Examiners' Report
Principal Examiner Feedback

October 2019

Pearson Edexcel International Advanced Subsidiary Level
In Chemistry (WCH12)
Paper 01 Unit 2: Energetics, Group Chemistry, Halogenoalkanes and Alcohols

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Introduction
This paper was the second one for the International Advanced A Level WCH12.

In the new specification, there is a requirement to ensure 20% of the marks available assess mathematical skills at Level 2 (GCSE equivalent). Many candidates displayed a good ability to apply their mathematical skills to problems especially when questions were set in a familiar context, e.g. determining the mass of magnesium hydroxide needed to neutralise an amount of hydrochloric acid. However, calculating the concentration of sulfur dioxide in the air in parts per million proved challenging for many.
There was a wide variation in the understanding of the interactions between molecules in the liquid state. Diagrams showing hydrogen bonding were largely correct, although more attention should be paid by candidates to matching their correctly stated bond angle with their drawing. Answers involving solvent/solute interactions often betrayed a superficial understanding, e.g. a "like dissolves like" approach rather than considering which types of intermolecular forces are operating between the molecules in the question.

For only the second time on the IAL specification, paper 2 contained a 6 mark extended writing question. Some candidates were very well-prepared for this style of question and scored high marks. It was disappointing when candidates who showed a good understanding of the Maxwell-Boltzmann distribution of energies on collision theory in their written answers, lost marks by a lack of attention when drawing diagrams.

The information provided in the questions is carefully designed to guide candidates in their responses. Candidates were asked to compare their calculated value for the enthalpy of combustion using bond enthalpy values with experimental data provided. Many answers showed that they had considered the reverse situation and gave differences based on experimental errors.

Multiple Choice
The mean mark for the multiple choice questions was 14.0. The highest scoring questions were 1 and 5(b), with over 90% of candidates achieving these marks. The most challenging questions were 3 and 9(a), with less than 40% of candidates achieving this mark.

Question 16

(a) The balanced symbol equation was generally well known but some candidates with calcium hydroxide as a product failed to check the balancing of the equation and omitted the hydrogen also produced.

(b) When answered well, candidates demonstrated a clear understanding of the trends in solubility in group 2, and why some solutions are more alkaline than others. Where one mark was gained on MP2, it was generally because, having stated that calcium hydroxide was more soluble than magnesium hydroxide and gained the mark, they went on to reinforce this by saying that hydroxides are more soluble going down group 2 thinking that they were making a separate point; whereas they were simply reinforcing the mark already gained. MP1 was less seen as candidates mainly focused on solubility and forgot to consider the alkalinity of the resulting solution, or just made a vague statement about change in pH.

(c) Many struggled to come up with the correct ionic equation in part (i), and even those who knew the relevant ionic species on the left-hand side of the equation made a mistake either with the charge on the carbonate ion or in the balancing of the whole equation. Most, however, redeemed themselves in part (ii) and were able to quote from memory a correct equation for the “lime water” test and the state symbols here were almost always correct.

(d) The mass of magnesium hydroxide was correctly evaluated by most candidates, but it was disappointing to see a perfectly executed answer penalised because of a failure to express the answer to an appropriate number of significant figures.

Question 17

(a)(i) The names, classification and skeletal formulae of alcohols were often correct. The most frequent error was the misnaming of methylpropan-1-ol as 3-methylpropan-1-ol.

(ii) Candidates often showed understanding that straight chained molecules have higher boiling points without expanding their explanation to give a detailed reason why. There were frequent references to the number of electrons that the molecules had, without linking it to the presence of London forces (or equivalent). On some occasions when London forces were mentioned, it was just stated that they were present in both molecules and candidates did not go on to compare the strength of the London forces in each of the two molecules. When answered well, candidates demonstrated a good understanding of the effect of branching on surface area/points of contact between the molecules and the consequential effect on the strength of the resulting London forces between molecules, hence the different in boiling points. Fortunately, only a few responses referred to the breaking of interatomic bonds.

(iii) Most candidates showed that they understood that the hydrogen bond was the strongest intermolecular force and correctly indicated a dotted line between the oxygen atom on one butan-1-ol molecule and a hydrogen atom on an adjacent molecule. Where candidates lost marks, they drew “O-H…H” bonding or created a linkage between the hydroxyl group and a methyl group at the end of the chain of another butan-1-ol molecule. It was also disappointing to see the value of bond angles given correctly but not drawn as (approximately) linear or drawn between atoms rather than bonds.

(b)(i) Most either balanced the combustion equation correctly or used 6½ moles of oxygen instead of 6. The presentation of the equation was designed to assist candidates with counting bonds in (ii) but some rewrote the equation using molecular formulae to assist in balancing correctly.

(ii) Many scored 11080 kJ for the energy released on forming the products, but the calculation to find the energy needed to break bonds often proved to be something of a challenge. The majority knew how to determine the enthalpy change from the total energies involved for the reactants and products.

(iii) Most candidates referring to “energy lost to the surroundings” or “incomplete combustion” without understanding that the assumptions made when using bond energies to calculate enthalpy changes was required rather than comments on the possible errors in experimental data. Some responses overlooked the state of the reactants and on occasion made vague references to standard conditions not being adhered to.

(c)(i) A few candidates read the question carefully and knew exactly what to do, obtaining the correct answer in one line of working. However, the majority appeared to multiply or divide values at random without having any clear method in mind.

(ii) The phrase in the question 'liquid alkanes' should have indicated that London forces should be considered. A frequent mistake was to write about hydrogen bonds. Vague references regarding 'intermolecular forces' without naming them did not receive credit. Candidates who lost Mp2 often missed the point about biobutanol being more miscible **with petrol** or forgot to make the comparison in terms of which compound has the ability to make stronger London forces with petrol, and why.

Question 18

(a)(i) The clearest way to answer this question was to annotate the first diagram or redraw it, as some of the written explanations were a little too vague or used incorrect terminology to award the mark. Mp2 was on the whole explained much more clearly and the mark was more frequently gained.

(ii) This was generally well answered. Candidates laid out their calculations well for the most part showing all their working out clearly and this enabled a method mark to be awarded if a mistake had been made, e.g. using atomic numbers to calculate molecular masses. Sometimes candidates forgot to write the overall equation.

(b) Mp1 was often awarded, although some candidates simply stated process B had a higher atom economy without an explanation - numerical or otherwise. Reading the question carefully **and** using the information given would have helped more candidates gain Mp2, as there were some vague responses simply stating that process B harmed the environment more than A without any clarification based on the information given.

(c) This question was often answered very well. Candidates had a good grasp of the basic principle that an increase in temperature or the introduction of a catalyst would increase the proportion of molecules with energy greater than the activation energy (IP5 and 6) but failed to link that with the increase in successful collisions(IP4). Frequently, the diagram let candidates down, mislabelling of the y-axis being common or Maxwell-Boltzmann curves being too far from the x axis at higher energies. There were many candidates whose diagrams were carefully drawn and labelled, with clear written explanations who gained full marks.

Question 19

(a) Many scored full marks for the 'dot-and-cross' diagram, and the majority of these answers were via the two double bonds, rather than one double bond and a dative bond. The most common error was to leave out the lone pair on the sulfur atom. Candidates should take care to place their dots and crosses on or near the outer shell. Diagrams where the electrons, bonded or non-bonded, are shown too close to the nucleus do not score. It is good practice to show electrons in pairs on these diagrams. There were a surprising number of diagrams showing three electrons in a sulfur-oxygen bond. Also, candidates who showed the sulfur non-bonding electrons drawn separately were allowed Mp2 in (a)(i) but failed to score in (a)(ii) as they concluded that the bond angle was tetrahedral.

(b)(i) This question was usually answered well. Those who failed to score generally did so because they referred to titration results within ±0.1 or ±0.2 cm^3.

(ii) The calculation in (ii) was usually correct, though many failed to scale up to 40 cm^3 and gave $5.275x10^{-5}$ moles as their final answer. Almost all candidates obtained the mark for (iii) but getting the correct answer for part (iv) was another matter. Most scored the mark for calculating the total volume of air -300 dm^3, but not many were able to go any further meaningfully, and some didn't know how to manipulate their results so as to be able to quote a value in ppm.

(c)(i) Many answers gave what would have been correct equations but left in Cl▪ on both sides. There were a lot of meaningless answers with various oxychloro species on each side of the equation and often with no mention of O_3 or O_2.

(c)(ii) For some candidates, a lack of understanding of the process was evident, especially regarding the propagation phase. A number of candidates either restated the information given in the question or gave a description of a free radical rather than answering the question.

(d)(i) Many students understood that a redox reaction involved a change in oxidation state for two or more species and correctly identified the change in both species involved. Most candidates had little difficulty with identifying the change for sulfur but many stated that the oxidation state of oxygen in sulfur trioxide was -6 rather than -2.

(d)(ii) This was answered well by the majority of candidates. Mp2 was sometimes lost when the arrow indicating the enthalpy change was omitted or showed the activation energy rather than the enthalpy change. Drawing an enthalpy level diagram for an endothermic reaction as opposed to exothermic reaction was also seen.

(d)(iii) Most candidates stated that carbon dioxide is a greenhouse gas/raised global temperatures for Mp1. Candidates who read the question carefully and used the information provided stated that the sulfuric acid droplets reduced global temperatures and then went on to fully answer the question by deducing that the effect of the sulfur dioxide must have been greater after the volcanic eruption. Many candidates misread the question as there were frequent references to acid rain affecting the environment and failed to score beyond Mp1.

Paper Summary

The candidates have been well prepared for this examination and can demonstrate their knowledge in familiar contexts. Those whose understanding of the subject is deeper are better equipped to successfully deal with unfamiliar questions.

Based on their performance on this paper, candidates are offered the following advice:

- read the question carefully and make sure that you are answering the question that has been asked
- plan your answer to extended writing questions by breaking the question down into 2 or 3 smaller questions
- take care in drawing diagrams, paying attention to matching these with written answers
- show all your working for calculations and make sure you round your final answer to an appropriate number of significant figures.

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