Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2021

Pearson Edexcel International Advanced Level In Chemistry (WCH11) Paper 01 in Structure, Bonding and Introduction to Organic Chemistry

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Introduction

Many students were well prepared for this examination and were able to demonstrate that they had a sound knowledge of the topics in the specification. There were few papers that showed that candidates had had insufficient time to address the final questions.

Section A

Multiple Choice

There are no statistics available to allow comments on this section.

Section B

Question 12

(a) This part of the question was intended as a straightforward introduction to this paper. The electron configuration of beryllium was almost always correct but a surprising number of learners were less successful when recalling that of calcium. The most frequent error was writing $3d^2$ instead of $4s^2$, despite calcium being an s-block element rather than a transition metal.

(b) Many learners drew the structure of gaseous beryllium chloride as ionic, losing both marks, despite the question stating clearly that it was molecular. Those who used circles, either open or shaded, and/or crosses to denote the electrons made the award of marks straightforward. Diagrams that started with circles to denote the shells and had “dots” added to these to show the electron pairs, were more difficult to see clearly. If it is necessary to amend diagrams, it is important to make changes obvious and often a clear cross-through and redrawing is preferable, if time allows. Many learners drew an additional non-bonding pair of the electrons on the outer shell of beryllium, losing a mark.

(c) There was a good knowledge of and ability to describe the formation of a dative covalent bond. A clear statement that the covalent bond formed between beryllium and chlorine involved donation of one electron to the shared pair by **both** atoms was seen less often.

Simple descriptions of a covalent bond as the attraction between the atomic nuclei and the shared pairs, did not sufficiently address the formation of the bond.

(d) The correct bond angle and repulsion between the two bonding pairs in the gaseous form of beryllium chloride was commonly seen and scored M1 and M4. Learners who recognised from the diagram of the polymeric form, that the four bonding pairs of electrons, whether dative or not, exerted mutual repulsion and might be expected to produce a tetrahedral arrangement were most likely to score the second and third marks. There was evidence that learners had a good understanding of VSEPR theory and there were very few references to atoms repelling each other. However, there were common references to lone pair repulsion which meant that M3 could not be awarded. The twisted structure of the polymer and the reduced bond angle actually seen meant that a larger range of bond angles for the solid form was allowed. This meant that an assumption of a trigonal pyramidal arrangement with a lone pair still allowed M2 to be scored.

12(e) A sizeable number of learners drew a covalent diagram for the bonding in calcium chloride, despite the statement in the question of its ionic structure. The appearance of Ca^{+} and neglecting to include charges altogether were the most common errors.
12(f) A significant minority of learners answered the last part of the question with little reference to the bonding previously covered. An approach which was commonly taken was to assume that the gaseous state of molecular beryllium chloride was due to intermolecular forces and the solid state of calcium chloride led to the formation of an ionic lattice.
Some responses showed a good understanding of the effect of the different sizes of the Group II ions in the polarisation of the chloride ion and hence the extent of covalency in the beryllium – chlorine bond.
Learners who used the difference in electronegativity also showed that they understood the concept but sometimes failed to express themselves clearly enough to score both M1 and M2.

Question 13

13(a)(i) This calculation was successfully completed by most learners, but a surprising number of responses lost the final mark for rounding 28.1095 to 28.12.
(ii) Although some candidates thought that atoms were broken in half in a mass spectrometer or that there were small amounts of different elements which could produce a peak
at m/e =14, very many correct answers were seen.
(b) The most commonly scored marking point was the absence of delocalised electrons in silicon dioxide, leading to an inability to conduct electricity. Some learners then failed to address the reason for the high melting temperature i.e., the presence of strong covalent bonding **throughout** the material. Responses that included a reference to a giant covalent structure and a link to the strength of the covalent bond scored M1 and M2.
(c) This question showed the ability of most learners to correctly perform a familiar calculation. The most common errors were the substitution of atomic numbers for mass numbers for calcium and /or silicon and very rarely oxygen. Even where slips were made, e.g., substitution of incorrect masses in step 1, the clear setting out of working enabled partial credit to be given. It is worth noting that in these calculations the usual rounding procedures are not always successful. Learners who incorrectly substituted atomic numbers for one or two mass numbers sometimes arrived at fractional ratios such as 1:1:1.5. Those who rounded to 1:1:2 rather than 2:2:3 unfortunately lost M2.
(d) The rearrangement of the expression was done competently by most learners. Common errors were failing to correctly convert the temperature in ^{o}C to K. Also, many learners failed to appreciate that their answer was in m^3 and neglected to convert correctly to cm^3 and so lost M4.

Question 14

14(a) The graph was familiar to most candidates and it was frequently interpreted correctly. Failure to state clearly that the difference in ionisation energy was much larger between the third and fourth values than the other intervals occasionally lost M1 and some learners thought that this was sufficient for both marks so failed to state the number of electrons in the outer shell to score M2.

(b)(i) Some learners did not seem to appreciate what was asked in the question and described the graph in detail, offering no explanation. The substantial proportion of responses showing that the general increase in Ionisation energy was due to an increasing nuclear charge were sometimes let down by a failure to state that the screening of this charge changed little across the period. There was also evidence of the misconception here that the decrease in radius causes the increase in attraction rather than vice versa.

(ii) There were some very good responses to this question, showing an improvement in understanding compared with previous years. Most scored M1 and many also scored M2, comparing the energy of the subshells and also shielding differences. Some learners mentioned electron repulsion from paired electrons in subshells indicating confusion between the difference between the Group 2 and 3 ionisation energies and those of the Groups 5 and 6.

(c)(i) The question on bonding in aluminium metal prompted many correct responses. M1 was more frequently lost than M2. Failure to clearly state the **attraction** of the cations for the delocalised electrons was the most common error.

(ii) The capacity of aluminium to conduct electricity was often quoted and its ductile nature or low density were also properties frequently offered. Some learners resorted to a general list of properties of metals, without reference to the particular application mentioned in the question.

(d)(i) This equation was correctly completed in a high percentage of responses. For those incorrect, the main stumbling block was an incorrect formula for aluminium oxide.

(ii) Many candidates failed to read the question carefully and compared the production of hydrogen from waste aluminium cans with burning fossil fuels rather than the production of hydrogen from fossil fuels. This led to many responses failing to gain credit for vague references to toxic gases being produced. Those that interpreted the question correctly usually gained credit for the non-renewable nature of fossil fuels and the increased production of greenhouse gases leading to global warming.

Question 15

15(a) There were very many correct responses although a significant number of learners lost a mark by adding reference to cracking and/or reforming in their answer.

(b)(ii) The skeletal formula of but-1-ene was frequently seen as an incorrect response, perhaps indicating that the question had not been read with sufficient care. Also, the repetition of an isomer drawn in different ways was a problem for some learners. There were very few instances of skeletal formulae with added carbons or hydrogens.

(b)(iii) Chlorination and hydrogenation reactions were well known and products 1 and 2 were frequently identified correctly. The oxidation reactions proved more challenging
with product 4 being the least often correct, possibly due to a failure to apply Markovnikov's rule correctly. The point available for those learners who knew that the reaction produced an alcohol was awarded for a correct formula and name of butan-1-ol. Just "butanol" was insufficient to score in this case.
Overall, the product formulae were identified correctly more often than the product names.

(c) This question was relatively straightforward for the majority of learners who understood that the double bond in but-1-ene breaks to produce a C-C bond with a propyl side group on alternating carbons. The most common incorrect response was poly(but-2-ene) but, disappointingly, poly(ethene) was not uncommon. Those learners who find these concepts difficult might be helped if they redrew the monomer with an unobstructed C=C double bond with any other groups in the monomer as pendant to the double bond. It is also important to remember that polyalkenes are saturated and so should not be shown with C=C double bonds.

(d) A significant number of learners thought that incineration of polymers requires/uses a lot of energy, rather than recognising that incineration has a net energy output. Responses stating that a large amount of land would be needed for incinerators rather than for the disposal of polymer waste in landfill were also common. Once again, there was evidence of answers which included CO_2 production causing global warming or climate change, despite the clear instructions that this was not to be considered.

(e)(i) Most all-correct responses followed the 1st method shown in the mark scheme, using ratios to calculate the required volumes. Many learners calculated the moles of butane and then worked out the moles and volume of carbon dioxide produced. Thus, having carried out three steps, perhaps they thought that this was all that was required. M1 was often the only mark scored. Having calculated the volume of carbon dioxide by this lengthy approach, some went on to obtain further credit using a ratio method. Again, those responses that were clearly set out facilitated the award of partial credit. It was disappointing to see some responses where the volume of oxygen required had been determined to show that the oxygen was in excess but then the logical step of adding the excess oxygen to the volume of carbon dioxide produced was not carried out.

(ii) Many, many responses discussed the undesirable flammability of butane or the risk of explosion of the butane cylinder. However, there were excellent answers where candidates clearly knew the biology of carbon monoxide poisoning very well.

Paper Summary

The students 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, students are offered the following advice:

- read the information given in the question carefully, noting any instructions given in bold type
- note the command words used and make sure that you are answering the question that has been asked
- highlighting or underlining key pieces of information given in the question may assist you in your answer
- show all your working for calculations, make sure you round your final answer to an appropriate number of significant figures and check your answer is reasonable if you have time
- in longer written answers where comparisons or differences are discussed, it is helpful to state clearly which items are under discussion. Phrases such as “it is more ionic” or “beryllium has a higher electronegativity” with no direct comparator are not clear enough to gain credit

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