CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2008

CHEMISTRY
(REGION EXCLUDING TRINIDAD AND TOBAGO)

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CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2008

THE STRUCTURE OF THE EXAMINATION

A revised CAPE Chemistry syllabus was assessed for the first time for Unit 2 in 2008, and for the second time for Unit 1. The revision included a reorganization of the Modules of the Units, as follows:

Unit 1
- Module 1: Fundamentals in Chemistry
- Module 2: Kinetics and Equilibria (previously in Unit 2)
- Module 3: Chemistry of the Elements (previously in Unit 2)

Unit 2
- Module 1: The Chemistry of Carbon Compounds (previously in Unit 1)
- Module 2: Analytical Methods and Separation Techniques (previously in Unit 1)
- Module 3: Industry and the Environment

The examination for each Unit consisted of two external papers. Paper 01 consisted of 45 Multiple Choice items, 15 from each Module. Paper 02 consisted of six compulsory questions, two from each Module.

The Internal Assessment, Paper 03, involved the continuous assessment of candidates by teachers over the duration of the Unit. Candidates were required to conduct at least 16 laboratory practical exercises. These were assessed by the teachers and comprised the Paper 03 marks for the candidates. Samples of candidates' laboratory books were externally moderated by CXC, and formed the basis of the moderation of all Internal Assessment marks submitted by the teachers.

The contribution of each paper to the overall examination was as follows:

- Paper 01 - 40 %
- Paper 02 - 40 %
- Paper 03 - 20 %

GENERAL COMMENTS

One thousand, seven hundred and two candidates registered for the examination in Unit 1, and 1176 candidates registered for Unit 2.

Unit 1

Overall, candidate performance was satisfactory. Approximately twenty-two per cent (22%) of the candidates achieved Grade I and more that 80 per cent achieved acceptable grades, Grades I-V.

Unit 2

Approximately twelve per cent (12%) of the candidates achieved Grade I, while almost ninety per cent (90%) achieved Grades I-V. This performance is satisfactory, considering that Organic Chemistry (Module 1) and Analytical Methods (Module 2) have been examined for the first time in this Unit.

DETAILED COMMENTS

Paper 01 – Multiple Choice

This paper comprised 15 items from Module 1, 15 from Module 2, and 15 from Module 3. The mean on Unit 1 Paper 01 was 56 per cent and 49 per cent on Unit 2 Paper 01. For Unit 1, candidates experienced difficulties with the following:

- Polarizing power of elements (Module 1)
- Feasibility of redox reactions given cell diagrams (Module 2)
- Trend in bonding re NaCl, $AlCl_3$, $SiCl_4$, PCl_5 (Module 3)

For Unit 2, candidates experienced difficulties with the following:

- Volatility of organic compounds (Module 1)
- Calculating the concentration of a solution given an absorbance graph (Module 2)
- Fragmentation pattern of CH_2Cl_2 (Module 2)

UNIT 1

Paper 02 – Structured Essay

Question 1

Specific Objectives: 4.1 - 4.3

This question sought to test candidates' understanding of the concept of oxidation/reduction, oxidation number as illustrated in redox reactions and the writing of relevant equations. Candidate performance was modest, giving the distinct impression of superficial comprehension of the above concepts.

There was some confusion surrounding the correct oxidation number change of the two processes.

Particular areas of weaknesses were:

- The balancing of redox equations
- The correct use of chemical terminology. Consistent reference to "clear solution" instead of colourless solution; "insoluble solution", "dirty solution", are clear indicators of the confusion between precipitate and solution.

Question 2

Specific Objective: 6.3 – 6.5

Candidates were required to demonstrate their understanding of the principles involving electrochemical cells and electrode potentials.

Overall candidate performance was rather modest. However, there were some instances when candidates demonstrated a good grasp of the contents presented by the question.

The majority of candidates were able to draw the cell diagram requested in Part (a). However, the identification of the correct electrode reactions with the corresponding $E^{\ominus}$ values and the products of changes required in Part (f) presented quite a challenge.

Question 3

Specific Objectives: 6.1; 6.2; 6.5

This question focused on the chemistry of a number of elements listed in Module 3 of this Unit. Candidates found this question to be difficult, producing a rather poor overall performance. The only section answered with any degree of competence was Part (a), involving the testing for Al^{3+} and Pb^{2+} using alkalis.

The perennial challenge of writing ionic equations and the uncertainty surrounding what constitutes 'observations' and 'inferences' were again quite evident. The best interpretation to be placed on candidates' writing of incorrect formulae was one of carelessness (H_2So_4 for sulphuric acid). It would be quite disappointing to suggest that at this level this presented a basic problem.

Question 4

Specific Objectives: 3.7 – 3.9

This question tested candidates on their knowledge of empirical and molecular formulae and relevant calculations, as well as the practical and mathematical applications of titrimetric analysis.

The majority of candidates were able to calculate the empirical and molecular formulae of caproic acid (Part (a) (ii)).

Candidate weaknesses encountered included:

- Explanations in distinguishing between empirical and molecular formulae (Part (a)(i)). A significant number of candidates used "atom" and "molecule" interchangeably in their attempt to answer this part of the question.
- The lack of appreciation of the fact that the molecular formula describes the ratio of **each** atom in the compound. Some examples used were inappropriate, for example, C_2H_4, C_2H_8.
- The calculation of molar concentration. Candidates were often guilty of relying on the use of the formula $M_1V_1 = M_2V_2$ with its subsequent misuse.

Question 5

Specific Objectives: 2.6; 5.1; 5.2; 5.5

This question focused on the applications and calculations surrounding the concepts of equilibrium and solubility product.

Candidate performance was rather inconsistent with a significant number demonstrating difficulty. The notion of equilibrium, explanations and application of the concept of solubility product presented a challenge for most candidates. However, most candidates were able to define Le Chatelier's Principle (Part (d)), wrote the correct expression for K_c (Part (a) (i)) and deduced the value of K_{sp} (Part (b) (i)).

Question 6

Specific Objective: 4.1; 4.2; 4.5; 1.1

Candidates were tested on their knowledge of the chemistry of the Group VII elements and the variation of ionisation energy across Period 3 of elements in the periodic classification.

Candidates showed a general knowledge of the subject matter, and grades were satisfactory. Candidates found the explanations required in areas represented in Parts (b) (ii), (c) (ii) and (c) (iii) to be challenging.

The above clearly indicates that while candidates were comfortable with questions in the area of "knowledge and comprehension", there was a lack of competence in responding accurately to questions in the area of "use of knowledge".

UNIT 2

Paper 02 – Structured Essay

Question 1

Specific Objectives: 2.4; 2.6 – 2.9

Candidates were required to demonstrate an understanding of the reactions of a number of functional groups with their associated reaction mechanisms.

Candidates' responses indicated a satisfactory grasp of the above concepts. The main deficiency was shown in the responses to Part (b), which required the writing of the reaction mechanism for the conversion of the tertiary bromoalkane to the corresponding alcohol. This deficiency resulted in the incorrect use of arrows, both single and double headed, showing uncertainty in the use of these symbols.

The failure to distinguish between the concepts of "observation" and "deduction" in Part (c) was again seen.

More work needs to be done to assure the removal of these deficiencies.

Question 2

Specific Objectives: 8.1 – 8.4; 8.6

This question tested the candidates' knowledge of chromatographic methods, in particular TLC and GLC.

Candidates' level of performance was somewhat inconsistent. The majority of candidates were familiar with the use of chromatographic methods. They were able to give examples of, and differentiate between, stationary and mobile phases, and to calculate R_f values.

Candidates' main difficulty stemmed from an inability to adequately explain the function of the two phases and hence to identify polarity as the property of the three compounds in Part (b) (ii).

Candidates also failed in their comparison of R_f values and hence found Parts (b) (iii) (a) and (c) (iii) difficult.

Question 3

Specific Objectives: 8.2; 8.3; 8.5; 8.6

In this question, candidates were asked to show a knowledge of the position of water as a vital compound in the environment; pollution sources and their detection; and purification methods in the provision of potable water.

Candidate performance was disappointingly low and apart from Part (c) (i), the question proved to be difficult.

Candidates showed a lack of knowledge of:

- The test for the presence of Pb^{2+} and NO_3^-
- The concept of eutrophication
- Thermal pollution of the aquatic environment as required in Part (d)

Question 4

Specific Objectives: 2.1; 2.4; 2.6; 2.11; 2.13; 2.17

This question focused on the areas of functional group analysis, their reactions and mechanisms. Candidates showed modest performance in their responses. The pattern of responses in this question mirrored those in the corresponding area as presented in Question 1.

Candidates again had difficulty in explaining the required mechanism and, additionally, found further challenges in the identification of individual groups in the stated reactions.

Candidates, however, had little difficulty in the case of the free radical mechanism.

Question 5

Specific Objectives: 9.1; 9.8

Candidates were asked to respond to questions relating to their knowledge of fractional distillation as a technique of separation.

Candidates were comfortable in answering Parts (c) and (e). However, there was some confusion in distinguishing between "principle" and "process" with respect to fractional distillation, with candidates describing the latter instead (Part (c)).

Many candidates also found the sketching of the boiling point/composition curve to be an area of difficulty.

Generally, candidates only attained a modest mark on this question.

Question 6

Specific Objectives: 4.1; 4.2

This question tested the candidates' knowledge of ammonia production via the Haber Process, and the associated industrial applications.

Candidate performance was again of modest proportions. The majority of candidates were able to write the equation for the Haber Process and to give examples of the use of ammonia, (Part (a) (i)). Candidate difficulty centered around the lack of ability to apply Le Chatelier's principle as required. Thus, candidates were unable to adequately explain the behaviour of the equilibrium mixture (and thus the equilibrium constant, K_{eq}) when the various factors were altered, Part (b).

Internal Assessment

While the general standard of this component of the examination has shown improvements over the years, there are certain areas which continue to be constant. This is cause for concern.

Mark Schemes

These generally were acceptable and served as useful guides for the moderators. There were, however, still quite a few cases where the mark schemes were either incomplete or contained irrelevant skills. For example, a number of mark schemes in assessing Observation, Recording and Reporting (ORR), awarded marks for Analysis and Interpretation (AI).

The construction of mark schemes for Planning and Design (PD) is still presenting great difficulty. This can be traced in part to inappropriate PD assignments.

Mark schemes must be made more informative and 'moderator friendly' by including the identity of unknowns and the observations expected when qualitative analyses are assessed.

Syllabus Coverage; Adequacy and Standard of Activities

This part of the Internal Assessment was very well met and the number of activities was good. Care should be taken to ensure an even spread of activities across topic boundaries. The practice of assigning five volumetric or qualitative analyses, one energetics experiment and an absence of an exercise on equilibrium should be avoided.

Efforts should continue to be made to upgrade the standard of activities so as to provide appropriate challenges for students at this level of competence, especially in the areas of volumetric and qualitative analyses.

Assessment of Skills

Generally each of the four skills was assessed at least twice. Some, however, were assessed in as many as seventeen (17) practical assignments.

Although this is commendable, only two practical assignments should be chosen and **indicated** for the assessment of a particular skill for moderation purposes.

Observation, Recording, Reporting (ORR)

This skill was satisfactorily assessed. This included the assessments of skills and concepts such as communication and correct English grammar. It must be borne in mind, however, that only five (5) marks of the twelve (12) are to be allotted for this purpose.

Candidates should be encouraged to improve their skills in the plotting and drawing of graphs, as well as the inclusion of state symbols in the writing of equations.

Manipulation and Measurement (MM)

Though not moderated, evidence of this skill must be present and indicated in the samples to be presented. Efforts should be made to assess the widest range of skills in this area.

Analysis and Interpretation (AI)

Activities testing this skill needed to be more challenging – calculations should be multi-staged. Deductions from observations/results should be relevant and made in a logical and sequential manner. Analysis of graphs and discussions of results should be encouraged, and it should be borne in mind **that drawing of graphs is an activity related to ORR but not AI.**

Planning and Design (PD)

The assigning and assessment of this skill continues to be the major concern of the whole Internal Assessment component of the examination and in quite a number of cases are unmitigated disasters.

Acceptable activities for PD should pose a problem for candidates to solve, using concepts contained in the syllabus. These problems should encourage hypothesis making, be conceptualized in "novel" situations and should not be activities previously done or readily available in text books.

It must be borne in mind that laboratory practical activities, which are written in the past tense, have no stated hypothesis and are based on common investigations, cannot be accepted for planning and design marks. It must be clear to the moderators that some planning and design was done by the candidates.

Candidates should be instructed not to include actual results in their prediction of results. It is recognized that in places where there is a large turnover of teachers, the need for implementation of strategies in the area of training is vital to the elimination of the above deficiencies in the assessment of this skill. Ministry and School Officials need to lend urgent attention to providing solutions to this critical area.

CONCLUSION

The overall performance of candidates across the region has been satisfactory and the revised syllabus has been effective in relating more closely with the developmental aspect of the candidates' learning processes.

Teachers however, should pay some attention to the:

- Wider use of practical assignments in the teaching of the various topics for example, oxidation/reduction, where candidates can be taught the difference between an observation and the corresponding inference

- Employment of strategies to enable candidates to understand and use the language of chemistry appropriately in descriptive work

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- Writing of equations, both ionic and stoichiometric with the inclusion of state symbols

- Recognition that candidates find certain topics more challenging than others, and, therefore, seek out methods to facilitate comprehension of such; for example, electrochemistry and various analytical techniques

- Insistence that calculations based on the sequential deduction of number of moles contained in a volume of solution be used instead of the parroting of the formula $M_1V_1 = M_2V_2$, which generally leads to muddled thinking.