CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2010

CHEMISTRY

GENERAL COMMENTS

Chemistry is a two-unit subject with each unit consisting of three modules.

Both units are examined by three papers. Papers 01 and 02 are external examinations, while Paper 03 is the internal assessment and is examined internally by the teacher and moderated by CXC.

Paper 01 consisted of 45 compulsory multiple-choice questions with 15 questions based on each module. Each module contributed 30 marks to the total 90 marks for the paper. This paper contributed 40 per cent to the unit.

Paper 02 consisted of six compulsory questions, two based on each module. Each question contributed 15 marks to the total 90 marks for the paper. This paper contributed 40 per cent to the unit.

Paper 03, the Internal Assessment, comprised laboratory exercises and contributed 20 per cent to the unit.

This year, a total of 4,810 candidates registered for the Unit 1 examinations compared with 4,039 in 2009, an increase of approximately 19 per cent; 2,960 candidates registered for Unit 2 compared with 2,708 in 2009, an increase of approximately 9 per cent.

DETAILED COMMENTS

UNIT 1

Paper 01 – Multiple Choice

The performance on each of these papers was good. In each unit, candidates were able to answer most of the questions correctly.

The mean score in Unit 1 was 56.5 per cent and standard deviation 16.1.

The mean score in Unit 2 was 64 per cent and standard deviation 15.3.

UNIT 1

Paper 02 – Structured/Essay

Module 1: Fundamentals in Chemistry

Question 1

Specific Objectives: 2.1, 3.4, 3.5, 3.8, 5.1, 5.2
Mean: 6.32
Standard deviation: 3.66

This question sought to assess candidates' knowledge in the areas of

- bonding
- equations and associated calculations
- kinetic theory of gas
- volumetric analysis and related experimental skills

Candidates' performance was modest. The majority of them were very familiar with the assumptions and conditions associated with kinetic theory and the concept of ideal gases. The main challenges were presented by Parts (b) and (d). Candidates sought to explain how the data collected in Part (d) could be used, however, what was required was a description of the method used to obtain such data. In the case of Part (b), the writing of chemical equations and making correct calculations continue to be perennial weaknesses.

Module 2: Kinetics and Equilibria

Question 2

Specific Objectives: 6.1, 6.3 – 6.5
Mean: 8.25
Standard deviation: 3.18

Candidates were required to demonstrate their understanding of the concepts involved in the area of electrochemical cells and electrode processes.

A satisfactory level of competence was demonstrated in this area, however, some confusion was evident in differentiating among the processes referred to in the question and the principle of electrolysis. The candidates also found writing the concise definitions required in Part (a) to be challenging.

Module 3: Chemistry of the Elements

Question 3

Specific Objectives: 3.3, 3.4, 5.5, 5.9, 5.10
Mean: 4.25
Standard deviation: 3.06

This question which was based mainly on the chemistry of vanadium and copper was poorly answered. All areas presented candidates with challenges. It was surprising that, at this level, candidates found calculating oxidation numbers and recognizing the acidity of the type of oxides in Group IV to be difficult.

It would appear that students were not exposed to the experimental aspect of transition metal chemistry and the principles leading to ligand exchange. Teachers are encouraged to apply appropriate teaching strategies to correct this deficiency.

Module 1: Fundamentals in Chemistry

Question 4

Specific Objectives: 1.2, 1.4, 1.9, 1.10
Mean: 8.84
Standard deviation: 3.26

This question tested candidates' understanding of the principles of

- radioactivity decay
- nuclear stability using the notion of n/p ratio
- atomic orbital structure
- electronic configuration

Candidates were generally comfortable in answering this question with slight difficulty shown in using n/p ratio to comment on the stability of atoms. Candidates had little difficulty in answering Parts (a) and (b) which dealt with the properties of subatomic particles and the identification of the products of nuclear decay and calculation of n/p ratio.

Module 2: Kinetics and Equilibiria

Question 5

Specific Objectives: 3.2, 3.3, 4.1–4.3
Mean: 6.40
Standard deviation: 4.07

The focus of this question was on candidates' understanding of the principles surrounding buffer solutions and pH, and their competence in performing calculations associated with these principles.

Their performance was generally of a modest level. Most candidates had no difficulty in stating the differences between buffer solution and pH, and in writing the expression for the acid dissociation constant (K) as required in Parts (a) and (b) (i). However, most of them encountered challenges in the remaining sections which required them to calculate and manipulate data in order to solve problems relating to concentration and pH.

More attention needs to be paid to the application of knowledge and to calculations involving the relationship between the varying concentrations of the components of buffer systems, pH and their attendant effects.

Module 3: Chemistry of the Elements

Question 6

Specific Objectives: 1.1, 1.3–1.5, 5.6
Mean: 3.42
Standard deviation: 3.30

In this question, candidates were tested on their understanding of the

- trends in Period 3 of the periodic table
- principles relating to the observed acidity of the aqueous solution of aluminum chloride
- difference in melting points of s-block and transition metals
- behaviour of the oxides of phosporpus when reacted with water

They were required to exercise higher-order cognitive skills of application and synthesis.

The performance of candidates was poor, with weaknesses demonstrated in many areas of the question. Some areas in which weaknesses were revealed included the

- relation of effective nuclear charge and electronegativity
- relation of structure to melting point
- concept of carge density and polarization as the factors in hydrolysis (Part (c))
- ability to write appropriate equations (Part (e))
- relation among the number of bonds and strength of bonds, and the melting points of s-block and transition metals

At the level of CAPE, candidates are expected to demonstrate the competency to synthesize and critically assess data as well as communicate results concisely and coherently. Teachers are encouraged to devise strategies to foster and enhance the acquisition of these competencies.

Paper 03/2 - Alternative to Internal Assessment

Range 13–32
Mean: 22.8
Standard deviation: 5.5

Question 1

This question required candidates to perform a number of tests on an unknown substance thereby testing their competence in the practical skills of observation, reporting, recording (ORR) as well as analysis/interpretation (A/I) .

Candidates' responses were weak. They were unable to record their observations accurately. Their exposure to practical activity was clearly inadequate.

Question 2

This question sought to assess candidates' ability to

- assemble correctly the various components of the apparatus for use in the investigation of reaction rates
- report appropriately the information provided from such an investigation
- plot accurately the associated graph
- interpret the information displayed by the graph
- make predictions based on the results

Candidates responded satisfactorily to this question. Most of them obtained the marks for Parts (a), (d) and (e) where they showed their competence in the first two objectives above. Many candidates, however, found the plotting of the graph to be quite challenging. This resulted in very weak interpretive responses as seen in their answers to Parts (b), (c) and (f).

Question 3

This question related to the planning and design of an experiment. Candidates' performance showed some inconsistency. The formulation of hypotheses with corresponding aims presented some difficulty to some candidates while the other aspects of experimental planning and design showed some weaknesses. It appeared that the weaknesses exhibited by candidates stemmed from a weak theoretical understanding of the topic involved.

UNIT 2

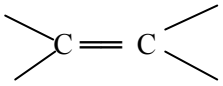
Paper 02 – Structured/Essay

Module 1: The Chemistry of Carbon Compounds

Question 1

Specific Objectives: 2.4, 4.1–4.4
Mean: 6.17
Standard deviation: 3.46

Overall, the achievement of candidates on this question was considered adequate. This question had as its objective the eliciting of responses demonstrating an understanding of the

- reactions of the alkenic group 
- structure and properties of polmers

Candidates were able to state the conditions and/or reagents required in Part (a) and found Part (c) well within their capability. However, Parts (b), (d) and (e) which involved writing displayed formulae and differentiating between the structures of nylon 6.6 and proteins presented significant difficulty.

Once again, candidates showed weakness in applying their knowledge.

Module 2: Analytical Methods and Separation Techniques

Question 2

Specific Objectives: 4.1, 4.2, 5.3
Mean: 4.98
Standard deviation: 2.87

This question required candidates to

- define various spectroscopic terms
- show knowledge of the various areas of the electromagnetic spectrum
- perform calculations based on spectroscopic data

The general performance was weak. Candidates gained most of their marks by stating the definitions required in Part (a) and completing the simple calculations in Parts (b) (i) and (ii). Candidates had challenges in completing the calculation presented in Part (d), with particular reference to the use of units and the manipulation of negative indices. Also presenting a challenge was Part (c) which dealt with the practical skills associated with UV/VIS spectroscopic analysis. A common misconception that was evident concerned the assumption that complexing agents had to be coloured.

In future, more attention needs to be paid to this area of the syllabus — the use of video clips, printed spectra, visits to institutions with relevant hardware (whenever possible) and practice in manipulating data in problem-solving activities would allow for improvement in the performance of candidates.

Module 3: Industry and the Environment

Question 3

Specific Objectives: 8.5, 9.6, 9.7
Mean: 6.89
Standard deviation: 3.11

Candidates were tested on their knowledge of the environment regarding water purity, acid rain and atmospheric gases.

Overall, candidate performance was very modest. Most marks were gained from Parts (a) (i) and (ii) and (d), which dealt with the factors and effects of acid rain. Some marks were lost for the writing of the equation in Part (a) (iii) and the inaccuracies presented in the answers provided for the tests required in Parts (c) (ii) and (iii). Many candidates were of the opinion that 'reagent' referred to a single substance and thus was not aware that acidified potassium manganate (VII), etc., were acceptable answers.

Module 1: The Chemistry of Carbon Compounds

Question 4

Specific Objectives: 1.5, 1.7, 1.8, 2.2, 2.4
Mean: 9.44
Standard deviation: 3.71

This question focused on testing the competence of candidates in the area of structural isomerism and stereoisomerism, and the concept of 'cracking'.

There was good candidate response to this question. Marks were lost due to lack of care in writing the various displayed formulae requested and some inability to clearly and concisely explain the similarities of the structural isomers in Part (a).

Module 2: Analytical Methods and Separation Techniques

Question 5

Specific Objectives: 7.2, 7.3, 8.6
Mean: 5.52
Standard deviation: 3.50

Mass spectroscopy and chromatography were the two analytical methods highlighted in this question.

An Analysis of candidates' performance showed significant weaknesses and revealed deficiencies in their competence. While candidates were generally able to adequately answer the section on chromatography, Part (d), complete the calculation in Part (c) and generally gain some marks for Part (a), the interpretation of the mass spectrum presented in Part (b) proved challenging and accounted for the majority of marks lost.

It is clear that candidates were unprepared in this area of the course. Teachers and students should devote adequate time and resources to this topic.

Module 3: Industry and the Environment

Question 6

Specific Objectives: 4.1, 8.4, 8.6
Mean: 7.92
Standard deviation: 3.98

This question tested an understanding of the manufacture of ammonia and knowledge associated with the source and effects of various pollutants. The overall response of candidates was satisfactory.

The main challenges related to the application of Le Chatelier's principle and the evaluation of conditions used in the Haber Process.

Part (e) dealt with pollutants. Candidates were able to gain at least four of the maximum marks for this part.

Paper 03/2 - Alternative to Internal Assessment

Range 8–30
Mean: 17.9
Standard deviation: 7.0

Question 1

This question focused on the properties of the alcoholic and carbonyl groups. Candidates were required to perform the various tests and record the relevant observations in the tables provided thereby allowing appropriate deductions to be made.

Overall, candidates' performance was weak and inconsistent. Candidates exhibited an unfamiliarity with many of the tests and so wrote unrelated observations. Again, they demonstrated a lack of exposure to practical activities.

Question 2

This question sought to assess candidates'

- knowledge of the principles of volumetric analysis
- exposure to skills associated with the experimental aspect

Most candidates were comfortable with the reading of the burette and the reporting of the resulting observations. The calculations required in Parts (c) — (f) presented great difficulty to the majority of candidates. The question therefore was not very well done.

It should be noted that calculations of this nature present a perennial challenge to candidates, therefore, teachers and students should seek to implement methods in both the experimental and theoretical aspects to reduce the level of such challenges.

Question 3

This question sought to test candidates' level of competence in the various skills associated with the planning and design (PD) of practical investigations.

Candidates obtained marks for determining the necessary reagents and equipment needed. However, the other segments of the exercise presented varying degrees of difficulty. Hypothesis formulation continue to be an area of difficulty, while some confusion was exhibited in the variables involved and a lack of clarity was manifested in the description of the various experimental designs offered.

It is evident that the area of planning and design remains a significant challenge for the majority of private candidates.

Paper 03/1 - Internal Assessment (IA)

The overall level of performance on the Internal Assessment component of the examination was satisfactory; however, some areas continue to raise concerns.

Submissions

Most schools submitted the sample of five laboratory notebooks. It should be noted that the computer generated sample printout **must** also be included with the samples, mark schemes and moderation sheet.

Laboratory notebooks must contain the following in the table of contents:

(i) Name of practical exercise. N.B. All practical exercises done must be included in the table of contents.)
(ii) Skills, if any, assessed for CXC
(iii) Page number
(iv) Date of practical

Appropriateness of Mark Schemes

Generally, mark schemes served as a useful guide to moderators. There were, however, many cases where the mark schemes were either incomplete or contained irrelevant skills. Teachers persist in awarding Observation/Recording/Reporting (ORR) marks for skills that are better classified under Analysis and Interpretation (AI). This might have been the working out of a mathematical problem, identifying sources of error or the writing of equations. Teachers are still experiencing great challenges writing mark schemes for Planning and Design (PD) experiments. This is partly due to the inappropriate PD activities chosen. Mark schemes could be made more informative and useful by including the names of the unknown and observations that are expected when qualitative analyses are tested. Also, where more than one mark is allocated for a particular skill, this should be broken down to indicate where each mark is awarded. Teachers should award an appropriate number of marks for each response required.

Syllabus Coverage, Adequacy and Standard of Activities

The syllabus coverage and adequacy of the number of activities completed from most centres were good. Teachers should, however, seek to spread the activities more evenly over the topics. For example, there should not be five volumetric or qualitative analyses, one energetic experiment and no exercise on rates or equilibrium.

Teachers should seek to ensure that assignments in volumetric analysis are more challenging, for example, exposing students to back titrations, the double indicator method and a variety of iodine/thiosulphate titrations.

Assessment of Skills

Most teachers assessed each of the four skills at least twice. Teachers must select only two assessments of any skill for submission to CXC. These should be clearly indicated on the mark scheme and also in the table of contents in students' books. Students should be tested in IAs on practical work with which they have had experience. Since the IA is formative, it is appropriate to assess the first practical exercise that the students attempt as an IA for submission to CXC.

Observation/Recording/Reporting (ORR)

Many teachers assessed this skill in a satisfactory manner. The majority complied with the CXC mandate to assess communication, grammar, spelling and punctuation; however, the primary skills of observation of colours and precipitates, and the drawing of proper graphs and tables should not be neglected.

The standard of the exercises undertaken for assessing observation skills was, in many cases, lower than expected and was more suitable for CSEC level.

In many instances, there were areas of assessment that were not appropriate for ORR for example:

(i) Inferences
(ii) Interpretation of graphs
(iii) Calculations
(iv) Discussions
(v) Writing equations
(vi) Computer generated graphs

Tables should be enclosed with relevant titles and headings.

Teachers are reminded that in qualitative analysis, 'no reaction', 'soluble', 'insoluble', 'acidic' and 'basic' are not regarded as observations but inferences. Instead the following should be used: 'no observable change/no visible change/no apparent reaction', 'solid/precipitate dissolves'.

Manipulation and Measurement (MM)

Though not moderated, evidence of this activity was examined in the samples. Evidence of two assessed practicals must be included in students' laboratory notebooks for these marks to be accepted. There should be more emphasis on measurement from two different types of practicals. Teachers should correct the entire practical in which the MM skill was tested so that students may benefit from the feedback. In fact, all practical activities must be so marked in order to provide students with relevant feedback.

Analysis and Interpretation (AI)

Activities testing this skill need to be more challenging. Many calculations were too easy. Where applicable in inorganic chemistry/qualitative analysis and physical chemistry, teachers should insist on deductions from observations/results with the level of difficulty increasing in a progressive manner, and well balanced ionic and/or other equations with state symbols.

Analysis of graphs and discussion of results should be encouraged. It is also important for teachers to remember that the drawing of graphs is an ORR activity and not an AI.

In volumetric analysis, the calculation of the average titre should involve the use of **only** the closest values (no more than a difference of +/- 0.10 cm^3). When there are identical values, these should be used to find the average.

Other areas tested under A&I include any type of calculation and answering questions generated by the practical activity.

Planning and Designing (PD)

The representation of this skill is still very, very problematic. Teachers need to acquire a fundamental understanding of this skill relating to scientific research. The problem statement which stimulates critical thinking and inductive reasoning must be able to give rise to a hypothesis and hence a plan that allows for ALL the components of PD — variables, method that demonstrates chemical principles, expected results etc. — to be tested.

Problem statements given to students by teachers should be clearly written in both the students' books and the mark schemes. These statements must not disclose the aim, method or the apparatus required.

In many instances, the hypotheses were either inappropriate or unacceptable. Aims were not linked to hypotheses and it was difficult to identify the chemical principle(s) that were being explored in testing the hypotheses. Mark schemes were not always assessing relevant requirements of the process, for example, marks were awarded for table presentations and discussions that were unrelated to the solving of the problem. There seemed to be confusion over the concepts of limitation and error. It should be noted that although a limitation can be regarded as a source of error, it is really an error that that particular design of experiment cannot reduce or eliminate. Teachers must be reminded that while they are responsible for students' understanding of what is required in this skill, there must be evidence of individual work by the students. There were too many answers which were teacher directed/dictated. Teachers are requested to include more detailed mark schemes for this skill which would indicate the particulars of what is expected from students.

The assignments should be clearly written in both the students' books and mark schemes. Explicit information regarding the aim, method or the apparatus required should not be disclosed as these form an integral part of the planning and design exercise.

Planning and designing activities that can be taken from a textbook are unsuitable. Teachers and students should resist the temptation to predict *actual results*. Teachers should also note that there are some types of practicals that do not lend themselves to PD.

Teachers should set problems that can generate responses that are within the topics of the particular unit being taught and assessed. If not, the PD is deemed unacceptable.

Integrity of Samples

There was adequate evidence to suggest that at a few centres, collaboration between teachers and students and/or students and students was more than desirable as evidenced by:

(i) Laboratory reports being reproduced verbatim.
(ii) Absurd burette readings of greater than 50 cm^3 in all of the students' books and the teachers' mark schemes.
(iii) Burette readings with assumed or estimated accuracy of +/- 0.01 cm^3.
(iv) Planning and design activities where both students and teachers have the identical plan.

In many instances, it was difficult to understand how teachers arrived at marks for students. For example, there were unmarked laboratory reports submitted with mark schemes that were unrelated to any of the practical exercises; however, marks were submitted on moderation sheets.

Summary

The overall performance on Paper 02 of both units was modest and teachers are invited to note the following:

- Candidates' inability to communicate their ideas in a concise and coherent manner continue to be responsible for loss of credit, ultimately leading to a lowering of achievement level.

- Mathematical applications, including the writing of equations, remain sources of challenge for candidates.

- There is need for the development of higher-order cognitive skills so as to equip candidates with the complete array of skills and competencies expected at the CAPE level.

- Paper 03/2 is experimentally based and therefore candidates' preparation *must* include exposure to a broad range of laboratory/practical activities at the required level of the CAPE examination so that relevant skills can be developed hence providing candidates with the opportunity to do well.

- There is an urgent need to improve the quality of the Internal Assessment component of the CAPE Chemistry examination. This need is intensified when trained teachers leave the system and are replaced by untrained counterparts. While CXC provides expertise and some training for teachers, schools are encouraged to organize in-house training for their newer teachers.