Examiners' Report

Principal Examiner Feedback

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Pearson Edexcel International Advanced Level

In Chemistry (WCH14) Paper 01

Rates, Equilibria and Further Organic Chemistry

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Introduction

This paper was similar in style and standard to previous Unit 4 papers. As is often the case, candidates seemed better prepared for standard questions which they had clearly practiced than using their knowledge in less familiar contexts. Candidates sometimes did not read questions with sufficient care and answered questions different to the ones actually set. In general the paper showed good discrimination between the grades allowing students of all abilities to demonstrate their knowledge and understanding.

Section A

This section scored quite well, though not as well as some recent examinations. The mean score across the section overall was 54.0% with Q9 proving to be the most difficult and question 16 scoring highest.

Question 18

In (a)(i) many candidates were able to use the data to deduce the orders of reaction for the rate equation. Very few forgot to include the rate constant in their equation which was encouraging.

Candidates in a(ii) who did not use Experiment 4 were still able to score full marks providing that they included units in their answer. Some candidates who deduced the wrong rate equation in (i) were still able to score full marks in this part.

Part (b) proved much more challenging. The expected answer that the particles in the rate equation and the equation for the reaction or that collisions of more than two particles were unlikely were rarely seen. Some candidates assumed the answer was related in some way to S_n1 or S_n2 mechanisms for nucleophilic substitution reactions.

Question 19

In 19(a)(i) some candidates were clearly very well prepared for this mechanism. Omission of the lone pairs or dipoles was the most common error, though the arrows, particularly that to the C of the nitrile group, were sometimes imprecise. Arrows should go from lone pairs to atoms, not to bonds, or from bonds to atoms or ions. On this occasion arrows that did not originate from lone pairs was not penalised.

The detail required in (a)(ii), that CN^- is the catalyst involved, can clearly be deduced from the question and from the mechanism. Some candidates recognised that the value for K_a was very low but then thought the reaction was catalysed by hydrogen ion and that this was the significant factor rather than the cyanide ion.

Candidates should have noticed in (a)(iii) that both the words homogeneous and catalyst were emboldened. This should prompt them to describe how the KCN achieves both of these, so a comment about the state of the reaction and the catalyst and the regeneration of the catalyst was expected. The question clearly asks about

KCN, but general descriptions of homogeneous catalysts were able to score 1 of the 2 marks.

The 3-dimensional representation of organic molecules is an area where some more time might be spent to consolidate these diagrams. They are far easier to draw if a candidate has learned to draw a tetrahedral structure, either with one dot and one wedged bond, or with two of one and one of the other. There are many examples available in textbooks and on the internet, but the technique needs to be directly taught as there are few resources available that allow candidates to do this independently.

Question 20

In (a)(i) quite a number of candidates did not read the question with sufficient care and wrote the chemical equation for the dissociation of hexanoic acid, rather than the mathematical equation for the calculation of K_a. Even many of these, however, were able to correctly calculate the pH in (a)(ii) which was a well understood skill.

As is often the case, this question, (a)(iii), about structure and intermolecular forces proved challenging. A scatter gun approach quoting intermolecular forces was often seen. As was the statement that butyl ethanoate was unable to form hydrogen bonds. Candidates need to remember that a hydrogen bond has two halves, with the oxygen (or nitrogen or fluorine) being one and the hydrogen being another. Absence of a suitable hydrogen does not prevent hydrogen bonding with a different substance. Candidates who recognised that hydrogen bonds could be formed by the oxygen in the carboxylic acid or ester group were generally able to score full marks.

(b)(i) was well answered. Candidates generally laid out the work clearly, often in the form of a table, and showed all the intermediate steps. Since the questions provides hints that the compound A is an isomer of hexanoic acid, simply jumping to the empirical formula of hexanoic acid without showing these steps did not provide access to full marks, though this was very rarely seen.

(b)(ii) was not well understood or answered. Candidates did not recognise what would be needed to deduce that A was an isomer, and simply said the mass spectrum would be the same.

(b)(iii) proved to be very discriminating. Candidates scoring 5 or 6 marks were generally those achieving very high grades. The main errors were associated with imprecision or too narrow deductions. Test 1 was well understood, though some candidates restricted the positive result to just alcohols or carboxylic acids. Test 2 was again well understood though some candidates forgot that 'C=O bond' could refer to CO in a carboxylic acid and so did not precisely say it identified either and aldehyde or ketone or showed the presence of a carbonyl group. Test 3 also scored very well with most candidates able to deduce the presence of a ketone. Test 4 was the least often scored. Candidates quite often used it as confirmation of the presence of a ketone rather that the fact that the alcohol present was tertiary. This is in part understandable, if this fact had not been successfully deduced from test 1 and the fact that a ketone was present (and so therefore there much be an OH group as it is isomeric with hexanoic acid). The polarimetry was often linked to a chiral carbon or the presence of one enantiomer, though the resulting structures sometimes did not agree with this deduction.

In (c), the presence of OH groups was often identified, but the information in the stem that the compound was cyclic was sometimes ignored, and the presence of only two peaks in the NMR was not fully understood, resulting in structures scoring only one of the two marks.

Question 21

In (a) more candidates achieved three marks than 4, with few recognising the need to comment on the fact that the numbers used in the equation to calculate K_c were moles rather than concentration, even though their equations clearly showed concentration. A statement that 'the volumes cancel in the equation' would have accessed the final mark. The calculations were good apart from this, though some started by assuming that the number of moles of sodium hydroxide indicated the number of moles of ethanoic acid that had reacted, not the number of moles remaining.

(a)(ii) was challenging, with candidates giving incorrect numbers of the types of bonds broken and made.

The acid was often correctly named in (b)(i). The catalyst was allowed if the formula was given. The final alcohol was the most challenging of the answers.

Full marks were rarely scored in (b)(ii), with candidates identifying the advantages and disadvantages but not then explaining them as required by the question. An advantage and a disadvantage still scored 2 marks.

Question 22

This first calculation of this question in (a) was well understood with many achieving full marks.

The graph in (b) proved to be accessible for many candidates, with 2 marks common.

The calculation in (c)(i) was often well done. (c)(ii) was the hardest of these marks to score, with activation energy a common incorrect response. (c)(iii) was often given with no working, so was probably read directly from the graph rather than calculated, though this scored the mark.

Parts (d)(i) and (ii) were well answered, though 22(d)(iii) proved discriminating with a range of scores. (d)(iv), however, was rarely scored.

22(e)(i) and (ii) proved challenging for candidates. (e)(i) had all the information provided with the reactants given (ammonia and H_3PO_4) and the product, diammonium hydrogenphosphate. A range of compounds were seen in responses with few totally correct. (e)(ii) proved equally challenging.

(e)(iii) is a very common type of question and many candidates knew a suitable form of words and equations to score at least some of the marks. Confusion as to what the ammonium ion and ammonia formulas were provided some difficulties when it came to writing a suitable ionic equation.

Paper Summary

Based on their performance on this paper, candidates should:

- be able to apply their knowledge to unfamiliar situations
- remember to read the questions with great care so as not to assume what is being asked
- practice drawing three dimensional structures of organic molecules
- understand the importance of bonding, structure and intermolecular forces in a range of properties including solubility and melting temperature for organic molecules
- practice the writing of equations, including state symbols where appropriate, for both familiar and unfamiliar reactions.

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