GCE

Chemistry

CHEM4 – Kinetics, Equilibria and Organic Chemistry
Report on the Examination

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General comments

The mean and standard deviation for this paper were both slightly higher than last year's paper but the general standard was similar. Students again demonstrated a well-practised ability with questions on many of the topics involved and scored highly. Questions which required either more explanation or working in several steps were found harder. The tendency shown in the synthesis question (Question 8(c)) to write a list of possible reagents and conditions rather than give a single answer should be strongly discouraged.

Question 1

This question was answered well. A few students lost marks through the incorrect use of calculators in the division necessary in part (b)(i) to find the rate constant, *k,* or by omitting s^{-1} from the units of the rate calculated in part (b)(ii).

Question 2

Parts (a) and (b)(i) were answered well. In part (b)(ii), over half of the students scored full marks, but others were unable to rearrange the expression for K_c or did not note the difference between the concentration of chlorine and the amount, in moles, of chlorine and failed to multiply the concentration by the volume (15 dm^3) in the final step of the calculation.

In part (b)(iii), few students recognised that K_c for the alternative equation was simply the square root of the original K_c. Some obtained the correct answer by substituting values in a new K_c expression and a slightly higher number gained the units mark.

Question 3

Although parts (a) and (b) were answered well, a considerable number of students again had difficulty in rearranging the expression for K_a in part (b)(ii). Part (c)(i) was well done, although HCl was a common wrong product. Part (c)(ii) proved to be difficult and was poorly understood by many students. In part (d), the indicator for the strong acid – strong base combination was surprisingly least well answered.

Many students found part (e) difficult and the question discriminated well. Despite the instruction to assume that sulfuric acid was fully dissociated, the factor of 2 was often omitted completely or alternatively used in the wrong place. Also, the number of moles of H^+ was often used instead of the concentration of H^+ to find the pH.

Question 4

In part (a), the molecular ion was often shown incorrectly without the plus and dot. Many also did not draw a displayed formula for the radical.

Part (b) was answered well, and although nearly half of the students gained full marks in the mechanism in part (b)(ii), several lost a mark by drawing the + on the Wheland intermediate too close to carbon number 1. A significant number also gave Friedel-Crafts acylation as the name of the mechanism rather than electrophilic substitution. In part (b)(iii), the formula of the acid anhydride proved to be challenging to a considerable number.

Question 5

Parts (a), (b)(i) and (b)(ii) were answered well. In part (b)(iii), students often correctly identified that polarised light could be used but then failed to gain the marks because they did not mention the effect of a racemic mixture on the light. Another concern was that answers appeared to suggest that the light caused the molecules themselves to rotate.

Parts (c)(i) and (c)(ii) were answered well but very few students scored full marks for part (c)(iii) where explanations were often muddled or referred to unspecified equilibria.

Part (d) was generally well attempted, with the main errors being in part (d)(i), where many gave three or more repeating units or failed to show an ester linkage, in part (d)(iv), where many gave the formula of the polymer or missed this part out completely, and in part (d)(v), where hydrogen bonding was often offered as an explanation.

Part (d)(iii) contained an unfortunate typographical error, which was identified after the examination had taken place. The end of the first sentence should have read "…from two lactic acid molecules" rather than "…..from two PLA molecules". AQA apologises for this error. The expected answer was given by about a quarter of the students. To ensure that students were not disadvantaged, a mark was also awarded to those students who drew any correct cyclic compound with molecular formula $C_6H_8O_4$. The number of students who did not attempt this question was low and in line with other question parts on this paper. The most common errors involved attempts to draw a cyclic compound but with one or more carbons having fewer than four bonds or oxygens with fewer than two bonds.

Question 6

This question was answered well, especially part (a). Parts (b) and (d) were the least well answered parts but a majority of students were still awarded the mark available in each part.

Question 7

In part (a)(i), tetramethylsilane was a common incorrect answer. The rest of the question was answered well apart from part (b)(iii) where the name of the ketone was found more difficult.

Question 8

The mechanism in part (a) was answered well by most students but many found the name of the product difficult. In part (b), the original amine was frequently drawn instead of the isomeric primary amine but the secondary and tertiary amines were well done. Most answered part (b)(ii) well although some suggested that the C-C bond absorption could be used to distinguish between the secondary and tertiary amines. Unfortunately this absorption occurs in the fingerprint region and so is excluded.

Only the very best students scored full marks in part (c)(i). Route B was almost always given correctly, but there were fewer good answers to Route A. Some wrongly suggested HCN or KCN with acid for Stage 1. Stage 2 proved more difficult with even those who correctly identified $LiAlH_4$ failing to gain the conditions mark. Most students made an attempt at part (c)(ii), with route B disadvantage being the most common mark given.

In synthesis questions of this sort, many students are writing lists of reagents and conditions in the apparent hope that something they have written might score. Students should be told that this method will not succeed because, where more than one answer is given to any question, an additional wrong answer will lose any marks which might have been gained by a correct answer.

Question 9

Very few students scored all three marks for part (a). The ability of either nitrogen atom to be protonated depended on the availability of the lone pair and this needed to be mentioned for the first mark. The inductive effect of the alkyl groups on the nitrogen labelled *b* was the most often scored mark. Many failed to mention that the lone pair on the nitrogen labelled *a* would be delocalised into the benzene ring, often stating that the benzene rings are electron withdrawing or simply that there were delocalised electrons present.

Part (b) was poorly answered with a structural formula sometimes being given or alternatively a molecular formula but with an incorrect number of hydrogen atoms. The number of ^{13}C peaks was also found difficult and eight was a common wrong answer.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.

UMS conversion calculator http://www.aqa.org.uk/exams-administration/about-results/uniform-mark-scale/convert-marks-to-ums