Examiners' Report
Principal Examiner Feedback

Ocotber 2022

Pearson Edexcel International Advanced Level
In Chemistry (WCH14) Paper 01: Rates, Equilibria and Further Organic Chemistry

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Introduction
While many excellent responses were seen to all questions, a significant proportion of the students were inadequately prepared for this examination and blank responses were seen for several questions.

Section A
The mean score for the multiple-choice section was 9.9. The highest scoring questions were Q6(c) and Q12 with around two-thirds of the students achieving these marks. The most challenging questions were Q3(c) and Q6(b), with less than one-fifth selecting the correct answers.

Section B
Question 15
Approximately half of the students were able to give the IUPAC name of lactic acid, with many demonstrating a poor understanding of organic nomenclature.
Most students clearly presented the non-superimposable mirror images of lactic acid in (b), often showing correct atom-connectivity; those who chose not to present mirror images often gave the same enantiomer twice.
Most students who did not score the mark in (c)(i) referred only to a lack of optical activity, failing to mention what a racemic mixture contains.
The overall standard of mechanisms in (c)(ii) was poor, with imprecise positioning of curly arrows and the omission of lone pairs and dipoles frequently seen.
Most students found (c)(iii) a challenging question and would benefit from further practice at writing equations for nitrile hydrolysis.
Imprecise language was often seen in (c)(iv), with many students failing to refer to the attacking nucleophile and/or referring to ethanal, instead of the arrangement of the bonds around the reaction site, as planar.
Most students were successful in the calculation in (d)(i) with many clearly presented and well-structured responses seen. A common error was to miss the conversion of pK_a to K_a. Students' understanding of the assumptions used in weak acid pH calculations was much less secure, with few appreciating the significance of dissociation of the acid on the initial mass required. Even fewer were able to demonstrate an understanding of the factors affecting the acidity of weak acids in (d)(iii), with most thinking that the extra OH group in lactic acid was acidic, or that additional hydrogen bonding caused increased dissociation.

Question 16
Most students were able to give a correct rate equation in (a), though some careless mistakes including the use of non-square brackets, or the omission of k were seen. A minority of students gave an expression for the equilibrium constant.
Most students were able to show the determination of a half-life on the graph in (b)(i) though many did not show a second half-life or failed to state that the half-life remained constant.

Although most students were able to rearrange the equation in (b)(ii), the majority were careless with units and did not convert minutes to seconds.
In (c)(i), most students correctly linked the higher value of the rate constant to a higher rate of reaction, but relatively few followed the command and explained the effect of temperature. The students' mathematical skills were again demonstrated in (c)(ii), with many successful responses to this unfamiliar calculation seen.
A large number of students did not know the units of activation energy, however, or did not follow the instruction to give their answer to two significant figures.
Many students identified the N=N bond in (d), presumably failing to realise that single bonds are generally weaker than double bonds and that the weakest bonds would be most likely to break. Identification of the N=N bond also suggested that students had failed to consider the products of the reaction, which were shown in the equation at the start of Question 16.

Question 17
Most students found (a)(i) challenging with many not even attempting a cyclic structure. Of those who did give a cyclic structure, many six-membered rings were seen, and many had an OH group attached to the ring. Students would benefit from numbering carbon atoms on skeletal formulae to better follow changes to the carbon backbone during organic reactions.
Similarly, relatively few students were able to demonstrate a sound understanding of the formation of a polyester in (a)(ii), with deducing the structure of the carbon backbone in the repeat unit causing most problems.
Again, spurious OH groups branching from the carbon chain were commonly seen, as were acid anhydride functional groups.
Very few students knew how to proceed with (a)(iii) and did not consider the number of molecules reacting or being formed in each reaction, instead making generic references to physical states and/or disorder.
Around half of the students gave the correct molecular formula in (b)(i), with far fewer being able to work through the alkaline hydrolysis of the triester in (b)(ii). Most students appeared to appreciate the significance of excess alkali, giving the correct number of moles of sodium hydroxide, but did not know how to break the ester bonds or deduce the structure of the products. A significant number of students gave sodium ethanoate with a covalent O–Na bond displayed.
Surprisingly, less than half of the students were able to give the correct reagent in (c)(i), with a significant number overcomplicating this straightforward one-mark question, including an additional incorrect reagent such as NaOH.
The students were more successful with the familiarity of the reaction is (c)(ii), but most gave a hydrogen chloride by-product instead of the more accurate ammonium chloride.
Students were less confident in drawing the analogy to esterification in (c)(iii), with only one-fifth of responses giving the correct answer.

A greater proportion of students were able to identify the amine required in (c)(iv); while the majority did give a skeletal formula, many careless errors, such as two hydrogen atoms or two methyl groups attached to the N, were seen.
Most students found the combined analysis challenging in (d), particularly in showing how they had used the information to deduce the structure of Z. Too many students gave vague responses, for example omitting any reference: to the relative molecular mass or molecular formula of Z; to the bond responsible for the infrared absorptions; to the number of carbon environments. Explanations of the chemical shifts and splitting of the peaks in the proton NMR spectrum often did not contain enough detail to receive credit. Students would benefit from more practice at constructing clearly presented responses to combined analysis questions.

Question 18

Most students gave the correct expression in (a), and many were able to use the data in (b) to calculate the value of K_c. Failure to follow instruction and give the answer to an appropriate number of significant figures was again a significant source of error, and incorrect rounding of the final answer was seen on numerous occasions. Many failed to distinguish between initial and equilibrium moles; students should expect a four-mark calculation to be more involved than the simple substitution of data into an expression and should be encouraged to practise the ICE (initial, change, equilibrium) moles approach to this type of calculation. Most students successfully completed the table in (c)(i), though some deviated from three significant figures or rounded their answers incorrectly.
The plotting of the graph in (c)(ii) was done well by most, though many failed to follow the instructions and show their working on the graph in (c)(iii). Most students worked through the equations in (c)(iv) to (c)(vi) correctly, though careless use of units (eg, giving J in (c)(iv) when J mol^{-1} was stated in the question) and signs meant that many did not score full marks. Students were generally well-prepared for explaining the feasibility of the reaction in (d), but many responses lacked precision, failing to refer to $\Delta S_{surroundings}$, or the signs of ΔH and ΔS_{system}.

Summary

Based on their performance on this paper, students should:

- be more precise with the use of curly arrows, lone pairs and dipoles in organic mechanisms
- practise writing equations for the hydrolysis of nitriles
- be aware of the limitations of the assumptions made when calculating the pH of a weak acid
- practise drawing the products of esterification, condensation polymerisation and hydrolysis reactions
- show how they are using the data provided in combined analysis questions
- give more attention to signs, units and significant figures in calculations

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