External Assessment Report 2013

Subject(s)	Chemistry
Level(s)	Higher

The statistics used in this report are pre-appeal.

This report provides information on the performance of candidates which it is hoped will be useful to teachers/lecturers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding. It would be helpful to read this report in conjunction with the published question papers and marking instructions for the examination.

Comments on candidate performance

General comments

The 2013 paper followed the pattern of question types seen in recent years, and assessed candidates' knowledge across all units and performance criteria. The overall impression of the paper from feedback received was that it was fair and was perceived to be of a very similar level of demand to that of the previous year.

In general, candidates performed well, demonstrating a good level of understanding and attainment across the paper. Most candidates appeared well practised in answering the different types of question found in Higher Chemistry exams and very few candidates failed to attempt every question.

Every Higher paper contains a number of relatively straightforward questions that well prepared candidates should be able to answer without difficulty. Higher papers also have a number of marks allocated to far more demanding questions, often referred to as 'A-type' questions because, in general, only candidates destined to secure an A-grade are likely to secure marks in these items. Whilst the overall level of difficulty of the questions in this paper were very similar to previous papers, the marking instructions for the A-type questions of the 2013 paper were made more exacting to bring the grade boundaries for A and B grades closer to the notional values of 60 and 70.

Areas in which candidates performed well

The following Questions in Section A produced high facility values.

Question 1	Standard Grade / Intermediate 2- Properties of ionic compounds
Question 10	Enthalpy of combustion- scaling an experimental value up for one mole
Question 11	Definition of electronegativity
Question 18	Using a balanced equation to calculate reacting gas volumes
Question 19	Recognising an example of catalytic cracking
Question 21	Formula of an alkanoic acid
Question 22	Naming an ester from a shortened structural formula
Question 24	Dehydration of an alkanol
Question 26	Names of functional groups involved in esterification
Question 28	Recognition that cross-linking is used to produce resins

Question 29	Melting points of edible oils
Question 31	Identifying a variable cost

In Section B, candidates performed particularly well in the following questions. This session, problem solving questions were generally very well attempted.

Question 1 parts (a) & (c)	Candidates recognised the process of reforming, and understood its use in producing components of unleaded fuel.
Question 2 (b)(i)	Candidates did well in this problem solving type question, calculating relative rate from a reaction time and using the graph provided to deduce reaction temperature.
Question 3(a)	The balancing of a chemical equation was extremely well done.
Question 4(b)	This was another problem solving question which was well answered. Candidates were able to apply their knowledge of condensation reactions in a context they were unlikely to have encountered before.
Question 6(b)	This question was better attempted than similar questions in the past, with few candidates confusing the role of the ozone layer with the effects of greenhouse gases.
Question 7(b)(i)	In previous years many candidates have experienced difficulty working out the number of hydrogen atoms present on substituted benzene rings when presented as shortened structural formulae. This year this question was well answered.
Question 9(a)	This question, comparing the boiling point of a diol with a monohydric alcohol of similar mass, was well answered showing that most candidates appreciated key role played by hydrogen bonding in determining the physical properties of alcohols.
Question 12(b)	This was intended to be a challenging question, requiring candidates to carry out a half-life calculation based not on the proportion of the radioisotope remaining, but on the quantity that has undergone decay. Given the level of difficulty of this question, this was well answered showing a good understanding.
Question 14(b)	Most candidates had no difficulty applying le Chatelier's principle to the production of methanol from synthesis gas.
Question 17(a)	This was an unusual application of Faraday's law, asking candidates to calculate the mass of lead converted into lead sulphate as a car battery is discharged. Given the level of difficulty of the question, this was well attempted with candidates' working showing an appropriate use of both a Q=It type formula and the use of the Faraday constant. Whilst it is true that some candidates made arithmetical errors calculating the number of seconds in an hour, whilst others used the gram formula mass of lead(II) sulphate in place of the relative atomic mass of lead, a pleasing number made a very reasonable attempt at this tricky question showing a clear understanding of Faraday's law.

Question 18(a) & (b)(ii)	Each year there is at least one problem-solving question that requires candidates to decode unfamiliar information. In previous years candidates have often been reluctant to attempt these questions, perhaps losing confidence at seeing chemistry they have not encountered during their exam preparation. This question was attempted by almost every candidate with many securing both marks available.

Areas which candidates found demanding

The following Questions in Section A produced low facility values.

Question 3 Standard Grade/ Intermediate 2- Precipitation

In this question, most candidates chose answer C- calcium iodide

Question 7 Applying both knowledge of enthalpy of neutralisation with the principle of excess.

In this question, the majority of candidates chose to pick answer B, the answer with the greatest concentration of hydrochloric acid failing to realise that, as hydrochloric acid was already in excess, increasing its concentration will not bring about any increase in the number of moles of water formed by neutralisation.

Question 9 Candidates were asked to choose which diagram was most likely to represent a fast, exothermic reaction.

Of the many candidates who selected one of the two diagrams showing an exothermic reaction, the majority went on to select the diagram showing the one with the higher activation energy.

Question 14 The majority of candidates failed to appreciate that polar covalent bonding cannot be found in elements because in an element all of the atoms are identical and have the same electronegativity.

Question 16 Candidates were asked to choose which of four compounds would be the most viscous. The options included three isomers of butanol in addition to butane-1,4-diol. The majority of candidates selected answer C, showing a branched chain isomer of butanol. It is possible that, as the formula took up most space on the page, and looked the most complicated structure, they assumed that this would mean that the molecules were most likely to experience difficulty moving past each other. This shows a lack of understanding of the role of intermolecular forces in determining viscosity as the diol would have both the largest mass, and arguably van der Waals' forces, and much stronger hydrogen bonding due to the presence of two hydroxyl groups.

Question 30 Candidates often experience difficulty in correctly predicting the products formed from the hydrolysis of peptides. This problem solving question asked candidates to consider the possible products of partial hydrolysis of a tripeptide. Almost as many candidates selected answer C as the correct response, answer A.

In Section B, in general questions relating to experimental work were not well answered. This may be indicative of a lack of exposure to practical work. The candidates' ability to answer questions relating to the Prescribed Practical Abilities appears to vary greatly from centre to centre, suggesting that some centres may be failing to provide candidates with adequate exposure to these experiments.

Question 2 assessed candidates' knowledge of the Prescribed Practical Activity, 'The Effect of Temperature Changes on Reaction Rate'. In part (a), around half of the candidature were unable to correctly state the colour change seen in this compulsory experiment whilst even fewer were able to answer question 2(b)(ii) which should have been familiar to candidates, being simply the second of the two evaluation questions taken from the compulsory PPA write-up sheet.

Markers raised concerns over the very poor standard of diagrams of experimental apparatus produced by candidates in response to question 5(b). Delivery tubes were frequently shown passing through the sides of beakers and measuring cylinders. Most worryingly, a number of candidates did not appear to be familiar with even the most basic of apparatus such as measuring cylinders or boiling tubes fitted with two-holed stoppers.

In Question 7(a), only just over half of pupils could name one of the three reagents used in the Prescribed Practical Activity, Oxidation'.

Question 15 assessed candidates' experiential knowledge of the Prescribed Practical Activity, 'Hess's Law'. In part (a), candidates were asked to repeat a calculation carried out as part of the PPA. Whilst most candidates were able to recall a formula of the type E_H=cmΔT, many encountered difficulties knowing the correct volume of water to use. Answers to part (b), which tested the candidates knowledge of the evaluation questions which form part of this PPA, were often confused mentioning apparatus only used in the Unit One PPA, 'Enthalpy of Combustion'. Finally, in part (c), candidates were asked which measurements were taken during the PPA to allow the temperature change to be calculated. Under half of the candidates were able to give a correct answer.

Many candidates use a number of well-rehearsed arithmetical procedures or formulae to solve problems. This year a number of candidates either applied an inappropriate strategy (see question 13(b) below), or failed to show a full appreciation of the underlying chemical principles (see question 3(b)).

In question 3(b), almost all candidates recognised this as a question involving use of Avogadro's number, and had no difficulty in employing a standard manipulation to calculate the number of moles of aluminium ions. Much fewer candidates appreciated that each formula unit of aluminium oxide contains two aluminium ions, so the majority of candidates went on to use the gram formula mass of aluminium oxide correctly to obtain masses exactly double the correct answer.

Question 11(b) was a percentage yield calculation of a very standard type. Whilst the majority of candidates solved this by first calculating the theoretical yield in grams and then using a formula such as ‘percentage yield = (actual yield ÷ theoretical yield) ×100’, an increasing number of candidates successfully answer this type of question by calculating the number of moles of reactant used and the actual number of moles of product formed by the reaction before applying a formula such as ‘percentage yield = (moles of product formed ÷ moles of reactant used) ×100’. Of the candidates employing the former method, perhaps fewer were able to correctly calculate the theoretical yield than in previous years.

Question 13(b) was a calculation based on a balanced equation in which candidates were asked to calculate the mass of a solid reactant required to produce a given volume of gaseous product. The first step, for most candidates, was to calculate the number of moles of hydrogen sulphide gas formed. When attempting to do this, a significant number of candidates attempted to apply inappropriate formulae. Some attempted to use $n=C\times V$, substituting either the molar volume or the volume of hydrogen sulphide gas into the formula as the value of V. Others attempted to apply the formula moles=mass÷gfm, this time inserting either the molar volume or the volume of hydrogen sulphide gas into the formula as the value for ‘mass’.

Question 14(a)(ii) was well attempted, with the majority of candidates showing a good grasp of how to approach this type of calculation. The appearance of H_2O in two of the given equations caused confusion however, and many candidates made the mistake of using the equation for the enthalpy of combustion of hydrogen on two different occasions, firstly in order to provide the one mole of water shown on the left of the target equation, and again, to provide the three moles hydrogen shown on the right. In their working, few candidates attempted to check their answer by adding together their manipulated equations to check that the overall equation produced matches their target equation.

Question 16(b)(ii) did not appear as well attempted as titration calculations posed in other recent Higher exams. Whilst most candidates were able to write down the correct mathematical formulae required many were unable to apply these, using an incorrect stoichiometric ratio for thiosulphate ions to iodine and/or interchanging the volume of thiosulphate with that of the iodine solution.

Other questions in Section B that presented difficulties for candidates are indicated below.

Question 8(a) asked candidates to draw the monomer required to produce poly(vinyl carbozole) given a section of the polymer formed from three monomer units. Whilst many candidates were able to identify the repeating unit, few went on to reconstruct the alkene monomer showing the C=C double bond.

Few candidates were able to correctly answer Question 17(b) which asked candidates to balance an ion-electron equation by adding water, hydrogen ions and electrons.

Advice to centres for preparation of future candidates

General

Much of the following advice, based on the responses to the questions in Section B of the paper, has been given for a number of years. However, some centres, particularly those in which the number of awards at the different grades is less than the number estimated, may find this information useful.

Every Higher paper will contain a number of questions which assess candidate recall of material from underlying courses, that is, from the topics common to both the Standard Grade and Intermediate 2 courses. Examples of this type of question can usually be found early in Section A, eg Questions 1, 2, 3 and 4, but these questions may also be embedded within Section B, eg Question 3(a). Recall of some parts of the Standard Grade/Intermediate 2 content can be particularly poor and candidates may benefit from some revision of the key aspects of carbohydrate chemistry, the reactions of metals, corrosion and precipitate formation.

Information on specific types of questions

Within Section B there are a range of different types of questions designed to test different skills; some require simple recall, some require candidates to provide an explanation, some require the application of problem solving or data-handling skills. Each Higher paper will contain at least one question of each type, so it is to the candidate's advantage to be able to recognise each of these forms of question within the paper and to know what type of answer is required. Below, some of the key question types are described.

Calculations

Some centres proved to be particularly effective at preparing their candidates for calculation questions, with even their weaker students managing to secure a significant number of marks in these questions. It was noticeable that, for these centres, almost all of their candidates would use the same basic layout for their calculations suggesting that their candidates are well practised at applying a single, taught strategy to tackle proportion-based questions. As these candidates tended to show all of the individual steps within a calculation, even the weaker candidates were able to pick up partial marks in most questions. Candidates should also be aware that, there is also the opportunity for 'follow through' without further loss of marks once a mistake has been made.

Prescribed Practical Activities

Every Higher paper will assess candidate knowledge obtained through the experience of the prescribed practical activities. In each paper, knowledge of at least three of the PPA experiments will usually be assessed. Some centres seem particularly good at preparing candidates for these questions with even the weakest candidates securing almost full marks. With around six marks allocated to PPA questions, centres should ensure that all candidates have a good knowledge of these experiments and have thought carefully about the evaluation questions which come at the end of each of the write-up sheets for each experiment.

Problem Solving in the context of experimental design

Each year there is at least one problem-solving question that requires candidates to think about an unfamiliar experiment, for example question 5(b).

Problem Solving involving unfamiliar contexts

Each year there is at least one problem-solving question that requires candidates to decode unfamiliar information, for example Question 18. Here again, centres may wish to review how the skills assessed in this type of question are developed over the Course.

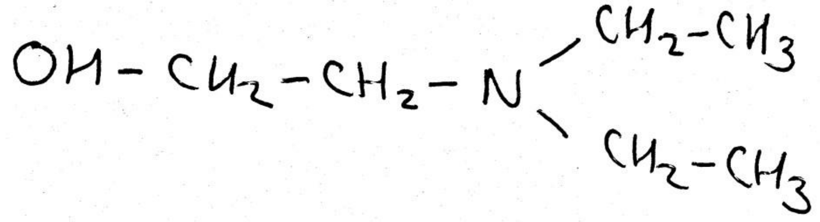
Questions requiring a detailed explanation

Each year there is at least one question that requires more detailed explanations from candidates (Questions 4(a)(ii) and 6(a)). These questions are signposted for candidates, by the words 'explain clearly' appearing in bold print within the stem. These questions will also tend to carry a mark allocation of at least two marks in recognition of the more detailed response required and it will be usual for the marking instructions for these questions to subdivide the mark allocation into a number of half marks. Often questions will provide candidates with additional support indicating important points to be covered in the answer. An example of this is provided in question 6(a) which states, 'Your answer should include the names of the intermolecular forces involved'. A significant number of candidates wrote very good accounts of how the intermolecular forces arose in the molecules mentioned in the question but, by failing to name these forces, lost marks unnecessarily. Centres should reconsider the extent to which candidates are given opportunities to practice answering such questions. To help prepare their candidates, some centres present their students with a number of 'pupil answers' to such questions and ask them to discuss why some answers are better than others. By doing this, these centres suggest pupils become better able to demonstrate their knowledge and understanding.

Questions involving the formulae of organic compounds

Candidates will be required to answer questions involving molecular formulae (Section A, Question 21), shortened structural formulae (Section B Question 10(a)(ii)) and full structural formulae (Section B, Question 5(a)). Common reasons for candidates to lose marks are:

- failure to show all bonds when a full structural formula is specifically requested
- when bonds are not shown connecting clearly to the correct atom in a shortened structural formula, eg in the example below, the hydroxyl group on the left is attached via the hydrogen atom.



Statistical information: update on Courses

Number of resulted entries in 2012	10361

Number of resulted entries in 2013	10001

Statistical information: Performance of candidates

Distribution of Course awards including grade boundaries

Distribution of Course awards	%	Cum. %	Number of candidates	Lowest mark
Maximum Mark 100				
A	30.7%	30.7%	3072	73
B	23.7%	54.4%	2371	60
C	22.5%	77.0%	2253	47
D	9.2%	86.2%	922	40
No award	13.8%	100.0%	1383	-

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.