Report on WCH01 Paper 01, October 2016

Introduction

The paper included questions for candidates across the whole-ability range and so gave them opportunities to demonstrate their knowledge and understanding. A significant number of questions had marks being awarded across the whole spectrum and so were effective discriminators. It was pleasing to note that there was no evidence of any shortage of time. The most demanding questions were those which required an explanation of key chemical concept and principles.

Multiple Choice

The overall performance was comparable with previous series with an average of 12.8. Only questions 4 and 12 had averages below one third. Teachers and candidates may find it helpful to review the drawing of polymer repeat units and the extrapolation of thermometric titration curves.

Question 14

14a) Candidates found these a very gentle start to the structured questions. The relative atomic mass of boron was correctly calculated by over three quarters of the candidates, with marks dropped for not using 3 significant figures rather than for not being able to do the calculation. Two thirds of candidates could complete the definition of relative atomic mass, with the main error being the omission of '1/12' for the reference standard carbon-12. The p, n and e question was well answered by the majority of candidates with one mark being dropped for not including electrons, however a minority scored zero which was a surprise considering that this is essentially a GCSE-type question.

14b) The mass spectrometry questions proved to be much harder. Those candidates that had used the 6CH01 papers for revision were likely rewarded because there had been a similar recent question on the effect of a vacuum and the performance on this question was fifty-fifty. On the Pearson website the iAL Chemistry section does include the papers for the 6CH0 specification and these remain to be a helpful resource for candidates. The idea of the molecules not being accelerated was understood by more candidates but there is still room for improvement as some incorrectly referred to deflection by the magnetic field. The question in part (iii) was extremely challenging with only the highest performing candidates scoring any marks; clearly a grade A discriminator. Frequently answers were given that related to the single oxygen atoms rather than the whole molecule that included the respective oxygen isotopes. This question would be a useful extension activity when revising this topic and evidence for reaction mechanisms.

14c) Part (i) was also an effective discriminator. However, a surprising number of candidates worried about the axis and thought that one of the errors was the axis label. The ^{35}Cl compared to ^{37}Cl was often qualitatively rather than quantitatively described, using longer of shorter or taller rather than three times. The formula of the ion required for part (ii) was likewise only given by the higher-performing candidates, with the erroneous isotope of chlorine ^{74}Cl being given on occasion.

Question 15

15a) and b) were well done, without too many incorrect types of formulae; just under half of all candidates scored full marks in (b). However choroethane was a common mistake in (b) and some candidates did not notice the switch from bromine in (a), to chlorine in (b), and so were penalised by one mark.

The question about ethane in (c)(i) and (ii) proved more problematical to candidates. The second mark was often scored but the first rarely. The general close wrong answer was to know that a double bond was required for electrophiles but not to mention electron density/ rich areas. Nearly 70%of candidates could correctly name and write the initial equation for two marks. There was a good spread of marks for the dot and cross diagram of the ethyl free radical and thus served as an effective discriminator. Occasionally the methyl free radical was given which was awarded one mark. The other main error was the omission of the unpaired electron but if all else correct then one mark out of the two available was awarded. The final part (v) was aimed at the more able candidates and so it proved with quite a few increasing the ethane, which suggests they just could not understand the question.

Question 16

The definition and equation required in parts (a) and (b) were correctly done by just under half of the candidates with the usual sorts of mistakes and inaccuracies given such as the lack of reference to gaseous atoms and/ or 'one mole of'. There were some word-perfect definitions showing good direct recall. It was an interesting change to require the wording of the definition and some candidates just gave equations which show an inability to answer the question set.

The answer to (c) that helium only has two electrons was correctly given by three quarters of candidates. The major mistake in (c) was to misread the question and assume it was about lithium.

The graph sketch in (d) was another effective discriminator with the full range of marks being awarded. Some candidates tried to draw changes across a period. Some did the 2,8,1 the wrong way around. A significant number of candidates drew as large an increase in ionisation energy with the loss of an electron from within an energy level to that from one energy level to the next and this was penalised.

The explanation required in (e) was high scoring with three quarters of candidates scoring three or four marks. The fourth marking point was for comparing the significance of the three key principles, namely that the shielding and distance effect outweigh the increasing nuclear charge. This was thus discriminating at the 'top end'.

The electron repulsion experienced by two electrons within the same orbital was understood by the majority of candidates, with the main error being omitting to refer to the 'p' orbital which is the specific orbital in the case of the comparison between phosphorus and sulfur given in the question.

The first marking point in (g) was for an estimation of the first ionisation energy of aluminium given the stated values of sodium and magnesium. A good teaching tip is to get candidates to practice sketching the change in first ionisation energy for the first 20 elements as this helps then to grasp the particular changes that occur. Most candidates struggled with this first task with only a minority correctly giving a value between 520 and 700. A 'rescue' mark was awarded for correct reasoning on increasing ionisation energy across a period if the value was given above 700. Common errors of understanding seemed to stem from comments about so-called stable full s-subshells and supposed unstable half-full s-subshells followed by stable half-full p-subshells. Comments along these lines reflect a serious lack of understanding and teaching should avoid these terms. Likewise there was confusion between 'effective nuclear charge' and 'nuclear charge'. The latter is clearly referring to the number of protons in the nucleus but the former is somewhat nebulous and is better if avoided.

Question 17

The completion of the Born-Haber cycle and the calculation of the lattice energy on parts (a) and (b) produced the full range of marks with two thirds of candidates scoring 3 and 4 marks. The part of the cycle already given clearly had arrows going up or down relative to their enthalpy change sign and this was appreciated by most candidates. Candidates should include the electrons and labels for the changes if required in the question. Candidates should take more care with the units because it was disappointing to see just "mol^{-}" instead of mol^{-1}. This is well worth teachers highlighting with their candidates.

17c gave a full spread of marks with a significant number of candidates just referring to changes in state requiring energy. The types of bonding for sodium and iodine were required and this should have been straightforward but some got muddled, giving sodium as metallic, ionic or covalent, while iodine was more often correct but could be given as ionic.

17d(i) was aimed at grade A candidates but even these struggled with only 3% scoring both marks. The better candidates deduced that the more negative Born-Haber value meant that there was covalent character in the bonding in sodium iodide but did not then go on to relate it to being 'stronger bonding' which is why the value is more negative.

17dii was a fifty-fifty with half of candidates getting 0 or 1. A few incorrectly drew dot cross diagrams which seems to suggest a failure to read the question. Occasionally some candidates showed that they understood the idea by drawing a distorted contour line but a single contour line was not credited because of course there are more than one.

Question 18

The skeletal formula required for part (a)(i) was done much better than on previous occasions which was pleasing to see and the majority of candidates gave the correct colour change for part (ii).

The calculation using bond enthalpies in (b)(i) produced a fairly even number of candidates across the whole mark range. The lay out of the calculation was wrong so method marks were difficult to award. Candidates should be reminded of the value in giving clear and orderly working.

Very few candidates scored the mark for (b)(ii) because although they appeared to know the reason required they rarely gave both points that bond enthalpies are for gaseous substances but that bromine is a liquid. It is often the case that questions towards the end of papers are more demanding and this was certainly the case here.

The reaction mechanism in part (b)(iii) gave some excellent answers but the common errors seen on previous exam series continue to be seen. Candidates found a variety of ways to drop one of two of the marks including for example the curly arrows starting from all over the place and it can be quite difficult to judge sometimes where they start from. The bromide ion was frequently given without the negative charge. A small number of candidates used the wrong alkene to start with.

The final part (b)(iii) was reasonably well done with the most common error being that some candidates missed the emboldened "water" for the solvent for bromine and thus gave the dibromo- product. In addition, candidates should always be reminded to clearly show bonds in OH groups to the O and not to the hydrogen.

Summary

There continues to be a number of questions where it was clear that the candidates had not read the question carefully. It is always strongly encouraged that candidates make sure that they have time to re-read their answers and to double-check that they have answered the question as it is set.

Chemistry includes a number of key concepts and these need to be firmly grasped if a candidate is to perform well in examinations. In addition the use of correct terminology in explaining concepts in ionisation energy questions is a particularly important area and would be good for candidates and teachers to review.

In addition the clear lay-out of working in any calculations is to be strongly encouraged and the careful placement of curly arrows in organic reaction mechanisms likewise.