

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®**

MAY/JUNE 2012

CHEMISTRY

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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 031 the School-Based Assessment (SBA), is examined internally by teachers and moderated by CXC. Private candidates write Paper 032 which is an alternative to the SBA.

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 comprised 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 031, the School-Based Assessment, comprised laboratory exercises and contributed 20 per cent to the unit. Paper 032 is an alternative to the SBA and comprised three compulsory questions focusing on candidate's laboratory experiences.

The number of candidates writing the Unit 1 examination increased by approximately eight per cent from 4,421 in 2011 to 4,772 in 2012. However, the number of candidates writing the Unit 2 examination decreased by approximately 16 per cent, from 3,168 to 3,012 in 2012.

DETAILED COMMENTS

UNIT 1

Paper 01 – Multiple Choice

Performance on this paper was good. Candidates were able to answer most of the questions correctly. The greatest challenge continues to be with items testing Kinetics and Equilibria (Module 2).

Paper 02 – Structured/Essay Questions

Module1: Fundamentals in Chemistry

Section A

Question 1

Syllabus Objectives: 2.5, 2.6, 2.7.
Mean: 5.01; S.D: 2.62

This question sought to test the candidates' knowledge of the types of bonding and intermolecular forces of attraction.

Candidate performance was very poor, with correct answers coming mainly from Part (a). Candidates exhibited great difficulty in describing the origins of the various intermolecular forces of attraction as well as identifying their individual presence in given compounds. It was also surprising to observe that the majority of candidates were unable to associate bonding types with corresponding solubility patterns.

It seemed that teachers may have assumed that students were familiar with this part of the course. The above performance belies this assumption and thus relevant review instruction should be provided.

Module 2: Kinetics and Equilibria

Question 2

Syllabus Objectives: 5.1, 5.2, 5.3, 5.4.
Mean: 3.70; S. D: 3.52.

The focus of this question was on candidates' understanding of the

- principles surrounding solubility product
- details of its experimental determination
- application of principles to problem solving.

The overall performance of candidates was poor. Candidates experienced significant difficulty in

- describing the experimental process involved
- defining and writing the appropriate expression
- calculating values from data provided.

It was evident that candidates were unfamiliar with the practical aspects of this part of the course and their inability to solve problems involving calculations continues to be a serious concern. Teachers need to invest more time in practical activities as well as to devise strategies to overcome the apparent fear of the mathematics involved in problem solving.

Module 3: Chemistry of the Elements

Question 3

Syllabus Objectives: 4.3, 4.4, 4.5.
Mean: 5.16; S. D: 3.11

This question which was based mainly on the chemistry of the halogens was answered unsatisfactorily.

Candidates were generally able to

- correctly describe the reactions of hydrogen with the halogens indicated
- identify the gases observed in Part (b) (i)
- describe the observations with silver nitrate as presented in Part (d).

Candidates demonstrated weaknesses in

- writing balanced equations
- presenting reasoned explanations for the trends observed in Part (b)
- describing the reaction of concentrated sulphuric acid with halides as in Part (c).

The above weaknesses can be corrected by meaningful instruction with constant review activities as well as relevant experimental experiences.

Section B**Module 1: Fundamentals in Chemistry**Question 4

Syllabus Objectives: 1.10, 1.11, 1.12, 1.13, 1.14
Mean: 7.13; S. D: 3.27

This question tested candidates' understanding of the principles of electronic configuration, ionization energy and its relevance to electronic structure. The responses in this case were modest with most marks being awarded for answers to Parts (a), (b) and (d) (i),(ii).

Again candidates exhibited difficulty in adequately explaining the relevant concepts and writing balanced equations with associated state symbols.

Greater attention must be given to the inclusion of state symbols in the writing of chemical equations.

Module 2: Kinetics and EquilibriaQuestion 5

Syllabus Objectives: 2.2, 2.3, 2.5, 2.7
Mean: 7.40; S. D: 3.72

This question sought to assess candidates' understanding of the

- concept of chemical equilibrium
- equilibrium constant
- position of equilibrium
- use of calculations in problem solving.

Candidates' level of performance was generally satisfactory. Candidates responded well to Parts (a) and (b); however, they struggled with Parts (c) and (d).

Performance on this question exemplifies the systemic weakness of candidates to respond adequately to questions requiring reasoned explanations and problem solving.

Teachers must note these weaknesses and must seek to implement the necessary strategies to overcome them.

Module 3: Chemistry of the Elements

Question 6

Syllabus Objectives: 1.1, 1.2, 1.3.

Mean: 6.88; S.D: 3.10

Candidates were assessed on their understanding of the trends in Period 3 of the Periodic Table relating to

- atomic radius
- melting points
- structure and bonding
- electrical conductivity.

Their understanding of the reaction of chlorine with the second member of the Period was also examined.

Candidates performed modestly on this question. Parts (a) and (b) were answered satisfactorily.

Candidates, however, encountered difficulties in

- sketching a diagram to illustrate the variation in electrical conductivity
- providing adequate explanations for variations in melting points and electrical conductivity based on structure and bonding
- writing equations with appropriate state symbols.

Candidates exhibited superficial acquaintance with the principles involved in the above trends. However, application of these principles in presenting cogent explanations for these trends was lacking. While candidates knew that delocalized electrons were responsible for electrical conductivity in metals, they failed to appreciate that the *number* of such would be responsible for the *increase* in conductivity from sodium to aluminium. Similar examples were observed with respect to the other trends. Many candidates were unfamiliar with the reaction and associated equation (with state symbols) for the reaction of chlorine and magnesium.

Paper 032 – Alternative to School Based Assessment

Syllabus Objectives: 1.2, 1.3, 1.6, 3.8, 3.9

Mean: 22.82; S.D: 9.10

Question 1

Candidates were required to perform a practical exercise to demonstrate their competence in

- manipulating various laboratory measuring apparatus and timing devices
- drawing an appropriate graph using the information collected
- making relevant deductions from the graphical display of information.

Candidates performed at varying level on this question. Some of them seemingly had difficulty with the level of manipulation required which lead to large variations in observed times, (t). Other candidates were unsure about the notion of decimal places in calculations.

Most candidates were comfortable with the plotting of the required graph.

Question 2

This question sought to assess candidates'

- knowledge of the principles of volumetric analysis and associated calculations
- exposure to skills associated with data collection and reporting.

Most candidates were able to correctly read the burette and record the resultant data in the appropriate manner. The associated calculations showed great variation among the candidate population with Parts (f)–(i) presenting the greatest challenge. Some candidates found difficulty in writing the required ionic equation while most candidates were able to suggest an appropriate indicator.

Overall, the level of performance was varied and below expectation.

Question 3

This question sought to test the candidates' level of competence in the various skills associated with the planning and design (PD) of practical investigations. Candidates obtained marks for suggesting the aim of the experiment and determining the necessary reagents and equipment needed; however, the other segments of the exercise presented varying degrees of difficulty.

Hypothesis formulation continues to be an area of weakness, while some confusion was present in the identification of the variables involved.

It is clear that the area of planning and design continues to pose significant challenges for these candidates.

UNIT 2

Paper 01–Multiple Choice

Performance on this paper was good. Candidates answered the majority of questions correctly. The greatest challenge continues to be with questions testing Industry and the Environment (Module 3).

Paper 02–Structured/Essay Questions

Section A

Module 1: The Chemistry of Carbon Compounds

Question 1

Syllabus Objectives: 1.5, 1.6, 1.7, 2.6.
Mean: 9.20; S. D: 3.58

Most candidates had few challenges in answering this question which sought to assess their competence in

- writing displayed formulae
- applying correct chemical nomenclature
- identifying isomeric compounds
- explaining the reaction of oxidizing agents with alcohols.

A few candidates showed some confusion in the application of the correct nomenclature as it related to the isomeric alcohols.

Generally this question was very well answered. However, teachers should insist on the use of the correct IUPAC name and avoid traditional or common names, for example, Butan-1-ol instead of butanol, and 2-methyl propan-1-ol instead of 2, methylpropanol.

Module 2: Analytical Methods and Separation Techniques

Question 2

Syllabus Objectives: 8.3, 8.4, 8.5, 8.6.
Mean: 5.6; S. D: 3.16

This question sought to assess candidates' knowledge of the principles and the operation of the thin-layer chromatography technique. Candidates' responses indicated a very weak understanding of both the principles and the practical details involved in this separation technique. The only part of the question that was handled well involved the calculation of R_f values.

Candidates should be given significantly more exposure to both the principles relating to the theoretical basis of chromatography and the practical processes involved.

Module 3: Industry and the Environment

Question 3

Syllabus Objectives: 8.3, 8.4, 8.5, 8.6.
Mean: 5.47; S. D: 3.20

The focus of this question was on the

- concepts of *reuse*, *recycle* and *reduce* in solid waste management
- chemistry associated with the fermentation of sucrose.

Candidates' responses were surprisingly weak.

Candidates seemed confused about some concepts of solid waste management, for example, *reduce* and *reuse* were used interchangeably and *recycle* was mistaken for *reuse*.

Candidates demonstrated a superficial understanding of the fermentation process and many of them were unable to name one compound responsible for the sharp smell resulting from the *souring* of beer.

Section B

Module 1: The Chemistry of Carbon Compounds

Question 4

Syllabus Objectives: 1.8, 2.4, 2.5
Mean: 5.06; S. D: 4.02

This question sought to assess candidates' knowledge of the chemical properties of alkenes including the use of arrows in the explanation of reaction mechanisms. Candidates earned most of the marks from Parts (a) (ii-iv), (d) and (e).

The majority of candidates failed to appreciate that the reaction of aqueous bromine involved the addition of BrOH; while the use of curved arrows to explain the mechanism in Part (d) presented a serious challenge although the formula of the product was known.

Module 2: Analytical Methods and Separation Techniques

Question 5

Syllabus Objectives: 3.2, 9.4.
Mean: 2.6; S.D: 2.97

This question required candidates to

- identify some of the apparatus needed to carry out separation by filtration
- define the partition or distribution coefficient
- explain the principles associated with solvent extraction
- perform calculations leading to the determination of the partition coefficient.

Candidates' performance on this question was poor. It seemed that little or no time was given to the teaching of this part of the course. They were clearly unfamiliar with and therefore unable to identify the pieces of apparatus presented in Part (a). These were images of a sintered glass crucible and a Buchner funnel respectively.

The attempts to explain the process of solvent extraction showed little or no understanding of the principles involved and the calculation in Part (b) (iv) only fared slightly better.

Teachers are encouraged to provide adequate laboratory experiments for students.

Module 3: Industry and the Environment

Question 6

Syllabus Objectives: 1.1, 1.2, 9.6.
Mean: 6.65; S. D: 2.67.

This question focused on the impact of industry on the environment.

Most candidates were able to

- list the influential factors involved in the siting of industrial plants (Part (a))
- write an equation to support the production of acid rain by sulfur dioxide
- provide a reason for the classification of sulfur dioxide as a pollutant (Part (d)).

Candidates demonstrated weaknesses in the identification of relevant safety concerns and the chemistry associated with the operation of vehicular catalytic converters. Generally, candidates performed satisfactorily.

Paper 032 – Alternative to School Based Assessment (SBA)

Syllabus Objectives: Module 1 - 2.4, 2.8; Module 2 - 2.4, 2.6, 2.9, 2.7, 3.1; Module 3 - 2.4, 2.5
Mean: 18.60; S. D: 11.30

Question 1

This question required candidates to perform a volumetric analysis using the technique of back titration to determine the concentration of barium ions, Ba^{2+} , in a solution.

Candidate s' performance was generally poor. The concept of back titration was unfamiliar and hence the calculations required posed serious challenges.

Question 2

This question tested candidates' knowledge of the chemical properties of various organic functional groups.

They were required to describe test-tube tests to differentiate between pairs of compounds while suggesting a further compound that would yield a positive test.

Candidates' responses exhibited a weak grasp of the knowledge required and thus were generally unable to provide correct suggestions as requested.

As seen in the answers to Paper 02 in the two units, there is a lack of exposure of candidates to experimental activities. This is a serious deficiency in the instructional strategy in the preparation for these courses.

Question 3

This question sought to assess the creativity and problem-solving ability of candidates in the planning and design of an appropriate experiment.

Candidates seemed to lack the depth of knowledge to enable them to produce credible experiments to solve the problem presented. This, along with the perennial challenges of hypothesizing, and identification of various variables, resulted in a candidate performance that can only be described as poor.

Paper 031 – School Based Assessment (SBA)

The overall level of execution and management of this aspect of the examination continues to see incremental improvement. This is evident in the areas involving

- submission of samples
- use of appropriate laboratory books
- the provision of relevant mark schemes
- the attempts at increased syllabus coverage
- skills assessment.

While it is heartening to note that some skills were assessed more than twice, it must be borne in mind that only *two* assessments for each skill should be selected and submitted for moderation. These should be clearly indicated in the table of contents at the front of the laboratory book.

Finally, it must be noted that in some schools teachers are engaged in practices that undermine the pedagogical philosophy of the SBA component of the syllabus. This philosophy is captured by the following excerpt from the current syllabus (CXC A11/U2/06):

Internal Assessment is an integral part of student assessment in the course covered by this syllabus. It is intended to assist students in acquiring certain knowledge, skills, and attitudes that are associated with the subject. The activities for the Internal Assessment are linked to the syllabus and should form part of the learning activities to enable the student to achieve the objectives of the syllabus.(p. 54)

In the following report an attempt will be made to deal with specific matters involving the assessment of the various skills and to provide reminders and examples where possible to facilitate a greater level of security and efficiency in the management and operation of this component of this the CAPE course.

Assessment of Skills*Observation/Recording/Reporting (O/R/R)*

Teachers are reminded of the following:

- (a) Activities NOT to be assessed under *O/R/R* but as ANALYSIS AND INTERPRETATION (A/I) include:
- The interpretation of graphs
 - All types of calculations
 - The writing of all equations
- (b) In qualitative analysis, the response '*no reaction*' is unacceptable as an observation and should be marked accordingly, students must respond by recording *no observable change/no apparent reaction/no visible change*.

Suggested Mark Schemes

(a) Graphs:

- | | | |
|--|---|-------|
| • Labelled axes | 2 | marks |
| • Units on both axes | 1 | |
| • Appropriate title | 1 | |
| • Scale (at least $\frac{3}{4}$ of the graph paper should be used) | 1 | |
| • Best straight line/smooth curve | 2 | |

(b) Tables

- | | |
|----------------------------|---|
| • Column headings | 2 |
| • Units in column headings | 2 |
| • Neat | 1 |

(c) Main components of a report

- | | |
|---------------------------|---|
| • Aim | 2 |
| • Apparatus and Materials | 4 |
| • Method | |
| – past tense | 1 |
| – no pronouns | 1 |
| – grammar | 2 |
| – observations | ? |

(mark to be awarded based on the type of activity)

Analysis and Interpretation (AI)

Additional criteria that can be assessed under this skill are discussions and conclusions resulting from observations made.

The above criteria are provided in the hope that teachers will include them in their assessment and not continue to limit themselves to the assessment of calculations.

It is further suggested that

- questions are asked of students that are directly related to observations made and not to general theory
- 'unknowns' be identified on the mark scheme for accurate moderation.

Planning and Design (PD)

This skill still presents the greatest challenge with some teachers demonstrating a lack of clarity concerning what constitutes an acceptable assignment for assessment. A planning and design activity is deemed appropriate if it can generate a hypothesis and variables as outlined in the statement below:

..... assignments 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 textbooks.

The following points are to be noted.

- Students given a problem requiring them to distinguish between unknowns, must identify each unknown in the hypothesis (for example, A is a simple covalent compound, B is a metal and C is an ionic compound).
- Problems which can be easily solved by lifting the answer from a textbook are to be avoided as these would be deemed to be inappropriate and unacceptable. Teachers therefore run the risk of their students being marked down as a result of moderation.
- *Expected Results* and *Treatment of Results* are two different criteria. In the latter criterion, students must describe how they will use the results obtained to solve the problem.
- Teachers should impress upon students the need to avoid using the term 'amount' when describing variables. Specific terms such as volume, concentration, and mass should be used.

Typical Mark Scheme for Planning and Design

• (a)	Hypothesis (must be testable)	2
• (b)	Aim (must be related to the hypothesis)	1
• (c)	Apparatus and Materials	3
• (d)	Method	
	- Logical sequence	2
	- Language (tense, no pronouns)	2
• (e)	Variables	3
• (f)	Treatment of Results	3
• (g)	Expected Results	2
• (h)	Sources of Error/Limitations	1
• (i)	Assumptions	1
	Total	20 marks

Samples of Planning and Design Assignments

- (a) Mark and Tim decided that they would produce biodiesel using different waste oils from Grandma's kitchen. Mark argues that coconut oil makes the better quality biodiesel than soya bean oil. Plan and design an experiment that proves or disproves this statement.
- (b) Jimmy was bitten by some large red ants when he climbed his neighbour's tree. He states that these ant stings were more potent than the small black ant stings. Plan and design an experiment to test the accuracy of this statement.
- (c) A local fish farmer noticed that as plant life thrived in the surrounding stream the fish began to die. They blamed a local soap and detergent plant located upstream from the farm for this occurrence. Plan and design an experiment to support or refute this claim.
- (d) Mr McGann tells his staff to pack the white eggs in styrofoam trays and the brown eggs in plastic trays because brown eggs have stronger shells than white eggs. Plan and design an experiment to test the validity of this statement.
- (e) Garlic contains the active ingredient Alicin. Some chefs use fresh garlic, others use ground, refrigerated, or processed garlic. Plan and design an experiment to determine which type of garlic is most potent, that is, has the greatest concentration of Alicin.
- (f) A limestone factory is located near a river between Villages A and B. Residents in Village B complain that since the factory has moved in the area, they were using much more soap in their laundry than before. They think that this is due to the factory affecting the quality of the river water. Plan and design an experiment to test this hypothesis.

Manipulation and Measurement

This skill is not moderated, however, criteria used to assess this skill should be recorded in the mark scheme. Criteria must include appropriate use of laboratory equipment.