts. Part(i) 36%; part(ii) (38%); part(iii) 49%. Performed as an A-type calculation but it was expected that more candidates would have done better, especially in part(i). It is always difficult to decide whether

	questions like this should be sub-divided into 3 parts where each part is worth 1 mark, meaning candidates get 1 mark or zero marks for each part or whether it should simply be worth 3 marks without subdivision, where partial marking might allow some candidates to score 1 or 2 marks. There is always follow-on from wrong answers in either case.
Q6(a) & (b)	(48% in both). Some candidates got these the wrong way round but these were fairly basic 'knowledge-type' questions and candidates should have done better here.
Q7(a)(i) & (ii)	(43% and 40%). Performed as an A-type question.
Q8(b)	Again performed as an A-type question. Part (i) (36%); part(ii) (35%); part(iii) 21%. In part(i), many candidates realised that compound A was the impurity but didn't appreciate that ibuprofen would also be there and so lost the mark because their explanation wasn't valid. In part(ii) markers were really looking for the Brady's reagent test and result but accepted anything that would work. However many candidates thought that compound A was an aldehyde and gave answers such as using Tollens' reagent or Fehling's solutions, etc. Part(iii) was difficult but a few candidates did very well getting both marks here.
Q9	Parts (a) and (b) were 'PPA' questions and as such performed as A-type questions. There are always about 6 marks based on PPAs in Section B of the paper. These should not be difficult marks to get if candidates have done the PPAs in class. Part(a) 36%; part(b) 35%. Part(c) 42%, a fairly difficult calculation but candidates should have been able to work out the relative molecular masses of aspirin and 2-hydroxybenzoic acid. Many candidates didn't seem to appreciate that with a yield of 67% more reactant would be required.
Q10(c)	(40%) S_N1 mechanism was required here but the answer had to follow on from answers to part (a).
10(d)	(17%). Candidates who had the wrong mechanism were always going to find this difficult/impossible to answer and even those who got the mechanism correct had problems here. Not an easy mark to get and well done the 17% who got this correct.
Q11(a)	Again questions based on a PPA. This question was always going to have a low facility value but did discriminate well between the different candidates. Part (a) 21%) performed pretty much as expected. A PPA question and an explanation required. Part(b) (28%) Again performed as expected. Part(c) (41%) Candidates probably did better than expected here. Part(d) (44%) Well done to those candidates who stated zero order. As expected most who got this wrong, gave first order as the answer.
Q12(a)(i)	(33%). It was expected that this mark would have been gained by more candidates. Too many didn't appreciate that the total volume was now 60 cm^3.
Q12(a)(ii)	(20%) As expected, this was poorly done.
Q12(b)	(34%). Candidates always find questions on buffer solutions difficult. The question performed as expected.

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 suggested in previous years, it might be worthwhile for centres to produce a summary of the PPAs which highlights the important points in each experiment. However there has been another slight 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.
- 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, 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.
- 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 or have not used 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.

Many candidates, and presumably their teachers, seem to think it is necessary to use more than one technique in their Investigation. This is not the case, and many candidates would do well just to concentrate on doing a good Investigation that involves only one experimental technique or procedure. Candidates end up not being awarded marks for not describing their second technique properly or not giving raw results for their second technique. These are marks which would have been awarded if they had concentrated on the one technique only.

Likewise, it is not necessary to include a modification. Some modifications are trivial and are just doing what should have been done in the first place.

The new additions to the Candidates' guide in 2012–13 are still in the current Candidates' guide, and include:

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 absolutely 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 aims are now only stated in the abstract/summary, it is important that they are written clearly and are easy to understand. Conclusions at the end of the report need to be

based on and cover all the aims. This is much harder to do if the aims 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, 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 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, 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 2013	2545

Number of resulted entries in 2014	2393

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	23.4%	23.4%	561	86
B	28.0%	51.4%	670	72
C	25.0%	76.4%	598	59
D	9.5%	86.0%	228	52
No award	14.0%	-	336	-

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.