# Report on WCH02 Paper 01, January 2017

## Introduction

The paper had questions which gave candidates from the whole-ability range opportunities to demonstrate their knowledge and understanding. There were no reports nor any evidence that candidates were short of time in completing the paper. There were a few calculation questions on the paper which, on the whole, were done well by all but also enabled distinctions to be made between candidates of differing ability. Candidates found the most demanding questions to be those which required the application of chemical concepts and principles.

## Multiple Choice

The average score on the multiple choice section was 12.6 and similar to previous series. There were no questions where less than one third of candidates scored the mark and there were no questions with a pass rate of over 85%. Hence candidates found different questions challenging.

## Question 18

The simple molar calculation required in parts (a)(i) and (ii) were done by all but then in part (iii) very few candidates could complete all three operations in the calculation. It was disappointing when all three operations were carried out correctly but the answer was then not given to three significant figures as required in the question. Similarly, the concept required in (a)(iv) proved beyond the vast majority of candidates despite only a simple multiple of 1.5 being required. The calculation of percentage uncertainty for the pipette was correctly performed by most but the need to double the uncertainty for the burette was missed by many. Part (a)(vi) allowed candidates to justify their choice of greater confidence in either result and both possible responses were seen.

Part (b) required the use of information given in the question about the role of $SO_2$ in wine and this proved to be a useful indicator of ability. The lack of prevention of microbial growth at values of less than 20ppm was often seen but only the more able scored both marks and deduced that $SO_2$ above 200ppm is toxic. There was also evidence of a failure to understand the question with some candidates referring to “acid rain” as a possible problem caused by having too much $SO_2$ in wine. However, it was pleasing that the majority appreciated that the end-point would be difficult to see in part (c) due to the colour of the red wine. Occasionally poor expression such as the simple statement that “it’s difficult to see” failed to score because it is not clear what cannot be seen, and also a small minority of candidates stated that it was difficult to read the burette but the wine was in the conical flask so this did not score.

The questions in part (d) proved to be very challenging for the candidates with only about 10% of candidates drawing a correct dot and cross diagram for sulfur dioxide in (i) and likewise the awareness of ‘d orbitals’ for the additional bonding electrons was poor with only around 14% scoring the mark. The understanding of the shape of sulfur dioxide was much better with the majority scoring the mark but the angle proved more difficult. Only the best candidates understood that with three areas of electron repulsion the angle would be about 120°.

Question 19

The ‘other product’ mark for hydrogen gas was frequently gained but occasionally the magnesium compounds produced with cold water and with steam were mixed up. Candidates should also be reminded that if a name and formula are given then both must be correct to gain the mark. At times both were given but a wrong formula such as MgOH negated the mark for the name magnesium hydroxide.

In (b) candidates were asked to give two ways that calcium chloride could be formed from “calcium” using different reagents. A significant number of candidates used calcium compounds such as calcium carbonate and thus gained no credit. The correct equations used calcium with chlorine gas and with hydrochloric acid. It was perhaps rather surprising that only the top 13% of candidates could do this. The third mark was for the correct state symbols for both equations. Those who did give two correct equations tended to give calcium chloride as solid in both reactions but when calcium chloride is made from hydrochloric acid it will be dissolve and so should the state symbol should be aqueous. Only 5% of candidates could write the two correct equations with state symbols and so this would be a useful area of practice for chemistry candidates.

It was very noticeable that the performance of candidates in (c)(i) was very centre-specific suggesting that not all centres have either shown this demonstration to their candidates or enabled them to try it for themselves. The importance of practical work cannot be over emphasised in the teaching of chemistry so that candidates can fully appreciate what actually happens in practice. If the delivery tube is not removed when heating is stopped then there will be ‘suck back’ and the limewater will be drawn up the tube into the hot tube which can result in the tube breaking.

Generally, candidates knew that limewater is an aqueous solution of calcium hydroxide and that the white precipitate is calcium carbonate. There were some candidates who misunderstood the question for (ii) and gave the answer as carbon dioxide but this reacts to give calcium carbonate which is responsible for the cloudiness.

Part (c)(iv) has been asked in various ways before and was answered reasonably well by most. However a significant minority did not read the question properly and note that it required a comment about the ‘time’ taken for decomposition to occur. Hence comments about the stability of the group 2 carbonates increasing down the group did not score the first marking point. Otherwise it was pleasing to see that many candidates understood that the larger the cation then the weaker the polarising ability and so the less the polarisation of the anion. At times the use of incorrect terms such as atom instead of ion, or molecule instead of compound/substance resulted in a loss of a mark. Candidates certainly benefit if they proof-read their answer since many would identify these kind of errors and correct them.

A discriminating question proved to be part (d) because a wide range of response were seen from comments on the increasing reactivity of group 2 elements to those that simply restated the information in the question by stating that barium hydroxide solution has more hydroxide ions. Only the more able candidates understood that this was really a question about the increasing solubility of hydroxides down group 2 and that is why barium hydroxide is more alkaline.

Questions in electronic transitions in flame tests continues to provide a full spread of marks and gives candidates the opportunity to show their understanding. It was rare but some candidates forgot to mention electrons in their answer or stated that it was ions that were promoted to a higher energy level. The most challenging mark was the explanation that the difference in flame colour arises from the difference in the energy levels in the metal ions. Oftentimes candidates referred to the electrons dropping from different energy levels suggesting from different quantum levels rather than the point of the gap between the energy levels being the crucial issue.

Question 20

This question was on a practical demonstration of equilibrium and the cast majority of candidates clearly understood the concept. However, the mark awarded was not always commensurate with this because of the poor or incorrect expressions used. For example, in (a) the candidates knew that the increase in chlorine gas would shift the equilibrium position to the right for one mark but the observation mark required reference to the fact that there would be 'more' yellow solid. This solid will be present in an equilibrium system and so to simply state that the shift in equilibrium position would give yellow solid did not score the second mark. This pattern of response was also seen in part (b) but the additional error was seen where candidates referred to an effect on rate instead of equilibrium. Thus further suggesting a failure to properly read the question.

The use of oxidation numbers to illustrate redox reactions remains a useful way of candidates demonstrating their chemical understanding. A large number correctly gave the oxidation number changes of chlorine and manganese with the appropriate oxidation or reduction term. These terms were important because the question required the use of oxidation numbers to show that it was a redox reaction. Alas a small number of candidates identified hydrogen as undergoing oxidation number changes and when this was in addition to two correct answers then it negated a mark. If it was stated as an alternative to the manganese change then the mark for that reduction was lost.

The question in part (d) was a high demand question of practical significance. The discerning candidate appreciated that the excess chorine gas from the equilibrium system would need to be removed in some way and this is the purpose of the sodium hydroxide. A wide range of suggestions were offered but not all were chemically sensible.

Question 21

The deduction of a molecular formula from a given skeletal formula continues to challenge candidates and this remains true even of the better candidates. Certainly this is a very useful exercise to practice on a regular basis. The number of hydrogen atoms is the most common error but at times an attempt at a structural formula was seen suggesting a lack of understanding of the term 'molecular formula'.

It was perhaps surprising that only about half of candidates could correctly draw the *E*-isomer of the hex-3-enal in (b). The orientation about the bonds other than the carbon-carbon double bond was ignored. On rare occasions the carbonyl group was missing and so despite an E-isomer being drawn it was not of the aldehyde so did not score. This serves as a useful reminder to double-check structures so that it is what candidates really mean to draw.

The calculation of the number of molecules that would be detected in the nasal cavity in part (c) proved problematic to all except for the most able because information given in the introduction to question 21 was required, namely that levels as low as $1.0 \times 10^{-9}$ g $dm^{-3}$ can be detected. Many candidates omitted to use this vital piece of information and divided the nasal volume by the molar mass of *Z*-hex-3-enal but this did not score.

The full spectrum of marks was awarded for (d) and thus was a very discriminating question, whilst giving candidates across the ability range the opportunity to gain credit. Common mistakes that candidates could benefit from avoiding are:

- Not giving each carbon either too many or too few hydrogen atoms, e.g. CHOH instead of $CH_2OH$
- Including 'an' in the name because "hex-1-ol" is not the same as 'hexan-1-ol
- To include the number '1' for primary alcohols since hexanol is not the same as hexan-1-ol

The conversion of the halogenoalkane into the corresponding alcohol by the nucleophilic hydroxide ion was known by just over half of the candidates for (e)(i) and (ii). The elimination reaction in part (e)(iii) was much more challenging as it required application of concepts. The adding of the curly arrow proved to be hardest mark to obtain, with many candidates writing some kind of transition state and adding the curly arrow in then rather than at the beginning which is where it is needed. Generally, the structure of the alkene was correct although at times there were the wrong number of carbon atoms. One of the marks available was for the other products of water and the chloride ion. Candidates would benefit from a reminder to balance for charge as well as for atoms because the Cl was frequently given without the negative charge; if there is a negative charge on the reactant side of the equation then there must be one on the product side etc.

It has been suggested before that candidates would often be helped to answer questions correctly if they underlined or circled key words/phrases in the question. This would have been useful in the mass spectrum questions in (f)(i) and (ii). Both questions required "fragment ions" and so formulae of the intact molecule cannot be correct and if they are ions then they should have a charge. The lack of a positive charge was penalised once in parts (i) and (ii) but it is a needless omission. In addition, the question in (i) required the *m/e* value for the fragment ion. Frequently this value was missing and so this was penalised.

Part (g) certainly proved to be the most difficult on the paper with less than ten candidates scoring all four marks. The most common response was for candidates to focus on the intermolecular forces that the substances has themselves rather than consider the intermolecular forces that could be formed between the solvent and Z-hex-3-en-1-ol. It was not uncommon to see simplistic statements such as "like dissolves like" which did not score. Likewise, statements made tended to be vague and unclear as to which of the three substances concerned was actually being referred to.

Summary

There were a number of questions where it was clear that the candidates had not read the question carefully enough. It is always advisable for candidates to make sure that they make the time to re-read the question to ensure that it is answered fully. The mantra of "$RTQ^2$" or Read The Question Twice is still to be highly recommended. In addition, it is always important to allocate time to re-read answers so that any obvious errors can be corrected.

Chemical terms must be used in their correct context so when commenting on group 2 carbonates for example, reference to 'molecule' is incorrect. Clarity of expression of what is being described or explanations are likewise very important if candidates are to achieve their true potential.

Furthermore, the practical aspect of chemistry always needs to be emphasised so that when candidates are required to describe what they would see or what difficulties might arise, then they can do so. Practical activities are always an excellent way to highlight the importance of chemistry and to stress its significance to young people today.