



Examiners' Report Principal Examiner Feedback

October 2023

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

General comments

The paper seemed accessible to the majority of candidates, with the full range of marks seen by the marking team. Looking at the performance of individual items, there was a clear ramp in demand towards the end of the paper, with 20(a)(ii), 20(b), 21(a)(iii), 21(b)(i) and 21(b)(ii) providing a significant degree of challenge and discrimination.

The mean performance on the paper was around 39 marks.

Multiple Choice Questions

Section A had a mean of 11 marks.

The most accessible questions were 1 (finding the number of sub-atomic particles), 3(b) (calculating product masses), 8 (features of a mass spectrometer), 10a (electrophilic addition of alkenes), 12(b) (converting ppm to a mass) and 17 (interpreting hazard symbols). A point perhaps worth noting in question 10 is that candidates were better at recognising a correct step in the mechanism than recalling the name of the process, even though recall is a lower demand skill.

The most challenging questions were 2 (recognising the shape and number of electrons in a p orbital), 4 (recognising the electron density map for an ionic compound) and 13 (calculating the concentration of ions in a solution). Again, it is worth noting that question 2 relied primarily on recall but was the most difficult question in terms of its mean score. This illustrates the point that a solid foundation of key knowledge is important for all chemists. This particular idea, to highlight the difference between a single orbital and a sub-shell, continues to challenge many.

Question 18

Most candidates were able to pick up some credit in (a)(i) though it was frustrating to see some state the trend without any explanation, and conversely others attempt to discuss nuclear charge and/or shielding without any context related to an increase in first ionisation energy. The command word 'explain' requires an exemplification or justification of a point, so a candidate could not score full credit unless the point about the general trend was explicit in their answer. In (a)(ii) those who could predict a sensible value for the first ionisation energy of oxygen could justify their choice in terms of electron pairing and repulsion. However, a significant minority could not recall the 'dip' in the trend so framed both their prediction and justification in terms of the general trend discussed in (a)(i).

Over 65% of candidates scored both marks in (b)(i). Common errors included omission of state symbols (despite the guidance in the question) and addition of electrons. Pleasingly few cases of stating the equation for first ionisation energy were noted. However, the explanation for the difference between first and second ionisation energies in (b)(ii) proved more challenging. Many responses talked in general terms about removal from 'different' shells, without making it clear which electron was removed from which orbital. The second mark was invariably awarded for the idea that the second electron removed is closer to the nucleus, with very few references to the idea that this electron is removed from a positive ion.

Beryllium chloride is listed on the specification as a molecule whose shape and bond angle candidates should recall. In (c), just over a quarter of the cohort could correctly draw the dot-and-cross diagram and fully justify the shape and bond angle. A significant number showed beryllium chloride as ionic, though interestingly this often did not prevent them correctly recalling the shape and bond angle. For those who drew a covalent dot-and-

cross diagram, the most common error was the inclusion of a lone pair around the beryllium atom.

Question 19

Candidates seem to cope well with the idea of a weighted mean in the context of calculating a relative atomic mass, but in (a)(i) many candidates could not link this skill to a novel context. The most common error was to not take into account the proportion of each fuel and so find the simple mean of the two values. Others ignored the prompt to give their answer to an appropriate number of significant figures. However (a)(ii) was straightforward for the majority, but even with the help of a given value to use in (a)(iii) many struggled to calculate an answer, either because they made mistakes with or ignored unit conversions or they lacked the numeracy skills to scale up the energy density values.

Despite the mark scheme covering a wide range of potential answers in (b), many responses seen by the team either lacked clarity, discussed the impact of petrol usage in generic terms or used ideas from previous mark schemes that were not appropriate in this context. For instance it was common to see answers referring to the efficiency of combustion in the engine, perhaps with candidates thinking about the role of branched hydrocarbons. Others spent time comparing the energy densities without any link to sustainability, whilst others talked about environmental impact in very general terms, with comments such as 'E10 causes less pollution'. Only a minority considered the source of the ethanol, which opened up several marking points linked to sustainability. Others did realise E10 had the potential to reduce carbon emissions, though it was often not clear if candidates believed that to be at point of combustion or as part of a cycle involving production of biofuel.

In (c) some confusion between reformation and cracking was evident, with candidates often reducing the number of carbons in the hydrocarbon product. Even when the equation in (c)(i) was correct candidates often suggested cyclohexane as the product, despite the question informing them the product had a 5-membered carbon ring.

Examiners did see a number of excellent answers in (d)(i) and it was clear that the majority of candidates realised the ultraviolet light played a role in bond-breaking. A lack of detail hindered a few, with discussions such as 'uv light breaks bonds forming radicals' missing credit without further exemplification of the process. Most candidates had some knowledge of the mechanism in (d)(ii) but a number seemed to want to jump in and write out the whole mechanism from memory without considering the context. Hence it was common to see additional, unnecessary termination steps given. Another issue arose from not reading the question with sufficient care. This resulted in a minority of the cohort basing their equations with dodecane as the starting alkane, rather than hexane. Such responses did not score full credit. Very few omissions of the unpaired electron were seen, but a small number of propagation steps incorrectly formed two free radicals.

Question 20

Over 30% of candidates managed to identify three or more isomers in (a)(i) though the question did discriminate effectively, with the full range of marks seen regularly. It seemed that candidates who used displayed formulae were less likely to achieve higher marks, though displayed and structural formulae were accepted. The most common pitfall for candidates was to draw the same structure more than once, but in a different orientation. Also seen were many cyclic structures, as candidates ignored the guidance that all four isomers were alkenes. In (a)(ii) the ability to communicate precisely was key.

Many candidates could describe the idea that the double bond has restricted rotation, though some suggested the double bond prevented rotation of the entire molecule. Far fewer made the point that **each** of the carbon atoms in the double bond has different groups attached. Many simply stated 'they have different groups attached' so it was not clear what they believed the 'different groups' were attached to. Part (b) proved challenging for many candidates. In (b)(i) a lack of precision again was an issue. Many answers got part way to the correct name but omitted key information. The absence of an *E* or *Z* was most common, but omitting to number the position of the double bond came a close second. Whilst candidates often recognised Compound Y is non polar in (b)(ii), they found it difficult to make comments to back up their judgement. The most common creditworthy statements spotted that the molecule was symmetrical so non-polar. However linking back to the stem and commenting on the student's statement about polar bonds was less common. A surprising minority described C-H bonds as polar.

The type of calculation in (c) continues to be a strength for many with over 35% of candidates scoring 5 marks across the question. Unit conversion still provides a difficult hurdle for a small number when using $pV=nRT$. Pleasingly most candidates made the link between their answers to (c)(i) and (c)(ii) and were able to deduce the number of double bonds in α -bisabolene. Success in (d) was often dependent the ability to deduce the formula of the monomer in (d)(i). This proved challenging for many, and a large number of the cohort struggled to accept the idea that the monomer could have two double bonds. Unfortunately this difficulty was compounded in (d)(ii) as few realised that the correct molar mass of the repeat unit could be found from structure in the stem, and so determined an incorrect value from their proposed monomer. Those who correctly deduced the structure of the monomer nearly always went on to score two marks in (d)(ii).

The context of (e) increased the level of demand for candidates, who often found it difficult to apply relatively straight-forward chemical ideas to a novel scenario. Many answers concentrated on the generic, so discussed 'removal of harmful gases' or 'removal of pollutants' without further exemplification linked to the nature of calcium hydroxide. Although the idea of a large surface area was commonly seen, a number did not link this to the increase in reaction rate.

Question 21

The majority of candidates understood the process to determine atom economy in (a)(i) and (a)(ii) so care with the deduction of M_r values provided a degree of discrimination. Whilst the majority could determine a value for the product, basic nickel(II) carbonate, omission of the multiplier for the value for sodium sulfate meant some loss of credit. Other candidates didn't seem to realise the denominator could be framed in terms of products rather than the reactants, so made the calculation more complex than was necessary. Few candidates appreciated that basic nickel(II) carbonate is not molecular in (a)(iii), revealing that the distinction between relative molecular mass and relative formula mass is not widely known.

The electronic configuration in (b)(ii) proved very difficult for many. Lots of answers gave the configuration for the atom, whilst others removed electrons from 3d sub-shell or added two electrons. A significant minority of candidates persisted in attempting to use the GCSE model of 2,8,8 etc. Despite all the information being present in the question only a quarter of candidates could construct the ionic equation in (b)(ii). Some candidates didn't appreciate the idea of spectator ions. For instance, the presence of sodium ions was relatively common. Others lost credit due to errors linked to the charge or balancing of ions. For example, CO_3^- and even Ni^{2-} were commonplace, as was the omission of '4' before OH^- ions. Others didn't appreciate that the waters in the hydrated product are bonded to the structure and left them out on both sides of the equation.

The advanced numeracy skills of many candidates were clear in (c) with over 40% of candidates managing to identify '**X**' with evidence of clear and succinct working. A small number tried to match 159.6 to the relative atomic mass of an element, suggesting Terbium. Others missed the stoichiometric ratio in the equation. Such candidates were able to score transferred error credit if they went on to suggest X was Francium.

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
- when drawing the structures of different isomers, try to name them to check that you haven't drawn the same isomer twice in different orientations
- practice deducing a wide range of monomer structures from more complex repeat units of addition polymers
- ensure you can describe the difference between the terms relative molecular mass and relative formula mass
- use the total molar masses of the products as the denominator in atom economy calculations. You will already have worked out one part of your value when determining the numerator, so to go back and work out the total molar masses of the reactants is often more time consuming