Examiners' Report
Principal Examiner Feedback

January 2024

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

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General Comment:

Many candidates had clearly prepared well for this paper and were able to apply their knowledge of the topics in the specification to familiar and novel situations. However, it appeared that a significant number did not seem to have a good basic understanding of ionic, covalent and metallic bonding and the naming of organic compounds. However, the calculation questions were done with impressive accuracy by the majority and there was no evidence of candidates running out of time.

The mean mark for the paper was 45.5 and the Multiple Choice, Section A had a mean of almost 12.

The most accessible multiple choice questions were 2 (electrons in boxes) and 7 (mass calculation) and the most challenging questions were 1(b) (deducing properties from ionisation energies) and 15 (properties of polyethene)

Q18(a) This question proved to be a good discriminator with most candidates able to score marks for the structures of A and B but many found C and D more challenging. A number did not read the question carefully enough and so did not make full use of the clues given resulting in structures being drawn in the wrong boxes. Furthermore, the naming of the compounds was often poorly done as the wrong stem was sometimes used and in particular dimethylethene was a common wrong answer. Other errors included the E/*Z* being omitted and the number indicating the position of the double bond being left out or incorrect.

Q18(b) The majority of candidates were able to draw diagrams correctly showing the areas of electron density in a σ bond and π bond, with many showing the overlap of the orbitals. However, occasionally the sigma bond was drawn as a single line so did not score. Although the idea of sideways and end on overlap seemed well understood, at times candidates used the wrong words to describe these bonds and so did not score. Also, some explanations did not include the terms overlap and orbital. One quite common misconception seen was the idea that the pi-bond was the double bond and that the sigma-bond was the single bond.

Q18(c) This first part of the question was answered well by the majority of candidates as most were able to explain the role of the double bond in geometric isomerism. However, there was often ambiguous wording in the second part and a number struggled to explain that two different groups were needed on each carbon. Stating that there were different 'molecules' attached to each carbon was a fairly common error and additional irrelevant information was also regularly seen.

Q19(a) This question was found to be quite challenging as a large number of scripts were left blank. Of those who correctly identified the two peaks at mass/charge ratio of 78 and 80, many were able to draw the peak heights accurately, with 75% and 25% being the most common correct answer. However, a few candidates got the peak height ratios wrong.

Q19(b)(i) The formation of free radicals was clearly understood but many candidates did not give sufficient detail to score. Some equations did not include arrows or failed to include products or state that UV light was required. A significant number also gave double headed arrows.

Q19(b)(ii) Although most candidates seemed to have a reasonable understanding of the terms homolytic and free radical, a lack of precision often cost marks. Many appreciated that homolytic meant equal splitting but failed to mention the movement of electrons. Likewise, some candidates failed to explain clearly that a free radical has an unpaired electron and 'free electron' or 'own electron' were common incorrect answers.

Q19(b)(iii) A number of candidates failed to provide an answer to this question. However, where a correct response was given, very few candidates mentioned further substitution reactions, instead most scored for noting that further reaction would occur, producing unwanted products. The most common wrong answers were associated with the process requiring lots of energy or safety issues associated with UV light.

Q19(c)(i) This mechanism was well understood with large numbers of totally correct, well-presented answers seen. However, marks were sometimes lost as curly arrows did not start or end precisely in the expected positions, in particular, the curly arrow form the chloride ion to the carbocation often failed to originate from the lone pair. Other common errors included not showing the H – Cl dipole and the chloride ion having a δ- charge.

Q19(c)(ii) Whilst there were many excellent answers to this question it proved to be quite challenging to the majority of candidates. The explanation of carbocation stability was recognisable in many answers but not understood. A significant number of responses argued that the haloalkanes were the carbocations or that the haloalkanes were primary and secondary and this led to stability. However, candidates who focused on their mechanism in (c)(i) often gave clear and accurate answers discussing the relative stability of the intermediate carbocations, rather than the products themselves.

20(a)(i) This type of calculation was familiar to the majority of candidates with most able to calculate the relative abundance of the third isotope, and to construct an appropriate equation to calculate the mass number of the unknown isotope. However, a number then lost the final mark as they gave an answer to more than 2 significant figures.

20(a)(ii) This question about of the similarities and differences of isotopes was well known by almost all candidates.

20(a)(iii) Most candidates correctly chose the ^{24}Mg isotope as being defected the most, due to it having the lowest mass. However, a number thought the isotope with the largest mass would be deflected the most and others thought the abundance of the isotope was of significance.

20(b)(i) This dot and cross diagram of magnesium oxide was answered well by almost all the candidates. However, despite the question saying the compound was ionic a surprising number of responses showed covalent bonding between the Mg and O.

20(b)(ii) Rather unexpectedly, this proved to be one of the most challenging questions on the paper and a lack of understanding of bonding was apparent in many answers.

References to electronegativity and polarisation were common as were discussions involving covalent bonds and intermolecular forces. Unfortunately, many candidates who appreciated the question was about the strength of the ionic bond made the mistake of comparing the size of the oxide ion with suphur or sulfide rather than sulfate. A number even referred to MgO as being smaller than $MgSO_4$, rather than comparing the sizes of the individual ions.

20(c) It appeared that the majority of candidates misread this question as they stated the differences and similarities in the electrical conductivity, instead of explaining them. This resulted in simply repeating the information from the table and many candidates ran out of space. However, it was also apparent that a significant number of candidates lacked a basic knowledge of this topic with many believing that conduction of electricity in MgO was related to the movement of delocalised electrons or the conduction of electricity in Mg was related to mobile ions. Even some candidates who clearly had a good understanding failed to score full marks as they did not mention that the delocalised electrons in Mg allows it to conduct electricity in both the solid and liquid state.

20(d)(i) Most candidates were able to write this equation correctly, but a significant a number lost the state symbol mark by thinking magnesium sulfate was a solid or sulfuric acid a liquid. It was also not uncommon to see water as a product instead of hydrogen.

20(d)(ii) Many candidates scored both marks on this question. However, a common incorrect observation was the formation of a white precipitate, presumably due to candidates thinking magnesium sulphate is insoluble in water. Confusion about the difference between an observation and inference was also noted with statements concerning the formation of hydrogen gas rather than the correct observation of bubbles or effervescence.

20(e) The calculation parts of this question, (i), (ii) and (v) were well done by the majority of candidates with many scoring full marks. However, most were less familiar with the practical aspects of this question and did not understand the significance the magnesium being in excess to ensure all the sulfuric acid reacted. This resulted in a variety of incorrect separation techniques being suggested for part (iv) including fractional distillation and evaporation.

21(a) Calculating an empirical formula was very familiar to candidates, so nearly all scored the first three marks via the first method on the mark scheme. However, only a minority continued and showed the empirical formula was equal to the molecular formula through calculation. Although far fewer candidates used the alternative method, when they did, they usually scored the full four marks.

21(b)(i) Despite the fact that the question asked for a dot-and-cross diagram for a molecule, a significant number of candidates attempted to draw an ionic structure and so could not score. Of those who drew a covalent structure there were some excellent diagrams scoring full marks. However, a significant number of candidates combined the oxygen and hydrogen together into one atom and some added a lone pair to the boron.

21(b)(ii) Although many candidates gave the correct bond angle and a suitable explanation, on the whole this question proved to be very challenging for the majority. Candidates who produced an ionic structure in(b)(i) could not score, and it appeared that many looked at the O – B – O in the question and chose an angle of 180 degreess with no explanation. However, where an attempt was made to explain the given bond angle the concept of minimising repulsion between electron pairs seemed commonly understood.

22(a) Despite this novel ideal gas equation question giving a value for the density rather than a volume, most candidates made a good attempt at the calculation with the average mark being almost 3 out of 5. Most candidates scored M2, for the conversion of temperature to K, and M3 for rearrangement of the equation, but the most common error was overlooking the need to convert the volume from dm^3 into m^3 for M1. Although arithmetical errors also lost marks, a significant number of candidates arrived at the correct answer. However, where the final answer was not correct examiners awarded candidates intermediate marks for correct steps where working could be followed, although this was not always possible as the work was sometimes poorly set out and not sequential.

22(b) For those who calculated the molar mass correctly in part(a) it was very surprising that so many did not go on to select methane as the unknown gas. Although this mark was available via transferred error from part (a), it proved elusive for many candidates. Some who arrived at 27 as a molar mass from part (a) reasonably guessed at C_2H_4, but many ignored their calculated molar mass and just randomly produced a formula, including non-hydrocarbons such as oxygen and carbon dioxide.

In order to improve their performance, students should:

- Always read the information in the question carefully, noting the command word
- Show working when carrying out calculations, think carefully about units, significant figures and rounding and check the legibility of your work
- Learn the difference between an observation and inference
- Learn the key terms involved in free radical substitution reaction
- Practise drawing dot and cross diagrams for both ionic and covalent structures
- Learn and be able to describe the properties of ionic compounds and metals

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