Examiners' Report
Principal Examiner Feedback

October 2018

Pearson Edexcel International Advanced Level

in Chemistry (WCH04)

Paper 01 Rates, Equilibria and Further Organic Chemistry

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General

This paper was similar in style and standard to previous and parallel Unit 4 papers of this specification; a range of skills and knowledge was assessed and the levels of difficulty allowed good discrimination between the different grades, while allowing well-prepared learners at all levels to demonstrate their abilities. Although this is an A level paper and therefore has a synoptic element, for the most part, learners seemed far better prepared for the straightforward type of question rather than those requiring application of knowledge and understanding. Many learners lost marks as a consequence of failure to answer the question that was actually set.

Multiple Choice Section (Questions 1−20)

This was the highest scoring section of the paper. 86% of learners gave the correct answers to question 8, while less than 29.6% of learners gave the correct answer to question 14, the lowest scoring question.

Q21

While most learners understood what was required for Q21(a) some over-complicated their responses by making reference to total entropy and the contribution of entropy of surroundings. There were a number of examples of inappropriate use of types of particles, for example references to molecules of sodium. The sequence of calculations in Q21(b)-(d) appeared familiar to the majority of learners and this resulted in high marks. The most common error was the incorrect use of multipliers in the ΔS_{system} calculation, particularly the use of a factor of three rather than a factor of six for nitrogen. Some learners did not appreciate that the enthalpy change given in the stem refers to the equation given and, in consequence, introduced a factor of two in (b) or in (c). Q21(e) produced few fully correct responses. Few learners realised that molar entropies increase with temperature and those that did often deduced that ΔS_{system} would not change. Many responses referred to the effects of temperature on an equilibrium system or discussed the effect of temperature on $\Delta S_{\text{surroundings}}$.

Q22

In Q22(a)(i) learners were more likely to score a mark for giving the effect of acid concentration on the dissociation equilibrium than an analysis of the relative values of K_a or pK_a. Many answers simply stated that citric acid was a weak acid or attempted an explanation in term of hydrogen bonding. Some learners suggested that limited dissociation was due to the alcohol group being more acidic than the carboxylic acid groups. Despite the emphasis in the question many responses to Q22(a)(ii) gave equations for complete dissociation of the acid. Other errors included failure to balance the equation while some learners misread the question and wrote the expression for K_a. While the method for Q22(a)(iii) appeared to be well understood, the conversions of pH and pK_a values to [H^+] and K_a often resulted in errors or were not attempted. Here and elsewhere in the paper, premature and excessive rounding caused learners difficulties and sometimes led to loss of marks, while very unlikely answers rarely seemed to prompt learners to review their calculation.

Only those learners who appreciated the practical aspect of Q22(b)(i) were able to suggest a sensible reason for removing any pulp from the mixture. Most learners identified a suitable indicator for the titration (22(b)(ii)) but they did need to realise that the equation now referred to the replacement of all three protons. Explanations for their choice often just referred to ‘the vertical section’ which was insufficient without a specified pH range. There were many excellent responses to Q22(b)(iii), often logically set out and clearly explained. Most learners were aware of the essential steps, the common errors being the omission of the stoichiometric factor and scaling the solutions incorrectly, often multiplying by 1000/250 rather than 1000/25. In 22(b(iv). while a good number of learners realised that the citric acid content of lemons would naturally vary, many responses focused on experimental errors and uncertainties despite the hint given in the question to avoid this approach.

In 22(c)(i) there were plenty of fully correct answers with marks most frequently being lost by stating that buffers maintained a **constant** pH or by failing to mention that additions of acid and alkali refer to **small** amounts. Explanations of the working of the citric acid-dihydrogen citrate buffer covered the full range of marks with many excellent answers. Marks were often lost by simple omission of one of the marking points from otherwise competent responses while the more complex species involved did expose learners who relied on memory rather than understanding. Despite the specific nature of the question, some learners relied on generalised systems, answers which could not be awarded full marks.

Q23

Most learners scored both marks on 23(a). The best answer to this is Brady’s reagent as 2,4-dinitrophenylhydrazine is the compound used to prepare the reagent. The various abbreviations were accepted but not if these were incorrectly recalled. Most learners identified the appropriate reagents for 23(b) although some simply stated ‘iodoform test’, which did allow the observation marks to be awarded. In some responses the observations were reversed or the negative observation for heptan-3-one was omitted altogether. Learners found 23(c)(i) very straightforward although some were unable to identify the appropriate peak on the spectrum. The most common reason for losing the mark in 23(c)(ii) was an inadequate justification for their choice. When learners correctly identified the six proton environments in 23(d), they were usually able to give the appropriate peak areas and splitting patterns. The most common errors were giving the environments on C4 and C5 as identical and labelling the carbonyl carbon as a proton environment; some learners left some of the environments unlabelled. There were some excellent examples of the nucleophilic addition mechanism in 23(e)(i) although some of these lost a mark by failing to re-form the cyanide ion in the final step. Otherwise marks were most likely to be lost for inaccurate placing of the curly arrows or the omission of charges. The explanation required in 23(e)(ii) was generally well known although quite a number of learners described heptan-2-one as a planar molecule, forfeiting the second mark.

Q24

The majority of learners were unable to draw the dot-and-cross diagram for hydrogen peroxide, with errors including the omission of the oxygen lone pairs, the appearance of double or even triple bonds between the oxygen atoms and incorrect sequencing of the component atoms in the molecule. Learners showed a good understanding of the role of intermolecular forces in determining boiling temperature (24(b)) although a good number failed to include a comparison and this was essential. Very few learners identified the weakness of the oxygen-oxygen bond as the key factor in determining the reactivity of hydrogen peroxide. The quenching methods suggested by learners in 24(d)(i) were often not related to the system under consideration, common choices being addition of acid or alkali. In 24(d)(i) most learners drew the graph competently. Errors in the axes were relatively rare but a good number of learners chose a scale which made plotting the points and measuring the half-lives more difficult. The most common error in 24(d)(ii) was giving the total times elapsed (eg 46 s and 92 s) rather than the two half-lives. In 24(d)(iv) some learners omitted the justification of the reaction order. Less than a third of learners deduced that, because the Fe^{3+} ions catalysed the decomposition, their concentration would remain constant. Most learners were able to deduce the order of reaction with respect to Fe^{3+} ions and go on to write the rate equation (24(e)). Relatively few learners failed to consider the concentration of hydrogen peroxide or omitted elements of the rate equation, such as the rate constant. In 24(f)(i) most learners dealt incorrectly with the factor on a thousand on the x-axis of the graph, either inverting it or omitting it altogether. In measuring the gradient some learners used ‘triangles’ that were too small and others failed to appreciate that the x-axis had one small division = 0.01 units whereas the y-axis had one small division = 0.04 units. Most learners knew that the gradient was negative. The subsequent conversion of the gradient to the activation energy also presented challenges to the learners and, although most recognised the need to multiply the gradient by *R*, both the sign and the units were frequently incorrect. Very few learners gave the products of the decomposition of hydrogen peroxide in 24(g), relying instead on general comments about products that were not harmful to individuals or the environment or speculation about the activation energy of the reaction.

Summary of advice to learners

- ensure that their answers match the requirements of the questions
- use the vocabulary of chemistry precisely eg correct use of the terms atom, ion and molecule is essential
- consider the feasibility of values obtained from calculations and review their working if appropriate
- when drawing reaction mechanisms, place curly arrows precisely, either from a lone pair or a bond pair to an atom
- when drawing graphs, remember that the grid provided is designed to fit the data with use of a scale which utilises most of the available space
- in measuring the gradient of a graph, choose the largest possible ‘triangle’ that is consistent with easy reading of values.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

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