Course Report 2016

Subject	Chemistry
Level	Advanced Higher

The statistics used in this report have been compiled before the completion of any Post Results Services.

This report provides information on the performance of candidates which it is hoped will be useful to teachers, lecturers and assessors in their preparation of candidates for future assessment. 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 assessment documents and marking instructions.

Section 1: Comments on the Assessment

Component 1: Question paper (100 marks)

The question paper consists of two sections totalling 100 marks, with a mixture of objective test, short response and extended answer questions. This is the first year of this new Advanced Higher course following on from the new course at Higher and National 5.

There are fewer objective test questions and more extended answer questions than in previous years, yet when scaled up, the performance in both sections was similar to previous years.

The question paper performed largely as expected, so no adjustment of the grade boundaries was necessary.

Component 2: Project (30 marks)

Candidates must undertake a chemistry project which is their own individual work. The project report is externally marked and totals 30 marks. The project report is worth 5 marks more than in previous years.

As with the question paper, when scaled, performance was not dissimilar to previous years at Advanced Higher level. Again, no adjustment to grade boundaries was necessary.

Section 2: Comments on candidate performance

Areas in which candidates performed well

Component 1: Question paper

Section 1 (objective test)

The objective test began with three straightforward questions from the electromagnetic spectrum and electronic configuration parts of the course. These were very well done by a very large majority of candidates.

Other areas where candidates performed well in this section include:

Q6: identifying an acid from a balanced equation.

Q11: predicting a mechanism from a rate equation.

Q12: identifying pi and sigma bonds in an organic structure.

Q13: identifying geometric isomers in the form of skeletal structural formulae.

Q14: identifying hydrogen bonding in molecules.

Q17: applying an unfamiliar organic synthesis (problem solving).

Q18: recognising a condensation reaction from an equation for an unfamiliar reaction.

Q19: applying Markovnikov's rule.

Q21: constructing a reaction sequence.

Q25: identifying structurally active fragments in drugs.

Q27: defining primary standards.

Q30: performing a gravimetric analysis calculation.

Section 2 (extended response)

This section of the assessment begins with a set of familiar thermodynamics calculations. These were done well by most candidates. Generally, this was the case for all of the calculations in Section 2.

Questions 3(b) (iii) and 8 (f) are open-ended questions and traditionally candidates find these quite demanding. The most common mark achieved by candidates for both open-ended questions was 2. A very small proportion of the candidates did not attempt these questions. This is a welcome improvement in performance.

Other areas of good performance in this section include:

Q2 (a): writing the electronic configuration of a neon atom.

Q2(b): drawing the shape of a p orbital.

Q3(b)(i): determining the coordination number of iron from the structure of a complex.

Q4(a)(i): defining 'weigh accurately approximately.'

Q4(a)(ii): outlining the preparation of a standard solution.

Q4(b)(i): suggesting a fast method of filtration.

Q5(b)(i): calculating the concentration of a solution from a mass and volume.

Q5(b)(ii): calculating the pH of a solution.

Q6(a): calculating the energy associated with a given wavelength of light.

Q6(b)(i)(A) and (B): determining the order of reaction with respect to the concentration of reactants.

Q6(b)(ii): writing the rate equation for a reaction.

Q7(a): determining the most abundant substance from an equilibrium constant.

Q7(b) (i): identifying a chiral centre.

Q7(b) (iii): drawing the skeletal structural formula for a named substance.

Q8 (a): defining the term agonist.

Q9(a)(i): writing a molecular formula from a skeletal structural formula.

Q9(a)(ii): stating the type of hybridisation in an aromatic ring.

Q10 (a): calculating an empirical formula.

Q10(b): identifying the bond associated with a peak in an IR spectrum.

Component 2: Project

Most parts of the project were completed quite well by candidates. The vast majority of candidates stated an aim and then choose a relevant procedure to achieve that aim. Procedures were generally well described and the results were presented in an appropriate way.

Areas which candidates found demanding

Component 1: Question paper

Section 1 (objective test)

Q7: realising that an indicator is not appropriate in titrations involving weak acids and weak bases or identifying weak acids and bases.

Q9: identifying the equation for the enthalpy of formation of a given reaction.

Q16: identifying the reactants required to produce a particular ether by nucleophilic substitution.

Q24: deducing the spitting pattern associated with a particular proton environment in a high resolution proton NMR spectrum. Many candidates would appear to have not applied the n+1 rule.

Q28: calculating the volume of a solution required to make a particular volume of a more dilute solution. Many candidates were not taking into account that the nitrate ion concentration was double that of the calcium nitrate solution.

Section 2 (extended answer)

It is worth noting that although many candidates found the following questions to be very demanding, the number who didn’t attempt the questions was relatively small.

Many candidates did not gain one mark by not giving the final answer to the correct number of significant figures. Likewise, a mark was not awarded for writing incorrect units. Candidates should take more care in copying units from the stem of the question.

Q2(c): knowing the three possible values of *m* for an angular quantum number, *l*, equal to 1. Many candidates either provided only one correct value or gave the two spin quantum numbers, *m*, +½ and -½.

Q3(a)(i): completing an orbital box diagram with six d electrons in the ground state. Many candidates appear to have read the phrase ‘unpaired electrons’ in the stem and gone on to complete the orbital box diagram showing the high energy state with unpaired electrons.

Q3(a)(ii): using the spectrochemical series given to explain how the decrease in the splitting and the resulting energy difference allows some electrons to be promoted. Many candidates simply described how splitting of the d orbitals occurs.

Q3(a)(iii): realising that there must always be an unpaired electron when there are only 5 d electrons present. Many candidates only stated that there were unpaired electrons present but this information had already been given in the stem.

Q3(b)(ii): suggesting emission or absorption spectroscopy to determine the presence of copper in a complex. Many candidates suggested colorimetry, but this would not prove that copper was present.

Q4(a)(iii): suggesting ways to reduce the uncertainty in a titration, for example titrating a larger sample of seawater. Many candidates confused this with improving the precision and suggested repeating the titration to get concordant results.

Q4(c): realising that when the concentration of an ion is very low, a gravimetric technique would not produce enough precipitate to measure accurately. Candidates may not have had sufficient experience of these techniques to be able to answer this question.

Q7(b)(ii): realising that when the enol form converts back to the keto form, either enantiomer can form. Eventually, a racemic mixture will form. Most candidates didn’t understand the principle involved here and concentrated on the equilibrium and the fact that the enol form was not optically active.

Q8(c): realising that step 3 involves a free radical process and as such, UV light is required.

Q9(b)(i): drawing a diagram of assembled reflux apparatus. Common errors include drawing lines across the top of the condenser making a sealed system, not showing water in and out and drawing a distillation setup instead. Again, candidates may not have had enough experience of the practical techniques to access this mark.

Q9(b)(ii): explaining that the products are soluble in water. Many candidates stated that the products were soluble in each other or the other layer had evaporated away.

Q9(b)(iii): explaining how a solution of a salt of a weak acid and strong base has a pH greater than 7 in terms of the equilibria involved. Most candidates did not mention the equilibria.

Q9(b)(iv): stating two factors that should be considered when choosing a solvent for recrystallisation. Many candidates gave the solubility of the product in hot and cold solvent as the two factors. However, this was only one factor.

Q10(c)(ii): suggesting an ion fragment based on spectroscopic data. Many candidates omitted the positive charge or placed the charge on the wrong atom or drew a fragment that was not possible for the data given.

Component 2: Project

Candidates scored 2 marks on average for the Underlying Chemistry section of the project. Quite often this was because they omitted relevant equations or the background to the techniques used. Sometimes the choice of project made it very difficult to gain more than 2 marks since there simply wasn’t enough relevant chemistry to discuss.

The Evaluation is traditionally the most demanding part of the project report. Many candidates found it easier to evaluate the procedures by consideration of uncertainties in equipment and areas where the procedure went wrong. However, they found it much more demanding to evaluate the results. Quite often, all that the candidate supplied was a restatement of the findings.

Section 3: Advice for the preparation of future candidates

Component 1: Question paper

Candidates should read each question carefully including the stem.

Candidates should try to get through Section 1 in around 30 minutes so that they have enough time to complete Section 2 and go back over any questions that they were unsure about.

It would be helpful if centres do at least the minimum number of experiments outlined in *Chemistry: A Practical Guide*, which can be downloaded from the Education Scotland website. This would ensure that candidates have experience of all techniques in the Researching Chemistry unit.

In almost every calculation question, units are not required in the final answer since they are stated in the stem. If the candidate gives incorrect units, a mark may not be awarded. Candidates should take care to write the correct units.

Candidates should 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 the number of decimal places.

It would be helpful if centres went over past paper questions especially the multiple-choice questions but also in Section 2. There is probably no better way to study to pass examinations.

There are no half 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.

Component 2: Project

More teacher/lecturer involvement at the planning/designing stage would be very beneficial to many candidates. However, the planning/designing stage should be the work of individual candidates and not done as part of a group. This is especially the case when it comes to the experimental stage.

Unless the centre is presenting a large number of candidates for Advanced Higher Chemistry, there is no reason for two candidates from any one centre to be doing the same or similar projects.

Candidates also need better advice on writing up the project report. It would appear that not all have seen copies of the very useful Candidates’ Guide available on the SQA secure website, or have not used it. A candidate who does a good project but writes it up poorly is likely to score fewer marks than a candidate who does a poorer project but writes it up according to the advice given in the Candidates’ Guide.

There is no need for a hypothesis in the Advanced Higher project report. No mark is given for a hypothesis.

The abstract, which should immediately follow the contents page, is a statement of the aims of the project and a summary of the main findings. All of the aims should be covered in the summary. Time is, more often than not, a factor in the success of the project, and many projects have several aims stated when only one aim would have resulted in a better project and write up and, consequently, a higher mark. Keep it simple.

Since the aims are only stated in the abstract/summary, it is important that they are written clearly and are easy to understand.

Although quite often interesting, historical information in the Underlying Chemistry section will not gain any marks. Marks are awarded for chemistry. Likewise, marks are not awarded for biological information unless it involves chemistry. Given that there is a word count limit on the project report, the allocation would be better spent on the Evaluation section than on interesting history and biology.

It is not necessary to use more than one technique in the project. Many candidates would do well to concentrate on doing a good project 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 that would have been awarded if they had concentrated on the one technique only.

Likewise, it is not necessary to include a modification. One mark is awarded for any one of:

- two or more techniques used
- modifications
- control experiment

It is not necessary to do all three.

There would appear to be some confusion over what constitutes a control experiment. A control involves using a pure sample or sample of known concentration to check the validity of the technique or procedure. If the project involves determining the vitamin C content of orange juice, 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.

Although time is a factor, experiments must be repeated where practicable. 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, each experiment should be carried out at least twice for each type of cheese. However, if the project involves a lengthy synthesis, it may not be practicable to repeat the whole procedure. In this case, duplication of a melting point determination or TLC analysis would be sufficient. If nothing has been duplicated in the project, this mark cannot be awarded.

A risk assessment must be included in the project report. Hazards associated with specific chemicals/procedures should be identified or a statement given that no hazards are present.

Precautions should be given for each of the hazards identified. If no hazards have been identified, again, a statement that no extra precautions are needed should be given.

Raw results should be given for all experiments. 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, it is not acceptable to simply take it to the nearest university and get IR, UV, NMR etc spectra carried out. The analysis should be done chemically giving the results, observations and conclusions plus reasoning at each stage. If the candidate does get different spectra runs, the report should show that the candidate has interpreted the different absorptions correctly and should assign the main peaks correctly.

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 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 or literature 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. 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 project report.

Grade Boundary and Statistical information:

Statistical information: update on Courses

Number of resulted entries in 2015	0

Number of resulted entries in 2016	2614

Statistical information: Performance of candidates

Distribution of Course awards including grade boundaries

Distribution of Course awards	%	Cum. %	Number of candidates	Lowest mark
Maximum Mark -				
A	34.3%	34.3%	897	91
B	27.8%	62.1%	726	78
C	20.8%	82.9%	545	65
D	8.2%	91.2%	215	58
No award	8.8%	-	231	0

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.