AM EXAMINERS’ REPORT MAY 2009

AM Chemistry
May 2009 Session
Examiners’ Report

Part 1: Statistical Information
The table below shows the grade distribution for the May 2009 Session

<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>62</td>
<td>54</td>
<td>130</td>
<td>53</td>
<td>50</td>
<td>122</td>
<td>17</td>
<td>488</td>
</tr>
<tr>
<td>% of Total</td>
<td>12.70</td>
<td>11.07</td>
<td>26.64</td>
<td>10.86</td>
<td>10.25</td>
<td>25.00</td>
<td>3.48</td>
<td>100</td>
</tr>
</tbody>
</table>

The examination consisted of three papers namely, Paper I, which contained 9 compulsory questions, Paper II, which contained 8 questions from which students choose 5 and Paper III, a practical examination which contained 3 compulsory questions. There were three versions of Paper III each of which was taken by approximately a third of candidates. Papers I and II each carry 40% of the total mark and Paper III carries 20%.

Four hundred and eighty eight candidates registered for the May 2009 examination which is 49 more candidates than in May 2008 and, of these, 471 candidates actually took all three papers of the examination.

A higher percentage of candidates (1.9%) scored a grade B or better in 2009 compared with 2008 but 7.7% more candidates failed the examination: the higher failure rate is likely to be a reflection of the fact that last year’s marks were inflated by award of ‘compensation marks’ due to a misprint in the paper; moreover, one may conclude that the higher scores obtained in the higher grades reflect significantly better prepared stronger candidates.

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 performance

2.0 General Comments

Paper I

Question (Q) 1 tested periodic trends in atomic structure and candidates gave answers that, although showing familiarity with the subject matter, often revealed a lack of proper understanding of some pretty basic principles: in some cases, students confused between cation and anion and were unable to distinguish between the properties of protons, neutrons and electrons.

Performance in Q 2, which tested structure and bonding and the concept of acid-base theory and pH, was good. Some candidates appear not to have understood the use of VSEPR theory as a tool to predict shapes of molecules.

Q 3 was on the application of Hess’s Law and equilibrium theory: Le Chatelier’s principle and its application appears to be well known to students. In multi-step calculations, students tend to drop the accuracy of intermediate values down to one significant figure resulting in considerable error in the final result.

Q 4 employed the structural formula of melamine to test knowledge of the difference between empirical and molecular formulae which proved quite challenging to many students: on the other hand, orbital hybridization appears to be well understood as is the relationship between structure and physical properties of a substance.
In Q 5, on the chemistry of chlorates, most students could determine the empirical formula from analytical data but several answers revealed a serious lack of knowledge of halogen chemistry. Thus, chemicals with such improbable formulae as Na$_4$Cl$_4$O$_{12}$ and Na$_2$Cl$_3$ featured among the proposals and frequently, chemical equations were not balanced.

Performance in Q 6 on the chemistry of s-block elements was fair. Most students correctly identified the products of strong heating of nitrate salts and of addition of sulfuric acid to MgCO$_3$ or BaCl$_2$. Some common errors included the inclusion of oxygen (rather than hydrogen peroxide) as a product of reaction of BaO$_2$ and water, attempting to write a reaction between MgO and NaOH, and listing Be(OH)$_2$ as a product formed when BeO reacts with NaOH.

Students performed quite well in Q 7, with a good number providing correct structural formulae for organic substances as required. A common error was in failing to realise that in order to be unreactive towards bromine water, the structural isomer of but-2-ene must be a cycloalkane.

Overall performance in Q 8 on the chemistry of cyclohexanol and its reaction products was not very good: students frequently failed to give correct conditions for the reactions in parts (a) and (b). In part (c), benzaldehyde or benzoic acid were frequently given as products of oxidation of cyclohexanol. In part (e) most students correctly identified the organic product as the alkoxide of cyclohexanol but listed the side product as H$^+$ or NaH rather than H$_2$.

Performance in Q 9 on the mechanism of Friedel-Crafts methylation was fair. Most students did well in part (a), correctly identifying the electrophile and outlining the alkylation mechanism. However a significant proportion of students used a curly arrow to show attack by an electron pair of the electrophile on the ring (arrow pointing towards the ring) rather than the other way round. In part (b) a number of students failed to state that heating was necessary for the reaction to happen. In part (c), the commonest errors amongst those students who correctly identified P were identifying Q (or R) as phenol, and subsequently giving the structural formula of S as phenyl benzoate rather than phenylmethyl benzoate.

**Paper II**

In this paper, students are expected to organize and write longer answers than in Paper I where the questions are highly structured. It was observed that the English was frequently of a poor standard, and in some cases, the answers were so badly organized that it was difficult to understand the arguments being developed.

Q 1 was a popular question and was attempted by 63% of candidates: the average mark was 40%. The most common mistake was committed in part (a): some candidates regarded LPG as a single compound instead of a mixture of gases (as explicitly stated in the paper) and most could not deduce the mole fraction from the given data. Several candidates interpreted the term ‘liquefied’ to mean ‘dissolved in a solvent’ and even invoked Raoult’s Law in the answer.

Only 28% of candidates attempted Q 2 on the chemistry of non-metals obtaining marks as in Q1. Frequent mistakes included failure to identify yellow solid B as sulfur and inability to write correct redox equations for reaction of iodide with sulfate. In part (b) a number of candidates thought F was KHSO$_4$ rather than the normal sulfate. Almost all candidates failed to describe correctly the reaction of iodide and chloride with concentrated sulfuric acid in part (c).

Q 3 was attempted by 65% of students but the average score was 34%. Most candidates answered part (a) correctly but the calculation in (b) proved to be a major hurdle. The vast majority did not realize that in the calculation one should also have taken into account the pH of the solution. Answers to part (d) were a mixed bag with the following common mistakes (among others): wrong explanation of chromatography, stating that amphetamine reacts with CHCl$_3$ or that it dissociates to give H$^+$, failure to recognise CHCl$_3$ as an organic solvent.
Performance in Q 4 was better than that in several other questions in this paper. Part (a) was generally answered largely correctly with some marks being lost occasionally for writing incorrect reaction conditions. In part (b) on the kinetics of decomposition of the diazonium salt, several candidates could not deduce correctly the value of \( k \) from the half-life and using the simple algebraic equation: \( t_{1/2} = \frac{0.693}{k} \). In part (b)(iii) a number of candidates wrote that by increasing the temperature of reaction one lowers the activation energy.

Q 5, on transition elements and their compounds, was chosen by 42% of the candidates and performance was rather mediocre. While part (a) was well answered, in part (b) most of the candidates did not write the chemical equation to reflect alkaline conditions thus:

\[
5 \text{MnO}_2 + 2\text{NO}_3^- + 8 \text{OH}^- = 5 \text{MnO}_4^{2-} + 4 \text{H}_2\text{O} + \text{N}_2.
\]

This caused some loss of marks although partial credit was given to answers showing the equation written as:

\[
5 \text{MnO}_2 + 4 \text{H}_2\text{O} + 2\text{NO}_3^- = 5 \text{MnO}_4^{2-} + 8 \text{H}^+ + \text{N}_2.
\]

In part (c) most of the candidates identified the compounds involved correctly, however most could not state which substance was formed on reaction of CuI with ammonia (\([\text{Cu(NH}_3]^+\)).

Q 6, on conversions in organic chemistry, was a popular choice (67%) and the average mark was good (65%). The most common mistake in this question was in part (e), involving a decarboxylation reaction, where most of the students stated that the carboxylic acid converted into an alkene. In parts (a) to (d), some marks were lost due to lack of mention of essential experimental conditions.

In Q 7, attempted by 58% of candidates, parts (a), (c) and (e) were answered correctly by most; frequent mistakes in part (d) included failure to mention and explain how delocalization in phenoxide and ethanoate ions help explain the acidity of phenol and ethanoic acid respectively. In part (b) on the spontaneous endothermic dissolution of ammonium nitrate in water most of the students did not involve in their explanation the entropy change and the Gibbs free energy change of the reaction.

Q 8, on a Grignard reagent, was the most popular question (74%) and the average mark was 52.5%. In part (a) most students stated that the carbanion was ‘MgBr’ rather than \( \text{CH}_3\text{CH}_2^- \). Part (c) was often answered correctly, while in part (d)(ii) several students could not distinguish between pentan-2-ol and pentan-3-ol using a simple iodoform test and instead suggesting such long winded (and inappropriate) approaches as dehydration followed by ozonolysis.

**Paper III**

There were three versions of this practical paper and each contained three compulsory questions namely Q 1 involving volumetric analysis, Q 2 involving qualitative analysis of inorganic substances and Q 3 that of organic substances.

The identity of each of the unknowns set in this paper in Q 2 and Q 3 were as follows: G = lead acetate; H = zinc chloride; X = butanal; Y = butanone; P = copper carbonate; V = ethanol; W = butan-2-ol; I = copper(II) chloride; J = chromium(III) chloride; Z = benzamide.

Chairperson
Board of Examiners
July 2009