C A R I B B E A N  E X A M I N A T I O N S  C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION MAY/JUNE 2004

## CHEMISTRY

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# GENERAL PROFICIENCY EXAMINATION
# MAY/JUNE 2004

## The Structure of the Examination

The examination consisted of four papers. The contributions of the papers were as follows: Paper 01 (25%), Paper 02 (30%), Paper 03 (25%), Paper 04 (20%).

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

Paper 02, a structured essay paper, consisted of five compulsory questions based on the objectives specified in Sections A and B of the syllabus. Question 1 was a data analysis question. Candidates were assessed under three 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 represented the continuous School Based Assessment (SBA) of candidates' Experimental Skills and Use of Knowledge. Resit candidates who obtained $\geq$ 50% in their previous SBA had the option of carrying forward their earned marks to this Examination..

## General Comments

A total of 9403 candidates were entered for the examination representing a 5.3 per cent increase over the 2003 candidate population.

Performance of candidates on Papers 02 and 03 was generally poorer than in 2003. However, the performance on Paper 01 was similar to that of the previous year. The total composite mark for the examination continues to show steady improvement over the last five years. In spite of this overall improved performance there seemed to have been a lack of syllabus coverage in certain critical areas. Section B.1 – the Organic Chemistry Section- seemed not to have been covered or understood by the candidates. The Organic Chemistry questions in both Papers 02 and 03 produced very low means. Also, there appeared to have been a lack of complete syllabus coverage of Units I and II in Section C of the syllabus.

The writing of molecular formulae and ionic equations still poses considerable difficulty. Incorrectly written formulae, for example, $No_3$, $Mno_4$, NaCL, appear in candidates' answers. Candidates should be encouraged to use state symbols when writing ionic equations.

Calculations involving electrolysis, as well as the mole concept, are still proving to be a challenge. Candidates have problems in arriving at mole ratios in which reactants combine. As such, they have difficulty carrying forward the calculations to completion.

## DETAILED COMMENTS

### Paper 01

This paper tested Sections A and B of the syllabus in the profile, Knowledge and Comprehension. Performance in this paper was reasonably good. The range of marks varied from 6 to 59. Candidates experienced difficulties with items on the following topics:

| Items | Syllabus Topics |
|---|---|
| 6 | Acid salts / normal salts |
| 9 and 14 | Recognizing oxidizing / reducing agents |
| 16 | Separation techniques |
| 19 | Effects of catalyst on a reaction |
| 20 | Properties of halogens |
| 22 | Examples of elements which exhibit allotropy |
| 25 | Characteristics of atoms |
| 29 | Calculation of volume of gas liberated given balanced equations |
| 33 | Calculation of number of electrons and neutrons in a charged species |
| 37 | Recognizing condensation reaction from a series of reactions |
| 49 | Collection of gases |
| 53 | Reagents for testing chloride ions |

### Paper 02

Note: These comments should be read in conjunction with the question paper.

**<u>Question 1</u>**

This question was based on Section A (1.2, 3.4) and Section B2 (7.1, 7.2, 7.3) of the syllabus. It tested the ability of the candidate to:

- Read off volumes of gas in a gas syringe.
- Construct a suitable table from a set of given information.
- Plot a graph.
- Make deductions from a graph.
- Perform simple calculations based on the gas laws (given).
- Identify anions, cations, gases.
- Write ionic/balanced chemical equations.

Part (a) involved the assessment of UK and XS profiles and was the more popular part of the question. It was generally well done. Most candidates were able to construct appropriate fully labelled tables and to plot the graph. However, many had difficulties with the calculations in (a)(iii) and (a)(iv). In Part (v), on hot air balloons, most candidates simply described how a hot air balloon works (often correct) but without any reference to their graphs which is what they were required to do.

Some common errors/misconceptions which appeared in candidates' answer scripts were as follows:

- Failure to add $100cm^3$ to the volume of gas in the syringe (in spite of the fact that they were instructed to do so). Such candidates were not able to plot the appropriate graph.
- Approximation (to the nearest whole number) of the volume of gas in the syringe.
- Difficulty converting degree Celsius to Kelvin.
- Joining of points on the graph, rather than drawing the line of best-fit. Some drew histograms and barcharts.
- Increase in temperature produces "more gas" rather than results in an increase in volume.
- Failure to use data from their graph in the calculations in Part (iii), in spite of being instructed to do so.

In Part (b), a question based on qualitative analysis, candidates were required to draw inferences and write ionic equations based on a given set of observations. They were also required to make observations based on given inferences. As was the case in previous years, this part of the question was very poorly answered. Many candidates either did not attempt this section or obtained 0 marks. It is recommended that more emphasis be placed on this topic and that students be given more practice in the answering of this type of question. It is critical for teachers to emphasise to students the need to describe, under the observation column in their qualitative analysis, what is observed when a reagent is added drop by drop with shaking, followed by what is observed in the presence of an excess of the reagent. Many candidates lost marks in Tests (iv) and (v) for failing to do so.

Some common errors/misconceptions were:

- The use of the word "solution" when what was intended was the word "precipitate". There is need for teachers to emphasise the difference between "precipitate" and "solution".
- The failure to balance and include state symbols in the ionic equations.
- Vague or incorrect description of colours of precipitates or gases.
- Writing of formulae, for example, $No_2$ for $NO_2$.
- Automatically assuming that evolution of a "brown" gas implies bromine as the gas given off. Candidates should pay more attention to the tests carried out and the expected observations and inferences.

**Question 2**

This question was based on Sections A (2.1, 2.8, 3.4, 4.1, 4.2, 6.2, 6.3, 6.8, 6.13) and B2 (1.1, 1.3) of the syllabus. It focused on the elements in Period Three of the periodic table and was designed to test the candidates' ability to:

- State the reasons for placing elements in the same period of the periodic table.
- Draw suitable diagrams to show the arrangement of electrons in an atom, given its atomic number.
- Predict with reasons the best reducing agent from among elements in a particular period.
- Write formula and predict the type of bonding expected for a compound, given the atomic number of one of the elements in that compound.
- Explain why certain elements exist as stable atoms in their natural state.
- Predict which of the elements given would form a basic oxide, which readily dissolves in water.

(a) This part of the question was generally well answered. Most candidates were familiar with the basis for placing elements in the same period of the periodic table (they should all have their valence electrons in the same major energy level/shell). However, a number of candidates incorrectly gave increasing atomic number/atomic mass/electrons as the reason for the elements being placed in the same period. Also, a number of candidates used the "peculiar" words "shelf" / "step" to indicate shells/energy levels.

(b) Almost every candidate was able to correctly draw an appropriate diagram to show the arrangement of electrons (2, 8, 5) in a phosphorous atom (atomic number 15).

(c) Many candidates incorrectly selected chlorine rather than sodium as the best reducing agent from among the elements in Group 3. This was stated in spite of the fact that they were able to correctly define what is a reducing agent. There thus appears to be a lack of proper understanding of the behaviour of a reducing agent in a redox reaction. Also, it was evident from some of the responses that candidates were not familiar with the fact that although many elements can act as reducing agents (or oxidising agents) some are more effective than others.

(d) Many candidates were able to correctly write the formula for the expected chloride of silicon as $SiCl_4$ and to indicate that the bonding would be covalent. However, a number of candidates were not able to fully account for the reasons for this. Typical vague responses which did not gain <u>full</u> marks were:

- Non-metals form covalent bonds by sharing their electrons.
- Silicon will not gain or loose electrons (without any further explanation).

(e) Most candidates correctly identified argon as the element that exists as stable atoms in its natural state. However, from the reasons given for this, it appears that there is a misconception that atoms are stable if they contain an <u>even</u> number of electrons in their valence shell. This misconception needs to be corrected in the classroom.

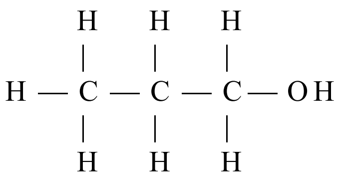
(f) Many candidates correctly identified sodium as the element that forms an oxide which readily dissolves in water to form a solution of pH > 7. However, candidates had great difficulty writing equations to illustrate this. A number of candidates also gave sulphur as the element of choice. They proceeded to write equations illustrating the dissolving of $SO_2$ in water to give $H_2SO_4$. Clearly such candidates did not understand the pH scale and acidity and alkalinity.

**<u>Question 3</u>**

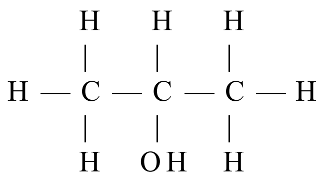
This question was based on Section B1 of the syllabus and in particular objectives 1.7, 2.1, 2.3, 2.7, 4.2 and 4.6. It was designed to test the candidates' ability to:

- Write fully displayed structures of organic compounds.
- Write the systematic name of organic compounds.
- Describe the tests for functional groups.
- Draw partial structures of polymers.
- Explain the chemical principle upon which the breath analyzer test is based.

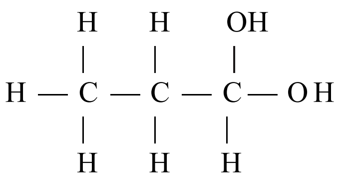
(a) Most candidates were able to correctly draw the fully displayed structures for $C_3H_7OH$ as:



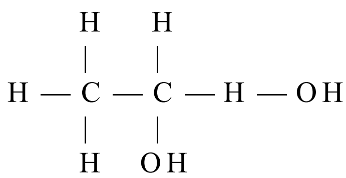
OR



However, they had great difficulty in correctly naming the compound as they drew either propan-1-ol (1-propanol) or propan-2-ol (2-propanol). Perhaps the term IUPAC was not used in the classroom. Also, many students in drawing the structure of the alcohol had incorrect valencies for O and H. Thus, <u>incorrect</u> structures such as those shown below were often given:



OR



(b) Most candidates recognized compound <u>C</u> as alkene (propene) but many had difficulty in correctly drawing its structure. Very few were able to work out the structure of D as $CH_3CH_2OM$ or $(CH_3)_2CHOM$ (where M is a metal cation). Since the reagent was not specified, the use of any reactive metal was accepted. Thus, answers such as $C_3H_7OM$ or $(C_3H_7O)_2Mg$ were credited.

(c) Here candidates were required to describe a simple test for the presence of the functional group present in compound C (an alkene). In the selection of the reagent to be used, bromine and acidified $KMnO_4$ were the most popular. Those candidates who selected acidified $KMnO_4$ as the reagent had extreme difficulty in writing the equation for the reaction occurring.

Inappropriate choice of words was often used to describe the colour changes, for example, the colour of the bromine solution was "destroyed", the bromine solution became clear (discoloured). Candidates were not credited for such descriptions of colour changes.

(d) Most candidates recognized that compound C (an alkene) can readily undergo addition polymerization. However, many had difficulty in correctly drawing the partial structures of the polymer formed (a polyalkene). Common errors included:

- The presence of C=C in the repeating unit.
- Not maintaining the quadrivalence of carbon.
- Not indicating the extension of the polymer chain.

(e) This part of the question focused on the chemical principle upon which the breathalyzer test works. Candidates were expected to include in their answers:

- The alcohol (ethanol) is oxidized to the aldehyde/acid.
- The dichromate changes from orange to green.
- The dichromate is reducted from $Cr^{6+}$ to $Cr^{3+}$.

Many candidates, instead of focusing on the chemical principle involved, described how the test is administered to suspected drunken drivers. Such answers were not credited. Of those who focused on chemical principles, many indicated that the alcohol was the oxidising agent. A few candidates stated that $KMnO_4$ is used in the breathalyser.

**Question 4**

This question was based on Sections A (3.4, 6.6, 6.20, 6.23, 6.24, 6.25, 6.27) and B2 (1.3, 5.3) of the syllabus. It was designed to test the candidates' ability to:

- Explain why electrolytes in the molten state (or when dissolved in water) and not in the solid state are used in electrolytic cells.
- Write ionic equations for reactions occurring at the electrodes.
- Calculate the quantity of material deposited at the electrode under specified conditions during electrolysis.
- Account for the observed differences in the products of electrolysis of brine (concentrated aqueous sodium chloride solution) and molten sodium chloride.

(a) (i) Most candidates obtained two of the three marks awarded to this part of the question. Many failed to state explicitly that mobile ions are necessary for the conduct of current during electrolysis. A number of candidates referred to "free" electrons or "mobile" electrons as being necessary for the conduction during electrolysis. Clearly there was "confusion" with electrical conduction in metals.

(ii) Most candidates were able to correctly write the equations for the reactions occurring at the cathode and the anode during electrolysis of molten sodium chloride as:

At cathode: $Na^+(l) + e^- \varnothing Na(s)$
At anode: $2\ Cl^-(l) \varnothing Cl_2(g) + 2e^-$

In a number of cases the reverse reactions were given at the electrodes.

(b) This part of the question required candidates to calculate the quantity of sodium deposited when 10 amperes of current is passed through the electrolytic cell for 2 hours. This part of the question was the most popular and most of the marks were obtained here. However, some candidates had difficulty converting hours to seconds. Also, some expressed their answers as 0.746 Faraday instead of in moles. The concept of a Faraday as a quantity of electricity rather than a quantity of a substance needs to be clarified in the classroom.

(c) Most candidates were able to state two uses of chlorine. However, a number of non-specific uses (for example, used for making other chemicals, used in reactions in the lab, for making cleaners) were not credited.

(d) This part of the question was very poorly answered. In Part (i) many candidates simply specified the products of electrolysis of molten sodium chloride or brine rather than stating the difference in the products of electrolysis of these two substances. Also, a number of candidates did not know what brine was. It was often confused for bromine. In Part (ii) candidates incorrectly stated that the $H^+$, which is acidic, was discharged and this made the solution basic! There appeared to be confusion with what was discharged and what was left behind during electrolysis. This should be clarified in the classroom.

**<u>Question 5</u>**

This question was based mainly on Section A (1.2, 7.2, 7.3, 8.1, 8.2) of the syllabus and was designed to test the candidates' ability to:

- Define the terms exothermic and endothermic reactions.
- Use their knowledge of the states of matter and enthalpy changes to explain why the conversion of steam to water is an exothermic process.
- Draw fully labelled energy profile diagrams.
- State the factors which affect the rate of the reaction and how these factors influence the yield of ammonia.
- Calculate the heat of neutralization from appropriate experimental data.

Overall, this question was very poorly answered.

(a) A significant number of the candidates were able to correctly define exothermic and endothermic reaction. However, it is of concern to observe the number of misconceptions which appeared in many of the candidates' answers.

These included:

- Exothermic reactions – reactions taking place outside of the cell/body/vessel.
- Endothermic reactions – reactions taking place inside of the cell/body/vessel.
- Endothermic reactions – heat needs to be added/applied; more heat is absorbed to break bonds than heat absorbed to form products; reactants are higher than products.

(b) (i) In this part of the question, candidates were required to suggest a reason for the fact that the conversion of steam to water is an exothermic process. Most candidates simply rewrote the definition for an exothermic reaction they gave in Part (a) without any reference to the states of matter of steam (gaseous, high kinetic energy, molecules far apart, very little or no intermolecular bonding) and water (liquid sate, lower kinetic energy, intermolecular bonding).

(ii) The majority of candidates had no idea of what should have been drawn for the energy profile diagram. Drawing of distillation apparatus, water cycles, boiling water in a pot were quite common. Most of those who were capable of drawing the energy profile diagram failed to include axes/properly labelled axes / identification of the reactant and product on their diagram as steam and water.

(c) (i) This part of the question was fairly well answered by the candidates, indicating that they were very familiar with the factors which affect the rate of a reaction.

(ii) This part of the question required candidates to suggest how two factors which they stated in (c) (i) would affect the yield of ammonia starting with $N_2$ and $H_2$ (equation given). In spite of the fact that candidates were required to study the commercial synthesis of ammonia from $N_2$ and $H_2$, it was realized that they were not required to be familiar with Le Chatellier's Principle. As such, candidates were credited for answers which focused on how the named factors influenced the rate of a reaction. However, factors such as enzymes, pH, surface area were not credited since they were not applicable to the synthesis of ammonia.

(d) Very few candidates attempted this part of the question. Those who did, were only able to calculate either $\Delta T$ or the heat change for the reaction. Many candidates did not know how to obtain the mass of the solution undergoing the reaction. Most used 50g or 1g instead of 100g.

## Paper 03

### <u>Question 1</u>

This was the less popular of the two questions in Section A of the paper, having been attempted by only 21 per cent of the candidate population. The question tested the concepts and principles as outlined in objectives A3.3, 3.4, 6.5, 6.6, 6.7, 6.10 and 6.11.Most candidates who attempted the question performed poorly.

In Part (a) candidates were required to define the terms acidic salt and normal salt and to suggest a simple test to differentiate between them. It was expected that definitions would be given in terms of the replaceable hydrogen ions of an acid being partly or completely replaced by a metal or ammonium ion. Many students gave inadequate responses such as acidic salts have a pH less than 7 or that they turn blue litmus red. No mention was made of their having to be first dissolved in water and therefore these answers were given full credit. Many of the candidates who did offer an explanation based on hydrogen seemed not to know that it was REPLACEABLE hydrogen IONS and not simply due to hydrogen or hydrogen atoms that were present in the salts.

In (a) (i) any simple test such as the use of litmus, a carbonate or a metal was accepted provided that the observation for each type of salt was described. Candidates lost marks for not first dissolving the salt(s) in water and for failing to indicate the expected result for the normal salt. In some cases candidates did not know the colour change for litmus, often confusing it with pH paper. Many also incorrectly stated that red litmus turned blue in the acid salt.

Part (b) required candidates to describe procedures for preparing samples of $Na_2SO_4$ and $NaHSO_4$ from 1 M $H_2SO_4$ and 1 M NaOH. The answer should have focused around using equal volumes of acid and alkali for preparing the acid salt and using half the volume of acid to alkali for the normal salt. The solution could then be heated to concentrate it/ make a saturated solution, cooled to allow crystals to form and then the crystals could be collected. A simple test should have been included to indicate how completeness of neutralization was established. Many candidates assumed that the salts had already been prepared and attempted to describe the crystallization of the salt from solution. Others did not realize that sodium salts are soluble and referred to precipitates being formed, which were subsequently filtered off. Many illogical sequences were outlined such as drying a solution, evaporating a residue and adding sodium sulphate to sulphuric acid to get sodium sulphate. Only a very small percentage of the candidates gave the principle upon which the preparation of the salts was based, that is, complete neutralization of the acid for the normal salt and half neutralization for the acid salt. The equations were, however, generally well done.

The calculation in Part (c) was also fairly well done. Teachers must emphasise to their students that ALL working must be shown as indicated in the Instructions of the question paper. Also, they must warn their students to read the questions carefully. Some candidates used 2M NaOH in their calculations rather than the 1 M NaOH specified in the question

**Question 2**

This was the most popular question on the paper. It was attempted by 79 per cent of the population. The question tested candidates' knowledge of atomic structure, mole concept and the particulate nature of matter as outlined in objectives A 1.1, 2.1, 2.3, 2.5, 3.1 and 3.5. There were some very good responses to this question.

The three fundamental particles present in an atom were well known by most candidates. A few confused atoms with states of matter and referred to the solid, liquid and gas in their answer. Others referred to the neutrons as the nucleus. The properties of the particles were less well-known. Candidates were familiar with the relative charges, although they made reference to the nature of the charges and not the size. For example, instead of a proton having a charge of +1, many stated that the proton is positively charged. Similarly the electron was negatively charged instead of having a charge of -1. In many cases the relative masses were omitted or referred to as size. Some candidates gave mass as the unit of relative mass, others erroneously stated that the electron has no mass. Teachers must make their students aware that as a particle, an electron must have mass. It is negligible (1/1836) but still present.

In (a) (ii) candidates gave a variety of incorrect responses for the particle upon which the chemical properties of an element depend. Instead of electrons, many gave "protons and electrons" whilst others suggested neutrons, protons or in some cases the nucleus.

The majority of candidates gave accurate drawings of the two isotopes of potassium (called X in the question). Candidates should be discouraged from depicting the total number of protons and neutrons in their diagrams as + signs and circles in the nucleus (many drew 19 + signs and 19 circles) as this wastes valuable time and the use of 19p and 20n is quite sufficient. Some candidates used the mass number as the number of protons and electrons.

In Part (c) a great deal of confusion was evident in the calculation of the number of moles and atoms in 100 g of iron. The more prevalent misconceptions included:

- Number of moles = relative atomic mass / mass or 56/100
- Number of atoms = number of moles / Avogadro's number

Many candidates did not state their answers properly so that it was often unclear what was being calculated. Also, a number of them mixed up the calculations and gave the correct working for the number of moles but stated that it was the number of atoms and vice versa. Many candidates did only one calculation, although the question clearly stated that both the number of moles and the number of atoms were required. Teachers are asked to remind their students that full marks can only be obtained if answers are clearly stated.

In (d) (i) candidates seemed not to understand what 'general deductions' were so that many of them identified the process taking place in EACH of the observations and explained them individually. It was expected that candidates would have deduced that matter is made up of particles that are in random motion, and that these particles moved across a concentration gradient from a region of high concentration to one of lower concentration. In many instances, particles were not identified and candidates referred loosely to matter. Some candidates reversed the direction of motion stating that particles move from low to high concentration.

In (d) (ii) most candidates recognized the process as diffusion but very few appreciated that the perfume had to be vaporized or that the gas had to travel to Suzie's nostrils/olfactory organs to be detected.

**<u>Question 3</u>**

This question was more popular than the alternative Question 4. It was attempted by 66 per cent of the candidate population. The question was centred around the homologous series of alkanes and included a calculation of the enthalpy of combustion of methane. The syllabus reference is B1. 1.4, 2.1 and 2.4 and A 5.3, 5.4 and 8.3.

In (a) (i) the characteristics of homologous series were generally well known. However, candidates must be careful when stating that the members differ from each other by a $-CH_2$ group. The correct property is that the members differ from the preceding/ next/ successive member by a $-CH_2$ group. Methane and hexane are members of the alkanes but they do not differ by a $-CH_2$ group. Any three different characteristics were accepted. Some of the weaker candidates merely listed a number of different homologous series, for example, alkanes, alkenes, alcohols and gave their general formulae.

In (a) (ii) candidates needed to select a characteristic of homologous series and discuss how it could be used as a basis for separating the members of the alkane series. A labelled diagram of the apparatus was to be included in the answer. Many candidates ignored parts of the instruction and either did not choose a characteristic or did not label their diagrams. Others chose inappropriate characteristics such as similarity in chemical properties or the fact that the members differed from preceding members by a $-CH_2$ group. Despite this, a creditable number of candidates selected the correct method of separation which was fractional distillation and correctly explained that the basis for separation was differences in boiling points. None, however, further pointed out that this method was more suitable than other methods because the variation in boiling points was slight.

Diagrams were generally poorly done. Some common errors were:

- Fractionating columns that had no surfaces for condensation such as beads, nor was there evidence of anything (for example, mesh) to keep the beads from falling into the distilling liquid.

- Condensers with improperly labelled inlets and outlets and which had no inner tube.

- Improper placement of the "pipes" for removal of fractions in an industrial tower.

In some cases candidates seemed to have confused separation of the alkanes with identification and proposed a chemical reaction such as bromination to separate them.

In Part (b) a correct molecular equation, using sunlight as catalyst was awarded full marks. Common errors in the equation included having hydrogen as a product and using chlorine atoms, Cl, instead of chlorine molecules as one of the initial reactants.

Part (c) focused on the properties of alkanes that made them useful as fuels and as a solvent to dissolve grease. Most candidates recognized that alkanes burn. Fewer indicated that they produced large quantities of heat on combustion and none recognized that to be considered a suitable fuel the products of combustion should be gaseous. The better candidates knew that the non-polar nature of the alkanes made them suitable solvents for grease. Many gave vague statements such as "like dissolves like" without any explanation of what was "like" in alkanes and grease.

The simple equation in Part (d) was well known, although quite a number of candidates lost the mark awarded for not balancing the equation. Only a small percentage of the best candidates were able to handle the calculation competently. Many assumed that methane had the density of water and therefore 100 $cm^3$ were equivalent to 100 g, or that 1kg of methane had a volume of 1000 $cm^3$. The task was to calculate the number of moles of methane in 100 $cm^3$, that is, 100/22400, calculate the number of moles in 1 kg (1000/16) and hence determine the amount of heat evolved by 1 kg (3.96 x No. of moles in 1kg )/ No. of moles in 100 $cm^3$.

## Question 4

This question tested the concepts and principles entailed in specific objectives A 4.6 and 4.7 and B2 2.1, 2.2 and 8.3. It was attempted by 34 per cent of the candidate population.

Part (a) tested candidates' understanding of the role of carbon in the production of metals, in particular iron and aluminium, from their oxides. It was expected that candidates would recognize that carbon monoxide is a reducing agent used in the production of iron from iron (III) oxide but that it could not reduce aluminium oxide as aluminium is too high in the reactivity series. Additionally, carbon monoxide is produced from the reduction of carbon dioxide by carbon. The role of carbon as electrodes in the electrolysis of molten aluminium oxide was also credited. Many candidates seemed to believe that carbon monoxide could reduce both oxides. Others thought that carbon itself reduced iron (III) oxide. The balancing of the equation for the reduction of iron (III) oxide was poorly done.

Part (b) focused on the allotropes of carbon. Diagrams were inaccurate and poorly drawn. In diamond, many 3-valent carbon atoms were in evidence. Some candidates drew diamond-shaped structures where carbon exhibited a valency of four but the basic structure was not tetrahedral.

In the diagram of graphite, the hexagons were made to touch tip-to-toe, so that carbon was bonded to four other carbons in the layers instead of three. Additionally, some diagrams had quadrilaterals and pentagons in the layers instead of hexagons. Teachers should advise students that single hexagons are not acceptable as representative of a layer. A few candidates confused allotropes with isotopes and isomers.

Many candidates failed to follow instructions to relate the properties and uses to the structures of the allotropes. A significant number simply referred to the strong bonds in diamond rather than the strong COVALENT bonds that accounted for diamond's hardness and its use in drill bits. The ability of graphite to conduct electricity and its use as a lubricant were well described and explained by many candidates.

Very few candidates scored high marks in Part (c). Although a substantial number of candidates mentioned that oxides of sulphur contributed to the formation of acid rain, few recognized that the acid produced was a stronger acid than the weak carbonic acid formed when carbon dioxide dissolves in rain water. The effects of acid rain on concrete and metals were rarely discussed. Equations were generally absent. Many candidates gave an equation that showed sulphur dioxide dissolving in water to produce sulphuric (VI) acid rather than sulphuric (IV) acid. A fairly large number of responses included an equation for photosynthesis which was accompanied by the explanation that since carbon dioxide was used to manufacture food, it was not as serious a pollutant as sulphur oxides. That was not credited.

## Question 5

This question was based on the Cooking option in Section C of the syllabus and tested objectives C 1.4, 1.5, 1.6 and 1.7. Sixty-one per cent of the population attempted the question.

Part (a) (i) required an explanation of how a pressure cooker works. Many candidates, however, focused on describing how to use a pressure cooker. The answer was expected to include an explanation of how water boils at 100ºC at normal atmospheric pressure and that in a pressure cooker the tightly sealed lid traps steam so that the pressure above the water builds up to more than normal atmospheric pressure and as a consequence the boiling point of water is raised. Many candidates also did not link the increased pressure to a higher boiling temperature.

In (a) (ii) many candidates believed that in the pressure cooker, meat was tenderized because the increased pressure "forced the amide bonds to break". These candidates did not appreciate that the essential reaction was hydrolysis of the amide bonds which was speeded up by the increased temperature. The partial diagram of the protein was poorly drawn. In some cases candidates drew only a single amide linkage. In others a di-amide was drawn whilst a few partial nylon structures were also offered. In many instances the valencies of carbon and nitrogen were not adhered to and the extensions at the ends of the partial structure were absent. Partial structure of condensation polymers should show at least three monomer units linked together with a minimum of two linkages.

Many candidates did not attempt an equation for this hydrolysis. Of those that did, many seemed not to realize that the products were amino acids. The fact that pineapples contain enzymes was known by the majority. However, many candidates incorrectly referred to the enzyme as papain instead of bromelin.

Many misconceptions were evident in (b) (i). In describing the role of yeast in the baking process, candidates did not focus on the fermentation of glucose to produce carbon dioxide and ethanol.

Instead, answers often involved the production of glucose from the hydrolysis of starches. Also, some answers included oxygen in the equation with the products of the reaction given as carbon dioxide and water. Other equations had water as a reactant. It was well known that the carbon dioxide produced aerated the dough and stretched the gluten. Candidates also were familiar with the contents of baking powder. However, many omitted to mention that water needed to be added to the mixture for the hydrogen ions of the acid to react with the hydrogen carbonate to produce carbon dioxide. Candidates were proficient at writing the corresponding equation for the reaction. Teachers must instill in students the need to include state symbols when writing ionic equations.

In (b) (ii) the majority of candidates failed to recognize that the temperature range 25 – 30ºC is the optimum for yeast to produce ethanol and carbon dioxide from glucose. Higher temperatures produce other compounds such as lactic acid and ethanoic acid which alter the flavour of the baked product. There was evidence that candidates misinterpreted the question as their responses suggested that the higher temperatures they considered were baking temperatures and their explanations involved the denaturing of enzymes. This would not be likely at the temperatures that would be achieved in a room.

## Question 6

This question tested the concepts and principles in C2.2, 2.4, 2.7 and 2.8 of the syllabus. Food preservation, like cooking, the other option for study this year, seemed to be very challenging even for the most able candidate.

The question revolved around the use of sodium chloride and vinegar as preservatives, the use of tin for canning fruit juices and the conditions affecting the rate of growth of micro-organisms.

Part (a) was fairly well answered. However, in preparing their students for the option, teachers must warn against using blanket terms such as “the micro-organisms are killed” as an explanation for everything concerning food preservation. It was expected that candidates would explain the use of sodium chloride in terms of the high osmotic concentration that it produces so that micro-organisms become dehydrated as water moves from their cells to the more concentrated salt solution. Many candidates focused their answers on the dehydration of the food. Most candidates recognized that the vinegar was acidic but few related this fact to the inhibition of enzyme activity at such low pH or explained that there is an optimum pH at which enzymes function. A few candidates mentioned the destruction of the cell membrane of the micro-organisms.

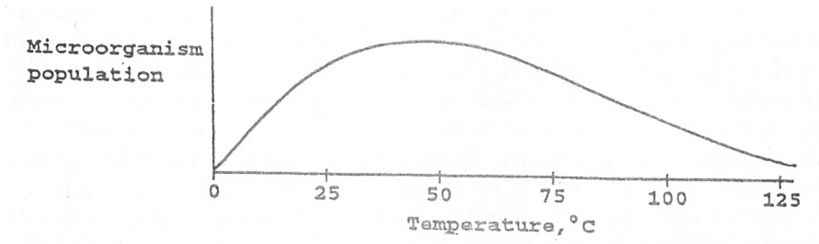
In (b) (ii) it was expected that candidates would link the pH of 2.5 to acidity and would offer an explanation of the deterioration of the tin in terms of the reaction of the tin with the acid. Many candidates thought that the can was made of iron coated with tin so that their answers concentrated on the can becoming scratched or dented so that the iron was exposed to the acid or air and rusted. The use of local jargon such as “the acid eat away the tin” should be discouraged. Candidates also did not relate the acidity of the fruit juice to the presence of $H^+$ ions so were unable to write the ionic equation:

$$Sn\,(s) + 2\,H^+\,(aq) \rightarrow Sn^{2+}(aq) + H_2(g)$$

Teachers must remind their students that when questions ask for an ionic equation, a molecular equation would not be credited. Also, it is imperative that they instill in their students the need for state symbols with all ionic equations.

In (b) (ii) the candidates were expected to line or coat the tin with an inert material such as plastic or a metal that is lower than hydrogen in the reactivity series. Many responses suggested that the tin can be replaced with plastic or glass bottles or that the juice be neutralized. It should be noted that the question clearly asked for a solution to the tin can deterioration and not an alternative to the tin can.

Part (c) required candidates to sketch three graphs to show the effect of temperature on moisture content and micro-organism population and also to show the relationship between percentage moisture and rate of spoilage. The third graph is presented below.




In the third graph, a large percentage of the candidates who recognized what the general shape of the graph should be, erroneously put the optimum temperature at > 50·C. Also, instead of explaining the shape that they had drawn for the third graph, many candidates proceeded to describe the shape. They were expected to know that enzyme activity is affected by temperature, that there is an optimum temperature at which these enzymes operate and that at temperatures above the optimum, enzymes are denatured. They were then expected to relate the increase, maximum and decrease in the micro-organism population, shown in the graph, to this.

In (c) (ii) a number of candidates ignored the instruction to base their chosen method of preserving beans to the graphs that they had drawn and gave canning as their answer. Their explanations involved keeping air away from the micro-organisms. Drying/ freezing was expected, as these methods lower the moisture content/temperature, thus inhibiting micro-organism growth.

## Paper 04 – School Based Assessment (SBA)

### General Comments

There continues to be improvement in the candidates' performance on some skills, as well as in the overall presentation of the books for moderation. In a number of schools there has been improvement in the selection of practical activities for assessing specific skills and in the breath of activities covered over the two years. This year the grades submitted for 59 per cent of the samples moderated were accepted. While this is commendable, signifying that many schools have taken the advice provided by previous reports on the SBA, far too many teachers continue to be challenged by the assessment of the Planning and Design skill in particular, and to a lesser extent the Analysis and Interpretation skill. It was also disturbing to note that a number of candidates did very little practical work in Year 1 and completed most of the SBA activities in Year 2. In addition, teachers seemed to be having difficulty developing suitable mark schemes, identifying suitably challenging activities and matching the selected activity with the required skills.

The standard of practical activity carried out by some schools was below that required by CXC. Many of the activities did not allow for critical thinking on the part of the candidates. For example, qualitative analysis activities that require two or three tests to confirm the presence of one anion or cation were sometimes used to assess the AI skill. In other instances routine separation activities were used and questions linked to the activity required the recall of information rather than the analysis of data.

Over the year there has been a great improvement in the number of activities being done in quantitative analysis, thermochemistry and to a lesser extent organic chemistry. However, this is not as widespread as desired. In addition, activities that include the development of graphing skills, writing balanced molecular and ionic equations, and activities related to electrolysis and redox reactions also need to be given greater attention.

Although the SBA grades are now required only at the end of Year 2, teachers are reminded that the SBA should be treated as continuous assessment and as such each skill should be assessed at least twice each year. Students should be given time to develop these skills before they are assessed. Hence, the first practical activity recorded in the students' books should not be treated as a SBA.

Teachers are again being advised to seek assistance from their colleagues in some of the more established centres as well as the Ministries of Education within their respective territories for assistance in conducting the SBA. Where possible, it may also be useful for teachers from the science department to engage in small-scale moderation exercises at their schools so as to evaluate mark schemes and the suitability of practical activities. It will also help to improve the consistency with which mark schemes are used.

The examiners have tried to provide useful comments on the standard of the SBA for each teacher in the moderation feedback report sent to each school. Teachers are encouraged to read those comments along with the more general comments that are provided in this report in order to get a more comprehensive picture of the performance of their students. Some of the specific problems encountered at moderation are outlined below.

**Specific Comments**

1. Assessment of Planning and Design Skill:

    (a) The most common problem associated with the assessment of this skill is the unsuitability of the activities selected. Teachers should note the specific description of the learning outcomes being tested by this skill as stated in the syllabus (Appendix 2 point 3). Activities that require the straight recall or reproduction of information that is available in any chemistry text book are not suitable for assessing planning and design.

    (b) Since the planning and design skill is not carried out, marks should not be awarded for conclusions such as "hypothesis confirmed". Candidates should be required to present POSSIBLE results for the hypotheses being upheld, as well as for it not being upheld by the planned investigation.

    (c) Activities selected should require application of concepts in chemistry rather than general knowledge.

(d) Students should not present specific readings for the expected results as if the activity was actually done. Where the activity is actually conducted, it cannot be marked for Planning and Design.

2. <u>Assessing the Observation, Recording and Reporting (ORR) Skill</u>

(a) It is advisable that at least one graph be assessed for ORR in each year.

(b) There must be some link between the stated aim of the activity and the rest of the report.

(c) For qualitative analysis, the identity of the unknown given to the students should be recorded on the mark scheme.

(d) Students should be encouraged to develop and use tables to record data where appropriate.

3. <u>Assessing the Analysis and Interpretation (A/I) Skill</u>

(a) Equations and discussions of activities should be assessed as A/I and not ORR. Teachers should pay closer attention to the writing of equations and are encouraged to correct inaccurate equations in students' books. State symbols are required for ionic equations.

(b) The actual plotting of the graph should be assessed under ORR but calculations and interpretation of data using the graph should be treated as A/I.

(c) For qualitative analysis, marks awarded for inference should be linked to the observations made. Also, qualitative analysis exercises that require students to conduct tests on known reagents are not suitable for assessing A/I. Rather, students should be given unknowns when testing for A/I. In conducting qualitative analyses, students should be encouraged to complete their results in tabular form.

(d) Questions that are used to assess A/I must be on the data collected in the practical activity.

4. <u>Table of Contents</u>

(a) This continues to be a sore point in many books presented for moderation. In this regard the comments made in the report on the June examinations for the past three years need to be re-emphasized. Not only is it important for students to date their work, this information should also be included in the table of contents for easy reference.

(b) There must be some common means of identifying the practical activities in the candidates' books and those in the mark scheme.

(c) The activities being used to compute the candidates' SBA scores for the various skills should be clearly indicated in the candidates' notebooks and mark scheme.

5. Absence of or Inappropriate Mark Schemes

(a) Where mark schemes are unclear or incomplete, it becomes difficult to moderate the samples of books. This could work to the candidates' disadvantage, as an alternate mark scheme has to be developed to assess the candidates. Teachers are again reminded to examine the examples of the mark schemes provided in the syllabus and the CXC modules for information on how the mark schemes should be presented.

(b) A small sample of books was sent without any mark scheme and some with mark schemes that bore no relationship to the laboratory practicals present in the candidates' books.

(c) In a few instances teachers have submitted general mark schemes for all the skills. This practice should be discontinued and teachers should submit specific mark schemes for each activity.

6. Resit Candidates / Extenuating Circumstances

Teachers are again reminded to pay attention to the syllabus guidelines (page7) for resit candidates. If books of resit candidates are submitted for moderation then these should be clearly identified. Where circumstances such as illness or absence of staff have resulted in some adjustments to the required number of activities and the times when assessment takes place, this should be outlined in writing to the Registrar so that candidates are not penalized unnecessarily.