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

REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION

MAY/JUNE 2008

CHEMISTRY

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GENERAL PROFICIENCY EXAMINATION

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GENERAL COMMENTS

This year marked the first sitting using the new format of the CSEC chemistry examination which now has two instead of three written papers. While there was no change to the multiple choice paper, for Paper 02, candidates were required to complete six questions, five of which were compulsory and the sixth selected from one of two questions from Section C of the syllabus. Questions 1-3 were structured items, while 4-7 were extended essay items.

The contribution of the papers to the overall examination was as follows:

Paper 01 (Multiple Choice) - 30%
Paper 02 (Structured Essay) - 50%
Paper 03 (School-Based Assessment) - 20%

Some candidates did very well on the examination scoring full marks on several of the questions. However, while it is clear that a relatively small number of candidates have done fairly well on this new examination, it is also clear that many continue to perform way below the required standard. In many instances questions that require straight recall of definitions proved to be difficult for some candidates, as responses were vague or inaccurate. Much of the inaccuracy arose from the confusion of terms which sound alike or have things in common. This suggests that enough care is not given to differentiating and clarifying concepts, as candidates prepare for these examinations. Some topics, such as, writing and balancing equations, organic chemistry, and solving mole related problems continue to pose significant challenges for too many candidates.

DETAILED COMMENTS

Paper 01 – Multiple Choice

This paper tested Sections A and B of the syllabus in the profile, Knowledge and Comprehension. Performance on this paper contained to be steady and satisfactory. The marks ranged from 0-59.

Candidates experienced difficulties with items based on the following objectives:

- A. 3.1 – the smallest part of a chemical compound that can take part in a reaction (answer being the molecule).

- B1. 1.8 – identifying that molecular formulae, empirical formulae and functional group were the same for two given compounds.

Paper 02 – Structured Essay

Question 1.

Syllabus References: A 6.6, 6.12, 3.4, 3.7, 7.2, and B2 7.1 and 7.2.

Part (a) tested candidates' knowledge of pH and its use in determining the end point of acid-base titrations. It also tested their ability to represent given data graphically and to carry out calculations involving molar concentration and number of moles present in a given volume of solution.

The majority of the candidates attempted this question and were able to score between 6-9 marks for recording the correct readings on the pH metres, plotting the graph and deducing the end point of the titration from the graph. However, most candidates were unable to provide clear descriptions of the pH scale. Their responses were either incomplete or poorly expressed. Most neglected to give a description of the scale but explained that the pH scale could be used to measure the acidity or alkalinity of a substance. Others referred to the pH scale as though it were a device or an instrument. Most candidates were able to explain the end point of the acid-base titration as the point of complete neutralization of the base or the acid. Some common incorrect responses were:

- The pH scale is a device used to measure the acidity or alkalinity of a substance.
- The pH scale measures the power of hydrogen atoms / ions in solution.
- The end point of a titration is time taken to complete a titration.
- The end point of a titration is when the titration is finished.
- The end point of a titration is when all the acid and base are used up.

The expected responses were:

- **pH Scale**: a scale ranging from 0-14 which measures the acidity or alkalinity of a substance
- **End point of a titration**: the point in a titration where all replaceable H^+ ions of the acid react completely with all the OH^- ions of the base.

The vast majority of candidates were able read the pH metres and use their values to plot the graph. Many did not recognize the end point of $15cm^3$ which gave a pH reading of seven. Rather they selected the reading of pH 10.8 which corresponded to a volume of 20 cm^3 of sodium hydroxide.

Plotting the graph proved to be difficult for some candidates. The main problem was the interpretation of the scale. Readings such as 2.2, 2.4 and 10.8 were often incorrectly plotted but most were able to plot values such as 15.0 and 20.0 correctly. Many graphs were untidy and very large dots or tiny indistinguishable dots were used when plotting the points. The curve was often jagged. Some candidates seemed unfamiliar with the curve associated with this type of data and attempted to draw a straight line.

Calculations were generally poorly done. Most candidates successfully calculated the number of moles of sulphuric acid used. However, the calculation of the concentration of the sodium hydroxide proved challenging. One common error was the use of the incorrect mole ratio of acid to base resulting in the incorrect number of moles of sodium hydroxide used. It was clear that in some cases candidates did not know how to proceed with the calculation. Many tried to use the molar gas constants (22.4 dm^3 and 24 dm^3), Avogadro's constant and the values for the relative formula masses in the calculations, while a large number of candidates did not attempt this part of the question.

Part (b) tested candidates' knowledge of the tests for chloride, copper(II) and sulphite ions.

Candidates did very poorly on this part, with 0-1 out of a possible 6 marks being the most common scores. From the responses, it appears that candidates were unfamiliar with the tests and in most cases did not know what to infer from the results obtained. Most of those candidates who attempted this question got one mark for correctly inferring that the blue precipitate formed in Test 3 was due to the presence of copper(II) ions.

Most were unable to write the one ionic equation required for Test 1, due mainly to incorrect formulae. Another problem was that some confused the reactions of oxidizing agents with those for reducing agents.

Part (c) required candidates to plan and design an investigation to compare the relative effects of four catalysts on the rate of decomposition of hydrogen peroxide. Most persons chose to compare the catalysts by measuring the volume of oxygen produced for a specific period of time, or comparing the rate of production of a given volume of oxygen. Some of the more common reasons why candidates failed to do well on this part of the question include:

- No means for comparing the relative effects of the catalysts
- No mention of control of the quantity of the hydrogen peroxide used
- Diagrams which were not feasible based on the experimental procedure proposed.

Question 2.

Syllabus References: A (2.1, 2.6, 6.2, 6.4)

Candidates were expected to use a partially completed diagram of the Periodic Table showing the Group 7 elements to answer questions on the properties of the elements shown. They were also required to analyse the chemical properties of two compounds of unnamed elements (X and Y), and answer questions pertaining to the nature, bonding and relative positions of X and Y in the reactivity series.

Part (a)

Most candidates were able to correctly identify the set of elements shown in the table as belonging to Group 7 or the halogens. However, a considerable number failed to give the correct reasons for placing the elements in Group 7, as they did not refer to the number of valence electrons the elements have in common. Vague responses such as “the same number of valence electrons” or “similar chemical properties” were not awarded any marks.

Part (b)

This part of the question involved the reaction of chlorine with aqueous potassium bromide. It proved to be very challenging for many candidates. Many wrote inferences such as “chlorine will displace bromine” and failed to include **observations of the colour** of the solution or the bromine gas produced although the question specifically asked for the observations. A high proportion of the candidates did not know the correct symbols and valencies of the elements. Hence, they were unable to write a balanced equation for the displacement reaction, and some compounded the error by writing incorrect formulae such as KBr_2, KCl_2, PCl, br_2 and CL.

Part (c) (i)

It appeared that most candidates did not use the information provided on Elements X and Y to deduce their properties. Most seemed to assume that if X were a metal then Y had to be a non-metal or vice versa. Both elements were metals.

Part (c) (ii)

This part of the question was very poorly done. A very high percentage of candidates misinterpreted the question and described the bonding between Elements X and Y or between Element Y and another Element (metal and non-metal) rather than the bonding within Element Y as required. A number of candidates who correctly identified the bonding in Y could not give an adequate description of metallic bonding. In a number of cases, candidates mentioned “sea of electrons” without any mention of **positive ions** held together by the “sea” of delocalized mobile electrons.

Part (c) (iii)

Most candidates were able to correctly predict the bonding between X and oxygen based on their response to Part (c) (i). However, this is yet another instance in which candidates seemed to have difficulty providing comprehensive explanations of why that type of bonding should occur.

Part (c) (iv)

The ability to simultaneously compare the two sets of reactions and arrive at the correct sequence of reactivity of elements seemed lacking for many candidates and as such, most were unable to arrange the Elements, X, Y and Mg in the correct order of reactivity. Many seemed not to understand how to interpret the order of reactivity of metals based on the thermal stability of their compounds and displacement properties. Responses to this part suggested that candidates did not analyse the information presented in the table. Rather than using the principles of displacement reactions and thermal stability of compounds to arrive at an answer, some candidates attempted to identify the unknown elements and use their memory of the reactivity series to answer the question. In many cases, responses were incomplete, referring only to the displacement of metals lower down in the activity series by those higher up, without considering the thermal stability of compounds. A common misconception was that metals are more reactive than non-metals and this principle was used to order elements identified as non-metals from c (ii).

Question 3.

Syllabus References: B1: 1.8, 1.3, 1.6, 1.7, 1.9, 2.7

Part (a) required knowledge of structural isomerism. Candidates were asked to demonstrate their understanding of this concept by drawing two named isomers of butane and to name and draw a third.

Many candidates were unable to give a correct definition of structural isomerism. There was widespread incorrect use of basic terms resulting in vague and inaccurate definitions. For example, many referred to isomers as “elements”, or “atoms” that have different structural formulae, while others omitted the “same chemical formula” from the definition and simply described structural isomerism as related to different structures. A few candidates gave the definition in terms of the compounds having different physical properties but similar chemical properties.

Common errors in drawing the isomers of but-1-ene and but-2-ene were failure to include the hydrogen atoms in the structures drawn and to ensure the tetravalency of carbon in its compounds. While most candidates were able to draw the structures of named isomers, most were unable to draw and name a third isomer of butene. There was a tendency to rewrite but-1-ene or but-2-ene in a different spatial orientation for the third isomer. Here also candidate had too many or too few bonds linked to carbon. A wide variety of incorrect names were also given to 2-methyl propene which was the third isomer required. Some of the more common ones were “butane”, “methyl butane”,” propene”,” 1-methyl propene” and “methyl-prop-2-ene”.

Part (a) (iv) was relatively simple, requiring one physical property of butane. However, far too many candidates seemed unable to distinguish between physical and chemical properties. Many chemical properties such as “burns with a smoky flame” and “decolourizes bromine water” were given for a physical property of butane.

In Part (b) (i), a substantial number of candidates failed to provide a suitable definition for functional group. A common error was the failure to link the functional group to chemical properties. In some cases, candidates referred to groups of the periodic table when describing functional group.

In Part (b) (ii), candidates were required to complete a table to show some common reactions of ethanol. They were provided with the functional groups of the products formed and asked to deduce the products and the reagents. This part was poorly done. The responses indicated that for the most part, the candidates were unfamiliar with the reactions of ethanol and did not know the reagents for converting ethanol to alkenes, carboxylic acids and esters. While most candidates were able to draw the structure of ethene, the product formed with the carboxyl group and the ester linkage proved to be more challenging. In the case of the ester, the contribution by the acid was often omitted.

<u>Question 4.</u>

Syllabus References: A: 6.22, 6.23, 6.24, 6.25, 6.26 and 6.27

Candidates were tested on their knowledge of the electrolysis of molten lead bromide. They were required to draw suitable apparatus for electrolyzing molten lead bromide, calculate the mass of product formed at the cathode and list factors that affect the product of electrolysis. The final part of the question required candidates to explain the relative reactivity of calcium and barium.

Many candidates scored marks in Part (a) (i) of the question but a large number produced very poor drawings of the arrangement of equipment for the electrolysis of molten lead bromide. While candidates showed a general understanding that an inert electrode was required they were unable to identify a suitable inert electrode, such as graphite or platinum. The main errors in the diagrams included:

- Electrodes were not dipping into the electrolyte.
- The electrodes were not drawn thicker than the connecting wire so as to distinguish between them.
- The electrodes did not match with the polarity of the battery / power supply.
- In some cases the polarity was not included but the polarity of the electrode was given.
- In some cases the electrolyte was not identified by way of a line to show the level of the electrolyte.

Responses to Part (a) (ii) showed a low competency in the writing of ionic equations. The following common mistakes were seen to be prevalent.

- Charges were incorrect and in some cases missing altogether, for example, Ba, Ba^{+}, Br^{2+}, Br, Br^{2-}.

- The equations were not balanced.
- In most cases, state symbols were not included or were incorrect.
- Candidates matched the ionic equations with the wrong electrode.

Many candidates scored some marks for Part (a) (iii), of the question. The majority of candidates scored marks for calculating the quantity of electricity. However, in some instances time in minutes were not converted or incorrectly converted to seconds. Some candidates wrote the incorrect units such as Joules, ^0C for Coulombs. The common errors were:

- The incorrect mole ratio was used. Many candidates used one Faraday to produce one mole of product (Barium).
- Limited knowledge of the products of electrolysis led to a wide variety of substances identified as the product, some with the correct formulae, and some with the incorrect formulae. The main error was with the product being identified as barium bromide. A smaller number used bromine as the product.
- A variety of incorrect formulae were used such as, BaBr, and even Ba2. This even occurred in cases where the correct equation for the discharge of Ba^{2+} ions was given for the cathode reaction.

Responses to Part (a) (iv) showed that the question was misinterpreted by many candidates and consequently vague answers were given. In some responses the term "ion" was omitted in the statement that one factor affecting the product of electrolysis was the "position of the ion in the electrochemical series". A large number of candidates confused electrochemical series with reactivity series. Some candidates misinterpreted this question and provided answers for factors that affect the amount of product formed instead of the nature of the product formed during electrolysis.

In the last part of Question 4, Part (b), candidates seemed to do rather poorly and as a result, lost this mark as they:

- did not provide a reasonable explanation for the reactivity of the Group II metals
- failed to link the position of the element in the group and its reactivity
- opted to use other chemical properties such as solubility.

<u>Question 5.</u>

Syllabus References: B.1: 2.2 and 2.5; B.2: 3.1 and 4.1

In Part (a) of the question, candidates were given four organic compounds from which they were to identify one saturated and one unsaturated compound. They were also required to name and give the general formula of the homologous series to which the compounds belong.

Part (b) of the question tested knowledge of the industrial preparation of nitrogen, the nitrogen cycle and the reactions of metallic nitrates.

In Part (a), a fair amount of candidates managed to obtain at least four of the six marks However, many responses to this question continued to reveal that candidates are not giving adequate attention to distinguishing between chemical concepts that may sound alike or have things in common but are quite different. As such, many candidates failed to correctly identify C or D as the saturated compound and A as the unsaturated compound. In many cases, C_4H_8 was described as saturated and C_4H_{10} as unsaturated. Instead of stating the name of the homologous series, for example, alkene, many candidates gave the name of the compounds, like butane.

Part (b) seemed to prove more challenging for the candidates and a fair number omitted this part. Here again there was confusion of terms, especially as they relate to the names of processes- nitrification and denitrification. Some had problems with the interpretation of the question and described the "ammonia plant" as if it were a living entity, perhaps because they were told that plants require nitrogenous compounds.

This question required candidates to explain how the conditions of temperature and pressure are important in the production of ammonia. As stated in the syllabus, "only simple treatment of the reversible reaction" is required. Candidates were not expected to explain the effect of temperature and pressure on the equilibrium position although a few did. Rather, candidates were expected to explain that the use of moderately high temperatures and pressures would increase the rate of collision of particles and favour a higher yield of ammonia. While many candidates described the effect of temperature and pressure on the rate of collision of particles, only a small number linked this to the yield of ammonia.

Part (c) was fairly well done but a wide variety of processes were used, some of the more farfetched ones seemed to be based on guessing. Correct responses for processes by which nitrogen from the atmosphere can be converted to nitrates were nitrogen fixation or the effect of lightning in thunderstorms, while the process by which nitrogen in soil nitrates can be released back into the atmosphere was denitrification. Evaporation, decomposition and filtration were some of the processes identified.

Part (d) was poorly done. Candidates were unclear about the reactions of Group 1 and Group 2 metals. Although many candidates realized that the brown gaseous product when Q was decomposed was nitrogen dioxide, they were unaware of the other products of the decomposition reaction.

Question 6.

Syllabus Reference: C: 5.1, 5.2

This question tested knowledge of the chemistry of glass. The questions were fairly straightforward. However, most candidates seemed generally unprepared for this question. It was by far the less popular of the two Option C questions.

In (a) Part (i), very few candidates were able to give the benefits of adding sodium carbonate or calcium carbonate to silica in the manufacture of glass. Adding these substances to silica causes a reduction of the melting point of silica and reduction in the tendency of glass to crystallise.

In (a) Part (ii), candidates were expected to state how the basic component of glass would be modified to make lead-potassium glass and borosilicate glass. In the case of lead-potassium glass, modification to be made to the basic components of glass should be a substitution of lead oxide and potassium oxide for sodium carbonate and calcium carbonate. In the formation of borosilicate glass, however, a substitution of boron (III) oxide was required for silica. The majority of candidates did not know this simple recall of information.

In (b) Part (i), candidates were expected deduce why it is important that glass does not crystallize as it cools. Candidates were expected to state that glass is ideal as a transparent container and as such if crystallization of glass takes place as it cools, it would obscure the view of the contents. Most candidates acquired at least one of the two marks here.

Part (b) (ii) proved to be very difficult for most candidates. Candidates were asked to relate the bonding in SiO_4 to the melting and moulding of glass. The expected response was that the SiO_4 bonds are not all of the same strength and as a result all bonds are NOT broken at the same temperature. Hence, the glass could gradually soften, thereby allowing time for the glass to be moulded. No candidate wrote this response in its entirety.

In (b) Parts (iii) and (iv), most candidates were able to explain why it was important to recycle glass and to give one advantage and one disadvantage of using glass in construction. Many got full marks for this part.

Question 7.

Syllabus References: A: 3.5 and 6.5; B.2: 7.1.7.2 and C

This was the more popular of the two questions in Section C. The majority of candidates displayed an awareness of global concerns regarding food production. However, they did not do as well on this question as anticipated.

In Part (a) candidates were expected to explain that mineral balance is required for healthy plant growth and metabolic processes. Most candidates scored marks here but the responses of the weaker ones were vague, such as “mineral balance was necessary for having the right amount of growth”. Many did not give satisfactory answers for the importance of pH in plants. They were expected to state that pH influences the availability of nutrients for uptake from the soil, since some nutrients form compounds that plant roots cannot absorb. Responses from weaker candidates were not specific about the role of pH, for example, “too acidic or too alkaline conditions are bad for plants” were common responses. Only a few candidates scored the one mark in this section.

Most candidates were able to state the importance of humus for plant growth and got the two marks for indicating that humus provides organic nutrients, aerates the soil, improves crumb structure of the soil, and regulates water retention of the soil.

In Part (b), candidates were required to explain the test for ammonium ions in the soil. They had to draw on knowledge from Section B of the syllabus but many failed to give the correct test for the ammonium ion. Acceptable tests were, adding aqueous sodium hydroxide to a sample of the soil and heating it to generate ammonia. Ammonia would then be identified by the use of red litmus or hydrogen chloride gas. Many candidates described the test for ammonia instead of ammonium ion. In a few cases, candidates stated that a magnet could be used and the presence of ammonium ion would be confirmed if the soil was attracted to the magnet.

Many candidates failed to recognize that acid rain and the ammonium ion from ammonium-based fertilizers are responsible for the acidic nature of soils. Adding lime to soil would neutralize the acid. Suitable ionic equations depicting a neutralizing reaction were awarded full marks.

Part (c) of the question required the candidates to take a position on the wisdom of adding lime to soil at the same time as when adding ammonium fertilizers. A large number of candidates failed to take a position when advising the farmer and so lost one mark. Candidates were expected to state that ammonium-based fertilizers would react with lime to produce ammonia which is toxic to plants. The production of ammonia would also reduce the amount of nutrients in the ammonium fertilizers. The better candidates gave the equations such as the following.

$$NH_4^+{}_{(aq)} + CaO_{(s)} \longrightarrow Ca^{2+}{}_{(aq)} + H_2O + 2NH_3$$

$$NH_4^+{}_{(aq)} + OH^- \longrightarrow NH_{3\,(g)} + H_2O_{(l)}$$

Paper 03 - School-based Assessment (SBA)

General Comments

Overall there have been noticeable improvements in the SBA assessment process. This is evident in the decline in the number of centres submitting laboratory practical exercises of unsatisfactory standard. This year, only four percent of the centres presented unsatisfactory activities. There has also been improvement in the assessment of both the Planning and design skills as well as Analysis and Interpretation skills. Teachers must be commended for making an effort to improve in the assessment process, for their efforts to ensure maximum coverage of the syllabus as well as undertaking at least the minimum number of activities.

However, there is a need to highlight some areas which will aid teachers in further improvement, as well as assist with an easier moderation process.

SBA Samples

In general the samples were presented in good condition. However, there were some cases where the following occurred:

- Some laboratory practical exercises were done on extra sheets which were not neatly or securely attached. This left the book looking extremely untidy and difficult to follow, and it increases the probability of exercises being lost in transition.

- Some books lacked a Table of Content, page numbers and dates. Teachers should emphasize to their students the importance and necessity of having an up-to-date index, numbering pages and dating exercise. Those exercise utilized for assessment should also have corresponding dates in the Mark Schemes.

- Some centres did not completely fill out the CHEM-3 form which shows the breakdown of marks for the individual skills. This hampered the moderation process.

- Again this year some books sent for moderation had chemical samples such as crystals prepared displayed in them. Whereas this serves as evidence of having actually carried out the experiment, it creates a problem since they tend to leak during shipping, obscuring words in some cases. This also presents a safety hazard.

Equations

The use of equations is still not being emphasized by teachers. This year 18 percent of the centres had equations which were used inappropriately, for example:

- Candidates wrote incorrect equations which were not corrected by the teachers.
- Many equations lacked state symbols.
- Some equations were incorrectly balanced, and were marked as correct.

The lack of emphasis on writing the correct symbols in formulae is again evident. For example, in many cases the symbol for sodium chloride was written as *NaCL* rather than *NaCl* and calcium carbonate as $CaCo_3$ rather than $CaCO_3$, without any evidence of correction in the students' books.

<u>Graphs</u>

More emphasis also needs to be placed on graph work. Twenty-five per cent of the centres submitted samples with unsatisfactory graph work. In addition, many teachers do not seem to be clear as to how and where graphs should be assessed. The plotting of graphs should be assessed under the ORR skills and not the AI skills. However, interpretations of the graphs can be assessed under the AI skills.

<u>General Assessment and Mark Schemes</u>

Teachers at a given centre are yet again encouraged to work together when planning and devising practical activities, as well as constructing marking schemes. Marking schemes are extremely important in the moderation process and it is difficult to adequately moderate a sample when

(1) the mark scheme does not correspond to the exercise shown in the books.

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

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

Mark schemes are extremely pertinent to the moderation process and in order to ensure candidates are not at a disadvantage, teachers are reminded to submit them to CXC along with the moderation package. A numbers of centres neglected to send Mark Schemes and some of those received were inappropriate and could not be used.

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

- All laboratory exercises should be corrected even if they are not being assessed for SBA purposes. This ensures that the student is given an opportunity to practise, hence sharpening their experimental skills and learning from their mistakes.
- It should be made easy to identify the Mark Schemes corresponding to the exercise.
- When there is more than one teacher at the centre the exercise assessed for SBA and hence the Marking Schemes should be the same. Where this is not possible, each exercise should be accompanied by an appropriate Mark Scheme.
- Marks should not be lumped together. Instead, each mark should be assigned to a specific content item, for example, when more than one mark is allotted for a calculation, a breakdown of how individual or partial marks are allocated should be included in the Mark Scheme.

- When students are expected to answer specific questions these questions, as well as their expected responses and the allocation of each mark, should be included in the Mark Scheme.

- For qualitative exercise, assessing ORR and AI skills, the unknown(s), tests carried out, the expected observation, and inferences should be noted in the Mark Scheme.

- For PD skills, the Mark Scheme should include the problem statement given to students, possible solutions, variables and so on.

- Ensure that an adequate amount of marks are allocated for an exercise while noting that **CXC does not award half marks**. For example, do not allocate five marks for an exercise which has more than five tests. Scale down the total mark of the exercise if necessary.

- All marks should be converted to out of ten.

- A maximum of two skills should be assessed per activity.

- If more than one skill is assessed per activity then the marks allotted for each skill must be clearly demarcated and not lumped together as one mark.

Planning and Design (PD) Skills

There are still major occurrences of standard exercise being utilized to assess PD skills. Teachers are encouraged to present scenarios to the students in the form of problem statements, which can be solved by standard chemical procedures or by employing sound chemical principles, covered in the CSEC Chemistry syllabus. Students should not have to come up with their own PD exercise for each assessment.

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

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

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

A housewife observed that cow's milk stayed fresh when placed in the refrigerator but when it was left on the kitchen counter over night she found that the milk had curdled. Plan and design an experiment to explain these observations.

Teachers are also reminded of the following:

- A reason or explanation is not needed in the Hypothesis.

- The main method to be used should be highlighted in the Aim.

- The procedure developed should theoretically satisfy the aim while being able to produce data which would "validate" the hypothesis.

- For data to be collected, if a table is drawn no results should be listed. Any PD lab carried out can no longer be assessed as PD.

- Where appropriate, controls and variables to be manipulated should be listed.

- It is suggested that one mark is not enough for procedure. There should be at least three marks:

    - Appropriate language and tense (1 mark)

    - Feasibility (1 mark)

    - Sequence (1 mark)

- Observations and Inferences should not be marked under PD.

- Equations and tests for gases should not be assessed under PD skills.

- Background information should not be assessed under PD. Instead, a problem statement must be given to the students by the teachers.

- It is recommended that aims should not begin with 'To plan and design…'

Analysis and Interpretation

The Analysis and Interpretation skill continues to be one of the better assessed skills. However, to ensure continued improvement the following should be noted:

- Observations should not be assessed under AI.

- Definitions should not be assessed under AI.

- Mole calculations should be done from first principle, using the unitary method. **CXC does not accept the use of the equation $M_1V_1=M_2V_2$.**