CARIBBEAN EXAMINATIONS COUNCIL

CSEC® CHEMISTRY

Subject Report

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CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

JANUARY 2025

CHEMISTRY
GENERAL PROFICIENCY

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INTRODUCTION

This guide has been put together using candidates' responses to the 2025 January examination in CSEC Chemistry.

This year 304 candidates wrote the examinations compared with 264 in January 2024, 293 in January 2023, 265 in January 2022 and 368 in January 2021.

There was a decrease in the overall performance of candidates; approximately 41.05 per cent of candidates achieved Grades I—III in January 2025 compared with 54.55 per cent in January 2024, 27.65 per cent in January 2023, 42.27 per cent in January 2022 and 39.95 per cent of candidates in 2021.

PAPER 01 – MULTIPLE CHOICE

This paper consisted of 60 compulsory multiple-choice items.

Generally, performance on this paper was satisfactory. The maximum score obtained was 55 out of 60 marks and the mean score was 30.81.

PAPER 02 — STRUCTURED/EXTENDED ESSAY

Question 1

In Part (a) (i), most candidates were unable to define the term *acid*. Instead, many of them attempted to describe acids by listing their properties rather than giving a precise definition. The correct definition of an acid is *a proton donor*; responses such as 'a substance that helps to break down other particles' or 'a liquid that has a pH level of 1–3' were incorrect.

In Part (a) (ii), most candidates did not define the term *normal salt* correctly and many of them did not attempt this part. Some responses included statements such as 'a normal salt is a salt made of one substance' and 'the term normal salt is a regular table salt that could be found in salt water'; both were incorrect.

Part (b) (i) required candidates to use the figure provided to determine the volume of gas produced. This part was generally well done, as most candidates correctly identified the volumes shown on the four syringes in the figure.

For Part (b) (ii), candidates were required to use the axes provided to plot a graph based on the data obtained. A few candidates had trouble reading the scale and plotted most of the points incorrectly.

Part (b) (iii) required candidates to use a graph provided to determine the volume of gas produced at 135 seconds. Most candidates earned one UK mark and one XS mark for this part. While many of them were able to determine the correct volume, some candidates neglected to draw the required lines or they drew them incorrectly.

In Part (b) (iv), candidates were required to use the answer from Part (b) (iii) to calculate the number of moles of gas produced at rtp. Many candidates were unable to recall the molar volume of a gas at rtp, while some incorrectly used the rtp value and others omitted it entirely. Common errors observed included the following.

- Multiplying the volume of gas calculated in Part (b) (iii) by 135
- Using the molar volume at stp

For Part (b) (v), many candidates were unable to write a correctly balanced chemical equation for the reaction between hydrochloric acid and sodium carbonate. An example of an incorrect response is '$2Na_2CO_3$ + HCL (g) → Na_2OH (aq) + CO_3 (g)'.

The correct equation should have been Na_2CO_3 + 2HCL (aq) → 2NaCl (aq) + CO_2 (g) + H_2O (l).

In Part (b) (vi), candidates were required to determine the number of moles of sodium carbonate that reacted at 135 seconds. Most candidates were unable to earn the two UK marks allocated for this part. The mole ratio between CO_2 and Na_2CO_3 was often not acknowledged, as many candidates did not recognize the relationship between the moles of gas produced and the moles of sodium carbonate. Some candidates incorrectly attempted to use the number of particles in one mole to calculate an answer.

In Part (b) (vii), candidates were required to use their answer from Part (b) (vi) to calculate the mass. Most candidates earned at least one UK mark. A few successfully recalled the relationship between the compound's mass and the moles obtained, enabling them to complete the calculation. Many calculated the mass of sodium carbonate correctly, while some left the space blank.

For Part (b) (viii), candidates were asked to state whether they agreed with Maxine's suggestion that Jestid is the stronger antacid. They also had to provide one reason to support their choice. Most candidates earned one UK mark for disagreeing with Maxine's suggestion. However, many of them did not mention that Jestid produced less gas within the same time.

Question 2

In Part (a) (i), candidates were asked to define the term *osmosis*. Many of them demonstrated awareness of the concept, noting the movement from a region of high concentration to low concentration. However, some candidates failed to specify that this movement refers to water or solvent molecules. Several partially correct responses included most aspects of the definition but omitted the requirement for a semi-permeable membrane.

Part (a) (ii) required candidates to state the observation that should have been made after 20 minutes. Many responses provided an inference rather than the actual observation expected during the experiment. Credit was awarded only for the observation since this is what was explicitly requested.

In Part (a) (iii), candidates were asked to outline how osmosis supports the particulate theory of matter. A few candidates defined the particulate theory correctly but a notable number of them incorrectly associated it with the three states of matter.

Part (a) (iv) required candidates to state how the arrangement of particles in a liquid differs from that in a solid. Several candidates focused on bond strength and other properties of solids and liquids rather than addressing particle arrangement. Some responses did not mention particle arrangement at all, while others failed to focus on it. In a few cases, candidates described the arrangement of liquid particles as that of the gaseous state, far apart and free flowing, indicating difficulty in accurately distinguishing between states of matter in terms of particle arrangement.

In Part (b), candidates were required to account for the observation provided. Many candidates did not identify that it is the air outside that changes state upon contact with the bottle. Instead, several candidates made incorrect observations by falsely attributing condensation either to the container itself or to the liquid inside the container. Additionally, while most candidates recognized that condensation was occurring, they struggled to explain it within the given context.

Part (c) (i) required candidates to insert missing information in the table provided. This part was generally well answered across the cohort. It was particularly the neutron and mass numbers that were calculated correctly. However, in a few instances, candidates who correctly determined these values did not calculate the atomic number for Element Z accurately.

For Part (c) (ii), several candidates who achieved full marks in Part (c) (i) did not identify the isotope pair. This suggests that these candidates did not recognize the relationship between the atomic mass number and the mass number of an isotope.

Part (c) (iii) required candidates to identify the element that was nonmetal. Most candidates were unable to use the atomic number to make this identification.

Question 3

For Part (a), candidates were required to state two natural sources of hydrocarbons. Most candidates earned at least one mark for their response; crude oil or petroleum was the most common answer.

In Part (b), a table with three fractions of crude oil was provided. In Part (b) (i), candidates were required to state the name of one of the fractions. This part was poorly done by most candidates; a common incorrect response was the fraction name 'Alkanes' for Fraction Number 1.

In Part (b) (ii), candidates were asked to state one use of Fraction 3. Most candidates were unable to earn one mark for this part. Common incorrect responses included 'production of petrol' and 'car fuel'.

In Part (c), a figure of a compound W was provided. In Part (c) (i), candidates were required to circle the functional group of the compound. Many candidates had trouble identifying the correct functional group; the most common incorrect response was the circling of the CH_3COO portion of the compound.

In Part (c) (ii), candidates were asked to identify the homologous series to which Compound W belongs. This proved challenging for most candidates; common responses such as 'carboxylic acid' or 'alkanoic acid' were incorrect. The correct answer was that *Compound W is an ester*.

Part (c) (iii) required candidates to list three characteristics of a homologous series. Most candidates earned at least one mark for this part. Common correct characteristics included *having the same general formula, the same functional group* and *similar chemical properties*.

Part (c) (iv) was poorly done by most candidates. They were required to draw the fully displayed structural formula of two molecules produced when Compound W was hydrolysed. Common incorrect responses included 'CH_3COO', '$CH_2CH_2CH_3$' and '$CH_3CH_2CH_3$'.

In Part (c) (v), most candidates accurately named the two molecules drawn in Part (c) (iv).

Question 4

In this question, a figure showing a portion of the periodic table with the positions of five unknown elements was provided and used to answer the subparts. In Part (a) (i), candidates were required to state the names of the horizontal rows and vertical columns in the periodic table. This part was generally well done, as most candidates correctly identified the locations of rows and columns. However, some candidates misinterpreted rows as groups and columns as periods. Additionally, a few candidates incorrectly stated that 'rows represented metals' and 'columns represented non-metals'.

In Part (a) (ii), candidates were asked to outline two factors used in arranging the elements in the periodic table. Most candidates demonstrated a clear understanding of these factors and so, this part was generally well done. However, some incorrect responses included suggestions that elements were arranged according to their reactivity or based on whether they were metals or non-metals.

Part (b) (i) required candidates to use the figure to determine whether a particular element, when compared to another element, would react more or less vigorously with dilute hydrochloric acid. Although some candidates answered correctly, this part was generally poorly done or left unanswered.

In Part (b) (ii), candidates were required to justify their response to Part (b) (i). While a few candidates provided accurate justifications, most were challenged by the incorrect responses that had given in Part (b) (i). Others who had provided correct answers for Part (b) (i) were unable to justify them.

Part (b) (iii) required candidates to write the balanced equation for the reaction between an element and hydrochloric acid. Some candidates provided the correct equation and earned full marks; however, this part was generally poorly done; there were many inaccurate responses or candidates did not attempt to respond at all. Candidates are encouraged to master the writing and balancing of chemical equations.

In Part (b) (iv), candidates were asked to identify one typical reaction of Element L or magnesium other than with hydrochloric acid. This part was also poorly attempted or left unanswered. Common incorrect responses included reactions 'with sodium carbonate', 'with sulfuric acid', or 'with sodium chloride'.

Part (b) (v) required candidates to state the pH range of a solution formed when an oxide of Element L is dissolved in water. Most candidates were unable to correctly identify Element L and therefore provided inaccurate responses.

Generally, most candidates provided inaccurate responses to Part (c), which required them to predict the physical state of Element T at room temperature. Many candidates were unable to identify Element T and, as a result, could not determine its physical state.

In Part (d), candidates were asked to write the formula for the hydrogen carbonate of Element R. Many candidates provided incorrect responses to this part of the question. This was largely because they were unable to identify Element R and therefore could not write the correct formula for its hydrogen carbonate.

Question 5

The condensed formulae of two compounds were provided. In Part (a) (i), candidates were required to deduce the homologous series of both compounds. Most candidates correctly identified both compounds as belonging to the alkene homologous series. Some candidates' annotations indicated that they translated each condensed formula into its molecular formula and identified the C:H ratios corresponding to alkenes. A common error was identifying the compounds as alkanes, which carried over into the drawing parts of this question.

Part (a) (ii) required candidates to state the name of Compound A. Generally, candidates scored poorly for this part. While many candidates correctly identified the carbon chain as *pentene*, their responses often lacked the inclusion of the alkene functional group position.

In Part (a) (iii), candidates were required to draw the fully displayed structure of Compound A. This tested their ability to translate between the condensed formula and its structure, including correct functional group positioning. Although some structures were well proportioned for legibility, most candidates scored poorly, indicating difficulty in drawing organic structures accurately.

Part (a) (iv) required candidates to state the name of Compound B. Like Part (a) (ii), several candidates identified the hexene chain but provided incomplete IUPAC names, failing to account for the placement of the alkene functional group. It should be noted that the correct convention uses a hyphen rather than a comma when separating the prefix/suffix and the functional group position.

Part (b) (i) required candidates to define the term *structural isomers*. Most candidates responded accurately, using appropriate scientific jargon.

In Part (b) (ii), candidates were required to draw the fully displayed structure of the isomer. This tested their ability to translate between IUPAC nomenclature and structural representation, particularly regarding the position of the alkene functional group and the methyl substituent on the chain. While some diagrams were well spaced and legible, drawing organic structures proved challenging for most candidates, as it did in Part (a) (iii).

Part (c) (i) required candidates to define the term *polymer*. Candidates should emphasize the size of polymers in their responses, paying particular attention to their length rather than simply referring to them as molecules or compounds.

In Part (c) (ii), candidates were asked to name the functional groups of the compounds shown in the figure provided. Many candidates appeared unable to distinguish between alcohol and carboxylic acids. Common errors included incorrectly labeling the carboxylic acid compound as an alcohol and leaving the other response blank or assigning it to an incorrect homologous series.

Part (c) (iii) required candidates to state one use of each polymer provided. The most common correct responses for nylon included *clothing*, followed by *rope;* the most frequent correct response for polypropene was *plastics*. However, a greater variety of specific uses for polypropene was expected. The limited scope of responses suggests a restricted knowledge base among candidates.

Question 6

Most candidates provided accurate responses for Part (a), where they were required to state two properties of nitrogen gas. As a result, many candidates earned full marks; this question was generally well done. However, some common inaccurate responses included the following properties.

- Nitrogen is a gas.
- Nitrogen has a high boiling point.
- Nitrogen is light.
- Nitrogen is heavier than air.

In Part (b) (i), most candidates provided inaccurate diagrams. However, several candidates demonstrated a good understanding of the laboratory preparation of ammonia gas and provided correct responses.

Part (b) (ii) was poorly answered. Most candidates were unable to write a balanced chemical equation for the laboratory preparation of ammonia. Nevertheless, a few candidates showed a good understanding of the topic and balanced equations, earning full marks.

In Part (b) (iii), candidates were required to explain why concentrated sulfuric acid could not be used in the preparation of ammonia and to identify an appropriate alternative drying agent. Only a few candidates scored well. The highest score on this part was one out of three marks, with the most common reason for losing marks being the omission of the fact that ammonia is basic. Overall, this part was poorly answered, with many candidates providing incorrect responses or no response at all.

Part (c) required candidates to briefly describe a laboratory test for ammonia and state the observation. Most candidates earned one out of two marks, as they failed to include that the red litmus paper must be damp, moist, or wet. This part was poorly answered.

Generally, Part (d) was done well. Candidates were asked to list three harmful effects of excessive nitrates in the environment. The highest score on this part was two out of three marks. Some common inaccurate responses included ‘the destruction of aquatic habitat’, ‘contamination of waterways’ and ‘air pollution, resulting in breathing problems’.

Recommendations

Teachers and students should take note of the following recommendations.

- The correct physical properties of gases should be learned and understood.
- Greater emphasis should be placed on drawing labelled diagrams for the laboratory preparation of gases.
- More time should be dedicated to learning compound formulas and writing accurate balanced chemical equations, as this is a fundamental aspect of Chemistry.
- The basic conditions required for chemical reactions should be thoroughly reviewed.
- Laboratory experiments should be utilized to aid in the identification of gases.

PAPER 032 — ALTERNATIVE TO THE SCHOOL-BASED ASSESSMENT (SBA)

Question 1

Most candidates scored at least one mark for Part (a); however, no candidate achieved full marks. The modal score was one out of nine. Common errors included the following.

- Burette readings were not recorded to three decimal places.
- Titre volumes were not within ± 0.1 cm^3.
- Titre volumes differed significantly from those in the supervisor's report.
- Many candidates were unable to read the burette correctly and entered volumes greater than 50 cm^3.

In Part (b) (i), most candidates could not identify the two closest titre values. In many cases, they did not know where to place the asterisk on the table, often placing it next to the final burette reading instead of next to the Volume of Solution A used.

For Part (b) (ii), most candidates correctly performed the calculations to determine the average volume of Solution A.

Part (c) was poorly done. The expected response for calculating the number of moles of $KMnO_4$ in Solution A was 0.025 ÷ 1000 × average titre volume.

Many candidates were unable to identify the appropriate ratio from the balanced equation or apply it to calculate the moles. Candidates were expected to write the following.

- Ratio of moles Fe2+: MnO_4^- = 5: 1
- Number of moles of Fe^{2+} = answer from Part (c) x 5

Part (d) (ii) was poorly done and no candidate achieved full marks. Most candidates were unable to identify the correct volume of Solution B used in the experiment to determine its concentration. The expected response is shown below.

Number of moles calculated from Part (d) (i) ÷ 25 cm^3 × 1000 cm^3.

Part (d) (iii) was poorly done. A few candidates were able to use their results to determine which iron supplement was more effective, but most could not justify their response. The expected answer was to compare the concentration of Fe^{2+} in the two supplements, identify the one with the higher concentration and state that the supplement with the higher concentration of Fe^{2+} is more effective.

Part (e) (i) was also poorly done, with the modal score being zero marks. The expected response was to determine the oxidation state of sulfur in $FeSO_4$ as follows.
Fe = +2, O = 4(–2)
(+2) + S + 4(–2)= 0
S = 8-2 = +6

Part (e) (ii) was also poorly done. Most candidates could not identify the oxidizing agent; the most common incorrect response was 'Fe^{2+}'. The expected response is shown below.

MnO_4^- or $KMnO_4^-$.

In Part (f) (i), many candidates scored at least one mark for identifying the importance of using protective gear during the experiment. Any two reasonable safety precautions, such as the use of gloves, goggles, or a lab coat, were expected.

Part (f) (ii) was poorly done. Common incorrect responses included 'adding the wrong amounts of solutions' and 'cleaning the equipment before use'. The expected response was any two reasonable sources of error such as *the incomplete filling of the burette (tip/air bubbles)*, *reading the meniscus above the liquid*, or *overshooting the end point*.

Question 2

In Part (a), very few candidates were able to clearly demonstrate the ability to plot corresponding values according to the scale provided. Similarly, very few candidates utilized two best-fit lines with a true intersection point.

For Part (b), the intersection point was expected to be clearly labelled and referenced using ruler-drawn dotted lines, and the appropriate volume should have been extrapolated. Many candidates incorrectly drew curves or simply connected all the points. However, approximately 63 per cent of candidates correctly identified the highest point before the inverse relationship as correlating to the end point of the reaction.

Part (c) was poorly answered. Some candidates earned only one mark out of a possible thirty-eight. Most responses were extremely vague. In addition, precautions should have been directly related to the procedure or apparatus involved. It should be noted that sources of error are not considered precautions. Some candidates referenced keeping the Styrofoam cup closed throughout the experiment. Appropriate responses may have included *ensuring the thermometer is suspended in the liquid without touching the sides or bottom* and *transferring the liquid quickly*.

Question 3

For Part (a), most candidates provided incorrect responses for this part of the question. Many did not show a clear understanding of the procedural steps involved in planning and designing a fractional distillation experiment. However, there were some instances where candidates provided accurate responses and demonstrated a good understanding of designing an experiment to separate ethanol in two different types of rum.

In Part (b), most candidates scored at least one or two marks for correctly labelling the drawn apparatus. A few candidates scored three out of four marks, which was the highest score awarded in this part.

For Part (c), most candidates provided incorrect responses or did not respond. Some candidates, however, correctly identified the data to be collected during the fractional distillation of rum.

Generally, most candidates provided incorrect responses for Part (d). Many did not comprehend the variables to be controlled during the fractional distillation experiment. The highest score awarded for this question was one out of two marks.

For Part (e), most candidates provided incorrect responses or did not respond. Very few candidates provided an accurate response and correctly presented a relevant discussion based on the hypothesis.