Examiners' Report
Principal Examiner Feedback

Ocotber 2022

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

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General comments

The paper seemed to be accessible to many candidates and the full range of marks were seen by the examination team. A number of candidates seemed extremely well prepared for the exam, showing a breadth of both the knowledge and skills required by the specification. In these cases, candidates could express themselves fluently with the correct use of chemical terminology and carry out calculations with clear working.

Other candidates found parts of the paper more challenging. In general, such candidates would benefit from taking more time to read the question with care, using revision strategies that embed ideas into the long-term memory, rather than relying heavily on short term recall of previous mark schemes. They should also take special care with the small details of a question, e.g., inclusion of state symbols where required and ensuring numerical values quoted are appropriately and accurately rounded.

The mean mark for the paper 40 marks.

Multiple Choice Questions

Section A had a mean of 12 marks, broadly in line with the June 2022 series.

The most accessible questions were 3 (finding the number of sub-atomic particles), 5 (naming an alkene using *E*/*Z* nomenclature), 7a (identifying the role of ultraviolet radiation in free radical substitution reactions), 7c (writing an overall equation for a free radical substitution reaction), 9 (calculating the number of moles of atoms in a copper sample), 10a (function of different parts of a mass spectrometer, 10c (predicting the number of peaks in a mass spectrum) and 12 (calculating the concentration of a solution in mol dm^{-3}).

The most challenging questions were 4 (deducing the total number of occupied orbitals in an atom), 6b (calculating reacting amounts using gas volumes), 8 (identifying a polar molecule from experimental observations) and 11c (predicting the element with the greatest second ionisation energy).

Question 14

In (a)(i), the majority of candidates were able to show understanding of third ionisation energy, with the omission of state symbols the most frequent way to not score the mark. Many candidates also found (a)(ii) straightforward, making the link between the significant increase in ionisation energy and the electrons removed, to the group number. A small number described the large increase in ionisation as between the 2^{nd} and 4^{th} electron removed, perhaps not looking carefully enough at the points on the graph.

In (b)(i), as in previous series, confusion between ionic dot-and-cross diagrams and covalent dot-and-cross diagrams was seen. Those who appreciated the ionic nature of barium chloride invariably scored both marks. The calculation in (b)(ii) enabled most candidates to score at least 1 mark. However, a significant number ignored the instruction to consider the number of significant figures in their final answer, so didn't score a relatively easy mark. Ionic equations, such as the example in (b)(iii) continue to provide challenge. Evidence from responses seen suggest many candidates treat these problems as something they should just remember, rather than a problem that can be solved. Of those who attempted to construct rather than recall the equation, a large number failed to cancel out the chloride ions.

In (c) more skilled candidates made a clear reference to the lack of mobile ions in the solid state. However, such answers were in the minority as many mistakenly believed that the lack of delocalised electrons was the primary factor. In addition, some gave generic answers discussing the absence of both free ions and delocalised electrons. This lack of a specific response to the question asked meant such answers did not score.

Question 15

The use of a skeletal formula and the positioning of the 2,2-dimethyl groups at the right-hand side of the diagram provided a slightly elevated level of cognitive demand in (a)(i), enabling a degree of differentiation by outcome. The most common mistake was the use of 2,4,4-trimethylpentane.

Only 35% of the cohort were able to link the reaction to the correct industrial process in (a)(ii), with fractional distillation and cracking frustratingly common. Answers in (a)(iii) tended to lack the kind of precision needed to score, with many generic answers linked to efficiency missing out on the mark as there was no specific reason given to describe the role of the branched alkane.

Over 70% of candidates scored at least 1 mark in (b) and very few structural or displayed formulae were seen, showing candidates had followed the model and advice in the question stem. Many candidates redrew 2-methylpropene in a slightly different orientation though, sometimes for two or three of their suggested isomers. The most challenging mark was recognition that one of the expected answers was a cyclic hydrocarbon.

The mechanism in (c)(i) discriminated effectively, and those who scored four marks showed excellent understanding of the process. Others seemed to rely exclusively on recall though, proposing generic mechanisms based on simple alkenes such as ethene. The need to be specific was also an issue for some in (c)(ii), with reference to the stability of a secondary carbocation more often seen that the tertiary carbocation drawn by many in their mechanism.

The use of data to determine a molecular formula in (d) was a real strength for many, with over 32% scoring all seven marks. Candidates seemed well prepared for this kind of calculation with errors evident in previous series seemingly less commonplace, e.g., mistakes with units when using $pV=nRT$.

Question 16

In (a) over 52% of candidates could give a very precise definition of an isotope. The most common omission was a referring generally to 'elements with…' rather than the more specific 'atoms of the same element with…'

High levels of numeracy were seen in (b), with nearly three-quarters of candidates scoring both marks. The most common mistake seen were transcription errors from data in the question or using five as the denominator in the final expression, basing their calculation on the number of isotopes rather than the total abundance.

In (c) the size and sequence of the sub-shells was known by the majority, but errors seen included filling 3d before 4s and mistaking the 3d sub-shell for the 4d sub-shell. A small but noticeable number of candidates persisted in using the octet model from GCSE, assuming each main energy beyond n=1 holds eight electrons.

More able candidates had few problems in calculating the atom economy in (d)(i). Slips in calculating the sum of the relative masses of products / reactants were evident. In addition, a small number of candidates didn't appear to read the guidance in the question

carefully. They were asked to use a value of 72.6 for the A_r of Ge, which is the value from the Periodic Table. This was to prevent them using their calculated value from (b). However, the issue that arose was a small number used 72.6 as the M_r for GeH_4 limiting the number of marks they could score.
A spread of marks was seen in (d)(ii) and d(iii), with most candidates able to show three bond pairs between the germanium and hydrogen atoms. The significance of the negative charge proved to be a useful discriminator. A significant minority didn't appreciate the charge was due to an extra electron and left an unpaired electron in the outer shell of germanium. Candidates seemed to approach the deduction of the shape and angle in a variety of ways. Some gave the correct answer irrespective of their dot-and-cross diagram, presumably based on drawing an analogy with ammonia. Others clearly used their diagrams, as evinced by a number of candidates showing three bond pairs and deducing a trigonal planar shape.

The calculation in (d)(iv) proved challenging to some candidates mainly because they struggled to interpret the unfamiliar units used to measure the gaseous concentration. Such answers used the expression to calculate the moles of solute in a solution. Hence, they assumed their initial value calculated to be in moles when it was in fact a mass. At this level candidates are expected to cope with a variety of units, and more candidates need to look carefully at the data in a question to help show evidence of this skill.

The scaffolding of the calculation in (e) helped many candidates achieve some credit, though a significant number found it challenging to apply the correct ratios from the two equations. This clearly illustrates that a maths skill regarded as low demand, can stretch candidates in a chemical context. Many candidates are well-trained in giving a final 'answer' to 2 or 3 SF answers. However, within this context, rounding was not necessary, as values were used in subsequent steps. For a few candidates the desire to round each value did lead to some loss of credit, with values given to 1 significant figure in (iii) a particular issue. Identification of chlorine in (iv) was straightforward for more able students. Others found it more challenging, often forgetting to carry out the subtraction and / or divide by four to find the A_r

Question 17

The molecular formula in (a) was a useful discriminator, with many of the more able candidates deducing the correct numbers of carbon and hydrogen atoms. Unsurprisingly the most common error was to overlook that each carbon in the double bonds has fewer hydrogen atoms attached.
Over two-thirds recalled the correct colour change in (b)(i), though less than a fifth of the cohort could draw the correct formula of the product formed. In some cases, this was because they failed to add hydroxyl groups to both double bonds, though many of the proposed structures as well as answers to (b)(iii) showed often candidates did not appreciate what type of reaction was taking place.

In (c) the unusual nature of the polymer, leading to a second double bond in the monomer, proved challenging for over 50% of candidates. A small number needed to read the question with care, as rather than drawing the monomer they attempted to draw a single repeat unit.

In (d) it was relatively common to see some candidates misinterpreting the question and discussing the range of disposal processes, rather than how chemists help mitigate problems caused by disposal. Even those who did frame their answers in terms of helping solve disposal issues, tended to talk in terms of the role the general population has, rather than specifically chemists. Although such answers could often score one mark, very few went on to make a second relevant point.

In (e)(i) very few candidates used their knowledge of the properties of carbon dioxide and hexane. It was almost as though some of the cohort expected to just 'know' the answer and not have to apply their knowledge. Those who did were credited primarily for the realisation that carbon dioxide was readily available and not flammable but required costly high pressure to obtain the liquid state. The unfamiliar calculation in (e)(ii) was competently handled by many candidates with sound numeracy skills. The ability to spot whether an answer looks right was relevant here. A common error was to invert the scaling factor, leading to a very small mass of orange peel. Perhaps time was a factor at this stage, but virtually none of these candidates seemed to stop to consider that their answer was unlikely to be correct. If time permits it is always worth thinking about any final values obtained, to check they make sense in the context of the question.

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

- very few questions expect you to just know the answer – expect to have to use your prior knowledge to make sensible suggestions, trusting the chemistry

- show all your working for calculations, making sure you consider when it is appropriate to round up, and how many significant figures you should round up to.

- in longer written answers try to frame your response specifically to the context of the question – specific is always better than generic

- practice drawing reaction mechanisms with a range of starting compounds, not just the common examples from notes or textbooks

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