Course Report 2018

Subject	Chemistry
Level	Advanced Higher

This report provides information on the performance of candidates. Teachers, lecturers and assessors may find it useful when preparing candidates for future assessment. The report 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.

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

Section 1: comments on the assessment

Summary of the course assessment

Component 1: question paper

Section 1 (objective test)

Overall, the objective test was slightly more demanding than anticipated and consequently did not perform as expected. There were no specific questions that could be identified as being the main cause of the increase in demand, and so the grade boundary was adjusted accordingly.

Section 2 (extended answer)

Questions 4(b), 6(c)(ii), 7(b), 8(a), 9(b) and 9(c) were identified as operating at A grade, meaning that they were not accessible to C grade candidates, as intended. Question 2(b)(i), which was predicted to have one A mark, in fact, had only C grade marks, and so was less demanding than anticipated. In question 9(b), all 3 marks were functioning as A grade marks, instead of the intended 2 marks. The A mark allocated to question 10(c)(i)(A) was not accessible to most A grade candidates due to the demand. The grade boundary was adjusted accordingly.

Component 2: project

The candidate's achievement in the project was very similar to last year. There were no changes to the marking of this component other than to increase accessibility of the quality mark, 5(d), by widening it to reward projects with a more complex or comprehensive approach to the investigation. The project performed as expected and no adjustments to the grade boundaries were necessary for this component.

Section 2: comments on candidate performance

Areas in which candidates performed well

Component 1: question paper

Section 1 (objective test)

It was intended that this section would open with three straightforward recall questions on physical chemistry. Almost every candidate managed to choose the correct response for questions 1 and 2. Question 3 was more demanding and is covered in the next section.

Other areas candidates performed particularly well in include:

Question 6	Determining the oxidation state of a metal in a complex.
Question 12	Identifying the components of a buffer solution.
Question 21	Interpreting a mass spectrum to identify a substance.
Question 22	Selecting a wavenumber range from the data booklet that would not appear in the IR spectrum of a given substance.
Question 23	Assigning a drug type to a compound based on a description of its action.
Question 25	Choosing the most appropriate solvent based on given criteria.
Question 28	Stating the purpose of a desiccator when heating to constant mass.

Section 2 (extended answer)

This section was opened using the area of electromagnetic spectra, contextualised within the subject of Roman pottery. Almost all candidates managed to name the metal in question 1(a)(i) and slightly fewer went on to successfully calculate the wavelength in question 1(a)(ii). This was a great start to the extended answer section.

Other areas candidates performed particularly well in include:

Question 1(b)(i)	Stating the aufbau principle.
Question 2(b)(i)	Most candidates managed to calculate the pH of a weak acid.
Question 2(b)(ii)	Suggesting the presence of hydrogen bonding from a structure.
Question 3(a)	A very large number of candidates were able to describe the procedure for preparing a standard solution. Almost all candidates were able to access at least 1 of the 2 marks available. This is also a Higher Chemistry technique and the benefits of this were seen here.
Question 4(d)(i)(A)	Calculating an enthalpy change from a table of data.
Question 6(b)(ii)(B)	Stating the co-ordination number of a metal in a complex.

Component 2: project

Candidates continue to perform well in the same areas each year.

Areas done particularly well include:

- being able to state the aim and findings of the project
- choosing an appropriate procedure to allow the aims of the project to be achieved
- using two or more techniques, performing a modification, or standardising solutions
- having an appropriate structure for the report, including a contents page and page numbers

A small number of candidates wrote a report that exceeded the word count limit.

Areas which candidates found demanding

Component 1: question paper

Section 1 (objective test)

The first three questions were expected to form a gentle introduction into the objective test. Questions 1 and 2 performed as expected, however, question 3 proved much more demanding than anticipated. Almost all candidates were using the principle that there is a maximum of two electrons in any one orbital, however, they did not select this as a response. Most candidates chose response D, which was the maximum number of electrons in the d-sublevel. Candidates appear to be confused over orbitals and sublevels.

Other areas of demand for candidates include:

Question 5	Determining the electron arrangement of a metal ion in a complex. Most candidates realised that the two electrons lost in forming the metal ion did not come from the 3d subshell (responses B and C). Of these candidates, half did not realise that there would be splitting of the d-orbitals due to the metal ion being part of a complex. Also, a number of A grade candidates realised that there would be splitting of the d-orbitals, but had incorrectly removed the two electrons from the 3d energy level instead of the 4s.
Question 17	Most candidates chose either response A (correct) or B. Candidates clearly had difficulty in visualising 3D structures.
Question 18	Identifying the most appropriate reagents for the synthesis of sodium butoxide. The majority of candidates chose response C. Whereas, this may lead to a small quantity of the desired product, and this is not an appropriate synthetic route. The correct response (A) is the only one to show an alkali metal and an alcohol. This should have been a straightforward question.
Question 19	Identifying a reaction type (nitrile to carboxylic acid). Around half of the candidates chose either response A or B. This is a straightforward

question and more or less a matter of accurate recall. There should have been no challenge seen here.

Question 29 Identifying a factor that would not affect the R_f value for a component. More than half of the candidates chose response A. This shows a lack of understanding about why R_f values are used in TLC. The candidates have simply chosen the response they associate with R_f, since the other responses are not usually linked to R_f values.

Section 2 (extended answer)

Areas of demand for candidates include:

Question 2(a)(ii) Writing the equation for the second dissociation of malic acid. Candidates did not appreciate that the second hydrogen ion would come from the carboxyl group on the left hand side of the molecule. Some removed the hydrogen ion from the middle hydroxyl group. Some candidates managed to introduce hydroxide ions into the equation. They should have followed the given example.

Question 3(b)(ii) Part (i) was quite well done and involved a calculation that would be appropriate at National 5. However, translating this result into a value for n proved challenging for most. A number of candidates did not use the titration data to calculate the number of moles of sodium carbonate in part (i), but instead used the relationship n = m/gfm. They then went on to use the titration data in part (ii) along with the answer to part (i). There was a lack of understanding of the calculation. This may be due to many candidates not having experience of doing this type of procedure.

Question 4(a) Most candidates could not state how transition metals can act as catalysts. Many explained this in terms of lowering activation energy, or providing a surface for the molecules to react on, or weakening the bonds in molecules. These explanations are not acceptable at Advanced Higher level.

Question 4(b) Most candidates were not able to draw a skeletal structure for cis-but-2-ene. Instead, they had drawn the trans isomer or a structure that was not fully skeletal.

Question 4(c) This was difficult for candidates to explain. Many candidates were confused between optical isomers and geometric isomers as they commonly mentioned non-superimposable mirror images. Also, candidates were not clear in specifying that the groups/atoms referred to were on either side of the double bond.

Question 4(d)(i)(B) Candidates were able to calculate the entropy value but found the unit challenging. Many wrote $J\ mol^{-1}$ or $kJ\ mol^{-1}$rather than $J\ K^{-1}$.

Question 5(b)	Many candidates made reference to electron transitions from the HOMO to the LUMO, however, a number of candidates failed to state the direction of electron transition, merely stating that electrons move between the HOMO and LUMO. Another common error was to state that the colour seen is due to light being emitted from the substance, or that the light is being produced by electrons dropping down energy levels. A significant number of candidates did not mention HOMO and LUMO in this question but went on to discuss this in question 5(c).
Question 6(c)(ii)	Most candidates achieved two marks or zero marks for this item. Those who achieved zero marks, did not understand the calculation involved. This may be due to not having any experience of performing this type of practical and calculation.
Question 7(a)(iii)	Candidates were giving a variety of answers to this question, such as sodium hydroxide, concentrated sulphuric acid, hydrochloric acid or lithium aluminium oxide. There were lots of random responses too.
Question 7(b)	Candidates did not appear to understand what is meant by ppm when it comes to solutions. A good number of candidates were using mg per kg and then did not know where to go from there. Other candidates wrote random numbers and showed no understanding.
Question 7(c)	Most candidates placed the spots on the solvent line. A good number of candidates had drawn a completed chromatogram with the original spots labelled on the start line. This was not what was asked for in the question. Candidates should ensure that they read the question carefully.
Question 8(b)	Many candidates simply stated that water was still present in the mixture. This is a restatement of the stem of the question. Other candidates stated that there were impurities in the ethanol.
Question 9(b)	This mechanism has not been assessed in previous years. It is therefore likely to be less practised by candidates. There were a variety of places where the candidates went wrong. A curly arrow pointing from H^+ or H_2O towards the C=C bond in the first step was a common error. Some candidates produced a cyclic intermediate as seen in a halogenation reaction. Other candidates used single-headed arrows. A good number showed attack of the carbocation intermediate by OH^- ions. Some candidates were not awarded the intermediate mark because they had a missing hydrogen on the first carbon.
Question 9(c)	Few candidates could identify the appropriate hydrogen atom. Although the question states 'circle the hydrogen atom(s)', many

	candidates circled a carbon atom instead. There are six peaks in the multiplet at 3.7 ppm and a significant number of candidates circled six hydrogens. These candidates did not understand the n+1 rule. Some candidates did think of this rule and circled five hydrogens. Overall, there is a poor understanding of high-resolution NMR spectra.
Question 10(c)(i)(A)	Colorimetery is one of the techniques candidates should be familiar with. Candidates frequently did not mention the use/choice of an appropriate filter or the need for a reference/blank.
Question 10(c)(ii)	Most candidates were unable to predict the number of peaks in the low-resolution spectrum. The most common responses were two or three. There is clearly a misconception.

Component 2: project

Most candidates achieved 2 or 3 marks for the underlying chemistry section of the project. Sometimes the choice of project made it very difficult to gain more than 2 marks, since there was not enough relevant Advanced Higher Chemistry to discuss.

The evaluation is traditionally the most demanding part of the project report. Many candidates find it easier to evaluate the procedures by considering uncertainties in equipment and areas where the procedure went wrong. However, they find it much more demanding to evaluate the results. Quite often, all the candidate supplies is a restatement of the findings. It is also common for candidates to attribute large differences between the actual and theoretical/literature values to uncertainties and human error in reading equipment, when this is not the case.

Slightly more than half of the candidates managed to reference their projects appropriately. Guidance on appropriate referencing is given in the *Instructions for candidates* section of the coursework assessment task, which should be made available to every candidate.

Section 3: advice for the preparation of future candidates

Component 1: question paper

Candidates should be encouraged to read each question carefully, including the stem. Many questions are not being answered correctly because the candidates do not understand the meaning of the question.

Candidates should try to complete section 1 in around 30 minutes so they have enough time to complete section 2 and review any questions they are unsure about.

Candidates should do at least the minimum number of experiments outlined in *Chemistry: A Practical Guide,* which can be downloaded from the Education Scotland website. This will ensure they have experience of all techniques in the Researching Chemistry unit. This unit tends to be the weak point in the performance of most candidates. Candidates are expected to describe the correct procedures associated with use of the listed pieces of apparatus and techniques. Full descriptions of the use of apparatus are not necessarily given in the course support notes, and teacher or lecturer input is essential.

Units are not required in the final answer when they are stated in the stem. If the candidate gives incorrect units then a mark may not be awarded. Candidates should take care to write the correct units if they wish to include them in the answer. A very common error is to use the incorrect case for the letter k. It is worth pointing out to candidates that they should make a clear distinction between their upper and lower case letters, such as k.

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. The acceptable range for final answers is one fewer to two more significant figures than the data provided. Candidates should be taught about significant figures and not confuse significant figures with the number of decimal places.

In multi-step calculations, candidates should not excessively round their intermediate values. Some candidates round intermediate values to one significant figure, making the final answer wildly different to the acceptable answer. A candidate will not achieve full marks for a question if they round intermediate values to less than one significant figure fewer than the data provided. Not rounding intermediate values ie retaining full calculator accuracy is best practice.

Candidates are advised to go over past paper questions, especially the multiple-choice questions, but also section 2 questions. This is a good way to practise and study for the question paper.

Component 2: project

More teacher and lecturer involvement at the planning/designing stage would be beneficial to many candidates. However, the planning/designing stage must 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. Group results are not acceptable.

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 are familiar with the *Instructions for candidates* section of the coursework assessment task on the SQA secure website. 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 *Instructions for candidates*.

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 aim(s) of the project and a summary of the main findings. All of the aims must 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. The advice is, keep it simple.

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

Although the historical information in the Underlying Chemistry section is quite often interesting, it 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 limit for the project report, the allocation would be better spent on the evaluation section than on 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 may not be awarded marks if they fail to describe their second technique properly or provide raw results for their second technique. These are marks that could have been awarded if they had concentrated on one technique.

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
- standardisation of solutions

It is not necessary to do all four.

There appears 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. For example, if the project involves determining the vitamin C content of orange juice, then the chosen procedure’s validity could be tested with a solution of ascorbic acid of known concentration as the control.

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 is not practicable to repeat the whole procedure. In this case, duplication of analyses done after the synthesis is sufficient. For example, a melting point determination and/or TLC analysis would be sufficient. All of the analytical techniques should be duplicated. If nothing has been duplicated in the project then 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 made that no hazards are present. Precautions should be given for each of the hazards identified. If no hazards have been identified then, 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, then it is not acceptable to simply take it to the nearest university and get IR, UV, NMR spectra carried out by a technician. The candidate will not get any credit unless it is clear from the report that they have done the procedures themselves. It is also essential that the analysis includes chemical tests, giving the results, observations and conclusions with reasoning at each stage. If the candidate does produce various spectra then the report should show that the candidate has interpreted the different absorptions correctly and assigned the main peaks correctly.

During the evaluation, the candidate should identify the main sources of error and explain 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 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 or lecturer. It is also very helpful to candidates, keeping them in the right direction, making sure they are using controls, and carrying out duplicates. It is also very useful when writing up the project report.

Grade boundary and statistical information:

(Completed by SQA)

Statistical information: update on courses

Number of resulted entries in 2017	2523

Number of resulted entries in 2018	2591

Statistical information: performance of candidates

Distribution of course awards including grade boundaries

Distribution of course awards	Percentage	Cumulative %	Number of candidates	Lowest mark
Maximum mark				
A	31.5%	31.5%	815	88
B	27.6%	59.0%	714	73
C	23.2%	82.2%	602	59
D	8.1%	90.4%	210	52
No award	9.6%	-	250	-

General commentary on grade boundaries

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.

SQA aims to set examinations and create marking instructions which 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.

Therefore, SQA holds a grade boundary meeting every year for each subject at each level to bring 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.

Grade boundaries from exam papers in the same subject at the same level tend to be marginally different year to year. This is because the particular questions, and the mix of questions, are different. This is also the case for exams set by centres. If SQA alters a boundary, this does not mean that centres should necessarily alter their boundary in the corresponding practise exam paper.