Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

January 2022

Pearson Edexcel International Advanced Subsidiary In Chemistry (WCH12) Paper 01
Unit 2: Energetics, Group Chemistry, Halogenoalkanes and Alcohols

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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 on the specification. Nearly all papers were answered through to the last question indicating there was no difficulty with completing the paper in the time allowed.

Question 1–19

The mean mark on the multiple choice questions was 16.

The questions that candidates found most difficult were Q19 (equilibrium observations, 9.10), Q6 (bonding in ice, 7.3) and Q10 (alcohol reagents, 10C.17c), with under 55% of candidates achieving these marks.

Q8 (boiling temperatures in homologous series), Q1 (identifying reaction types) and Q12 (oxidation numbers) proved were more accessible to candidates, with over 80% of candidates scoring these marks.

Question 20(a)

A great variety of answers were seen but 70% of candidates gained both marks.

Question 20(b)(i)

Marks were lost here due to candidates not being specific enough in their answers e.g., “missing lone pair on the ammonia”, not referencing the nitrogen atom, or “missing charge on then carbon” without stating what the charge should be. Most candidates only gained one mark here; many responses also listed supposed incorrect parts of the diagram so the word “omission” may have been unfamiliar to some candidates.

Question 20(b)(ii)

This question was poorly answered. The mean mark was one out of three. This was usually awarded for the correct products. It was obvious that many candidates had failed to read the question as ammonia was often seen as the nucleophile, this meant that the first mark was lost but the other marks could be given as transferred error. The curly arrow from the hydroxide was regularly shown attacking the positive nitrogen instead of a hydrogen atom, and then the arrow from the N–H bond going to the hydrogen atom. This meant many of the mechanisms drawn would not lead to the correct products. Candidates generally need to improve the precision of their curly arrows, ensuring they start from a lone pair or bond and end at an atom. Some covalent bonds were shown between the sodium ion and oxygen of the

hydroxide which lost M1, as did omitting the negative charge on the hydroxide ion. Spectator ions were ignored for this exam, but the unbalanced nature of some candidates' mechanisms showed that they do not appreciate the role of some species.

Question 20(c)

The most candidates scored here, though often only one from the three marks available. Usually candidates could state that 2-bromo-2-methylpropane would react faster. Some were able to identify the tertiary and/or primary structure, though there were frequent responses referring to the molecules being carbocations (instead of forming them) and a number of candidates referred to the substances being alkanes rather than halogenoalkanes. The mark relating to the strength of the C–Cl bond was the least frequently awarded, and there was evidence of a misconception that a stronger bond would lead to a fast rate. Many candidates did not refer to the different halogen being present at all, and some answers made irrelevant comments about branching and intermolecular forces.

Question 21(a)

In part (i) the vast majority of candidates scored the mark. A negative temperature change was not awarded, and this was seen occasionally.

The calculation in part (ii) was not well done, with the mean mark being two from four. Many candidates substituted the wrong numbers (such as the moles of alcohol) into the mcΔT expression and/or calculated the M_r incorrectly. The negative sign and units were essential for the final mark, so some students lost out here from not reading the question carefully.

Question 21(b)

Part (i) was poorly answered, many failed to state either that oxygen was an element or that it was in its standard state. Only 15% of candidates scored here.

The cycle in part (ii) was designed to make these marks easy for candidates to achieve but was poorly answered, many could either not balance the equations or omitted the state symbols for the elements on the bottom line. A significant number of candidates forgot that hydrogen and oxygen are diatomic in their elemental states, and some didn't include the oxygen atom in the alcohol on the bottom line.

The calculation from the cycle in was better than the part (ii), most candidates gained both marks here. Common errors were omitting the stoichiometry or one or more negative signs, though the vast majority included a negative sign in their final answer showing that they could use the cycle correctly.

Question 21(c)

Most candidates scored a mark here. Common errors included stating that “not all the alcohol burned fully” which is ambiguous and was not accepted in place of incomplete combustion, as well as listing heat loss from two locations (this could only gain M1).

Question 22(a)

This part was correctly answered by just over half of the cohort. Frequent incorrect answers included only the colour or state rather than both. Alternatively, some candidates described the trend down Group VII instead of answering the question.

Question 22(b)

Part (b)(i) was poorly answered, with many candidates failing to mention either a pair of electrons or a bond. In (b)(ii) most candidates described the trend, but many referred to the size of the atom (or worse, the ion) rather than the electronic effects.

Question 22*(c)

The responses to this question received the full range of marks but the average mark was 2 of the 6. Some candidates obviously knew the topic well and could answer with either full or ionic balanced equations, as well as discussing disproportionation in detail. Other candidates showed no familiarity with this area of the specification and either left the answer space completely blank or made up some chemistry. This topic hasn’t been tested regularly and this may be why some candidates were less prepared for this extended response. M3 and M6 were the most frequently awarded marking points showing a good understanding of oxidation numbers where candidates attempted the answer. A few candidates were confused by the word “alkali”, some even showing a reaction with sulfuric acid.

Question 23(a)

Over half of the candidates gained the mark for (a)(i). The word “toxic” alone did not score as it was not clear which compound the candidates were referring to. “CO is harmful” was also not enough for credit.

In (a)(ii) a common error was to neglect to add the 1.8 g to the 3.15 g for the final mark. Candidates could gain marks from using a variety of methods and the majority gained at least two marks here. A large number of candidates that incorrectly calculated M_r values were still able to score marks by transferred error, highlighting the importance of students continuing to work through calculations to give a final answer.

Question 23(b)

This question was poorly answered. We regularly saw “thermal decomposition decreases down the group”. This response fails to score as it does not refer to either the temperature of decomposition or the thermal stability. Many candidates referred to polarisation of the ion, without specifying which ion was polarising which so couldn’t gain M2 and there were lots of vague responses about the sizes of ions (and atoms) that also didn’t score M3. Candidates need to ensure they are referring to the compound, here the carbonate, rather than the stability of Group 2 elements.

Question 24(a)

Candidates most frequently gained the mark for hydrogen bonding, though sometimes it was unclear whether candidates were actually referring to the nitrogen-hydrogen covalent bonds within the molecule rather than the intermolecular forces. Comments about breaking covalent bonds negated a mark being awarded. M3 was regularly given for comments about hydrogen bonds being the strongest intermolecular force (though some candidates did not include any comparisons in their responses and couldn’t score). M2 was the least frequently awarded mark; even when candidates recognised the polar bonds it was a minority who went on to relate this to intermolecular forces. Very few responses mentioned London forces at all.

Question 24(b)

This question was well answered.

Question 24(c)

Only half of all candidates achieved this mark with many confusing the nitrogen oxide gases with those contributing to global warming and climate change. A clear elucidation of the specific gases involved in each environmental problem is required during the teaching of this topic.

Question 24(d)

Over 80% of candidates could identify the relevant area of the spectrum, but fewer could recognize the bond causing the absorbance at 1683 cm^{-1}. Some candidates drew the whole molecule, or several atoms, rather than identifying a bond.

Question 24(e)

Just over 60% of candidates scored the mark in (e)(i). The most common error was failing to balance the equation or adding additional products, and those who gave the correct products sometimes used a single arrow.

In (e)(ii), few candidates achieved all three marks. A lot of double headed arrows were seen, these were penalised once. Some candidates drew the more familiar exothermic reaction profile, where two marks could be awarded for correct arrows as transferred error. Candidates need to focus on precision here, ensuring arrows accurately show the energy change (by clear start and end points) and are pointing in the right direction.

Question 24(f)

Half of the candidates could describe the difference between a catalyst and a reactant for (f)(i). Some candidates stated that “catalysts do not take part in the reaction” which shows a misapprehension about how catalysts work. Many candidates responded that urea does not reduce the activation energy, this is not an adequate explanation and was ignored.
In part (ii), the first two marks were regularly awarded but many candidates failed to give an indication of time or frequency to score M3.

Question 24(g)

Fewer than 25% of candidates scored the mark in part (i). Many candidates stated that the reaction was endothermic, which is counter-intuitive when the question is about heating. A surprising number of candidates failed to read the question and gave an irrelevant answer relating to the balance of rate and equilibrium. This was a relatively simple question and candidates need to remember that sometimes only a straightforward answer is needed.
A third of candidates scored full marks in part (ii). Common errors included failing to convert from m^3 to dm^3 and multiplying by the 51.1 dm^3 instead of dividing. A few candidates attempted to use the molar volume in standard conditions instead of the value given on the paper. Some candidates lost the final mark for calculating the number of atoms instead of molecules.

Summary

In order to improve their performance, students should:

- read the question carefully and make sure that they are answering the question that has been asked
- write formulae and numbers carefully, checking their legibility
- practise applying reaction conditions to different molecules
- learn chemical definitions, such as those for electronegativity and enthalpy of formation
- be able to draw reaction profiles including single headed arrows and labels
- show all working for calculations and give final answers to an appropriate number of significant figures, including units
- consider suitable precautions when working with hazardous substances
- make sure they understand the difference between reagents and conditions, including when catalysts are involved
- practise % uncertainty calculations for different equipment in core practicals
- reread questions and answers, where time permits, to avoid careless mistakes.

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