External Assessment Report 2011

Subject	**Chemistry**
Level	**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 2011 paper closely 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 but challenging. Any Higher paper is a mix of relatively straightforward questions, often known as C-type questions, and more challenging questions which only the best candidates will be able to answer correctly, referred to as A-type questions. Whilst the number, and level of demand of the A-type questions was very similar to previous years, a few of the C-type questions in Section B were more difficult than the C-type questions in preceding years' papers, increasing the level of demand for potential C-grade. This is reflected in adjustments made to the grade boundaries for this paper.

In general, candidates demonstrated a consistent level of understanding and attainment across the paper indicating that most candidates are well practised in answering all of the different types of questions found in Higher Chemistry exams.

As in previous years, there are some centres in which candidates appear to be underperforming in the PPA questions which could possibly be the result of a lack of active participation in these experimental activities.

Areas in which candidates performed well

The following questions in Section A produced high facility values.

Q1	Standard Grade / Intermediate 2 — Monatomic gases
Q5	Avogadro number and mass
Q6	Collision theory (effect of changing temperature)
Q10	Enthalpy of combustion
Q11	Atomic size
Q12	Using electronegativity values to predict bond polarity
Q13	Properties of ionic compounds
Q17	Prevention of ‘knocking’
Q18	Hydrogen as an alternative fuel
Q20	Naming an alkanal
Q25	Properties of esters
Q29	Novel polymers
Q31	Chemical industry — feedstocks
Q37	Balancing an ion-electron equation

In addition, in the following questions in Section A, candidates performed significantly better than would have been expected on the basis of candidate performance in similar questions in previous years.

Q7	Chemical excess
Q15	Gas volume from mass
Q22	Naming organic reaction types
Q29	Novel polymers

In Section B, the majority of candidates showed a considerable degree of skill in attempting calculation questions, performing particularly strongly in the following calculation-based questions.

Q5 (a)	Calculation of the mass of a reactant using a balanced equation and the molar volume of a gas
Q11(b)(iii)	Calculation of pH for a solution of NaOH
Q15 (c)(ii)	Using Faraday’s law to calculate the mass of a material obtained by electrolysis
Q16 (b)	Problem solving in an unfamiliar context

Calculations involving enthalpy were a particular strength this year. In Question 14 (b), candidates were asked to calculate the enthalpy of combustion for an alcohol from experimental data. This required candidates to both calculate the heat energy released when 1 g of fuel is burned, and to scale this answer up to give the enthalpy change associated with a full mole of substance. It was very reassuring to see that the majority of candidates appreciated the need for this second step, and this question was well attempted. Question 14 (c) asked candidates to apply Hess's law to calculate the enthalpy of combustion for pentan-1-ol. Neither the balanced equation for this, the target reaction, nor the balanced equations for two of the reference reactions were given, adding an extra level of complexity to this question. Again, the majority of candidates scored very well in this question.

Other areas of the Course in which candidate answers were particularly strong are highlighted by the following questions.

Q1 Reaction rates (all parts of this question were very well done)

Q5 (b) Deducing the name of an unfamiliar organic compound from a named analogue

Q9 (a) Extracting information from a table

Q10 (a)(ii) Problem solving based on knowledge from a Reaction Rates PPA

Q11 (a) Definition of a weak acid

Q12 (c)(i) Half-life of a radioisotope

Areas which candidates found demanding

The following questions in Section A produced very low facility values.

Q4 Standard Grade/Intermediate 2 — Testing carbohydrates with Benedict's

Q24 Hydrolysis of an ester

Q33 Dynamic equilibrium

Q36 pH of salt solutions

In addition, in the following questions in Section A, candidates performed less well than would have been expected on the basis of candidate performance in similar questions in previous years.

Q2 Standard Grade / Intermediate 2 — Atomic structure

Q23 Oxidation of alcohols

In Section B, the following questions highlighted areas of difficulty for candidates.

Q2 (b) Electronegativity

Q3 (a) Intermolecular bonding in covalent molecular substances

Q3 (b) Ionic lattices

Q7 (a) Writing a molecular formula from a given structural formula

Q10 (c)(ii) Using an unfamiliar reaction sequence to relate reactants to products

Q11 (b)(ii) Dissociation of an acid

Q12 (a) Radioisotopes

Q12 (c)(ii) Calculation involving the Avogadro number

Q13 (b)(i) Knowledge of procedures from the Vitamin C PPA

Q15 (a) Naming reaction types

Q15 (c)(i) Chemical industry

Advice to centres for preparation of future candidates

General information

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 that is estimated, may still benefit from a consideration of this information.

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 10 (a)(i). 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 continue to make every effort to learn basic 'routines' for the different types of calculations in the Course. Due to partial marking, a significant number of part-marks can be picked up. 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. This may be by questions which clearly signpost the experiment concerned, such as Question 4 (c) or by questions in which the candidate's knowledge of a particular reaction or technique is embedded within a different context, for example Question 13 (b)(i). This year, the benefits of effective teaching and learning with respect to PPAs were clearly evident. In many centres, large numbers of candidates produced very sharply focused answers to Question 4 (c), being able to describe clearly how an ester is prepared in the PPA experiment. However, there were some centres in which even the better candidates appeared to have no knowledge of: the use of a water bath, the concentrated sulphuric acid catalyst, any arrangement to act as a condenser. This would seem to suggesting that, within these centres, there would appear to be a lack of candidate involvement in undertaking these PPAs.

Problem solving within 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 2011, see Q 10 (b)). In particular, it should be noted that the quality of the diagrams produced in the examination remains disappointing.

Problem solving involving unfamiliar contexts

Each year there is at least one problem-solving question that requires candidates to decode unfamiliar information (for 2011, see Q7 (c), Q16 (a) and (b)). 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 (for 2011, see Q6 (b) and Q13 (a)). These questions are signposted for candidates, by the word 'explain' appearing in bold print within the wording of the question. Centres should reconsider the extent to which candidates are given opportunities to practice answering such questions. These questions will also tend to carry a mark allocation of at least two marks in recognition of the more detailed response required.

Areas of common misunderstanding

Q1 (b)(i) An significent number of candidates correctly calculated the average rate for this reaction, but incurred a half mark penalty by writing the unit of rate as $mol^{-1}\ min^{-1}$. The correct unit of $mol\ l^{-1}\ min^{-1}$ was given in the stem of the question.

Q2 (b) This was intended as an A-type question, and proved to be so. Many candidates answered by simply stating that argon is a noble gas, but this information is provided in the stem of the question itself. Here candidates needed to provide an answer indicating that they appreciate that noble gases do not form covalent bonds.

Q3 (a) This question tests the candidate's appreciation that in molecular substances, it is intermolecular forces, not covalent bonds, that are being overcome when such a substance boils. Most candidates will have already met this idea in Standard Grade or Intermediate 2, but a worrying number wrote answers which clearly indicated that they thought covalent bonds were being broken as a molecular substance boils. A number of candidates stated, erroneously, that only covalent networks, and not covalent molecular substances, can form solids.

Q4 (b) Rather than answering the question which was posed, many candidates seemed to be trying to answer one regarding octane numbers.

Q6 (b) It was pleasing to see that the majority of candidates were able to identify that triethanol amine molecules will experience hydrogen bonding. However, an alarming number of these candidates clearly thought that a hydrogen bond is the covalent bond between the oxygen and hydrogen atoms within a hydroxyl group.

Q7 (a) Many candidates did not know what was meant by the term ‘molecular formula’ and attempted to write either an IUPAC name or a shortened structural formula for the compound.

Q9 (a) In a significant number of answers, candidates correctly stated that palm oil contained more saturated fatty acids but then went on, incorrectly, to state that this meant that there were more carbon-to-carbon double bonds in palm oil. In many candidate responses, candidates thought that covalent bonds were being broken when these molecular substances melted and stated that palm oil had a higher melting point because the carbon-to-carbon double bonds needed more energy to break than the carbon-to-carbon single bonds in olive oil.

Q10 (b) Although electrolysis is covered both in the Standard Grade and Intermediate 2 Courses, and by a Higher PPA, many candidates did not include any power supply/battery/d.c.-supply in their experimental set-up.

Q11(b)(ii) This was a challenging A-type question and it is perhaps not surprising that many candidates failed to realise that sulphurous acid is diprotic whilst hydrochloric is monoprotic. (Candidates were not required to have learned the formula for sulphurous acid, it was given in the stem of the question. Candidates were also not required to use the terms ‘diprotic’ or ‘monoprotic’, credit being given for answers which indicated that they had appreciated this key difference between these acids.)

Q12 (a) Although the stem of the question sets the context in terms of the stability of certain nuclei, many candidates confused nuclear stability with chemical reactivity and attempted to answer the question in terms of the atom’s outer electron arrangement.

Q13 (b)(i) One of the objectives of the PPAs is to familiarise candidates with common chemical techniques. This question, asking candidates to ‘*describe how these crystals should be dissolved and then transferred to a standard flask*’, tests a technique candidates should have performed as part of the Redox Titration (Vitamin C) PPA. This technique was previously examined in 2000 by Q15 (b). Centres should consider the extent to which candidates appreciate that the techniques they meet in the PPA experiments, such as the preparation of a solution in a standard flask, are in frequent use in a wide variety of experimental contexts.

Statistical information: update on Courses

Number of resulted entries in 2010	10,177

Number of resulted entries in 2011	10,288

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	28·7%	28·7%	2,953	69
B	23·6%	52·3%	2,427	56
C	24·4%	76·7%	2,513	43
D	10·1%	86·8%	1,041	36
No award	13·2%	100·0%	1,354	-

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, therefore, SQA 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 Head of Service 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.