Part 1: Statistical Information

The examination consisted of three papers namely; Paper I, containing 9 compulsory, structured questions; Paper II, which contained 8 longer-answer questions from which students choose 5; and Paper III, a practical examination which contained 3 compulsory questions. Paper I and II each carried 40% of the total mark while Paper III carried 20%.

Five hundred and one students registered for the May 2014 examination and, of these, 489 candidates presented themselves for examination.

The grade distribution was as shown below.

<table>
<thead>
<tr>
<th>GRADE</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>Abs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>42</td>
<td>94</td>
<td>147</td>
<td>66</td>
<td>62</td>
<td>78</td>
<td>12</td>
<td>501</td>
</tr>
<tr>
<td>% of Total</td>
<td>8.38</td>
<td>18.76</td>
<td>29.34</td>
<td>13.17</td>
<td>12.38</td>
<td>15.57</td>
<td>2.40</td>
<td>100</td>
</tr>
</tbody>
</table>

The average mark obtained in Paper 1 was 10 percentage points higher than in Paper 2 and in the practical paper, the average mark was 7 points higher than in Paper 1. There were 27.1 % of candidates who got a grade A or B, which is 1.2 percentage points higher than in 2013.

Detailed discussion of each of the questions in the examination is given below. This should be read in conjunction with the examination papers.
Part 2: Comments regarding candidate’s performance

Paper I

In Question 1, on the nucleus, nuclear reactions and nuclear decay, the average mark obtained was of 6.7/10. The vast majority of the students obtained marks greater than 6 in this question. By far the largest problem was encountered in the calculation involving half-lives.

Question 2 dealt with two different aspects. Firstly the question dealt with the redox reaction between Cl₂ gas and aqueous sodium hydroxide, secondly students were asked to determine the volume of chlorine gas, at 1 atm and 298 K. The question was, on the whole, very well answered and the average score in this question was 6.3/8. Once again, the part of the question that caused most problems to students was the calculation which in this question dealt with the ideal gas equation.

Question 3 dealt with acids and bases. The average mark for the question, 10.6/13, was rather high. The students who scored below the average mark for this question were generally able to identify the acid, base, conjugate acid and conjugate base in the dissociation of ethanoic acid in water as well as writing an equation for the dissociation constant of the acid in water. Calculations and explanation of sodium ethanoate on the dissociation of ethanoic acid in water proved problematic for a number of students.

In Question 4, the average mark was 8.2/13. Problematic parts of the question concerned the observation that some elements deviate from the general trend of ionisation energy across Period 3, the trend in ionisation energy in Group 1, and the identification of the element with the greatest atomic radius in Period 3.

The average mark in Question 5 was 6/11. The question dealt with bonding in ammonium chloride, the structure of the ammonia and the ammonium molecular ion, the solubility of ammonia in water and the conductivity of HCl in water and in ethoxyethane. Difficulties were encountered in all areas especially the parts dealing with the bonding in ammonium chloride and the conductivity of HCl in water and in ethoxyethane.

Question 6 dealt with chlorides of Period 3 elements. The average mark in this question was 6.6/14. Common mistakes were in the Hess Law calculation for the determination of the average bond energy of the P–Cl bond, and also the observations expected on addition of sodium hydroxide solution to aqueous solutions NaCl, MgCl₂ and AlCl₃.
The average mark for **Question 7** was 4.9/9. The most common problem was the bromination of methylbenzene where a significant proportion of students did not give the correct products. Consequently, a large number of students could not explain why the only isomers produced were the only ones possible.

**Question 8** concerned geometric isomerism and reactions of geraniol. The average mark for the question was 5.6/11. Most marks were lost for reactions of geraniol and also for the mechanism of the reaction between geraniol and 1–chloro–2–methylpropane.

**Question 9** tested knowledge of nitrogen containing organic compounds. The average mark in this question was 5/11. A significant number of students had problems giving the structures of the compounds that can be used to synthesise Alizarin Yellow R as well as giving the intermediates and conditions for the reaction. Whilst most students were able to label the amines and the ammonium salt, most found difficulty in identifying a peptide link and also how the link can be synthesised using ethanamide.

**Paper II**

**Question 1** was chosen by 86% of the candidates and the average mark was 10.6/20. The majority of students answered part (a) reasonably well. Although there were a few candidates who exhibited poor knowledge of structures, the concept of hydrogen bonding seemed to be well-understood. In part (b), most of the respondents were aware that different conditions give rise to different products, and how the benzene ring is activated and gave the requested reactions. In part (c), although Markovnikov’s Rule was well grasped by the majority of the candidates, not many respondents attempted to draw the mechanism of the reaction. The added stability of the carbocation in the transition state was not mentioned by a significant number of the candidates who chose to answer this question. The majority of answers to part (d) question were somewhat disappointing as most candidates showed no in-depth knowledge of the strength of the bonding and many seemed unaware of how the bonding affects the chemistry and reactivity of the different hydrocarbons. In fact, there was a lack of examples in answers to this part of Question 1. Part (e) was concerned with distinguishing between 1-hexanol and 1-propanoxypropane. Most respondents could distinguish between the compounds by chemical means. There were some problems when it came to distinguish them via mass spectrometry.

**Question 2** was chosen by 67.5% and the average mark was 11.5/20. Part (a) of this question did not trouble most of the candidates. A few respondents omitted to write the equation for the reactions. Others confused IR spectroscopy with mass spectroscopy, and it seems that not many
were aware of the C=O stretch and most of respondents mentioned wavelengths, showing that at least they have some knowledge of this type of spectroscopy. Part (c) of the question did not trouble most of the respondents. The reagents given were for the most part correct. Conditions of reaction were in some cases omitted. In part (d)(i) oxidation reactions of aldehydes and decarboxylation reactions to decrease carbon chain were for the most part answered correctly. In part (d) (ii) the pathway from the aldehyde to hexanonitrile involved more than one correct pathway and it seems that the majority were in control of what they were doing and not just randomly giving reactions and conditions.

The response rate for this Question 3 was 55.89%. The average mark was a meagre 6.3/20. This average mark gives a clear indication that the subject matter was not well understood by the respondents. It is superfluous to delve into problems with each part. The examiners feel that future candidates should give due importance to the subject matter for this question.

Only 25.35% of the cohort opted to answer Question 4. This probably reflects the lack of confidence of students to carry out mathematical questions involving moles. The average mark was 9.5/20. The performance of candidates in such questions is worrying and needs to be improved. In part (b), weak responses did not show awareness of the degeneracy of the orbitals or how the difference in colour arises. Only a small number of respondents mentioned the d-d transitions.

Question 5 was selected by 43% of the participants, scoring an average mark of 11.7. Most of the candidates did well in parts (a) and (c), while most of the marks were lost in part (b). In part (b), the candidates were asked to outline the laboratory preparation of hydrogen from different reagents, however most did not attempt to answer the question. In part (d) most of the candidates did not give a correct example and equation for a homogeneous catalyst.

Question 6 was chosen by 83% of the candidates, with an average mark of 9.8. Most of the students did well in part (b), however marks were lost in section (iii), since most did not mention Raoult's law and Azeotropic mixtures. In part (a), most of the candidates did not take into account the effect of steric hindrance on the boiling point of the different alcohols. In part (c), most of the candidates did not give the correct synthetic route for the formation of product D.

Question 7 was chosen by 44% of the candidates, with an average mark of 9.3. Marks were lost in both part (a) and part (b) in the large majority of cases. In part (a) most of the candidates did not complete the calculation, since most did not calculate the amount of energy released per mole of cyclohexane combusted. In part (b), most of the marks were lost in section (iii) and (iv). In section (iii) most of the candidates failed to explain how an endothermic reaction can become energetically feasible.
**Question 8** was chosen by 72% of the students with an average mark of 11.2. Most marks were lost in part (a), since most of the candidates did not give a suitable equation to explain how the rate equations and order of a reaction with respect to different reactants is dependent on the rate determining step. Furthermore, in part (b), most of the candidates did not show how the concentration of the reactant changed with time, but instead plotted the change in product concentration with time. In most cases, the candidates did not state how 2nd order reactions can be distinguished from 1st order reactions.

**Paper III**

This practical paper contained three compulsory questions, namely Q 1 on volumetric analysis and Qs 2 and 3 on the qualitative analysis of inorganic and organic substances respectively.

The average mark for **Question 1** was 35/50. The majority of the marks were lost in the titration exercise although a number of students answered the calculations poorly.

**Question 2** was answered fairly well with the average mark being 16.5/25. Marks were lost mainly in the inference parts of the question.

**Question 3** was answered fairly well with the average mark being 15/25. As in the case of **Question 2**, marks were lost in the inference parts of the question.

**Chairperson**

**2014 Examination Panel**