CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE EXAMINATION
MAY/JUNE 2005

CHEMISTRY

CHEMISTRY
GENERAL PROFICIENCY EXAMINATIONS
JUNE 2005

The Structure of the Examination

The examination consisted of three written papers. The contributions of these papers were as follows: Paper 01 (25 %), Paper 02 (30 %), and 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. 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 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 involved the continuous assessment of candidates by teachers over a two year period. Samples of candidates' laboratory books were externally moderated by CXC. This was used as the basis for moderation of all SBA marks submitted by teachers.

General Comments

A total of 10 619 candidates were entered for the examination representing a 21.6% percent increase over the 2004 candidate population. Candidate performance on Paper 01 was similar to that of June 2004. However, performance on Papers 02 and 03 showed a decline.
This resulted in an overall decrease in the total composite mark for the examination. Candidates seemed to be not adequately prepared for the examination, as evidenced by the number of parts of questions left unanswered.

DETAILED COMMENTS

Paper 01 – Multiple Choice

This paper tested Sections A and B of the syllabus in the profile, Knowledge and Comprehension. Performance in this paper continues to be generally good. The marks ranged from 0-55.

Candidates experienced difficulties with items based on the following objectives:

- A3.3 - calculations involving the mole concept
- A6.10 - solubility of salts
- A6.28 - industrial applications of electrolysis
- B1.1.3 - writing general and molecular formulae for members of a given homologous series
- B1.1.9 - writing fully displayed structures of isomers
- B2.7.1 - identification of cations
- B2.7.2 - identification of gases

Paper 02 – Structured Essay

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

Question 1.

This question was based on Section A (7.2 and 7.4) and Section B2 (1.1, 7.1 and 7.2) of the syllabus. It tested the ability of the candidates to:

- Read off temperature values from a thermometer
- Construct a suitable table from a given set of data (Figure 1)
- Plot a graph
- Make deductions from the graph plotted
- Write balanced chemical equations
- Identify anions, cations, and gases
- Plan and design an experiment given basic information

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 the required table and record the correct temperature values. Parts (i), (ii), (iii) (iv) were answered correctly by most of the candidates, but some failed to gain marks for (v). Some common errors/misconceptions which appeared in candidates' scripts were as follows:

- Part (a) (i): units such as °C for temperature and *s* for seconds were omitted from the table headings.
- Part (a) (ii): Incorrect plotting of some points, especially those not involving whole numbers where estimations had to be made, for example 55.3, 59.3, 37.6, 42.6, and 31.8 °C. In a number of cases, plotted points were either too faint, small, or too big. In drawing the curve, most candidates did not draw a smooth curve – they simply joined the points. Others drew a straight line instead. A few just plotted the points, but did not connect the points.
- Part (a) (iii): most candidates confused rate with time and used these terms incorrectly in their response to conclusions to be drawn from the graph about the rate of reactions. For

example, typical responses were: “as temperature increased rate of time decreased” or “as temperature increased rate in seconds decreased”. Also many candidates used time as a manipulated variable and temperature as a responding variable. Thus responses such as, as time increased temperature decreased, and *vice versa*, instead of as temperature increased rate increased, were quite common

- Part (a) (iv): Few candidates were unable to correctly read off information from the graph.

- Part (a) (v): Equations were balanced incorrectly. Also there were incorrect writing of formulae such as Na_2Cl, $NaCl_2$, Na_2Cl_2, So_2, NaCL, and Nacl.

Part (b) was based on qualitative analysis. Candidates were required to draw inferences and write an ionic equation based on a given set of observations. A fair number of candidates answered this part of the question reasonably well. However, poor performance in questions based on qualitative analysis is still a cause for concern. Common errors in Part (b) of this question included:

- Incorrect formula for ions
- Omission of state symbols for iron (II) hydroxide..
- Incorrect charge for anions.

It must be emphasized that **ionic equations** must be accompanied by the correct **state symbols**.

Part (c) was based on planning and design. It was very poorly answered. Candidates were given three possible routes by which ethanoic acid could be prepared. They were required to plan and design an experiment to determine which route would produce the highest yield of ethanoic acid. Most candidates focused instead on designing experiments for synthesizing ethanoic acid (which they could not do and was not required) rather than determining the quantity of ethanoic acid produced by each method. Commons errors observed were as follow:

- Confusion of “hypothesis” with the “aim”, a continuing widespread problem which must be corrected
- Some candidates who opted to analyse the ethanoic acid via a titration method, omitted to mention the indicator. Also, the base used was not identified. In some cases, the apparatus stated was **NOT** used or related in any way to the method described.
- Many candidates only prepared the ethanoic acid and did not carry out any analysis to determine the quantity produced. In some cases ethanoic acid was used to prepare ethanoic acid, and many candidates titrated other acids with ethanoic acid!
- Candidates wrote all variables, not only controlled as required.
- Candidates did not specifically state the volume (%) ethanoic acid collected as data to be collected. Instead they listed all possible data they could have collected in the experiment as part of their answer.
- Most candidates gave answers that suggested they actually performed the experiment rather than planned and designed the experiment.

Question 2.

This question was based on Section A (2.5, 2.8, 3.3 4.1, 4.2) of the syllabus.

Most candidates appeared to be familiar with the topics being tested.

Part (a): Most candidates were able to deduce correctly the number of electrons, protons and neutrons in the given species. In addition, they were able to correctly illustrate the arrangement of the electrons and the location of the protons and neutrons in the nucleus. Some candidates laboriously drew 14 circles and 13 crosses in the nucleus in order to represent the protons and neutrons respectively.

Common errors included placing a “B” (the symbol given for species) in the centre of the atom, placing the two innermost electrons in the nucleus and drawing an incorrect arrangement or an incorrect number of electrons around the nucleus.

Part (b): A majority of candidates were able to correctly identify the element as belonging to Group 7; others gave instead the group name, “the halogens”. Most of the candidates who correctly identified the group indicated that their choice was based on the electronic configuration of the element. Some candidates incorrectly stated that A had a valency of 7.

Part (c): Many candidates correctly deduced that the type of bonding expected as ionic based on the deduction that A was a nonmetal and B a metal. Only a few were able to describe correctly the electron transfer process between A and B and the subsequent attraction of the resulting cations and anions. Common errors included choosing covalent and metallic bonding between A and B and describing ionic bonding in terms of the sharing of electrons.

Parts (d) (i) and (ii): There were many incorrect answers in this section. It would appear that many candidates were unable to deduce the formula of molecules and compounds based on data from atomic structure. Some candidates use the symbols for the elements ‘Al’ and ‘F’ in writing the required formulae.

Part (d) (iii): This section proved to be very difficult to the candidates. Many candidates were unable to deduce the mole ratio between the element B and the compound formed between **B** and **A**. Some used the formula from Part (d) (i) and worked out the mass by addition. The fact that atomic masses were not formally presented may have contributed to the unsatisfactory responses.

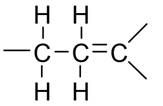
Part (e): Most candidates attempted this section. The properties of covalent and ionic compounds appear to be well known. Common errors include stating properties without comparing reference to the two substances, A and B, that is, metals and nonmetals. Reference to solubility should include reference to the nature of the solvent (polar as against non-polar) and reference to electrical conductivity should have included the state of the substance, that is, molten and dissolved in water.

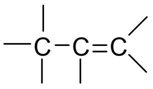
Question 3

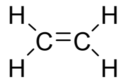
This question assessed syllabus objectives, B1 (1.3, 1.6, 1.7, 4.4, 2.1, 2.8, 2.3, 3.4, and 3.5). This question required that candidates analyze the data given in the flow chart before attempting any part of the question. Generally, the question was poorly done. Approximately 80 % of the candidates scored 0-4 marks out of a possible 16. The KC marks were easier to obtain than the UK marks.

Part (a): This required candidates to draw the fully displaced structures of three organic compounds based on information given. Many candidates gave condensed structures for their answers and were not awarded full marks. Typical errors included leaving out symbols for atoms, using the wrong case for symbols, showing carbon with three or five bonds and drawing structures with additional or less carbons than required. These errors are illustrated in the following representations.

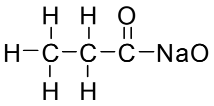
In some cases, E was incorrectly represented as:

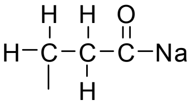




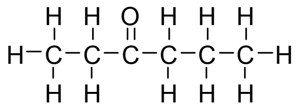


C was also incorrectly represented as:

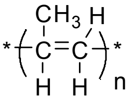


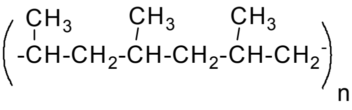


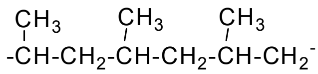
F was also represented as:

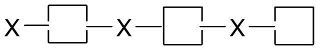


Part (b): This part of the question required that the structure of a partial polymer be drawn with three repeating units. It was observed that most candidates drew the partial structures but illustrated them as discrete entities -there being no bonds to indicate the extension of the polymer chain. Although the linking of the monomer units occurred via linkages across the double bond many candidates drew structures which simply joined three monomer units via their carbon-carbon single bonds as illustrated below:









Part (c): Candidates were required to identify the reactions in the flow chart. This task which involved analytical skills rather than simple recall proved to be extremely difficult.

Part (d): This section was generally well done with most candidates identifying bromine as the reagent. Common errors included using bromide and chlorine as the reagent. In cases where the reagent selected was potassium manganate (VII), most candidates failed to state that it must be acidified/aqueous. They also could not write the correct chemical equation for this reaction.

Part (e): This section required candidates to state reagents and reaction conditions required to carry out specific conversions. Usually candidates failed to specify whether the reagents must be dilute/ aqueous. Also, instead of stating specific names of reagents, terms such as “alkali” or “acid” were used. In addition, the term ‘temperature’ was very vaguely used in the description of the reaction conditions, usually “heat” or “suitable temperature” was the term being used.

Question 4.

This question assessed syllabus objectives A (6.7, 8.1, 8.2, and 8.3). This question was very poorly done. Over fifty per cent of the candidates gained less than four marks. It tested the candidate's knowledge of the following concepts and principles:

- During chemical reactions, energy is required to break bonds and energy is released when bonds are formed
- The overall enthalpy change of a reaction is related to the difference between the enthalpy of reactants and products
- Heat of neutralisation
- Strong acids/bases are completely ionised in aqueous solutions
- Calculation of the number of moles of a substance given relevant data
- Calculation of enthalpy change when a salt dissolves in water given relevant data
- Assumption used in calculating enthalpy data
- Energy profile diagram for endothermic/exothermic processes

Parts (a) and (b): Few candidates were able to gain the three marks allocated for Part (a). A mark was lost for not explicitly stating that the observed heat change occurs as a result of the DIFFERENCE between energy required to break bonds and the energy released when bonds are formed. In fact, quite a number of candidates stated that bond making process absorbs heat energy. A number of candidates misread the question and simply gave definitions of endothermic and exothermic reactions in terms of heat gain/loss with no reference to the actual question.

Part (b) (i): A concise statement of heat of neutralization was required. The expected definition was that heat is evolved when one mole of H^+ ions is neutralized by one mole of OH^- ions to form one mole of water. Common unacceptable responses were:

- The energy needed to form one mole of water during a reaction between an acid and a base
- The heat required by a base to neutralise an acid

Part (b) (ii): Expected answer: The indicated substances are all strong acids and bases and as such are completely ionized in aqueous solutions. As such during neutralization the only reaction occurring is between H^+ ions and OH^- ions to form water. Hence the molar heat of neutralization will be the same in each case. Many candidates interpreted "strong" to mean "concentrated", while others stated that an acid and a base react to produce a salt and water.

Part (c): Most candidates were able to calculate the number of moles of KNO_3 used. However, few candidates were able to proceed further and correctly calculate the heat change and the enthalpy change for the reaction. By far the most common mistake was to use **M in the equation** as 112 g instead of 100 g. The majority of candidates omitted the positive sign for ΔH, the enthalpy change. Only a small number of candidates stated an acceptable assumption used in their calculation, although it was implicitly found in the data provided for use in their calculations. Many candidates made the assumption of no heat loss/gain, ignoring what was asked in the question.

Evidence of uncertainty was seen in the energy profile diagrams drawn. Some candidates deduced the enthalpy change as exothermic, and proceeded to draw an exothermic energy profile diagram while a few presented both diagrams. A common error was the omission of ΔH on the diagram.

Question 5.

This question was based on Section A (3.4, 6.1, 6.4, and 6.10) and Section B2 (1.2 and 4.1) of the syllabus. It tested the ability of the candidate to analyse and interpret the stimulus material presented in the question. Generally, candidates omitted several parts of this question, and as a consequence scored very poorly.

Part (a) was generally well answered. However, many candidates failed to interpret the information given and confused the terms conduction and melting point.

In Part (b), the liberation of hydrogen gas was readily identified as the gas liberated when an acid reacts with a Group 2 metal. However, many candidates wrote H^+ to represent hydrogen gas. The majority of candidates did not correctly identify the second product as hydroxide. Instead they identified it simply as an oxide. Some wrote $Q^{2+}(aq)$ instead of the symbol Q in the equation.

In Part (c), formation of the oxide was correctly identified. However, many candidates failed to comprehend the concept that the oxide initially formed on the surface protected the metal underneath from further reaction. Many candidates were unable to link the term “inert” to a lack of reactivity. Instead the term “inert” was related to the achievement of a stable electronic configuration associated with the noble gases. A few candidates thought that no reaction would occur since the element Q was on Mars.

In Part (d), it was obvious that the majority of candidates were unfamiliar about the effect of heat on nitrates. Thus they failed to score in this part of the question. A few opted for a description or word equation. Those who knew the products of the equation had extreme difficulty balancing the equations.

In Part (e), it was quite clear to many candidates that the desired method of preparation of the salt involved a precipitation method. However, descriptive experimental errors resulted in an unnecessary loss of marks. The identity of the solutions used was not always clear, and retention of the residue (not the filtrate) was ambiguously stated. Other common errors observed were as follows:

- The use of barium sulphate as a source of sulphate ions in solution
- The use of titration as a preparative method
- Evaporation of the filtrate to retrieve the salt
- The use of fractional distillation as a separation method

Finally, it must be noted that very few candidates correctly wrote the desired ionic equation:

$$Q^{2+}(aq) + SO_4^{2-}(aq) \rightarrow QSO_4(s)$$

PAPER 03- EXTENDED ESSAYS

Question 1

This question was by far the most popular question in Paper 03. It involved the concepts and principles outlined in objectives, Section A (1.1, 1.2, and 5.3) of the syllabus.

In (a) (i), candidates were required to describe one piece of experimental evidence for the existence of the particulate nature of matter. Questions involving experiments usually require the candidate to give experimental details and the observation or result that is expected. Many candidates did not seem to realize this and gave one or the other. Other responses were simple definitions of diffusion, osmosis or Brownian motion, none of which was credited. One of the better answers described the experiment with the pollen grains suspended in water and viewed under a microscope and the haphazard movement of the pollen grains that resulted.

Part (a) (ii) of the question was a straightforward description of the differences between the three states of matter. Candidates were asked to explain these differences in terms of arrangement of particles, forces of attraction and kinetic energy. Despite this guidance, candidates often omitted one or more of these criteria in their explanations. Teachers should remind their students of the importance of reading and re-reading their questions to ensure that all parts are answered. One common misconception which permeated a large number of answers was that solids had the greatest amount of kinetic energy and gases the least.

Many candidates wrote about the motion/speed of the particles and the compressibility of the various states. It was expected that candidates would follow the given guidelines and describe the solid state, for example, as having particles that were closely packed, with strong forces of attraction between the particles and possessing very little kinetic energy. Despite these difficulties this part of the question was fairly well answered.

In Part (b), candidates were asked to discuss how it was possible for gaseous pollutants to affect areas far removed from its source and to include the role of air molecules. Most candidates recognized that diffusion was responsible for this occurrence and gave good definitions and explanations of the process. The role of the air molecules was not as well understood, however. Some candidates used the air molecules and the pollutant particles interchangeably so that it was difficult to understand their explanations. Some referred to the pollutants bombarding the air molecules rather than the air molecules bombarding the pollutants, thus missing the significance of the transmission of the energy from the air molecules to the pollutants. It was expected that candidates would therefore deduce that the increase in kinetic energy would cause the pollutants to be more quickly transported.

In Part (c), almost every candidate was familiar with the osmosis experiment that was illustrated and stated this as the process being investigated. However, some again ignored instructions to do two drawings to show the changes that had occurred after two hours and drew only one so that they could not be fully credited. Others did not properly label their drawings and again lost marks. Still others mixed up the labels of the liquids inside the potato and in the beaker.

Explanations of the changes were often imprecise. Many candidates contented themselves with a definition of osmosis. It was often unclear, too, whether the candidates were referring to the concentration of the solution /solvent or solute.. Quite a large number of candidates believed that only the salt particles moved. A description of what caused the changes should have included that the water particles moved along a concentration gradient from outside the potato where they were in high concentration to the inside where their concentration was lower.

The two solubility curves in Part (d) seemed to have confused some of the candidates who could not determine that X had the greater solubility at 10ºC. It is recommended that more work be done with candidates on interpreting graphs. Even more candidates found Part (ii) too challenging and could not calculate the mass of substance deposited when solution Y was cooled from 80ºC to 20ºC. Candidates subtracted the temperatures, divided and/or multiplied by 100 and generally showed their unfamiliarity with this kind of simple calculation. The topic appeared unfamiliar to many.

Question 2

This question involved various aspects of the topics, oxidation and reduction and electrolysis, as outlined in the syllabus objectives found in Section A (6.13, 6.14, 6.15, 6.16, 6.24, 6.25, 6.26, 6.27, and 6.28). Candidates were required to recall the uses of potassium dichromate in the laboratory and to calculate the oxidation number of chromium in it and in its reduction product, chromium (III) sulphate, $Cr_2(SO_4)_3$. They were also required to determine the conditions needed to electroplate a tenor pan with chromium and calculate the time needed to deposit a given mass of chromium onto it. It was attempted by only a small percentage of candidates.

Many candidates performed well in Part (a) and even some of the weaker candidates earned three out of the four allotted marks for stating a laboratory (school) use of potassium dichromate. Some however, ignored the fact that a laboratory use was required and instead mentioned its use in commercial processes. Candidates should be warned against ignoring directives in a question. Very few candidates recorded that the reagent had to be acidified before use. There was also evidence that it was confused with potassium manganate (VII).As such the colour change was often given as purple to colourless and many candidates believed that it was used to differentiate between alkanes and alkenes.

The calculation of the oxidation number of chromium in potassium dichromate was well done, most candidates obtaining the value of +6 that was expected. The calculation of the oxidation number of chromium in chromium (III) sulphate, however, proved to be much more challenging despite the fact that many of the candidates stated in (a) (i) that potassium dichromate was converted to Cr^{3+}. Impossible answers such as 21.8, 10.5 and even negative values abounded. The sign for oxidation numbers was often omitted, especially the positive sign and in many cases candidates placed the sign **AFTER** the number so that a charge instead of an oxidation number was recorded. Teachers **MUST** insist that the sign is always used in writing an oxidation number and that it is placed in front of the number. Also, teachers might encourage students where there is a compound containing a polyatomic anion such as sulphate, SO_4^{2-}, to use the following approach to calculate the oxidation number of the cation (chromium in this case) as follows:

$$2 \times Cr + 3 \times \text{charge on the anion} = 0$$
$$2 \times Cr + 3 \times (-2) = 0$$
$$Cr = +6 / 2$$

This approach may be better than trying to calculate individual oxidation numbers, since it was in trying to calculate the oxidation number of sulphur that mistakes were made.

In electroplating the tenor pan in Part (c), many candidates chose chromium (III) sulphate as the electrolyte. Unfortunately, they neglected to include the state of the electrolyte (aqueous). Also, a number of candidates incorrectly selected potassium dichromate as the chromium salt. This does NOT produce a positively charged chromium ion and is therefore unsuitable. Teachers should warn their students about the use of formulae when they are not asked to do so, especially in unfamiliar circumstances such as this question. For example,some candidates gave $Cr\ NO_3$ as the electrolyte and were not given the mark since chromium does not exist in the +1 oxidation state generally. They would have been credited for writing out the name chromium nitrate instead.

Most of the candidates understood that the tenor pan should be used as the cathode and a strip of pure chromium the anode. Some, however, interchanged the two electrodes whilst others used an inert anode.

Electrode equations were competently handled by many. The most common errors found were for the candidates to use Cr^{2+} rather than Cr^{3+} and for them to omit the state symbols. It is good practice for students to use state symbols for all equations but it is imperative that they do so for ionic equations.

It was expected that candidates would mention the need for the tenor pan to be thoroughly cleaned before electroplating in order that the plating would not peel off. Most candidates did just the opposite. They greased the pan, anodized it, galvanized or painted it before electroplating. Others believed that putting a really thick coat of chromium would solve the problem. This is the opposite of what should be done as thick coats tend to flake off more readily.

Two main problems were noticed in the candidates' calculations. The first was that many candidates ignored the fact that the mass was given in kilograms rather than grams and failed to multiply by 1000. Thus, instead of getting 10 moles of chromium, most got a value of 0.01 moles. The second error was to ignore the mole ratio between the chromium and the electrons from their electrode equation and to simply use a 1:1 ratio. Thus, the quantity of electricity that had passed was calculated as 0.01 x 96000 or 960c. The rest of the calculation was well done as most candidates seemed familiar with the relationship, $Q = It$.

Question 3

This question was the more popular of the two questions in Section B of the paper. It assessed syllabus objectives, Section A (4.1 and 4.2) and Section B (1.7, 2.1, 2.2, 2.5, 2.8, and 3.3).

Part (a) of the question involved knowledge of the bonding in methane and an explanation of why carbon formed covalent rather than ionic bonds. Candidates recognized that carbon has 4 electrons in its valence shell, although some erroneously gave the configuration as 2.8.4. They also knew that as a result of having these four valence electrons there would be a sharing of electron pairs when it bonded with hydrogen. However, the reason for this was not clearly stated as many referred to it being easier to share than to gain or lose four electrons without any reference to the relative energy requirements of these two processes.

Most candidates did not give a complete illustration of the bonding process leading to the formation of methane from carbon and hydrogen. They drew a diagram showing the four shared electron pairs between carbon and hydrogen but failed to begin their illustration with the diagrams of the outer shells of carbon and 4 H atoms. A few candidates drew a displayed structure of the methane molecule with dashes (-) representing the bonds. This type of drawing is not used to represent the bonding process. Instead it is used to represent structure.

In Part (b), which focused on the very familiar reaction of methane and chlorine, most candidates received full marks for knowing that the type of reaction undergone was substitution and that light was needed. A great deal of time was wasted giving the four equations that show successive substitution of the hydrogen atoms by chlorine when only one overall equation was required. One common misconception was that one of the products was hydrogen rather than hydrogen chloride.

Part (c) was the best done part of this question. Candidates were asked to identify an alkene and a carboxylic acid from a group of compounds whose formulae were given. They were then asked to draw the structures of, and name the compounds that they had identified. Some candidates gave the alkane as the alkene whilst others gave C_3H_8O as the carboxylic acid. The latter was the more common error. The drawing of the structure of the carboxylic acid proved more challenging than that of the alkene. Many candidates did not correctly draw the functional group of the acid. In naming the structures, the most common errors were as follows:

- Use of the prefix –'but'- rather than-'prop'- for the alkene AND the acid
- Reference to the acid as propanol rather than propanoic acid
- Reference to the alkene as prop-1-ene and the acid as propan-1-oic acid

In (c) (ii) candidates were asked to differentiate between an alkane and an alkene in the first instance and an alkane and a carboxylic acid in the second instance. It was hoped that candidates would choose reactions that had some observable change. For example, in the case of the alkene and the alkane, the use of bromine dissolved in an inert solvent would produce no reaction with the alkane in the dark whilst the alkene would show an immediate decolouration. Many candidates used bromine but did not indicate the conditions of the reaction. Some candidates failed to state what would be observed with the alkane and simply stated that the alkene would decolorise the bromine. Teachers should remind their students that when comparisons are required, results for both substances must always be recorded. The equation for the reaction was straightforward and most candidates who used this reaction got the marks awarded. Candidates who used the reaction with acidified potassium manganate (VII) ran into difficulty when writing the equation as the equation for this reaction is not on the syllabus and the product, the diol, was unfamiliar.

Many reactions could have been used to differentiate between the alkane and the carboxylic acid. Candidates could have used the reaction with a reactive metal or a carbonate or the reaction with an alcohol. In each case the acid produces an observable change and the alkane gives no reaction. Supporting equations were generally poorly done as many candidates failed to balance the equations or wrote incorrect formulae for the salts produced.

Most students recognized the process in Part (d) as cracking. A few thought that it was fractional distillation. The advantage of the process was more often than not given as "to convert large useless alkane molecules into smaller more useful alkenes". Few candidates focused on exactly what these alkenes could be used for. These would include use in making solvents, to produce polymers or for use in many of the downstream petrochemical industries.

Question 4

This question required candidates to apply their knowledge of the reactivity of elements in the electrochemical series. Candidates who attempted this question generally performed worse than their counterparts who attempted the alternate question in this section of the paper. The question examined syllabus objectives Section B1 (2.1, 4.1, 5.1, and 5.2).

In (a) (i) candidates were asked to explain why copper, silver and gold were used to make coins but sodium, calcium and magnesium were not. Many candidates compared the reactivities of the two sets of metals instead of stating why one group was suitable and the other group was not. For example, instead of stating that Cu, Ag and Au were unreactive, most candidates wrote that these elements were less reactive than Mg, Na and Ca. This was not considered acceptable as there are many elements that are less reactive than Mg, Na and Ca that are also not used to make coins because they are still too reactive. Most candidates also failed to indicate that to be used for making coins, a metal would have to be durable since frequent handling of coins meant that the metal would be exposed to all kinds of environments. Marks were also lost as candidates made no reference to the positions of these elements in the electrochemical series.

Only an extremely small percentage of the candidates were able to give a proper ionic equation for the reaction. The expected equation was:

$$M(s) - ne^{-} \rightarrow Mn^{+}(s)$$

The few that were able to give a correct equation used magnesium as an example. This was accepted.

Part (a) (ii) was better answered, generally. Candidates knew that zinc displaced copper from an aqueous solution of its salt because zinc is higher in the reactivity series than copper. Many also wrote correct equations for the reaction and explained that since copper is below zinc in the reactivity series, it could not displace it and so there is no reaction when a copper rod is placed in an aqueous solution of zinc sulphate. The fading of the blue colour when zinc is placed in copper (II) sulphate solution was poorly handled. Most candidates did not refer to copper *ions* being removed.

In (a) (iii), it was surprising to note how many candidates did not know that aluminium is extracted by electrolytic reduction whilst iron is extracted by chemical reduction. Furthermore, they did not appreciate that the reason for this is that aluminium, being higher in the reactivity series than iron, forms stronger bonds in its oxide and therefore requires a more powerful method of reduction. Many candidates believed that the reducing agent in the extraction of iron is coke rather than carbon monoxide.

In Part (b) as in Part (a) (i), candidates compared the reactivity of copper to that of iron in an effort to explain why copper is more useful when pure and iron is almost never used in its pure state. It was expected that the candidates would have focused on the use(s) to which **EACH** metal is put. Copper is used as a conductor and conducts electricity well when pure. When impure, this ability is diminished. In the case of iron, which is used as a construction material, when pure it is not suitable as it is too soft. Alloying it, however, increases its tensile strength and makes it more useful. Many candidates simply stated the properties of the two metals without stating the effect of the addition of impurities on these properties. For example, candidates simply stated that pure copper is a good conductor of electricity.

Question 5

This question tested the concepts and principles in the first unit of Section C of the syllabus, namely the option-'Chemistry in the Home'. It focused on the chemistry involved in cooking and tested specific objectives, Section C (1.2, 1.4, and 1.10).

In Part (a), candidates were expected to explain the role of water, gluten, leavening agents and heat in making and baking dough. In considering the role of water, it was expected that candidates would focus on the hydration of proteins in flour to form gluten, providing moisture for the fermentation of yeast and the ionization of tartaric acid in baking powder and aeration of the dough during the baking process. Some misconceptions that were noticed were that water hydrates starch to form gluten, that it reacts with baking powder and that it binds the ingredients together. The simple experiment in which dough is made and placed under running water to remove the starch could perhaps clarify this first misconception.

In describing the role of gluten, many candidates focused on a description of what gluten is instead of explaining what it did. For example, there were many descriptions of it being a sticky/ visco-elastic substance without further stating that it stretches and traps aerating gases giving the dough its fixed shape, or that it binds the constituents of the dough.

Many candidates spent a great deal of time writing about the components of leavening agents, especially about the baking powder rather than explaining their role. Others simply stated that leavening agents raise the dough. The better candidates described the production of carbon dioxide by fermentation (for yeast) and the action of an acid and hydrogen carbonate (for baking powder) and then stated that it was this gas that was responsible for the aeration of the dough.

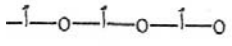
Heat was thought to be responsible for cooking the dough and for making the dough edible. It was also believed that its role was to give the dough a "nice brown colour". Although all of these do happen when dough is heated none of these were credited as being the role of heat, which has many more important functions. Some of these include: expansion of carbon dioxide and conversion of water to steam, both of which cause an increase in volume of the dough, destruction of the yeast causing fermentation to stop and coagulation of proteins.

The equations were poorly written. All the relevant equations can be found on pages 10 and 11 of the CXC module #12.

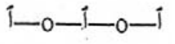
Part (b) required candidates to explain why flour which is left in a hot humid room for a long time does not turn iodine black. A relevant equation was needed to accompany the explanation. Many candidates incorrectly stated that heat destroys starch completely ignoring the role that the water played in this "destruction". Few candidates recognized that the process that was occurring was hydrolysis although a creditable number mentioned that the starch was converted to simple sugars. The equation seemed beyond most of the candidates, who, as a result, simply omitted it. The expected equation was:

$$2\,(\,C_6H_{10}O_5\,)_n + n\,H_2O \rightarrow n\,C_{12}H_{22}O_{11}$$

In (b) (ii), candidates seemed not to have read the question carefully and, instead of showing part of a polymer chain, showed a discrete trimer molecule. Since polymers are long chain molecules the diagram drawn should have shown continuity lines at the end of the joining together of the three monomer units. Many candidates did not draw these lines and lost marks. Some of the incorrect structures drawn included:



and



Question 6

This question tested the concept and principles contained in the alternative option of the first unit in Section C, namely Chemistry of Food Preservation. The specific objectives tested were Section C1 (2.6, 2.7, and 2.8).

Part (a) required candidates to copy a table of the steps of the canning process and fill in the purpose of certain steps. Many of the candidates did not know that blanching inactivates enzymes, softens the food and removes trapped air in the food. The purpose of the addition of brine/syrup, sealing and sterilization steps was, however, well understood. Candidates should be warned against the use of loose language such as “removing/ getting rid off” micro-organisms when they mean killing or destroying them. In addition, it was found that the term “impurities” was often substituted for bacteria/ micro-organisms. The reason for rapid cooling, like that for blanching, was not well understood. Few candidates recognized that this step avoids significant changes in nutritional quality/flavour/colour of the food. A popular response was “to prepare the food for packaging”.

In (a) (ii), many of the candidates were familiar with niacin. They knew that it was an antibiotic that killed bacteria. Very few, however, knew that the niacin was added specifically to kill heat-resistant bacterial spores although this is given in the CXC module.

Part (b) of the question focused on the two unknown metals, A and B, which could be used to coat a steel can. Candidates were asked to determine which of these metals would be more suitable and to justify their choice in terms of the need for coating the can, the rationale for selecting one metal over the other and any possible limitations to their recommendations. Relevant equations were to be included also. This part of the question was poorly answered. It is important that teachers emphasize that when unknown metals are given, candidates are not required to identify the metals. Many of the candidates referred to A and B as tin/aluminium/lead and copper respectively.

Most candidates earned a mark for stating that iron would rust or corrode if not coated. They did not, however, develop this point to conclude that as a result, the can would become porous and bacteria and air would enter or that the can would begin to leak. It was expected that candidates would choose metal B to coat the can as this is below hydrogen in the reactivity series and is therefore less reactive than A. Furthermore, since the can is used to hold fruit juices, metal A would more likely be attacked by the acid in the juice while metal B would not react. Despite this unreactivity, metal B could still leach into the fruit juices. Another limitation was that being below hydrogen, it is most likely one of the heavy metals and as such most likely its ions would be toxic. These points eluded almost all of the candidates. The limitations quoted were often socio-economic or environmental rather than chemical in nature.

The chemical equations should have included:

1. An equation showing the reaction of metal A with acid:

$$A\,(s) + n\,H^+ \rightarrow A^{n+}(aq) + H_2(g)$$

2. Equations showing the conversion of iron to rust.

$$Fe\ (s) \rightarrow\ Fe^{2+}\ (aq)\ +\ 2e^-$$

$$½\ O_2\ (aq)\ +\ H_2O\ (l)\ +\ 2e^- \rightarrow\ 2OH^-\ (aq)$$

$$Fe^{2+}\ (aq)\ +\ 2OH^-\ (aq) \rightarrow Fe(OH)_2\ (s)$$

$$2Fe(OH)_2\ +\ ½\ O_2\ +\ H_2O\ \rightarrow\ 2Fe(OH)_3\ \rightarrow Fe_2O_3.xH_2O$$

These four equations could have been condensed to:

$$4\ Fe\ (s)\ +\ x\ H_2O\ (l)\ +3\ O_2\ (g)\ \rightarrow\ 2\ Fe_2O_3.xH_2O\ (s)$$

These equations seemed completely unfamiliar to most of the candidates.

Paper 04 - School-Based Assessment (SBA)

General Comments

Most centres continue to perform at a high standard on the Observation, Recording and Reporting (ORR) and Manipulation and Measurement (MM) skills. However, in spite of the detailed comments in previous reports on assessing the Analysis and Interpretation (AI) and Planning and Design (PD) skills, these continue to be a major challenge for many teachers. As such, many candidates are performing poorly on these skills. In particular, many of the newer centres are having difficulty in

- developing suitable mark schemes
- using the mark schemes developed
- selecting appropriate activities for assessing PD
- identifying suitable challenging and appropriate activities
- identifying suitable criteria for assessing the skills, particularly AI and ORR
- presenting laboratory books for moderation.

In a number of cases, activities that are not considered practical activities are being used for SBA. Teachers from these centres are strongly 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. There is also valuable information in the CXC syllabus and module on the SBA.

There are some activities that need to be given greater attention, generally. These include analyzing data presented in a graphical format, activities related to organic chemistry and redox reactions, writing balanced equations and qualitative analysis including identification of gases, cations and anions.

Some of the specific problems encountered at moderation are outlined below.

1. **<u>Assessment of Planning and Design:</u>**

   a. Assessment of this skill continues to be affected by poor selection of activities. In a few instances teachers tested concepts from biology and physics in the PD activities. Concepts tested in PD activities should be drawn form those in the chemistry syllabus. Teachers should also note that the description of the learnign outcomes being tested by this skill as stated in the syllabus (Appendix 2 page 71) point to the use of "a known procedure in a novel context or a novel use of a known procedure". Activities that require the straight recall or reproduction of information that is available in any chemistry textbook are not suitable for assessing, planning and design. These include experiments that require students to plan and design activities to

i. Find the heat of solution or neutralization

ii. Determine if rate of reaction is dependent on surface area or temperature

iii. Prepare gases and salts

iv. Prepare a sample of ethanol

v. Electroplate a spoon

b. In order to test concepts teachers have to pose problems in ways that do not require straight recall of information. Rather, students should be required to use the concepts from chemistry to solve problems. Examples of the types of tasks suitable for assessing PD have been given in previous reports and also in the CXC modules and syllabus. Teachers are encouraged to review these resources for additional help.

2. **Assessing Analysis and Interpretation**

Assessment of this skill is affected by poor selection of activities and the use of assessment criteria which do not relate to A1 but to some other skills, usually ORR. In many instances, marks awarded for A1 do not relate to A1 but to some other skilll. The following are some factors that should be considered when assessing the A1 skill.

a. Equations and discussions of activities should be assessed as A1 and not ORR.

b. Questions used to assess A1 should be based on data collected. For example, when conducting a chromatography experiment, questions such as “What is the purpose of chromatography?” and “What colours do you see?” are not suitable for A1. However, “Explain the reason for the different positions of the two colours in the chromatogram,” is a suitable question.

c. The actual plotting of the graph should be assessed under ORR but calculations and intrepretation of data using the graph should be treated as A1.

d. For qualitative analysis, only marks awarded for inference should be used for A1. In conducting qualitative analyses, students should be encouraged to complete their results in tabular form.

3. **Assessing Organization, Recording and Reporting**

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

b. There must be some correlation between the stated aim of the activity and the rest of the report. When awarding marks for the report, teachers should ensure that the aim of the activity reflects the purpose of the exercise and the process to be used to conduct the exercise.

4. **Presentation of Laboratory Books**

a. There was much improvement in the books presented for moderation this year. Tables of Content were usually present and many students dated each practical. However, teachers need to ensure that there is consistency in how the practical exercises are identified in the Tables of Content for all the samples. In some cases, practical exercises were identified by title. There were a few instances in which the number of the practical exercise in the Table of Content did not correspond with those in the laboratory books. In other circumstances, the numbers allotted to each practical exercise did not always correspond for all the books from a given centre.

b. The comments made regarding the dates and page numbers made in previous reports must be repeated here. 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.

c. The activities being used to compute the students' SBA scores for the various skills should be clearly indicated in the students' notebooks and mark scheme. In many cases, teachers assessed each skill more than twice in one year and it was not always clear which assessments were used to determine the final score for that skill. In some instances it appeared that different activities were used to compute the scores for different students from the same centre. This should not be the case.

5. Absence of or inappropriate mark schemes

a. Detailed mark schemes are essential if moderation is going to be successfully completed. Incomplete and inadequate mark schemes will undoubtedly work to the students' disadvantage. In one case of a PD activity, students were required to plan a suitable activity to determine if an unknown compound was lead (II) nitrate. The mark scheme for the activity was as follows:

i. Explain observation fully
ii. Uses background knowledge
iii. Identify and state limitations
iv. Make accurate predictions
v. Accurately interprets and analyses
vi. Conclusion related to aim.

This mark scheme is both inappropriate and inadequate. No marks are indicated for the various criteria identified. In addition, most of the criteria are vague and can be interpreted in several different ways.

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

c. Teachers are again reminded to examine the examples of the mark schemes provided in Appendix 2 of the syllabus for information on how the mark schemes should be presented.

6. Re-sit candidates/extenuating circumstances

Where books of re-sit candidates are submitted for moderation, 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 points where assessment takes place, this should be outlined in writing to the Registrar so that students are not penalized unnecessarily.