AQA

A-level
CHEMISTRY

CHEM4 Kinetics, Equilibria and Organic Chemistry
Report on the Examination

2420
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General comments

CHEM4 2016 was a harder paper than last year's. The mean was three marks lower but the standard deviation increased by one mark. The boundary mark for Grade A was 76, a fall of two, and the boundary mark for Grade E was 49, a fall of three marks.

Much excellent work was seen. Most calculations were answered well although a recurring error was to confuse amounts in moles with concentrations where the volume of the solution or of the mixture should have been used to convert one to the other. Questions about organic reaction mechanisms continue to be answered well, and it was pleasing to see that students were able to apply their knowledge and understanding of nucleophilic additions to an unfamiliar context.

Question 1

Question 1a was generally well done, but a large number of students did not include a reversible sign in their equation for dissociation of the weak acid. Part 1b differentiated well as weaker students failed to show how ethanoic acid could act as a base and accept a proton.

Part 1c(i) was more straightforward but some students failed to calculate the concentration of the acid correctly and just used a number of moles. Part 1c(ii) differentiated well: many students realised a subtraction was needed in the calculation, but then failed to use the total volume to convert the amount, in moles, of H^+ ions to a concentration to calculate the pH.

Part 1d(i) was completed very well with most students gaining either 3 or 4 marks. In part 1d(iii) a significant number incorrectly used the original amount in moles of acid (0.0125) in their ratio. Even some of the strongest students struggled with the maths skills required and a frequent wrong answer was the inverse of 1.20 due to incorrect rearrangement. A significant number did not work out the hydrogen ion concentration and so lost M1 when they couldn't complete the rest of the calculation.

Part 1e differentiated well with full descriptions seen in about a third of the answers and one mark gained by another third. In part 1f the first mark proved very accessible but the second proved trickier; many students showed poor maths skills and thought that K_a would equal 1 or zero.

Question 2

Both parts of question 2a were answered very well and it was good to see the correct use of curly arrows. Part 2b(i) was well done but in 2b(ii) many students simply stated what stereoisomers do to plane polarised light and so failed to answer the question. Part 2c(i) was answered extremely well and the K_c expression in part c(ii) was also answered well. The calculation was well done but a frequent error was to use amounts, in moles, rather than concentrations by not using the volume. Better students answered part 2d correctly while others showed only one hydroxyl group from the diol reacting and so produced an answer for the acetal which did not match the given molecular formula.

Question 3

The IUPAC name in part 3 a(i) proved harder than expected with answers including 1-chloro or ethyl. The mechanism in part a(ii) was well known with over half of students gaining full marks. There was a wide range of answers to part 3d with both the number of hydrogens and the overall M_r proving harder than expected, but, even so, nearly half of all students scored both marks. Many students knew 3e was tertiary but some thought it was an amide rather than an amine.

Part 3f(i) was generally well done and in the correct responses there was a fairly even distribution between those describing why b is a stronger base or why a is a weaker base. Part 3f(ii) proved more difficult and only the best students scored any marks. The term salt was given in the question and so just that link was not credited. Few stated that the ionic character of the salt would make it more water-soluble than lidocaine itself.

Question 4

In part 4a(ii) many students drew the correct displayed formula; for others the location of the positive charge was the most common error. In part 4a(iii) several students lost marks by not reading the question carefully and failing to include the mass numbers of the chlorine isotopes in both fragments. Apart from the occasional suggestion of $AlCl_4^-$ as the electrophile, part 4b(i) was answered well as was the mechanism in 4b(ii). Marks are still lost by some students who draw curly arrows that lack the precise start and end positions required to gain the mark. About a third of students scored full marks in part 4c. The vast majority of incorrect answers involved oxidation: using Tollens or Fehling's or acidified potassium dichromate solution. Students should be reminded that when asked to give an observation, those who write the word "nothing" or "no observation" will not gain a mark.

Part 4d(i) was answered well although a few students drew more than one repeating unit. Part 4d(ii) was also answered well. About a third of students did not answer part 4e(i) correctly. Part 4e(ii) proved a good differentiator with many gaining a mark for noting that PGA is biodegradable, but only the best students were able to linked this to the presence of polar bonds in PGA. Some students included the term polar but applied it to the whole molecule and not a specific bond.

Question 5

Many correct structures were seen in question 5a(i) and nearly half of students scored both marks. A large number of incorrect answers occurred when students drew the full dipeptide and not the repeat unit. In part a(ii), the linearity of the hydrogen bond proved the differentiating factor and many students failed to see the importance of this.

All parts of question 5b were answered well. The name in 5b(i) proved the most difficult part; common errors included the mention of incorrect numbers and incorrect acids but the main error was because the amino and methyl groups were in the wrong order.

Question 6

Part 6a was answered well and two thirds of students scored both marks. By contrast, part 6b was a hard question with few correct answers. Many students spoke about the changing concentrations but few mentioned the importance of knowing the initial concentration. The first mark in part 6c for mentioning a gradient was often gained but the location of where to measure the gradient was only given by a third of students.

Question 7

Part 7a was answered correctly by just over half of the students. The majority of incorrect answers were because students didn't answer the question and simply just repeated what the rate equation told them.

Calculation of a rate constant in part 7b was answered very well as usual but part 7c proved to be very difficult. A large number of students could not deduce the correct rate equation. Those who did gain this mark were not often able to give a reason for their answer and the second mark was rarely seen.

Question 8

Most students knew that that the reagent was sodium hydroxide, but many did not know the correct conditions for its use in Question 8a. Incorrect answers included 'concentrated' or 'dilute' and the occasional 'acidified'. The separation part of this question was answered well. In 8b the structure of compound **S** was frequently correct. The reagent and conditions in Step 3 were often confused and acidified KCN was a popular incorrect combination as was alcoholic HCN. In Step 4 most students correctly used hydrogen and a nickel catalyst, while others gained the marks for $LiAlH_4$ in ethoxyethane. Sadly some students who used $LiAlH_4$ included acidic conditions with the hydride and hence lost the marks. However, clearly stated use of acid after the reduction stage with $LiAlH_4$ was accepted.

Question 9

Part 9a proved straightforward and most students gained full marks. A number lost the final mark because they did not explain why the empirical formula was half of the molecular formula.

Part 9b proved a challenging question which required a logical approach. It was pleasing to see many excellent answers and nearly a quarter of students scored seven or more marks. In the infra-red analysis some students did not include the full name of O-H (alcohol) for the peak at 3400 cm^{-1} whilst some described the adjacent C-H absorption as OH (acid) and lost the first mark.

The outcome of the potassium dichromate(VI) test was not always fully explained and some of those who correctly stated that compound **R** was a primary or secondary alcohol but not a tertiary, then contradicted themselves in their final structure by drawing a tertiary alcohol.

When analysing the nmr data, many simply restated the information on the data sheet without using the integration data and then struggled to 'do the jigsaw' at the end and come up with a structure that fitted everything.

Most students did draw a structure for **R** as required although some only included analysis of the separate peaks and not the overall structure. A few students who drew several suggested structures were penalised if they failed to cross out the extras to leave just one 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