Pearson Edexcel

# Examiners' Report

# Principal Examiner Feedback

## January 2022

Pearson Edexcel International Advanced Level In Chemistry (WCH11)

Paper 01: Structure, Bonding and Introduction to Organic Chemistry

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**Introduction**

The mean mark for the paper was 46.4 which is 4.5 marks higher than the WCH11 paper sat in October 2021. Many candidates were well prepared for this examination and were able to demonstrate a good knowledge across the specification. There were very few scripts that indicated candidates had insufficient time to complete the paper.

**Section A**

The mean mark for the multiple choice questions was 13.9. The most challenging question was 13 where 41.4 % achieved the mark. The highest scoring question was 1(a) where 90.4 % achieved the mark.

**Section B**

**Question 19**

This question was intended to be a straightforward introduction to the paper and the majority of candidates had a reasonable understanding of how to determine the water of crystallisation.

(a)(i) Although most were able to calculate the masses of magnesium sulfate and water, a significant number of candidates got the values the wrong way round and some incorrectly gave a mass of 5.5g (the mass of the hydrated salt rather than the anhydrous form).

(a)(ii) The calculation of the number of moles of water of crystallisation produced many excellent answers that were well structured and easy to follow. However, it was quite common to see numbers truncated in the intermediate steps of the calculation to only 1SF, and incorrect rounding was also seen. Candidates who found this question more challenging often got no further than calculating the molar mass of magnesium sulfate.

(b) There was very little middle ground in this question. Many candidates struggled to understand the nature of the practical and there was clearly confusion with other experiments. Most answers incorrectly focused on simply repeating the experiment and taking an average and many others suggested changes to the method, such using a lid to prevent water loss, despite the question stating the same apparatus should be used. On the other hand, candidates who had experienced this type of experiment, clearly understood the concept of heating to constant mass and scored well.

**Question 20**

After a relatively straightforward start this question about copper and its compounds became more challenging and the calculations proved to be good discriminators.

(a) The electronic configurations of Cu and $Cu^{2+}$ proved to be well known. The majority of candidates got the correct arrangement for Cu, but $Cu^{2+}$ was seen less frequently as both electrons were sometimes removed from d subshell, instead of one from the s and one from the d. Although not penalised,  some candidates failed to use superscript for the number of electrons or lower case letters for subshells.

(b)(i)-(iii) Most candidates had a good understanding of isotopes and scored well. However, a number did not refer to the sub atomic particles, as instructed and answered in terms of mass number and atomic number. Although the reason for the same chemical reactivity was well known, few responses mentioned the same electronic configuration and instead referred to the same number of electrons. A number mentioned the same number of outer electrons which did not score.

(b)(iv) Candidates with a reasonable mathematical ability solved this question quite simply with algebra, knowing that the abundance of the two isotopes together was 100%. Some candidates achieved the same result by trial and error or, in some ingenious cases, by using ratios of the difference in atomic masses. However, for a number it proved challenging and expressions that contained two variables and so could not solved were seen.

(c)(i) A surprising number of candidates were unable to recall this basic reaction of an acid. The formula of copper carbonate was regularly represented as copper(I) carbonate and many failed to realise carbon dioxide was produced and it was not uncommon to see carbonic acid as a product.

(c)(ii) The majority of candidates carried out this calculation successfully and many scored full marks with logically presented steps. The most common errors were failing to give the answer to the correct number of significant figures or truncating the answer rather than rounding correctly. For those who found the question more challenging, most were able to score a mark for the correct number of moles of sulfuric acid.

**Question 21**

Although several parts of this organic question proved to be quite challenging, they were interspersed with more accessible parts of the specification.

(a) The majority of candidates did not seem to understand how to draw the areas of electron density in a carbon to carbon double bond and the mean mark was 0.7/2.  Many responses simply joined the two carbon atoms with lines to make a double bond. Where an area of electron density was shown, marks were often lost as the pi bond was not present above and below the sigma bond.  Other common errors included incorrect or missing  labels and contour maps.

(b)(i) Of the three reactions, candidates were most familiar with the reaction of propene with bromine, followed by acidified potassium manganate(VII) and then steam. The most common errors were adding both -OH or -Br groups to the same atom and changing the length of the carbon chain. Although the use $KMnO_4$ to form diols was generally well understood, occasionally Mn or even Mg was seen covalently bonded in the organic product.

(b)(i) This standard electrophilic addition mechanism was familiar to the majority, although a lack of precision cost marks and candidates should be encouraged to ensure their work is clearly set out. Common errors were missing the dipole on HBr in M1; drawing a primary carbocation rather than a secondary carbocation in M2; and not having the curly arrow coming from a lone pair on the bromide ion in M3.

(c)(i)-(ii) Almost 60% of candidates were unable to deduce the molecular formula of ocimene from the skeletal formula and a similar number could not identify the part of the molecule that produced geometric isomerism. Sometimes the wrong double bond or just a single carbon atom was circled and a surprisingly large number of responses were left blank.

(c)(iii) This question proved to be very challenging and correct answers were rarely seen, with candidates often drawing only sections of the ocimene molecule, or moving a methyl side chain to somewhere else on the molecule. Some candidates simply drew a reflection of the cis isomer and others removed all the side chains.

(c)(iv) The start of the final calculation was well done and many candidates obtained the 3:1 ratio, however, the conceptual step to what this ratio meant to the hydrogenation of the alkene was often missed.

**Question 22**

This question contained a significant number of straightforward definitions and basic concepts about bonding which were often poorly expressed. Candidates need to be reminded of the precision required when defining the interactions in bonding and explaining trends.

Q22(a)(i) This definition was well remembered by the majority of candidates although a significant number did not mention the word "attraction" and so did not score the mark.

Q22(a)(ii) The main issue for most candidates was terminology, with answers not distinguishing between atoms and ions – for example, statements such as "magnesium has a higher charge than sodium" rather than "the magnesium ion has a higher charge than the sodium ion". Candidates also lost marks by not referring to the electrons being delocalised as this was important to access the M1 and M4 marking points.

Q22(b)(i) Although there were some very good responses to this question, many candidates gave a very basic definition concerning the sharing of electrons with no reference to the attraction to the nuclei. At this level, the definition needs to be complete.

Q22(b)(ii) Many candidates were able to successfully describe the bonding in silicon and phosphorus and so scored M1 and M2. However, M3 required a comparison of the two elements and many found this more challenging.  Some failed to mention the relative strength of the forces being overcome and there was also confusion as a number noted the weak covalent bonds in phosphorus and strong intermolecular forces in silicon.

Q22(c) Over 80% of candidates correctly completed the dot and cross diagram of sulfur dichloride and scored both marks.  However, a minority missed out the non-bonding pairs and this led to a linear shape in the second part of the question. The majority of candidates deduced the correct bond angle, but explanations were not always detailed enough. Many answers stated a number of bond pairs and lone pairs, but did not explain the shape adopted was a result of minimising electron pair repulsion. Other responses explained how each lone pair reduced the bond angle by $2.5^{o}$ but did not show an understanding of why this approximation works.

**Question 23**

This question about ionisation energy started with a simple equation. The demand then increased and careful use of key terms was required to score good marks.

Q23(a)(i) This equation was well remembered by the majority of candidates although a small number either omitted or used the wrongs state symbols.

Q23(a)(ii) Most candidates referred to increasing nuclear charge, or increasing  the number of protons to score M1 and the commonest way of scoring M2 was to refer to similar or the same shielding. The trend in first ionisation energy across a period was particularly well known and candidates often scored the marks several times over.

Q23(a)(iii) Overall, candidates were familiar with the dip between nitrogen and oxygen, however, their answers were often confused and lacked clarity in their use of technical language. What was required was a comparison between electrons being paired in oxygen's 2p sub-shell, but not paired in nitrogen's. Many candidates did not appear to know the difference between a shell (here, the $2^{nd}$ quantum shell), a subshell (here, the 2p subshell) and an orbital (here, the 2px orbital holding a pair of electrons in oxygen). Candidates need to learn these terms and understand they are not inter-changeable.  It was noted that  candidates who drew an "electrons in boxes" diagram almost always scored both marks.

Q23(b) A large number of candidates just focused on the jump in ionisation energy between electrons five and six due to the change in shell. However, those who linked this to nitrogen being in Group 5 and not the number of number of outer shell electrons gained no credit. Of those who developed their answers further, many were able to explain the general increase across the period but very few noted the small rise between electrons three and four being due to the change in subshell.

**Question 24**

Successfully converting the units in this ideal gas equation question was the main requirement to score good marks and the identification of the unknown liquid was a more challenging finish to the question.

(a) The ideal gas equation calculation produced many well-structured answers as it was a topic familiar to most candidates. The key to this question was using the correct units and the majority coped with the conversions from $cm^3$ to $m^3$ and kPa to Pa. However, a number found these conversions quite challenging and common errors included multiplying by $10^6$ instead of $10^{-6}$, converting $cm^3$ to $dm^3$ and just leaving the volume and/or the pressure units unchanged. Some responses were seen where the volume was converted from $cm^3$ to $dm^3$ and the pressure left as kPa. These two errors cancelled each other out allowing the candidates to potentially get the correct answer, but not score full marks. Almost all candidates were able to rearrange the gas equation and so scored M2 even if they had not scored the conversion marks. A few incorrectly tried to convert 358K to Kelvin by adding 273 but were still able to access TE marks. Rather surprisingly, a few calculations stopped after finding a value of n, with some stating that this was the molar mass, despite the fact that this number was far too small. Once again, truncating intermediate numbers to 1SF during the calculation was as issue, with some candidates converting 0.002437 moles to 0.002 moles.

(b) About half of the responses scored this mark with either the name or formula of hexane. However, despite the question stating that the organic liquid C, was a hydrocarbon, this was missed by a number of candidates and a range of answers including alcohols, rubidium and radon were seen. Rather oddly, hexene or $C_6H_{12}$ was occasionally noted from candidates who had calculated the correct molar mass in the previous part of the question.

**Summary**

In order to improve their performance, candidates should:

- read the question carefully, note the command word and make sure they are answering the question being asked
- learn definitions of the key terms in the specification
- understand the difference between shells, subshells and orbitals. Practise drawing electrons in boxes diagrams
- practise drawing organic mechanisms, paying particular attention to the starting and finishing point of curly arrows
- show working for calculations and make sure the units and significant figures are correct
- not truncate intermediate numbers in multistep calculations and round correctly
- practise converting units in ideal gas equation questions
- practise drawing skeletal formula from structural formula and vice-versa

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