CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN SECONDARY EDUCATION CERTIFICATE
JANUARY 2008

CHEMISTRY

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GENERAL PROFICIENCY EXAMINATIONS

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THE STRUCTURE OF THE EXAMINATION

The examination consisted of four written papers. The weightings of these papers were as follows: Paper 01(25 per cent), Paper 02 (30 per cent), Paper 03(25 per cent) and Paper 042, the Alternate to School-Based Assessment (SBA), which contributed 20 per cent.

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

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

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

Paper 042, the alternate to SBA, was the practical paper consisting of three questions. This paper was written by all those candidates who scored below 50 per cent in their previous SBA assessment (Paper 04) or by those writing this examination as a first attempt. In the case of candidates who had scored 50 per cent and above in their SBA, they were allowed to carry forward their SBA grades to this examination.

Candidates were required to answer all three questions. In Questions one and two candidates were required to carry out experiments and record their results, plot graphs, perform calculations and draw inferences as required. Candidates were assessed under the profiles, Use of Knowledge (UK) and Experimental Skills (XS).

General Comments

Candidates' entry was about the same as 2007, with 656 candidates entered for the examination in 2008.

Candidate's overall performance was similar to that of 2007. While performance on Paper 01 was steady, performance on Paper 02 improved, but performance on Paper 03 declined.

Of significance is the overall improved performance on Paper 042, especially on Question 1 (which tested manipulative skills, observation/reading and recording as well as plotting of graphs), and Question 3 (planning and design). However, the poor performance on the qualitative analysis exercise (Question 2) continues to be of concern. It appears that students are taught to simply learn these tests (observations and inferences) without much emphasis on actually carrying out these exercises in the laboratory. Students need to be exposed to more practical exercises in qualitative analysis.

While there was a general improvement in the overall performance of candidates, especially with respect to questions based on organic chemistry, there are still some fundamental areas that need to be addressed. These include failure of candidates to read questions carefully. Very often candidates were asked to give ionic equations and instead gave balanced molecular equations. Also, candidates when asked to describe expected observations (for example, a gas evolved, vigorous effervescence, a coloured precipitate), instead identified the actual substances. Writing of the partial structures (or repeating unit) of polymers from their monomeric units continues to pose great difficulty for candidates. The difficulty of writing of the partial structures of polyesters is a case in point.

In Paper 03 many of the questions were answered very superficially giving the impression that many of the topics were not adequately covered by the candidates. Also, candidates continue to perform very poorly in the options in Section C which are not “biology or environmentally” oriented. The poor performance on the question on dyes and fabrics (Question 5) when compared to the one on soils (Question 6) is a case in point. This may be a reflection of inadequate classroom preparation on essential topics such as cement, clays, glass and fabrics. It is critical in a rapidly emerging technological society that students be properly grounded in all these topics at the secondary school level.

More detailed comments on the specific questions are outlined below.

DETAILED COMMENTS

Paper 01 – Multiple Choice

Performance on Paper 01 continues to be generally good. The mean and standard deviation were comparable to those obtained in 2007. Also, the performance on the equating items was very similar.

However, a number of candidates experienced difficulties with items based on the following topics:

- The smallest particle of a chemical compound which takes part in a reaction
- Products formed from the electrolysis of dilute sulphuric acid
- Definition of a mole of atoms of an element
- The process of anodizing
- Identification of a metal which forms a carbonate stable to heat

Paper 02

Question 1

This question covered the Syllabus Objectives A: 3.5, 7.2, 7.3, and 7.6, B2: 7.1, 7.2, 7.3 and 7.4.

Part (a)

Candidates were presented relevant experimental data related to the effect of concentration on the rate of the reaction between KIO_3^- and HSO_3^- ions. Specifically candidates were required to read the times (in seconds) on five stop watches corresponding to the different concentrations of KIO_3 used, present the data in a tabular format, plot a graph of 1/t against [[$KIO_{3]}$ and explain the shape of the graph.

In general, most candidates were able to correctly manipulate the raw data in the appropriate format required to complete the table. However, some candidates had difficulty converting *t* into 1/t as required. This created problems for such candidates when they attempted to plot the graph of 1/t versus [KIO_3]. Also, many candidates did not appreciate the meaning of the number of significant figures they attached to a value and had difficulty plotting these values on the graph.

In plotting the graph, some candidates struggled to interpret the y-axis scale and lost marks in their plot. A common mistake was for candidates to attempt to plot time (rather than reciprocal time) against [KIO_3]. For example, for *t* = 40s some candidates plotted 1/t = 0.40 on the y axis.

The explanation of the shape of the graph was the most challenging part of this question for candidates. They seemed more familiar with concentration – time relationships than with reciprocal times. As a result many candidates mistook 1/t for *t* and therefore instead of recognizing that 1/t varied directly with [KIO_3] they said that *t* varied directly with [KIO_3]. Also, many candidates came up with the correct relationship between [KIO_3] and the rate of reaction by looking at the data in the table rather than at their own graph, which in many cases were in contradiction to their stated relationship. This again demonstrated that they could not relate the use of 1/t to the rate of the reaction.

Part (b)

This part of the question tested the Syllabus Objectives B2: 7.1, 7.2, 7.3, and 7.4 and A: 3.5. Candidates were presented with details on various tests performed on a substance Q and the corresponding observations. They were required to make inferences based on these observations. Many candidates did not attempt this question (or parts of it). Those who did showed a lack of deductive reasoning.

None of the candidates were able to infer that a solid which is yellow when hot and white when cold is most likely zinc oxide. In addition, many did not indicate the charges on the ions and hence implied that the metals were present in solution rather than the metal ions. Also, in many cases the observed brown fumes which resulted from the addition of copper turnings followed by concentrated H_2SO_4 were identified by many candidates as Br_2. Even those candidates who correctly recognized that the brown gas was NO_2 could not infer that this indicated the presence of a nitrate (NO_3^-).

The continued poor performance over the years on questions related to qualitative analysis is of grave concern. It appears that students are inclined to simply learn the tests for these cations/anions/gases from the textbooks. They would need to be exposed to more laboratory practice in carrying out such learning activities.

Part (c)

In this part of the question the candidates were required to plan and design an investigation to find out which brand of beer had the highest percentage alcohol content. It was generally poorly done.

It was expected that candidates would have been able to link the apparatus and materials they detailed in (c)(i) to the method they proposed in (c)(ii). However, in many cases candidates simply listed apparatus and materials without giving a methodology. Thus, it was difficult in such cases to determine (and hence award marks) whether the apparatus/materials listed were appropriate to the proposed methodology. When methodologies were proposed they were often inappropriate and could not lead to the quantitative determination of the ethanol present in the beer sample.

Common but incorrect methodologies proposed included:

- formation of esters
- dehydration of plant tissues
- burning of the beer to remove the alcohol
- evaporation and measuring the residue
- the acidified dichromate test

In a number of cases where the appropriate methodology was described (fractional distillation), candidates could not correctly represent a fractionating column. Very often the condenser was left out. Also, when the condenser was included, the drawing indicated that the cooling water and the condensate would have mixed.

In Part (iii), where candidates were required to list one variable to be controlled, many incorrectly stated "the amount of alcohol placed in each flask" rather than "the volume of beer". Such responses were not credited.

In Part (iv), candidates were required to state one precaution. The responses clearly indicate that students simply learn a set of "generic" precautions and reproduce them when required without taking into consideration the experiment under investigation. As such, the suggested precautions (or variables to be controlled) often bear no relation to the stated experiment.

In Part (v), many candidates incorrectly indicated that the beer with the smallest percentage alcohol was the strongest which was opposite to what they stated in their hypothesis.

Question 2

This question covered the Syllabus Objectives A: 2.3, 2.5, 2.7, 2.8, 2.9 and 4.2. Specifically candidates were given the electronic configuration of two unknown elements and were required to:

- Deduce their atomic numbers
- Place them in the appropriate positions in the periodic table provided with explanation
- Classify them as metal or nonmetal with reason
- Comment on their relative reactivity with water
- Write a balance equation between one of these elements and O_2 and identify the type of bonding that exists in the oxide of this element

Part (a)

The majority of candidates were able to correctly deduce the atomic numbers (10 and 20) of X and Y, position them in the periodic table provided and classify them as metals. However, many had difficulty explaining their rationale for their placing X in Group II and Period 3, and Y in Group II and Period 4 respectively.

Part (b)

This required candidates to comment on the relative reactivity of Metals X and Y (same group but different periods) with cold water. This proved difficult for most students. More attention should be given to the reactivity series as well as to the variation in reactivity across the period as well as down the group.

Part (c)

This section also presented some challenge to the candidates. Many identified the bonding between X and oxygen to be covalent in spite of the fact that they correctly identified X as a metal.

Question 3

This question tested the Syllabus Objectives A: 6.15, 6.20, 6.21and 6.22. Specifically candidates were presented with two circuit diagrams and were required to:

- Identify the processes occurring in each case which will cause the bulb to light and to explain how these processes differ
- Identify a replacement for graphite which will cause the bulb not to light
- Give an example, with appropriate explanation, of a suitable replacement substance, Q, that will not cause the bulb to light as brightly as when P is used
- Identify the processes that occur at the electrode surfaces in Experiment II

Overall, the majority of candidates were able to obtain full UK marks but scored very poorly in the KC marks allocated.

Part (a)

Most candidates were able to correctly identify the processes (metallic conduction and electrolytic process) which cause the bulbs to light in both cases. However, the required explanation for the differences in these two processes proved to be challenging. It should be emphasized that in metallic conduction mobile electrons are responsible for carrying the charge, whereas in electrolysis the ions are involved.

Part (b)

Here most candidates recognized that replacement of graphite with a non-metal will cause the bulb not to light.

Part (c)

Most candidates recognized that P was a stronger electrolyte than Q and as such would cause the bulb to light brighter. However, they were not able to relate this to the relative number of ions present in solution (degree of ionization).

Part (d)

Most candidates correctly identified the cathode and anode but were unable to identify the processes (reduction and oxidation) occurring at these surfaces. Those that did had difficulty representing this in the form of ionic equations.

Question 4

This question tested the Syllabus Objectives B: 2.1, 2.2, 2.3, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10. In general candidates had great difficulty with this question. This poor performance in Organic Chemistry related questions has been occurring over the years. Greater emphasis should be placed on this section of the syllabus.

Part (a)

Many candidates did not recognize compound A (C_3H_6) as an alkene. As such they incorrectly represented its structural formula as that of an alkane. They also wrote a substitution reaction to represent its reaction with bromine (an addition reaction was expected). Teachers are urged to ensure that students are properly grounded in this section of the syllabus.

Part (b)

Here again many candidates incorrectly represented B (C_3H_8) as an alkene rather than as an alkane. As such, the reaction with bromine was incorrectly given as an addition rather than as a substitution reaction. Many of those who correctly recognized the reaction as a substitution reaction failed to include HBr as one of the products.

Part (c)

Most candidates recognized C and D as an alcohol and an acid respectively. However, describing a simple test tube reaction that can be carried out in the laboratory to distinguish between these two compounds proved to be challenging. Many described reactions (such as the alcohol will undergo dehydration to form an alkene) which are not test tube reactions, and were not credited. This point should be emphasized in the classroom. In describing simple chemical tests to distinguish between compounds, tests should be described which would result in some observable difference (colour change, formation of a precipitate, gas evolved, change in pH (effect on litmus).

With respect to Part (ii), candidates had great difficulty writing the equation for the reaction between the acid and the alcohol to form an ester. Students should be given practice exercises in writing out the full structures of the esters formed from such reactions. It should also be stressed that water is one of the products formed.

Question 5

This question tested the Syllabus Objectives B2: 5.1, 5.2, and 5.3. In general the question was poorly answered. From the responses it appears that the objectives on alloys were not covered in the preparation for this examination.

Part (a)

Candidates were required to list the main components of the alloys, steel and duralumin, and state how their properties differ from that of the starting materials. Many were unfamiliar with the composition of duralumin (copper and aluminum) and failed to include the components such as nickel, chromium and manganese as components of steel. Also, they were not able to contrast the properties of these alloys with that of the starting materials.

Part (b)

Candidates were unfamiliar with the properties of lead that allow it to be used as a component in solder (low melting point) and as a protective shield against X-rays (absorbing these rays). However, many were familiar with the environmental impact of lead as a pollutant.

Part (c)

This section was generally well answered. Candidates were able to correctly write the formulae for the oxides of sulphur, carbon and silicon and indicate their use in industry. However, many candidates were still carelessly writing the formula for CO as Co and SO_2 as So_2. Marks were deducted for this. These errors should be pointed out in classrooms.

Paper 03

Question 1

This question tested the Syllabus Objectives A: 1.2, 4.5, 4.7 and 4.8. Specifically, candidates were required to:

- Draw the lattice structure of diamond and sodium chloride
- Discuss how the melting point and conductivity of electricity are related to the structure of diamond
- Account for the differences in melting points of magnesium oxide and sodium chlorides
- Account for the electrical conducting properties of graphite
- Predict the type of lattice structure in solid air fresheners

Part (a)

Most candidates were able to correctly represent the lattice structures of diamond and graphite. However, very often the tetrahedral arrangements of the carbons in diamond were not properly represented. This point needs to be stressed in the classroom.

Most candidates were able to relate the high melting point of diamond to its giant covalent lattice. However, with respect to conduction of electricity, many confused graphite (a conductor) with diamond (a non-conductor) and as such incorrectly stated that it was the mobile electrons in diamond that were responsible for conduction.

Part (b)

Although the question stated that both sodium chloride and magnesium oxide have giant ionic lattices, many candidates attempted to account for the observed differences in melting points in terms of “intermolecular forces”, “covalent bonds”, and “van der Waals forces” rather than in terms of differences in the force of attraction (lattice energy) between the ions in the lattice structure (differences in charge and size of the ions).

With respect to conduction of electricity by graphite, most candidates correctly attributed this to the mobile electrons. However, a significant number confused the sliding of the layers (lubricating properties) as being responsible of its conducting properties.

Part (c)

This part of the question proved challenging to most candidates. Here candidates were expected to use their knowledge of the properties of compounds with various types of lattice structures to predict that since solid air fresheners are volatile, the forces of attraction between the particles would be expected to be very weak and hence would most likely have simple covalent structures.

Question 2

This question tested Syllabus Objectives A: 3.3, 6.5, 6.7, 6.10 and 6.12. Specifically, candidates were required to:

- Distinguish among the terms alkali, strong alkali and weak alkali
- Sate the name and use of a strong alkali used as a household chemical
- Write the equation for the formation of lime from limestone
- Explain whether sodium sulphate and calcium sulphate can be prepared by observing changes in temperature during neutralization by an acid
- Calculate the percentage yield of salt formed by a neutralization method.

It was the less popular of the two questions in Section A. The performance of candidates was generally poor. Many demonstrated inadequate knowledge of scientific terms, procedures for preparing salts and the balancing of chemical equations.

Part (a)

Many failed to score marks in this section as they were unable to give reasons for distinguishing bases as alkali, strong alkali and weak alkali in terms of their solubility and degree of ionization. Also, many confused acids and alkalis by attempting to define alkalis in terms of H^+ ions rather than in terms of OH^- ions. Typically, vinegar and ammonia were frequently and incorrectly given as examples of a strong alkali used as a household chemical.

Part (b)

Most candidates failed to score marks here simply because they did not know the formula for lime (CaO). Also, many incorrectly included oxygen as one of the products formed from heating limestone ($CaCO_3$).

Part (c)

Part (c)(i) of the question was very poorly answered. Candidates failed to distinguish between the solubility of sodium sulphate and calcium sulphate and as such concluded incorrectly that calcium sulphate rather than sodium sulphate can be prepared by a neutralization reaction. Also, many candidates were unable to write the correct formula for sodium sulphate (Na_2SO_4).

In Part (c)(ii), most candidates recognized the reaction as exothermic and hence the point of neutralization would have corresponded to the maximum temperature rise as neutralization proceeded.

Most candidates failed to score marks in Part (c)(iii). It is evident from the responses, that students were programmed to learn a set of generic limitations associated with the conduct of basic experiments. However, in most cases the limitations given bore no relationship to the actual experiment under investigation. Teachers are urged to point out to students that precautions/variables/limitations should be related to the experiment under investigation.

In Part (c)(iv), most candidates were unable to describe the method for calculating the percentage yield of the salt produced. A common misconception was that the theoretical yield can be calculated from the mass of the substances in the reaction flask rather than from the volumes of acid and base used.

Question 3

This question tested the Syllabus Objectives B1: 2.7, 2.8, 3.3 and 3.4. Specifically, candidates were required to:

- Show by means of chemical equations the preparation of ethanol from ethene and glucose
- Draw a fully labeled diagram of the apparatus used to obtain pure ethanol from fermentation mixture of sugars
- Use an ionic equation to represent the reaction which occurs when white wine reacts with acidified dichromate ions

- Use an equation to illustrate the production of ethene from $C_{14}H_{30}$ by catalytic cracking
- Specify a reagent which can be used to distinguish between ethanol and ethanoic acid in the laboratory

Part (a)

Most candidates were familiar with the methods and the corresponding equations for preparing ethanol from glucose (by fermentation) and ethene (by hydration). However, the conditions for these two reactions were often not stated or incorrectly stated in a number of cases.

Part (b)

Most candidates were able to gain marks for drawing the distillation apparatus. However, diagrams were often carelessly drawn. The water inlet/outlet to the condenser attached to the fractionating column was often represented to indicate that the water would have mixed with the distillate rather than served as a cooling agent. Correct drawing of condensers (double surface reflux verses air condensers) should be stressed in the classroom.

Part (c)

Many candidates did not recognize that (white)wine contains ethanol and as such would be oxidized by acidified dichromate as demonstrated by the latter changing from orange (Cr^{6+}) to green (Cr^{3+}). Many who did, incorrectly stated that it was the dichromate which was oxidized rather than the alcohol. This is a common mistake repeated year after year where candidates state that the oxidizing agent is the species which is oxidized during a redox reaction. This misconception needs to be corrected in classrooms.

Part (d)

Most candidates were familiar with the process of catalytic cracking and were able to represent this process by means of an equation using $C_{14}H_{30}$ as an example.

Part (e)

Most candidates incorrectly gave sodium as the reagent which could be used to distinguish between ethanol and ethanoic acid in the laboratory. Hydrogen would be liberated in both cases and as such would be unsuitable. It needs to be stressed in the classroom that tests to distinguish between compounds in the laboratory refer to test tube type reactions where changes in colour/precipitate formation/gases evolved can be readily observed.

Question 4

This question tested Syllabus Objectives B2:1.1, 1.2, 1.3, 2.1, and 8.3. Specifically, candidates were required to:

- Name and explain the extraction process by which W and Y can be extracted from their respective ores given their positions in the reactivity series
- Write a chemical equation to represent the extraction process of W from its ore, WO.
- Compare, using relevant equations, the properties of metals and nonmetals with respect to their reaction with oxygen to form acidic/basic oxides and their oxidizing/reducing powers
- Suggest a reason why the oxides of nonmetals rather than metals were more likely to pollute the atmosphere

Part (a)

Most candidates correctly selected electrolytic reduction as the most suitable method for the extraction of W from its ore and related this to its position high up in the reactivity series. However, few were able to write a chemical equation to represent this reduction process. With respect to Y, most candidates correctly selected reduction by a reducing agent such as C or CO. However, a number incorrectly gave direct heating of the oxide as the method of reduction.

Part (b)

Most candidates knew that metals and nonmetals react with oxygen to form basic and acidic oxides respectively. However, the majority were not able to write appropriate chemical equations to illustrate the basic/acidic nature of these oxides. Similarly, most candidates knew that metals can act as reducing agents and non-metals as oxidizing agents. However, many could not illustrate this in terms of appropriate equations.

Candidates also had great difficulty suggesting a plausible reason as to why the oxides of nonmetals (rather than metals) are more likely to pollute the atmosphere. They failed to make the connection between the bonding in these two types of oxides (giant ionic lattice in metal oxides versus small covalent molecules with weak intermolecular forces in the case of the oxides of nonmetals), and their ability to volatize and disperse into the atmosphere.

Question 5

This question tested Syllabus Objectives C 2.0, 5.7, 5.8 and 5.9. Specifically, candidates were required to:

- Classify linen and polyester fibres as natural or synthetic
- Draw structures to represent the monomeric units of these fibres and how they are linked to form macromolecules
- Suggest observable differences that might be noticed upon exposure to sunlight and washing fabrics made from these two sets of fibres
- State the general properties and the chemical principles upon which dyes work
- The steps which should be taken prior to applying methelene blue dye to fabrics

This question was poorly answered. The responses lead one to conclude that this topic was not covered by the candidates in the classroom.

Part (a)

The majority of candidates were not familiar with the fact that the repeating monomeric unit in linen fibres is glucose. The few who knew this could not accurately represent the linkage of these monomeric units (three of them) to form the macromolecule present in the fibres. Candidates continue to have great difficulty representing the ester functional group.

Similarly, although most knew that an ester was the repeating unit, they were unable to illustrate the linking of this monomer to form the polyester. Practice in writing partial macromolecular structures from corresponding monomer units should be stressed in the classrooms.

Part (b)

The responses clearly indicated that candidates were totally unfamiliar with the types of fabric dyes and their mode of action. It needs to be stressed that to be effective a dye must penetrate the fabric and remain there (not readily washed out). This can occur due to a chemical affinity between the dye and the fabric (presence of acidic/basic groups) OR to the formation of insoluble coloured compounds which remain in the fabric. The importance of mordants in helping dyes adhere to fabrics also needs to be stressed.

Question 6

This question tested Syllabus Objectives C: 2.0, 5.7, 5.8 and 5.9. Specifically, candidates were required to:

- Discuss the nature and importance of humus
- Describe a laboratory method for measuring the pH of a soil sample
- Discuss an appropriate method for reducing the acidity of soil
- Design an experiment to investigate the effects of the deficiency of a named element on plant growth

Part (a)

Most candidates demonstrated a good understanding of the composition of humus and its importance in soil. However, the important role of microorganisms in soil fertility was not evident in the majority of responses.

Part (b)

In describing the laboratory procedure they would use to determine soil pH, most candidates simply stated that they would test the soil (dry?) with blue litmus paper. No indication was given that the soil sample should have been extracted with water and as such were not fully credited. It should be stressed in the classroom that the test with moist litmus paper would simply indicate whether the soil is acidic and would not give the actual pH value. The use of a pH meter (details not required) would have been more appropriate.

Most candidates were able to name a suitable substance (limestone, lime, hydrated lime, dolomite limestone) used to reduce soil acidity. However, they had great difficulty explaining, with the use of a relevant chemical equation, how the named chemical substance can bring about the reduction in pH. A simple acid base neutralization reaction ($H^+ + OH^-$ H_2O) was expected.

Part (c)

Whilst most candidates were able to name an element essential for plant growth, the majority had great difficulty designing an appropriate set of experiments to investigate the effect of the deficiency of this element. Of concern was the lack of control experiments in the candidates' designs. This aspect of planning and design needs to be emphasized in the classrooms.

Paper 042

Question 1

This question tested Syllabus Objectives A: 8.1 and 8.3. Specifically, candidates were required to calculate the heat of solution for potassium nitrate from data obtained by dissolving 5g of potassium nitrate in 50 cm^3 of water and measuring the observed temperature change at 1 minute intervals for 10 minutes. The data was used to plot a graph of temperature against time.

Most candidates did well on this question obtaining more than 12 of the 25 marks, with a significant number scoring more than 18 marks. This was due mainly to their performance on recording the temperature changes and plotting the graph.

Part (a)

While a large number of candidates were able to record accurate temperature readings, a number recorded values such as 2.8 ^{0}C, instead of 28 ^{0}C. Others read the thermometer to ±0.1 ^{0}C although it was calibrated to ±1 ^{0}C. In completing Table 1, a number of the candidates did not calculate the value of " T as required.

Part (b)

For (b)(i) most candidates were able to accurately plot graphs using their data although some had a difficulty selecting an appropriate scale.

In (b)(ii) many candidates did not use their graphs as required to determine the maximum value for "T. Instead they used their raw data from their tables to deduce this value.

Part (b)(iii) posed the greatest challenge for the candidates. Far too many candidates confused the shape of the graph with that for the energy profile diagram for an exothermic reaction and concluded incorrectly that the reaction was exothermic.

The more alert candidates correctly deduced that the reaction was endothermic due to the reduction in temperature during the reaction.

In (b)(iv), most candidates who attempted this section knew how to do the calculation but lost marks due to careless mistakes. These include:

- Using the incorrect value for the molar mass of KNO_3. A number of candidates used 69 instead of 101 suggesting that an incorrect formula (KNO) was used instead of KNO_3.
- In determining the mass of the mixture to be used to calculate “H, many added the mass of the water (50 g) to that of the potassium nitrate (5 g).
- While almost all candidates were able to convert grams to kilograms they were unable to determine the heat produced by 1mol of potassium nitrate given the heat produced by 5 g.

Question 2

This question was the qualitative analysis question and tested Syllabus Objectives B: 7.1, 7.2 and 7.3. Candidates were required to perform tests on the solid sample, M, and record their observations as well as inferences based on the observations.

Overall, the question was not well done. Approximately 70 per cent of the candidates scored less than 7 out of a possible 13 marks and less than 8 per cent scored 10 or more out of 13.

General Comments

- Many candidates did not pay attention to critical observations. While they readily noted colour changes, they failed to record the formation of gases or precipitates.
- A number of candidates incorrectly used the word “filtrate” in place of the word “precipitate”, presumably because they were asked to filter.
- Far too many candidates did not differentiate between the ions and the element. For example, instead of writing Pb^{2+} or ***lead ions*** present many of them recorded ***lead*** as being present.

In (i), candidates were required to heat the sample strongly and were expected to observe a brown gas evolved. Instead many candidates focused their observations on the remaining residue and the “popping and sizzling” sound but made no mention of the obvious brown gas evolved.

In (iii) (a, b), candidates were required to add separately aqueous (a) sodium hydroxide and (b) ammonia slowly until in excess to a solution of the sample. The responses clearly indicate very poor technique. Apparently, many failed to add these reagents drop by drop with shaking. As such, many failed to recognize the solubility of the precipitate in the presence of excess of the reagent. This technique should be strongly emphasized in the laboratory.

In (iv), most candidates reported the formation of a "cloudy yellow solution" rather than a yellow precipitate. This again points to poor experimental techniques. Some candidates were also unable to write a balanced ionic equation for the reaction between Pb^{2+} and I^- ions. In general, it appears that students simply learn from their texts the tests for various cations/anions/gases. Teachers need to carry out more laboratory exercises in qualitative analysis with their students, paying special attention to the techniques.

Question 3

In this question candidates were given an "extract" from a student's note book which outlined the procedure used by the student to determine the volume of sodium hydroxide required to react with $25cm^3$ of three different brands of rust remover. Based on this information, candidates were required to:

- Suggest a possible hypothesis the student may have wanted to test
- List the apparatus and materials required
- Construct a suitable fully labeled table to show relevant experimental results the student may have gathered
- List possible precautions and variables to be controlled
- Discuss whether the results gathered supported or contradicted the hypothesis

This question was generally poorly answered. Candidates had great difficulty suggesting a possible hypothesis. Most instead stated an aim. Teachers are urged to have this distinction fully discussed in class, utilizing appropriate examples in order to help students to distinguish between these terms.

Candidates also had great difficulty differentiating between a "precaution" and a "variable that needs to be controlled". Candidates were simply stating variables and precautions which had absolutely no bearing on the experiment.

With respect to the construction of a fully labeled table, many candidates failed to:

- Indicate the initial and final burette readings
- Record burette readings to one decimal place
- Give a minimum of two titre readings for each rust remover titrated