External Assessment Report 2015

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

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

This is the third and final year of the revised Advanced Higher exam. In 2013 there were 111 candidates and they performed well in the new exam. In 2014, 262 candidates sat the exam and they also performed well. This year the number had increased to 334. The main differences in the exam for the revised course compared to the traditional course are

- Since there are no PPAs in the Revised course then there are no PPA questions in the exam.
- In the revised exam, there are two open-ended questions. Each question is worth 3 marks.
- There are 30 multiple choice questions and 70 marks in the written section in the revised exam compared to 40 multiple choice questions and 60 marks in the written section in the traditional exam.

Therefore the exam for the revised course is more similar to what we expect the CfE exam to be like compared to the traditional exam. The content of the revised course is also very similar to the content of the CfE course.

The mean mark in Section A (multiple choice) was 21.1 out of 30 compared to 29.4 out of 40 for those sitting the traditional exam. The mean facility value for those questions common to both the revised and traditional exams was 0.78 for the revised and 0.77 for the traditional. Almost 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 40.7 out of 70 in the revised exam compared to 33.8 out of 60 in the traditional exam. The open-ended questions were poorly done compared to other questions with the mean mark for both being just above 1 out of 3. Most candidates made some effort at these questions. The mean facility value for those questions in Section B common to both the revised and traditional exams was 0.47 for the revised and 0.44 for the traditional exam.

The mean mark in the Investigation was 16.9 out of 25 for the candidates doing the revised course compared to 15.0 out of 25 for those candidates doing the traditional course. The marking instructions were the same for both except that, since there are no PPAs in the revised course, there was no penalty for turning a PPA from the traditional course into an Investigation. Markers stated that very few of the candidates doing the revised course did investigations based on the traditional course PPAs.

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.

Q.1 Knowing that infrared radiation has longer wavelength and lower frequency than visible radiation (85%)

Q.2 Knowing that each line in an emission spectrum results from an excited electron dropping to a lower energy level (94%)

Q.3. The electronic configuration of a krypton atom (94%)

Q.4 Working out that PH_3 can act as a Lewis base (75%)

Q.5 Working out the shape, number of bonding and non-bonding pairs of electrons in H_3O^+ (84%)

Q.11 Working out the name of a complex carboxylic acid from its skeletal formula. (82%)

Q.12 Selecting the compound which will have an enantiomer. This is the same question as No. 37 in the traditional paper except that in the traditional paper the word 'enantiomer' was replaced by 'optical isomer'. (91%)

Q.13 Working out the most likely products of heterolytic fission of 2-chloromethylpropane (83%)

Q.14 Selecting the equation that did not represent a nucleophilic substitution. (79%)

Q.16. Knowing that $LiAlH_4$ would bring about the reduction of a ketone in the preparation of Ibuprofen. (83%)

Q.21 Realising that nitric acid and sodium nitrate would not make a buffer solution (75%)

Q.22 Knowing that the entropy of a perfect crystal is zero at 0 K (79%)

Q.23 Selecting the correct graph of ΔG^o v Temperature for a reaction which is always feasible. (85%)

Q.24 Knowing that if the position of equilibrium is to the products side then K>1 and ΔG^o<1. (75%)

Q.25 Calculating that rate increases by factor of 16 from 20 ^oC to 60 ^oC (78%)

Q.26 Selecting correct rate equation (72%)

Q.28 Selecting the correct apparatus for accurate dilution (82%)

Section B

In general, calculations were done well except for question 3.

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 still tend to perform poorly in any question in which they have to 'explain' or 'describe'. It would appear that their ability to perform better in chemistry exams is limited by their inability to express themselves on paper. This is true of the answers given to both

open-ended questions (OEQs). Although there were some very good responses to the open-ended questions, many candidates struggle to get a total of 3 marks in these OEQs.

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. The number in brackets is the facility value for that part of the question.

Q.1(a)(i) 90% of candidates understood the meaning of 'degeneracy'. (90%)

Q.1(a)(ii) 96% of candidates were able to explain why the representation of the electronic configuration of nitrogen given in the question was wrong (96%)

Q1(a)(iii) Stating the 4 values of the quantum numbers for the 3s electrons in sodium (86%)

Q.1(b)(i) Calculating the wavelength from the energy (83%)

Q.2(a) Familiar type of question. Calculating ΔH^o (84%)

Q 2(b) Calculating ΔS^o (92%)

Q.2(c) From the results in (a) and (b) calculating the theoretical temperature above which the reaction becomes feasible (75%). As with the traditional paper it is encouraging to see so many candidates performing well here.

3(b)(i) Calculating the number of moles of sulfuric acid in the average titre. (81%)

Q.4(b) Knowing that recrystallization is needed to purify the product (90%)

Q.4(c) Calculation of percentage yield (87%)

Q.5(d) Realising that when the stopper was removed the $V^{2+}(aq)$ ions are oxidised by the oxygen in the air. This part of the question was answered better than had been expected. (77%)

Q.6(b)(i) Determining numerical values for x and y (initial rates) (81%)

Q.6(b)(ii) Calculation of the rate constant with the correct units (71%)

Q.8(a) Knowing that sp^2 hybridisation is present in phenol (71%)

Q.9 (c) The structural formula for the geometric isomer of indigo was well done (87%)

Areas which candidates found demanding

Section A

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:

Q.15 Always seems to cause problems, knowing that Na(s) reacts with ethanol to form the ethoxide ion. (48%) Worked well as an A-type question with low facility value and very good discrimination.

Q.29 Knowing that the distance moved by the solvent front has no effect on the R_f value. Only 15 % got this correct and, in fact, was the option chosen by the least number of candidates. Not a good A-type question since it did not discriminate well. Definitely a worthwhile teaching point though, when discussing chromatography and explaining R_f values. R_f is a ratio and whatever the distance moved by the solvent front, the component in the mixture will move relative to that distance since the R_f value is constant.

Section B

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

Q.3(a) Explanation of what is meant by a 'back titration'? (20%). Very poorly done. Most candidates found it very hard to write down a good, general explanation for a back titration even though they had a good idea of when a back titration is used. Again a problem writing a clear and acceptable explanation.

Q.3(b)(ii) Calculating the number of moles of excess sodium hydroxide in the **standard flask** (36%). A-type question with good discrimination but, nevertheless, disappointing that so many candidates lost this mark.

Q.3(b)(iii) 38% were able to calculate the number of moles of sodium hydroxide which reacted with the acetysalicylic acid. Again a good discriminating question but also disappointing to see so many candidates losing the mark here, despite correct follow through rule being applied.

Q.3(b)(iv) Calculating the mass of acetylsalicylic acid in one aspirin tablet (45%). Not many candidates got the actual correct answer but the correct follow through rule meant many were awarded marks for the correct working here even if their final answer was incorrect.

Q.3(c) Only 17% were able to suggest a control experiment suitable for this back titration. A good teaching point here would be to explain that a control experiment is not the same as a blank experiment.

Q.4(d) Describing how to carry out a mixed melting point experiment (46%). Again an opportunity for candidates to write more than a few words but many have problems with this type of question.

Q.5(b) Working out why the yellow solution turned green before it turned blue (24%). Just looking for a mixture of the blue and yellow ions giving a green colour. This question didn't discriminate well, perhaps because too many of the more able candidates were looking for a more complicated answer.

Q.6(a)(ii) Explaining whether the forward reaction is endothermic or exothermic. Not good enough to say 'endothermic' on its own. Most candidates worked out that the forward reaction is endothermic but their explanations were not good enough. (39%)

Q.7 An open-ended question which had a facility value of 47% with a good discrimination means that this one worked as intended. Good opportunity for candidates to show how much they knew about electrons and how they affect reactivity of elements and their involvement in chemical reactions. Remember to get 3 marks, the marker is looking for a good answer rather than an excellent answer so not everything has to be covered.

Q.8(b)(i) candidates needed to get a suitable reagent **and** catalyst correct to get the mark. Had this been out of 2 marks, most candidates would have lost both marks. 34% did get the mark and this worked very well as an A-type question with very good discrimination.

Q.8(c)(i) Drawing the structural formula for 2,4,6–trinitrophenol (39%). Most candidates who got this wrong put NH_2 groups instead of NO_2 on the 2,4,6 positions on the benzene ring.

Q.8(c)(ii) 36% got the formula of the reactive species (NO_2^+) acting on the phenol correct. Getting part(i) wrong made it very difficult to get this mark.

Q.9(b) Another explanation type question. Markers were looking for an answer along the lines of 'red and green being absorbed and blue being transmitted'. However blue is not being 'reflected' and neither is blue light being 'emitted' and these were treated as cancelling errors. Again, important teaching points for future candidates. Facility value for this part was a 30%.

Q.9(d)(i) Writing the molecular formula from a complicated skeletal formula. This was another A-type question in which the candidates did well. The facility value was 47% with good discrimination.

Q.10(c)(ii) Drawing the transition state. Always an A-type question but a commendable 34% got this correct. The 5-membered transition state had to show the bond from the HO to the C and the bond from the C to the Cl as dotted lines and the whole structure should be enclosed in brackets with a negative charge outside the brackets or with a negative charge shown on the central carbon.

Q.10(f) Definitely an A-type question. The wording in the question was such that the candidates were meant to realise that a different explanation was required for each isomer. The facility value was 38% and with very good.

Q.11(a)(i) Describing how a reactant is acting as a nucleophile. As expected this question had a low facility value (25%) and it also discriminated well. Once again, candidates doing poorly when asked to describe or explain in their answer.

Q.11(a)(ii) Appreciating that the OH is the group present in the product but which is in the reactant and looking up the wavenumber range in which its absorbance peak will be found (46%).

Q.11(b) The second OEQ. A very difficult one and some good attempts but the facility value was 31%.

Q.12(b) Facility value 34% which was unexpectedly low. As stated in previous years with this type of question, some candidates do not seem to appreciate that compound **X** is the same substance in parts (a), (b) and (c). The major variation this year was that compound **X** contained sulphur. However the facility value for part (a) was 65% and the empirical formula was also given and so the expectation was that more candidates would get this part correct.

Q.11(c) An A-type question, gathering the information collected in parts (a) and (b) and drawing a structural formula for **X**. Facility value = 41% with very good discrimination.

Advice to centres for preparation of future candidates

General

The Revised AH Chemistry course and exam has been short lived having existed for three sessions only. However centres which have taught the revised course are likely to be better prepared for the CfE AH course which is very similar in content and the CfE exam will also have two open-ended questions.

As usual there are general points that should be mentioned:

Advise candidates to:

- Read each question carefully including the stem.
- Try to get through Section A in about 30—35 minutes so that they have enough time to complete Section B and go back over any questions that they were unsure about.
- Spend no more than 5 minutes on each open-ended question so that they have enough time to complete all the questions. If time permits they can always go back over their answers to these questions at the end of the exam.
- 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 AH Chemistry questions, especially the multiple-choice questions but also Section B questions as well. Teachers should point out to candidates which questions still fit in with the new CfE course. Many questions in the traditional paper are still valid but there will not be questions for parts of the new course. The Revised Advanced Higher papers provide a very useful source of suitable questions for practising. There is probably no better way to study to pass examinations

Chemistry project

The Project report in CfE AH Chemistry will be marked out of 30 rather than 25 and so the marks per category, in some cases, will be quite different. A new set of guidelines to centres and candidates is available and it is important that candidates download and use the candidates guide from the SQA website.

Points which have been important in the past for Advanced Higher Chemistry Investigations will still be relevant to the Advanced Higher Chemistry Project, and some of these are included below:

- More teacher involvement at the planning/designing stage will be very beneficial to many candidates.
- Candidates should be given good advice on writing up the Project Report.
- A candidate who does a good project but writes it up poorly is likely to score fewer marks than a candidate who does a poor project but writes it up according to the advice given in the Candidates' Guide.

- It has been obvious in the past that candidates from some centres have been 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.
- 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 which involves only one experimental technique or procedure. In the marking of the Traditional AH Chemistry Investigation reports, candidates often ended 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.

Other important points include:

- There is absolutely no need for a hypothesis in the AH Chemical Project 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) 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 project 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 project 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 project 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, in addition to the analysis carried out by the candidate, they do 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 projects.
- Groupwork approaches are not permitted for Advanced Higher Projects.

- In Underlying Chemistry, 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.
- 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(s) 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.
- 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, major and minor gridlines are included 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) must relate to all the aims given earlier and the conclusions should be given under a separate heading in 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 projects
- Candidates are expected to keep an up-to-date day book or record of work with entries being checked regularly by their teacher. This will be 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 Project report. In the past it has been 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 2014	278

Number of resulted entries in 2015	335

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	38.8%	38.8%	130	86
B	25.2%	63.6%	83	74
C	19.1%	82.7%	64	62
D	7.8%	90.4%	26	56
No award	9.6%	-	32	-

For this course, the intention was to set an assessment with grade boundaries at the notional values of 50% for a Grade C and 70% for a Grade A. A 1 mark adjustment was made at the A and the upper A boundaries to account for the wording of Q29. Q29 was a non functioning 'A' question.

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.