Examiners' Report
Principal Examiner Feedback

Summer 2019

Pearson Edexcel International Advanced Subsidiary Level
In Chemistry (WCH01) Paper 01 The Core Principles of Chemistry

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Publications Code WCH01_01_1906_ER

Introduction

This paper was the final one for the International Advanced A Level WCH01. The paper tested many aspects of knowledge and understanding of the foundation of this subject. There was no evidence that candidates were short of time such that they had difficulty in completing the paper.

The calculation questions on the paper showed a wide variation in standards. Many candidates displayed a good ability to apply their mathematical skills to problems, but others abandoned their responses or carried on producing answers which, on even a brief inspection, were obviously outside the expected range.

Multiple Choice

The multiple-choice section had an average score of 12.

Only question 5 had a percentage of less than 20% gaining the mark and only one question with more than 85% scoring the mark. Hence the vast majority of questions were found to be challenging by candidates and provided a means to test their chemical ability.

Question 21

(a)(i) The details of the mass spectrometer were generally well known. This question was similar to one on the 2018 paper and there was some evidence that candidates had learned the answers to the previous question and reproduced it without considering its relevance to the question asked.

(a)(ii) This question showed that many candidates understood that ions with lower mass and higher charge would be deflected to a greater extent in the magnetic field of a mass spectrometer. However, many candidates failed to state clearly how this could be applied by comparing both ions X and Y to those reaching the detector; often only the paths of X and Y were compared. Candidates who compared the mass of these to those reaching the detector were generally more successful in achieving both marks as those who compared the charge on the ions often included a statement that "Y has less charge than ions reaching the detector" which is incorrect.

(b) The definition of an isotope was known by nearly all candidates but the failure to use data from the Table, as instructed, led to a loss of marks.

(c) Many candidates found this question challenging. Few scored full marks for all three parts to the question.

(c)(i) More than 60% of candidates did not take into account the percentage of copper atoms in the alloy which was 51% of the sample. This led to an incorrect answer of 32.4 for the relative atomic mass of the copper, which was inconsistent with the data given in the table and also with the value in the Periodic Table. Percentage abundance was used in less than 15% of the responses seen.

(c)(ii) Very few transferred error marks were able to be awarded for this question. Only a minority of candidates took into account the % of copper in the alloy. These tended to be stronger candidates who calculated 63.6 in the first part of the question. 39% copper: 61% gold proved to be a popular, but incorrect response, obtained by expressing the mass numbers of the isotopes of copper (63 +65 = 128) or gold (197) as percentages of the sum of the mass numbers of all three isotopes (63 + 65 + 197 = 325). Some candidates who had calculated 32.4 rescued their situation by returning to the data in the table to calculate the ratio. These were mostly successful.

(c)(iii) For this part of the question, transfer error marks were frequently awarded for expressing the % purity in carats from their calculations in part (ii). It was disappointing to see answers greater than 24.

Question 22

(a)(i) This reaction was generally well known, but many candidates lost marks by incorrectly stating that there would be bubbles of gas evident.

(a)(i) This was answered very variably, which was surprising as it was a low demand question. Full equations were seen with no attempt to cancel ions on both sides. A frequent incorrect answer was simply the combination of copper (II) ions with sulfate(VI) ions.

(b) This question was accessible to most candidates and was generally well-answered. For many candidates the question appeared to be extremely straightforward, and examples of clear and accurate calculations were commonplace. However, having correctly calculated the number of moles of acid present in 25.0 cm^3 of 0.500 mol dm^{-3} hydrochloric acid solution as 0.0125 mol, some candidates forgot to divide by 2 ,although they usually picked up the final mark. Having arrived at the correct answer, some candidates lost credit by expressing their answer in the wrong units (dm^{-3}, dm^3mol^{-1}, etc.).

(c) This question proved accessible and straightforward. Most candidates recognised that the neutralisation of any strong acid (H^+/H_3O^+) by any strong base (OH^-) would lead to the formation of water (H_2O) and could write a balanced ionic equation to represent the process.

Question 23

(a) This was answered correctly by over 95% candidates. The most frequent incorrect answer showed some confusion between mass number and atomic number leading to an excess of electrons with a consequent increase in the number of orbitals.

(b) This apparently straightforward question proved to be surprisingly difficult for many candidates. Despite the helpful introductory statement that 'this question is about the lattice energy of lithium sulfide, Li_2S', suggesting that the compound exists as a giant ionic crystal, a surprising number of candidates chose to draw diagrams of a covalent Li_2S molecule. Examples of dot-and-cross diagrams with incorrect numbers of electrons in the outermost shells of Li^+ (8 electrons) were frequently seen, as were examples with incorrect charges on the ions, or where the charges did not balance. In some cases, the lithium ion was shown as the anion and the sulfide ion as the cation.

(c)(i) MP3 was awarded for the enthalpy change which was most often not scored as candidates failed to include the second electron affinity. There was also evidence that some candidates did not appreciate the difference between ionisation energy and electron affinity. MP1 was frequently not scored because candidates omitted x2 as there are two lithium ions in the lattice or neglecting to state that the first ionisation was needed. The most frequent correctly stated enthalpy change was for X, the atomisation of sulphur. The most frequent mark not to be scored was for Y - the first and second electron affinity of sulphur.

(c)(ii) There were quite a lot of answers with x2 in them. Candidates clearly did not understand that the letter represented the complete energy change. Maths notation was sometimes an issue with the bracket missing so Z-V+W+X+Y resulted.

(d)(i) Candidates rarely acknowledged that the lithium ion is common to all four of the compounds in the table. The relative sizes of the lattice energy values are only affected by the anions and the final two marks were awarded for statements that related the lattice energy to the size and charge of the anion. Many candidates related the difference in anion size to a difference in polarization or to the ability of the nucleus to attract the outer electrons. There was also evidence that candidates failed to distinguish between atoms and ions in their responses with consequent loss of marks.

(d)(ii) This question was a good discriminator, allowing those who understood the concept to answer well. Some candidates made no attempt at producing an explanation, merely leaving this section of the paper blank. Where an explanation was offered, MP1 scored in nearly all cases. Many reasons for the experimental value being more negative/exothermic revealed very limited understanding of the practicalities involved. Suggestions such as ‘heat loss to the surroundings’, ‘human error’, and ‘incomplete combustion’ were not unusual.

(d)(iii) Most diagrams scored even when the explanation in d(ii) did not.

Question 24
(a)(i)-(ii) Most candidates were able to write balanced reaction equations for the complete combustion of butane and but-2-ene. However, the calculation of the final total number of moles of gas at the end of these reactions proved to be more testing. Some candidates included the number of moles of H_2O produced within their total moles of gas, thus ignoring the statement in bold type which instructed them to calculate the number of moles of gas ‘at room temperature’. Others overlooked the excess oxygen in arriving at their total.

(b)(ii) This question was generally well-answered. Most candidates were able to gain credit for showing the movement of electrons in the initiation step. Occasionally, candidates made careless mistakes, using full arrows, rather than half arrows as instructed in the question, to show the movement of electrons on homolytic cleavage of the Br-Br bond.

(b)(iii) Most candidates were able to provide equations for the two propagation steps in the reaction of bromine with butane to form C_4H_9Br and were able to give an equation for a termination step leading to the formation of an organic compound. The most common error was the failure to appreciate that a radical must be produced in a propagation step.

(b)(iv) This was known better than (iii). The formation of octane was favoured. There was again evidence that candidates failed to read the question and offered 2 Br · → Br_2.

(b)(v) The reaction mechanism for electrophilic addition was understood by most candidates. However, marks were often lost through a lack of precision in representing the various stages. Curly arrows often did not start or end precisely in the expected positions, the Br-Br dipole was not shown, the bromide ion was assigned a δ-minus partial charge, or the lone pair on the bromide ion was not included. These omissions often caused candidates to lose marks, even though they appeared to have a clear grasp of the mechanism involved.

(c) This question, which required a representation of the skeletal formula of the product of the reaction of but-2-ene with hydrogen bromide, proved straightforward for the vast majority of candidates. The most common error was to react bromine rather than hydrogen bromide.

(d) Often the correct displayed structure was shown but named incorrectly as butan-1,-ol or but- 2,3 diol losing the second mark available.

(e) This question proved to be accessible to most candidates. The displayed formula of the repeating unit of the polymer was usually shown clearly and accurately.

(f)(i) Most candidates recognised the need to calculate the energy change involved in the formation of the bonds of one mole of but-2-ene from its constituent atoms. Along with the energy change involved in atomising the constituent elements in their standard states, in order to determine the value of the standard enthalpy change of formation. A series of careless errors in summing the various enthalpy terms led to erroneous final answers in many cases. Nonetheless, most candidates who attempted this calculation gained some credit.

(f)(ii) It was widely recognised that bond enthalpies will depend upon the particular molecular environment, and that the values quoted in the data book are mean/average values. However, 'bond energy' was often missing, so just 'mean values' stated which did not score.

Paper Summary

Responses in which a candidate fails to score marks because of a failure to read the question carefully are frequent and disappointing. Taking a few extra seconds to note the key information required helps to avoid these losses. There are many instances of this, but producing ionic equations when these are specifically asked for and ensuring that the correct number of carbon atoms are shown in formulae and equations in organic chemistry questions are easy to check, if time is allowed for at the end of the examination.

Precision in chemical terms cannot be stressed enough. The use of atom, ion and molecule must be considered carefully. The difference in "sulfur "and "sulfide" is important and an incorrect choice leads to loss of marks.

In calculation questions, a brief glance at the answer arrived at, with the question "Does this seem reasonable? Is it roughly what I would expect?" might prompt a revision of the response.

Practical experience is extremely valuable in this subject. Time spent in linking the skills and observations during practical activities with the underlying theoretical concepts is never wasted. Students enjoy these and those that are well directed and thoroughly engaged score well on assessments.

One of the major themes that really needs to be stressed to candidates again and again is for them to read the question very carefully. It is always advisable, some would say vital, for candidates to make sure that they make the time to re-read the question to ensure that it is answered fully. In reinforcement of this point, it is also always important to allocate time to re-read answers so that any obvious errors can be corrected.

It remains crucial that candidates can give correct chemical formulae and that chemical terms are used in their correct context so when commenting on ions for example, reference to 'iodine' instead of 'iodide' is incorrect. The penalising or answers such as these can make the difference between grades and so greater care and accuracy is vital.

Finally, the practical aspect of chemistry and its application to the real world always needs to be emphasised so that candidates appreciate that chemistry is of true importance to all of our lives. Practical activities are always an excellent and enjoyable way to highlight the importance of chemistry and to stress its significance to young people today.

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