CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE EXAMINATION
MAY/JUNE 2007

CHEMISTRY

St Michael, Barbados

CHEMISTRY
GENERAL PROFICIENCY EXAMINATION
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The Structure Of The Examination

The examination consisted of three written papers. The weightings of these papers were as follows: Paper 01 (25%), Paper 02 (30%), Paper 03 (25%), Paper 04, the School-Based Assessment (SBA), contributed 20%.

Paper 01 consisted of 60 compulsory multiple choice items based on the specific objectives in Sections A and B of the syllabus. The items were assessed under the profile, Knowledge and Comprehension (KC).

Paper 02, a structured essay paper, consisted of five compulsory questions based on the objectives in Sections A and B of the Syllabus. Question 1 was a data analysis question. Candidates were assessed under the profiles, Knowledge and Comprehension (KC), Use of Knowledge (UK) and Experimental Skills (XS).

Paper 03, an extended essay paper, was divided into three Sections, A, B and C, with each section consisting of two questions. Candidates were required to answer one question from each of the three Sections. Section C of the paper tested Section C of the syllabus. Candidates were assessed under the profiles, Knowledge and Comprehension and Use of Knowledge.

Paper 04 involved the continuous assessment of candidates by teachers over a two-year period. Samples of candidates’ laboratory books were externally moderated by CXC.

GENERAL COMMENTS

A total of 10,471 candidates were entered for the examination representing a 4.2 % increase over the 2006 examination candidate population. Candidates’ performance on Paper 01 was similar to that of 2006.

While there was a general improvement in the overall performance of candidates, especially with respect to questions based on organic chemistry, there are some fundamental areas that need to be addressed. These include failure of candidates to read questions carefully. Very often candidates were asked to give ionic equations and instead gave balanced molecular equations. Also, candidates when asked to describe expected observations (for example, a gas evolved, vigorous effervescence, a coloured precipitate), instead identified the actual substances. Writing of the partial structures (or repeating unit) of polymers continues to pose great difficulty for candidates. Also, in Paper 03 many of the questions were answered very superficially, especially questions relating to the impact of pollutants on the environment, giving the impression that many of the topics were not adequately covered by the candidates.

DETAILED COMMENTS

Paper 01 – Multiple Choice

Performance on this paper continues to be generally good. A number of candidates experienced difficulties with items based on the following syllabus objectives:

- A. 5.2 - distinguish among solutions, suspensions and colloids
- A. 6.1 – trends in the reactivity of Group 2 elements
- B1. 2.1 – recognizing addition reactions of alkenes
- B1. 2.7- identification of the combustion products of ethanol
- B 1.4.3 – the linkages present in named condensation polymers
- B2. 3.1 – catalyst used in the industrial preparation of ammonia

Paper 02 – Structured Essay

NOTE: THESE COMMENTS SHOULD BE READ IN CONJUNCTION WITH THE QUESTION PAPER IN ORDER TO DERIVE THEIR FULL BENEFIT.

Question 1.

Part (a)

Candidates were expected to complete the data required in Table 1 to show the titration values based on a series of burette readings given in Figure 1. They were also required to carry out a series of simple calculations, based on the titration readings and other given information to determine the mass of sodium hydroxide in 250 cm^3 solution.

Part (a) (i) of the question was generally well answered with most candidates scoring full marks for correctly reading the burette. A few candidates, however, incorrectly read the burette scale "bottom up " rather than "top down" For example, a correct burette reading of "1.3" was given as "2.7". Also, some candidates incorrectly summed the initial and final burette readings instead of subtracting them in order to obtain the volume of acid used in the titration.

In (a) (ii), most candidates were able to write the balanced equation for the reaction occurring during the titration. Common errors included writing NaOH as Na_2OH and NaOh. HCl was also frequently written as HCL. This error should be brought to the attention of students in the classroom since it is a perennial problem.

In (a) (iii), most candidates were able to correctly calculate the number of moles of hydrochloric acid used in the titration based on the concentration of the standard solution (0.050 mol dm^{-3}).

In (a) (iv), candidates were wrongly applying the formula: number of moles = concentration x volume to obtain the number of moles of sodium hydroxide in 25 cm^3 of solution. They failed to take into consideration the balanced equation for the reaction (a) (ii) between NaOH and HCl and the corresponding mole ratios (1:1).

In (a) (v), many candidates failed to use their answer in (a) (iv) to calculate the number of moles of NaOH in 250 cm^3 of solution. Instead, they incorrectly based their calculation on 1000 cm^3 = 0.05 moles (the given concentration of hydrochloric acid).

In (a) (vi), some candidates had difficulty calculating the mass of sodium hydroxide in 250 cm^3 of solution which could be simply obtained by multiplying the answer in (a) (v) by 40 (moles x molar mass).

Part (b)

This part of the question required candidates to make appropriate deductions based on a series of tests and the corresponding observations. All of these tests would have been carried out in their laboratory exercises as part of their tests for various cations and anions. The performance was generally poor.

Test 1

Most incorrectly identified the brown gas evolved which turned blue litmus red as bromine or Fe^{3+} rather than as nitrogen dioxide. Of those who identified the gas as nitrogen dioxide, some of them incorrectly represented it as NO^2 or NO^3. Also, many incorrectly represented the formula for nitrate as NO_3^- or NO_3^{2-}.

The test for oxygen was generally well known but many represented the formula for oxygen as O_2^- or O_2^{2-} indicating the serious misconception that oxygen ions were being tested for, rather than gaseous oxygen (molecular form).This misconception should be corrected in the classroom.

Tests 2 and 3

The responses indicated that candidates did not know of the distinguishing feature of the aqueous sodium hydroxide and the aqueous ammonia test in determining the presence of certain cations.

Also, many candidates have the propensity for incorrectly writing the chemical symbol for the neutral atom rather than the intended ions in solution, for example, writing Pb when Pb^{2+} is intended.

Test 4

Many did not recognize aqueous potassium iodide as the confirmatory test for Pb^{2+} ions and did not use their inference in Test 3 to guide them along. Also, the writing of the ionic equation posed a challenge to many. Some wrote an electrode half equation for the ionic equation ($Pb^{2+} + 2e^{-} = Pb$).

Test 5

Many candidates were unable to identify Q as lead nitrate. While some correctly did, their deductions from tests 1 – 4 were not in keeping with such a deduction. Also, many had problems writing the formula of lead nitrate.

Part (c)

This part of the question required candidates to plan and design an experiment to obtain "solid sea salt" from a bottle of sea water containing sand. Specifically they were required to:

- List the apparatus to be used;
- Outline the steps of the procedure to be employed;
- List the main observations expected at each step of the separation procedure;
- Test for the presence of Cl^{-} ions in the extracted sea salt.

In (c) (i), candidates were expected to list the apparatus that could be used to bring about the desired separation. In many cases the listed apparatus bear no relation to the procedure the candidates outlined in (b).The responses were wide and varied and included the use of cloth, sieves, strainers, pots and pans, light bulbs, furnaces, ovens. The expected response was for appropriate laboratory apparatus which could be used to first separate the sand from the sea water (filtration apparatus), followed by concentration/crystallization (evaporation to dryness) of the filtrate.

In (c) (ii), an outline of an appropriate procedure in recovering "solid sea salt" from the sandy sea water was required. The majority of responses were in keeping with a methodology involving, as a first step, filtration followed by concentrating/evaporating the filtrate and recovering the crystals/residue. However, a significant number of candidates incorrectly used a separating funnel instead of a filter funnel to separate the sand from the sea water. Also, some attempted the process of separation by using distillation prior to filtration. This of course would lead to contamination of the sand and salt. Other methods of separation included centrifugation followed by decantation.

In (c) (iii), candidates were required to list the main observations at each stage of the separation procedure they described in (c) (ii). The typical responses were expected to include sand on the filter paper during the filtration stage and a white solid (salt) formed in the evaporating basin during the concentration step. A number of candidates stated the process (filtration, evaporation) rather than the observations and as a consequence lost valuable marks. Candidates are advised to carefully read the question before writing their responses.

In (c) (iv), candidates had surprisingly great difficulty describing a possible test for chloride ions in the solid sea salt. Many incorrectly suggested the use of $AgNO_3$ /HCl instead of the expected $AgNO_3$ /HNO_3. The use of HCl would lead to the introduction of chloride ions into the sample and hence lead to an incorrect deduction. Many other incorrect tests included electrolysis of the sodium chloride, heating the sea salt to liberate chlorine gas and testing for the bleaching of litmus, and the flame test with the sea salt giving a green flame.

Question 2.

Candidates were required to:

- Define oxidation and reduction;
- Recognize standard tests for oxidizing/reducing agents;
- Distinguish between oxidizing and reducing agents;
- Predict chemical reactions based on the position of an element in the electrochemical series;
- Write balanced ionic equations to illustrate oxidation and reduction;
- Suggest suitable household chemicals to remove a layer of carbonate coating based on their knowledge of the reactions of carbonates.

Part (a)

The candidates' responses clearly indicated a serious misconception between a reducing/oxidizing agent and the substance which is oxidized /reduced in the course of a reaction. This was reflected in the fact that whilst a number of candidates recognized that in Experiment I, Solution A was acting as a reducing agent whereas in Experiment 2, Solution A was acting as an oxidizing agent, very few were able to explain this in terms of the observations given: namely, the reduction of chromium ions from + 6 to +3 (orange to green) and the oxidation of iron from +2 to +3 (from pale green to pale yellow).

Common misconceptions included oxidation as electron gain and reduction as electron loss. Also, many candidates lost marks for simply stating that there is electron exchange without specifically referring to the species involved.

Part (b)

Candidates still have difficulty writing ionic equations as represented by the reaction between Cu and aqueous silver nitrate. Many did not include state symbols. Others included all the species involved in the reaction including spectator ions. Other common errors included writing the formula for silver ions as Ag^{2+} rather than Ag^{1+}, and representing the symbol for silver as Au.

Most candidates were able to correctly account for the blue colour of the solution observed in Experiment 4 in terms of the presence of Cu^{2+} ions. However, many very carelessly referred to simply the presence of copper rather than to Cu^{2+} ions.

Part (c)

The majority of candidates correctly stated that no reaction would occur when a strip of copper metal is immersed in an aqueous solution of iron (II) nitrate. However, many of these candidates were not able to fully account for this in terms of the relative positions of Cu and Fe in the reactivity series.

Many simply referred to Cu with no reference to Fe. Also, some candidates apparently misconstrued the term "electrochemical series" and as such referred to the preferential discharge of ions relative to H^+ ions during electrolysis.

Part (d)

Most candidates recognized the need for a mild acid cleaning agent (such as vinegar) to remove the carbonate coating on a copper ornament. However, few were able to score full marks for writing the corresponding ionic equation. This problem is inherent throughout the examination and clearly indicates that students need to be exposed to more practice in writing ionic equations in the classroom.

Question 3.

Candidates were required to:

- Deduce mass number, atomic number, number of protons, number of neutrons, electronic configuration and group number based on given information;
- Predict the likelihood of an atom forming an ionic or a covalent bond based on atomic structure;
- Use dot cross diagrams to represent bonding in ionic compounds;
- Explain metallic bonding;
- Relate the structure of graphite to its properties;
- Distinguish between ionic and molecular solids.

Part (a)

This was generally well done indicating that candidates had a fair grasp of the arrangement of electrons in the various energy levels, atomic number, group number and period number. However, there were some candidates who were unable to determine group number and period number based on the electronic configuration. Also, there was some apparent confusion of mass number with proton number.

Part (b)

Most candidates correctly predicted the formation of an ionic bond between Elements A and B. However, several were unable to make the connection between the number of electrons in the valence shell and whether the element is a metal or nonmetal. As such, many were unable to give an appropriate explanation for the formation of an ionic bond between A and B. A common misconception was that A and B became noble gases upon gain or loss of electrons.

The drawing of dot cross diagrams to illustrate the bonding between A and B (ionic bonding) was a challenge to many candidates. Even though candidates correctly identified ionic bond formation in b (i), the dot-cross diagrams instead reflected covalent bonding/electron pair sharing. Diagrams at the best of times were drawn carelessly indicating either candidates did not have experience drawing dot cross diagrams or that the concept of complete electron transfer in ionic bonding is not well grasped.

Although candidates were not required to identify the elements, those who identified B as fluorine incorrectly wrote Fl as the symbol rather than F.

Part (c)

Many candidates correctly identified the bonding in A as metallic bonding. However, their description of the bonding clearly indicates a lack of understanding of metallic bonding. Terms such as floating cations or positive atoms were used to describe the cations in the crystal lattice. Many also referred to mobile electrons without reference to the cations.

Part (d)

This proved to be the most difficult part of the question for candidates. Many attempted to describe the bonding in graphite with no reference to the weak forces of attraction (Van der Waals forces) between layers.

Those who attempted to describe such forces of attraction between layers often referred to them as weak covalent bonds. Teachers need to stress the difference between the bonding within layers, as distinct from the forces of attraction between layers. Thus, although candidates knew that graphite acts as a lubricant they were not able to explain this property in terms of the weak forces between the layers in the graphite structure.

Question 4.

Candidates were required to:

- Use data on the combustion of a hydrocarbon, X, in order to deduce its molecular formula, the homologous series to which it belongs, its name as well as its fully displayed structure;
- Deduce the homologous series, name and fully displayed structure of a hydrocarbon, Y, of formula $C_5 H_{10}$;
- State a test (reagents and observations) that could be used to distinguish between hydrocarbons X and Y;
- State the reagent and reaction conditions necessary to convert Y(an alkene) into X(an alkane).

Generally the question was poorly answered with a high percentage of candidates failing to gain any KC or UK marks. In spite of this there were a number of excellent responses, with candidates gaining full marks.

Part (a)

Many candidates were unable to use the data given (moles, volumes of gases at r.t.p.) to determine the formula of the hydrocarbon (C_5H_{12}). Most were only able to calculate the number of moles of CO_2 produced from the given number of moles of hydrocarbon but were unable to use the mole ratio approach to carry the calculation forward to the end. Many candidates incorporated oxygen into their final formula, apparently because combustion data was given, in spite being told compound X is a hydrocarbon. Thus, formulae such as $C_5H_{11}OH$ were quite common.

In a number of cases the correct formula was stated without any calculations given. Such candidates were not credited with the full marks. To obtain full marks candidates were required to show evidence as to how they arrived at their answers.

Part (b)

This part of the question required candidates to link their answers to the formula of the hydrocarbon they derived in Part (a). In spite of this, many candidates gave responses to (b) (i), (ii), (iii), which bore no relationship to their answers to (a). In fact, a number of candidates had correct responses to (b) (i), (ii), (alkane, pentane) whilst identifying X as C_2H_5OH or as $C_5H_{11}OH$.

Part (c)

Most candidates were able to correctly deduce the homologous series, the name and the fully displayed structure of the compound corresponding to the given hydrocarbon, Y, of formula C_5H_{10}. Common errors included:

- Using the wrong prefix for the name of the hydrocarbon. Hexene and propene were often given instead of pentene;

- Drawing structures with pentavalent carbons instead of tetravalent carbons.

Part (d)

Most candidates correctly identified a suitable reagent (bromine, acidified potassium manganate (VII)) that could be used to distinguish between Y (an alkene) and X (an alkane). However, many failed to clearly state the expected observations when BOTH X and Y are treated with the named reagent. Most focused on what is observed when the alkene is treated with the reagent with no reference as to what would be observed when the alkane is treated with the reagent.

An area of concern is the number of candidates who used combustion information (number of moles of CO_2 and H_2O formed) as a means of distinguishing X from Y. What is expected is simple test tube type reactions.

Part (e)

This part of the question proved challenging for many candidates. Many confused reagent with reaction condition as well as hydrogenation with hydration. As such, many gave H_2O as the reagent in the presence of acid rather than H_2/Pt, Ni.

Question 5.

Candidates were required to:

- Define the terms amphoteric oxide and acidic anhydride;
- Describe specific chemical tests which could be used to determine whether a compound is an amphoteric oxide or an acidic anhydride;
- Write equations for the reaction between SO_2 (an acidic oxide) and water;
- Suggest with reasons a suitable substance which could be used to remove acidic gases from factory effluents.

Part (a)

The responses clearly indicate that candidates did not have a clear understanding of the meaning of the terms amphoteric oxide and acidic anhydride. Instead of defining amphoteric oxide as the oxide of an element which reacts with both an acid and an alkali/base, many incorrectly conceived of it as a **mixture of two oxides** which dissolves in water to give an alkaline or acidic solution.

Similarly, instead of defining an acidic anhydride as the oxide of a nonmetal which dissolves in water to give an acidic solution, it was frequently defined as an acid without water/water of crystallization.

Part (b)

Generally, there was a positive correlation between the responses of candidates to Part (a) and Part (b), in that those who correctly responded to Part (a) were also able to describe a test, the results of which could be used to determine whether a substance (for example, zinc oxide) is an amphoteric oxide or an acidic anhydride. However, most candidates limited their responses to simply stating that the substance (the zinc oxide) should be reacted with both an acid and a base (in the case of the amphoteric oxide) or dissolved in water (in the case of the acidic anhydride) without describing the RESULTING observations of the corresponding tests. As a result they failed to mention how the results of the experiments could be used to determine whether the substance is an amphoteric oxide or an acidic anhydride. For example, in the case of the acidic anhydride, most candidates simply stated it should be dissolved in water without proceeding to say that the resulting solution should be tested with litmus paper (or any other suitable method for testing acidity), and that the moist blue litmus would change from blue to red if the substance is an acidic anhydride. Such candidates failed to secure maximum marks for this part of the question.

Part (c)

Many candidates were surprisingly confused by the (IV) in the term sulphur (IV) oxide. As a consequence, such candidates incorrectly wrote SO_4 and S_2O_4 as the formula for sulphur (IV) oxide rather than SO_2. Teachers should be encouraged to use such terminology in their regular classes to describe substances with variable oxidation states, so it will eventually become part of students' vocabulary.

Candidates who wrote the correct formula for sulphur (IV) oxide were able to generate the correct balanced equation for its reaction with water.

Part (d)

Most candidates were able to correctly suggest the use of a basic oxide/hydroxide as a suitable substance for use in removing acidic gases from factory effluents. However, the majority could not give a corresponding balanced equation for the expected reaction.

Most candidates gained full marks for their responses to Part (d) for indicating that the recommended substance should be used in the powdered form since it provided a larger surface area, which in turn would result in more efficient reaction with the acidic gases emitted.

A common misconception which emerged from the candidates' responses is that the powdered form of the substance allows for more rapid escape (diffusion) of the acidic gases into the atmosphere. This misconception needs to be corrected in the classroom.

Paper 03 – Extended Essay

SECTION A

Question 1.

This question was slightly less popular than Question 2, the alternate question in Section A. Candidates were required to:

- Define the terms acid salts and normal salts;
- Write equations to illustrate the formation of acid salts and normal salts using phosphoric acid and aqueous sodium hydroxide;
- Explain the chemical principle involved in the treatment of excess stomach acid.

Part (a)

Most candidates were able to correctly define acid salts as those formed from acids by replacing only some of the ionizable hydrogens, whereas in normal salts all of the ionizable hydrogens are replaced during salt formation. However, candidates had problems representing this knowledge in terms of balanced chemical equations for the reaction between phosphoric acid and sodium hydroxide. The normal salt was typically represented as $NaPO_4$ rather than by Na_3PO_4.

In (b) (iii), most candidates were familiar with the use of antacids and their mode of action. A few incorrectly referred to the use of strong alkalis such as sodium hydroxide and also reference was made to milk. However, many had difficulty representing the mode of action in terms of an ionic equation. Most candidates used molecular equations to represent the neutralization reaction.

Part (b)

Candidates had difficulty with calculating the heat of neutralization for the reaction between sodium hydroxide and hydrochloric acid based on the given information, in spite of the fact that the formula to be used was given (heat evolved = mass (g) x specific heat capacity x change in temperature). Candidates were able to calculate the number of moles of the acid and base used, but were not able to relate this to the number of moles of water formed, and hence calculate the molar heat of neutralization. Also, most candidates neglected to include the sign (-) associated with ΔH, indicating that the reaction is exothermic. As such, many drew the energy profile diagrams as representing an endothermic reaction rather than an exothermic reaction. Many candidates failed to take into consideration the fact that there was a temperature rise (8.9 ^{o}C) upon adding the acid to the base indicating that the reaction is exothermic.

Question 2.

Candidates were required to:

- Write a balanced equation for the reaction between zinc and sulphuric acid;
- Calculate the volume of hydrogen liberated at r.t.p. when 6.5 g of Zn reacts with excess sulphuric acid;
- Predict the effect of using 2.0 mol dm^{-3}, instead of 1 mol dm^{-3}, on the expected shape of the graph when compared to that given for Experiment II in Figure 1;
- Discuss the effect of temperature and concentration on the slopes of the graphs for Experiments I,II and III.(Figure 1);
- Explain how a catalyst works;
- Draw labelled energy diagrams to illustrate the effect of a catalyst on the rate of a reaction.

Part (a)

Most candidates were able to write the balanced equation for the reaction between zinc and aqueous sulphuric acid. However, many had difficulty using the information in this balanced equation (1 mole zinc would liberate 1 mole of hydrogen) to calculate the volume of hydrogen that would be liberated at r.t.p. when 6.5 g zinc (0.1 moles) reacted with excess 1 mol dm^{-3} sulphuric acid. Students should be given more practice in calculations involving the mole concept.

Part (b)

Although candidates were asked to make a sketch of the graph of Figure 1 in their answer booklets, many sketched only the axes without including the shapes of the curves for Experiments I and II. As such, the graphs they sketched for Experiment III could not be evaluated relative to those for Experiments I and II, and hence such candidates could not be credited. It was expected that candidates would include all three curves for Experiments I, II and III on one graph, and that the curve for Experiment III would reflect a steeper initial slope when compared to the curves for Experiments I and II. However, in all three cases the maximum volume of hydrogen liberated would be the same.

In (b) (ii), candidates were expected to discuss the effects of temperature and concentration on the rates of production of hydrogen and specifically relate these to the slopes of the graphs for Experiments I, II and III. The responses were, in general, very poor and lacking in details. Most candidates simply stated that both an increase in temperature and concentration would result in an increase in reaction rate and hence an increase in rate of production of hydrogen. It was expected that candidates would have made reference to the increase in kinetic energy of the particles with increasing temperature resulting in increasing collision frequency and relate this to the slopes of the graphs. A similar reference to increase in collision frequency with increasing concentration was expected.

Part (c)

The precautions stated in most cases bore no relation to the experiment under investigation. Most candidates simply referred to safety measures in the laboratory (protective eye gear, spills). Very few took into consideration that the objective of the experiments was to measure the rate of evolution of hydrogen. Thus, precautions such as ensuring that no gas escapes, the temperature of the gas collected is kept constant, all the zinc has reacted were expected.

Part (d)

Most candidates were familiar with the fact that catalysts increase the rate of reactions by lowering the activation energy. However, some candidates had difficulty illustrating this in terms of a fully labelled energy profile diagram. A common error was the wrong labelling of the activation energy for the enthalpy of the reaction.

SECTION B

Question 3.

This question was the more popular of the two questions in Section B and tested candidates'

- Knowledge and application of the reactions of alkenes and alcohols;
- Knowledge of addition and condensation polymerization;
- Ability to write balanced equations;
- Ability to write partial structures/repeating units of polymer formed from addition and condensation reactions.

Part 1 (a) (i)

Many candidates correctly stated that bromine (dissolved in an appropriate solvent) was the reagent required to convert compound A (an alkene) to its corresponding dibromoalkane. However, a number of candidates unnecessarily lost marks for stating "bromide", "Br", "bromium", as the required reagent.

Part (a) (ii)

Most candidates were able to recall H_2/Pt, Pd or Ni as the reagent required for the conversion of A (an alkene) to C (an alkane). However, some candidates confused **hydrogenation** with **hydration** and gave H_2O/Pt, Pd or Ni as the reagent.

Part (b) (i)

Candidates were required to describe, as well as to explain, what will be observed when compound D (an alcohol) reacts with acidified potassium chromate (VI). Most candidates limited their answers to **"the solution will turn from orange to green**" or **"the alcohol will be oxidized'**. Only a few gave a change in oxidation number of chromium (from + 6 to +3) to account for the colour change.

Part (b) (ii)

Candidates were also required to DESCRIBE WHAT WILL BE OBSERVED when Compound D (an alcohol) reacts with sodium metal. Most candidates identified the gas as "hydrogen is evolved" rather than **describe the observation** as "vigorous effervescence, colourless gas evolved".

Most candidates had difficulties writing the balanced equation for the reaction. Most used ethanol rather than Compound D as the starting material. Teachers, as a strategy in the classroom, should encourage students to practise writing equations for reactions involving functional groups using varying structures. The principle of the reaction needs to be stressed.

Part (c)

This was fairly well answered indicating that candidates were quite familiar with the characteristics of saturated compounds and compounds which undergo addition and condensation polymerization reactions. In a few cases candidates confused the double bond (C = C) with the equal sign.

Part (d)

This part of the question posed the greatest challenge to candidates. Candidates simply could not extrapolate their basic knowledge of writing the partial structures (or repeating units) of polymers of simple structures like ethene to a compound such as A, although the principle is the same. The same comments apply to writing the partial structure of the condensation polymer formed from Compound F. Teachers are encouraged to urge students to practise writing repeating units of addition and condensation polymers using various compounds, pointing out the principles in the process.

Question 4.

This question was the less popular question in Section B. In particular candidates were required to:

- Write chemical equations to represent the major steps involved in the manufacture of sulphuric acid by the Contact Process starting with sulphur. Reaction conditions were also required;
- Suggest how such an exothermic reaction can be used to make the manufacturing process more economical;
- Explain why sulphur trioxide is dissolved in conc. sulphuric acid rather than directly in water in the manufacturing process;
- Name two factors that should be taken into consideration in siting of a sulphuric acid plant;
- Explain why sulphur burns in air to form a gaseous oxide whereas sodium, an element in the same period, forms a solid oxide;
- To illustrate by means of a diagram the role of sulphur in the vulcanization of natural rubber;
- Determine whether sulphur dioxide and sulphuric acid are acting as oxidizing/reducing agents in a given set of reactions.

Part (a)

This part of the question was fairly well answered and reflected that the candidates had a good grasp of the main steps involved in the manufacture of sulphuric acid. However, a number of candidates lost marks quite easily for:

- Not correctly balancing rather simple equations;
- Simply describing in words (without equations) the steps involved;
- Stating vanadium as the catalyst rather than vanadium (V) oxide;

- Vaguely stating high temperatures/pressures as the reaction conditions required;
- Wrongly stating that the catalyst is required in the step involving the formation of oleum;
- Wrongly stating that sulphur trioxide is dissolved in conc.sulphuric acid rather than in water because it is insoluble in water.

Also, many candidates were not able to apply their knowledge of exothermic reactions to suggest that the heat evolved in the process could be used economically to heat the incoming gases (the concept of industrial ecology).

The response to the factors that need to be taken into consideration in the siting of a sulphuric acid plant was generally well answered. However, in a number of cases candidates incorrectly focused on health and safety issues in the plant itself. Others misconstrued the word "plant" as meaning a tree and as such referred to the amount of soil around the tree as one of the factors that should be taken into consideration.

Part (b)

Most candidates recognized sodium as a metal and sulphur as a nonmetal. However, they were not able to further develop this point to account for the fact that the oxide of sodium is a solid (an ionic compound, giant lattice structure, with strong forces of attraction between ions) whereas sulphur dioxide is a gas (simple covalent molecule, weak intermolecular forces of attraction).

Part (c)

This part of the question, which required a simple explanation (via an illustrative drawing with sulphur atoms forming bridges between the polymer chains – a description of this was credited in the marking) was not attempted by the majority of candidates. Some candidates who attempted it thought that vulcanization was an example of electrolysis and as such drew electrolytic cells. Others associated the term with volcanoes and drawings of erupting volcanoes were given.

Part (d)

Candidates were able to correctly identify the oxidizing agent in equation (i) as sulphuric acid and the reducing agent in equation (ii) as sulphur dioxide. However, many were unable to show how they arrived at their answers and as such failed to gain full marks. This demonstrated a lack of understanding of calculations of oxidation numbers and the significance of these in determining oxidizing and reducing agents.

SECTION C

Question 5.

This question was by far the more popular question in Section C.

Part (a)

Here candidates were required to:

- Name the main greenhouse gas;
- State two factors responsible for the increase in the concentration of the named greenhouse gas;
- Use a labelled diagram to illustrate the greenhouse effect.

Parts (a) (i), (ii)

Almost every candidate correctly stated that carbon dioxide is the main greenhouse gas (in terms of quantity rather than in terms of global warming potential) and that combustion of fossil fuel and deforestation are the two main contributing factors to its increase over the years.

Part (a) (iii)

Here the majority of candidates gave the equation for the combustion of coal to explain the increase in CO_2 resulting from the combustion of fossil fuel. Those who attempted to use a hydrocarbon as the source of the fossil fuel had difficulty balancing the equation.

Those candidates, who focused on deforestation as the contributing factor, indicated that photosynthesis would decrease and as a result less CO_2 would be removed from circulation.

Such candidates had difficulty writing a balanced equation to represent the overall process of photosynthesis.

Part (a) (iv)

Most candidates were able to adequately explain the greenhouse effect with the aid of a labelled diagram in terms of:

- Sun rays penetrating the earth's atmosphere;
- The heating of the earth's surface;
- The reflected rays (longer wavelengths) from the earth's surface being "trapped" by the clouds and reflected backwards towards earth causing an increased warming of the earth's atmosphere.

Some candidates incorrectly confused the greenhouse effect with the carbon cycle. Others assumed that it was the ozone layer that traps the outgoing radiation.

Part (b)

This part of the question, which tested the candidates' ability to analyse and synthesize, proved to be quite challenging. Few recognized that the use of electric cars could make a significant positive impact on the greenhouse effect if the source of electricity itself is not generated using fossil fuels but from some other renewable source of energy such as solar energy.

Part (c)

The majority of candidates had a fairly good grasp of the effects of CFCs on the ozone layer. Specifically, candidates were aware of the following:

- The ozone layer shields the earth from the shorter wavelength radiation(UV) from the sun;
- The shorter wavelength radiations are more damaging to human health and the environment (for example, causing skin cancer, cataract, mutation, coral reef damage, reduced food production);
- CFCs destroy the ozone layer by means of a complex series of chemical reactions;
- The phasing out of the use of CFCs (MONTREAL PROTOCOL) and replacing them with alternatives(for example, HFCs).

However, the responses to the possible long-term consequences of the reduction of the ozone layer on the Caribbean tourism industry did not reflect a sense of critical thinking. Most tended to correlate this with global warming rather than to health effects (for example, skin cancer) and other environmental effects (for example, damage to coral reefs).

Question 6.

Candidates were required to:

- Suggest how detergents work;
- Suggest reasons for the necessity to clean bathrooms more often when soaps rather than bath gels are used for bathing;
- Give an example of a reagent that could be used to remove tea stains and rust stains and explain how each works;
- State the nature and function of fabric softeners.

Part (a)

Here candidates were given the generalized structure of a detergent and were required to use this information to suggest how detergents function in removing dirt from fabric. The responses indicated that this topic was not fully understood or adequately covered in the classroom. Most candidates confused the role of the polar head (sulphonate group) and the non-polar hydrocarbon tail, stating in the process that it was the polar head which is attracted to the grease (grease loving). It is the long chain hydrocarbon non-polar tail that is attracted to the grease. Also, there was little or no reference to the role of the polar head being attracted to the water molecules.

Part (b)

Most candidates were familiar with the fact that soapless detergents do not produce scum in hard water whereas soaps do. However, most failed to identify the ions (Ca^{2+}) responsible for hardness of water and as a result were not able to fully account for the observation. Also, most candidates incorrectly associated sud formation (lather) with scum formation. This common misconception should be corrected in the classroom.

Part (c)

Although most candidates were able to correctly name a reagent to remove tea stains and rust stains, the majority failed to identify these stains as acidic and basic in nature, respectively. As such they were not able to explain the mode of action of the named stain removers. Most vaguely mentioned that a neutralization reaction takes place.

Part (d)

This part of the question was also poorly answered giving the impression that the topic was not covered in the classroom. Most candidates were able to state the reasons why fabric softeners are used. However, they were unable to identify fabric softeners as cationic or non-ionic compounds and as such explain how fabric softeners work.

School-Based Assessment (SBA)

General Comments

There has been some improvement in the standard of practical activities submitted for SBA assessment. Only five per cent of the Centres moderated were considered to have submitted laboratory exercises of a somewhat unsatisfactory standard. Teachers are once again to be commended for their efforts in ensuring minimum coverage of the syllabus, as well as undertaking at least the minimum number of activities, in spite of adverse laboratory conditions and technical support. For those teachers having difficulty in completing the required activities, the topics listed on the moderation feedback report could be used as a guide to ensure adequate syllabus coverage for practical activities. Unfortunately though, there are some teachers that continue to "over practise", some topics and or skills at the expense of others. For example, qualitative and volumetric analysis; separation; states of matter; acids, bases and salts are the topics which are generally "over practised" whereas topics such as reduction and oxidation, electrolysis and heating of nitrates and carbonates are generally not being adequately carried out.

Although most practical exercise were up to standard in terms of quality there were some cases where the requirements for assessment did not make sufficient demands on the students. A case in point is utilizing the construction of tables with headings to assess ORR skills but awarding as many as 10 marks alone for this activity.

Teachers are reminded that each skill is required to be assessed as least twice a year. However, students should benefit from carrying out other experiments to help develop these skills before they are actually assessed for SBA purposes. This seems to be lacking. In most cases it is not that students do not carry out the practice experiments since some were able to do as many as 35 – 40, but rather that only those exercises used for SBA assessment are being marked. THIS IS A GROWING CONCERN SINCE THE STUDENT DOES NOT SEEM TO BENEFIT FROM THE FEEDBACK OF THE PRACTICE LABORATORY EXERCISES.

In most cases, teacher marking was consistent but there is a disturbing trend emerging with a number of teachers awarding a mark of zero because of late submission. It is suggested that other means of punishment be utilized.

Teachers still seem unsure regarding the assessment of diagrams and graphs. Please be reminded that both are assessed as ORR skills and not AI nor MM. Students should be also reminded that in chemistry, diagrams should not be artistic representations and therefore no shading or colouring is necessary but rather only 2D representations are required and rulers should be employed when necessary.

In general the laboratory books presented were in "good condition". However, there are some occurrences where

1) the books are in such an immaculate condition – this gives the idea that the laboratory exercises are just copied into the book at one time. The book should be a working documentation of exercises actually carried out at a specific time and place.

2) some practical exercises are done on extra sheets, for example, photocopies and graphs and in some cases these are not neatly or securely attached – this leaves the book looking extremely untidy and difficult to follow, as well as increases the probability of a lab being lost in transition.

Teachers are reminded that the assessment is to be done over a two year period and there should be a clear demarcation of Year I from Year II in the laboratory books, as well as in the marking schemes.

This year many books sent for moderation had chemical samples such as crystals and soap prepared displayed in them. Whereas this serves as evidence of having actually carried out the experiment it creates a problem since they tend to leak during shipping, obscuring words in some cases. This also presents a safety concern since there are clericals with no chemistry background handling these packages.

In cases where there are more than one chemistry teacher at a Centre, teachers are encouraged to work together as a team when planning and devising practical activities as well as constructing marking schemes. Marking schemes are extremely important in the moderation process and it is difficult to adequately moderate a sample when

1) the mark scheme does not correspond to the laboratory exercises shown the books

2) two or more teachers send one group of five samples and only one teacher sends a marking scheme which cannot be used for all the books.

The non-collaboration of teachers also creates a problem where the Centre is to be given feedback on the assessment of the individual skills. This is especially difficult when one teacher has done sufficient assessment and another from the same Centre has not.

Some of the specific problems encountered at moderation are out lined below.

Planning & Design (PD) Skills

There are still major occurrences of "standard laboratory exercises" being utilized to assess PD skills. Teachers are encouraged to present scenarios to the student in the form of problem statements which would encourage critical thinking, and can be solved by standard chemical procedures or by employing sound chemical principles which are covered in the CSEC Chemistry syllabus.

The way in which a PD exercise is presented determines whether it is classified as "standard" or accepted as an authentic PD activity. A common PD lab which is considered standard is

> *Plan and design an experiment to show that the rate of a chemical reaction is dependent on temperature.*

This standard activity can be presented in a form which makes it acceptable to be used to assess PD skills, as follows:

> *A housewife observed that cow's milk stayed fresh when placed in the refrigerator but when it was left on the kitchen counter for a morning she returned to find that the milk had curdled. Plan and design an experiment to explain these observations.*

Teachers are also reminded of the following:

- A reason or explanation is not needed in the Hypothesis;
- The main method to be used should be highlighted in the Aim;
- The procedure developed should theoretically satisfy the aim while being able to produce data which would "validate" the hypothesis;
- For data to be collected, if a table is drawn no results should be listed. Any PD exercise actually carried out cannot be assessed as PD;
- Where appropriate, controls and variables to be manipulated should be listed.

Observation, Recording and Reporting (ORR) Skills

In some cases, for the ORR skills only the Reporting aspect was being assessed not Observation or Recording. Teachers should make an effort to assess all three aspects over the two-year period.

Mark Schemes

As previously mentioned, mark schemes are extremely pertinent to the moderation process and in order to ensure students are not disadvantaged teachers are reminded to submit them to CXC along with the moderation package.

Teachers are also asked to take note of the following reminders:

- It should be made easy to identify which marking schemes correspond to which practical activity;
- When there is more than one teacher at the Centre the exercises assessed for SBA and hence the marking schemes should be the same. Where this is not possible, each exercise should be accompanied by an appropriate marking scheme;
- Marks should not be lumped together. Instead, each mark should be assigned to a specific content item;
- When students are expected to answer specific questions, these questions as well as their expected responses and the allocation of each mark should be included in the marking scheme;
- For qualitative exercises, assessing ORR and AI skills, the unknown(s), tests carried out, the expected observation as well as inferences should be noted in the mark scheme;
- For PD skills, the mark scheme should include the problem statement given to students as well as possible solutions, variables;
- Ensure that an adequate amount of marks are allocated for an exercise while noting that CXC does not award ½ marks. For example, do not allocate five marks for an exercise which has more than five tests. Scale down the total mark of the exercise, if necessary.

Equations

The use of equations is not being emphasized by teachers especially in qualitative analysis since they are not being assessed in the mark schemes.

In some cases ionic equations are written for precipitation reactions but activities which require students to write molecular equations with state symbols are avoided, for example, reactions of metal carbonates with acid or the effect of heat on nitrates or carbonates.

The lack of emphasis on writing the correct symbols in formula is also evident, that is, using capital letters appropriately. For example in many cases the symbol for sodium chloride is being written as $NaCL$ rather than $NaCl$ and calcium carbonate as $CaCo_3$ rather than $CaCO_3$, without any evidence of correction in the students' books.