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General Certificate of Education

Chemistry 2421

CHEM4 Kinetics, Equilibria and Organic Chemistry

Report on the Examination

2010 examination - January series

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Dr Michael Cresswell Director General.

General Comments

As was the case for the previous Specification, candidates generally found the physical parts of the paper easier than the organic. However there were many very pleasing performances across the whole range of questions and the paper discriminated well.

Question 1

In part 1(a) most candidates calculated the amounts of propanoic acid and of ethanol in the equilibrium mixture correctly but the amount of water proved more difficult. Full marks were awarded to candidates who used their values correctly in the subsequent calculation of K_c. In part 1(b), the effect on the time was found slightly more difficult than the other two parts.

Question 2

This question was generally well answered and only rarely did candidates fail to follow the instructions to give their pH values to two decimal places.

In part 2(a)(ii) only a fifth of the candidates realised that sulfuric acid is diprotic and in part 2(b)(i) only two thirds of the entry could write a correct equation for the reaction of ethanoic acid with sodium hydroxide. The following titration calculation was very straightforward but was thought more complicated by many including those who introduced K_w. It was disappointing to see that only the very best candidates understood that sodium hydroxide solution reacts with carbon dioxide in the air and many candidates showed a strange understanding of the composition of air. Part 2(c)(ii) was well answered; nearly four fifths of candidates answered this part completely correctly. Answers to the unstructured buffer calculation in part 2(c)(iii) were also quite pleasing; the question differentiated well and over twenty percent of candidates gained full marks. Other candidates were hindered by poor mathematical skills.

Question 3

As usual for questions on kinetics, this was answered well. It was also pleasing that, in part 3(d), over half of the candidates gained both marks on a question which required understanding of a new part of the specification. Application in part 3(e) of their understanding of the use of curly arrows in organic mechanisms was, however, less well done.

Question 4

In part 4(a), large numbers of candidates were able to write a correct mechanism for the nucleophilic addition of HCN to ketone **Q**. By contrast, most found it difficult to name the product correctly and so only 15% scored full marks overall. In part 4(b) many answers discussed the optical activity of the original ketones **Q** and **R** rather than that of the products of their reactions with HCN. Many also thought that both ketones produced racemic mixtures. In part 4(c), the formula of the molecular ion needed to show both a positive charge and a radical dot to score the mark.

Question 5

The IUPAC name of glycerol was given correctly by about two thirds. Whereas many knew the use of the sodium salts produced in part 5(a)(ii) as soaps, only half as many recognised that the methyl esters made in part 5(b)(i) are used as biodiesel. In part 5(b)(ii) the position of hydrogen atoms in a *Z*-isomer was very well known but disappointingly, only two-fifths of the candidates could write a correct equation for the combustion of the ester given.

Question 6

The first two parts of this question were answered well and nearly three quarters of the candidates gave correct answers. Part 6(a)(iii) was less well done and many missed that the second amine group would also be protonated in acid conditions.

In part 6(b) some candidates did not read the question sufficiently carefully and only drew one dipeptide while others drew a repeating unit. Only two-fifths suggested some form of chromatography for the separation method required in part 6(c).

Question 7

This question differentiated well and the five sections were found progressively harder by candidates. Over two-thirds scored both marks in part 7(a) but only a fifth gave both amines correctly in part 7(e). In part 7(b) a common wrong answer for **D** was cyclopentane. This clearly has only one ^{1}H peak, but its molecular formula is C_5H_{10} and not C_5H_{12} In part 7(e) candidates showed a lack of understanding of the structure of secondary amines and many drew NH_2 groups on a central carbon atom of butane.

Question 8

Part 8(a)(i) was answered well by most candidates who showed a good understanding of the numbers of peaks in ^{13}C spectra. By contrast, large numbers did not draw a displayed formula in part 8(a)(ii). The topic of electrophilic substitution involving nitration in part 8(b) was familiar to most candidates and high marks were frequently scored. However, many marks were lost by careless drawing of intermediate structures with incorrect positioning of + charges in the mechanism and also by a failure to give the name of the mechanism. Similarly, an equation for the reduction of a nitro compound to an amine should be very familiar to candidates but only about a quarter gained both marks in part 8(c)(i) where two such nitro groups were involved. The repeating unit of Kevlar was much better known and both marks were gained by three-fifths of candidates.

In part 8(c)(iii), many candidates discussed the polarity of bonds in Kevlar but failed to note that the bonds in polyalkenes are non-polar and therefore lost the final mark.

Question 9

In part 9(a), a significant number missed out the name of the mechanism and also could not name the product correctly. However, better candidates scored well in this question.

Part 9(b) required synoptic understanding and knowledge of some reactions from AS as well as knowledge of the chemistry of amines from A2. A surprising number could not give the correct

reagent for the formation of CH_3Cl from methane. Although many realised that the second step in the synthesis required use of a cyanide to increase the carbon chain from one to two, many confused the use of HCN in nucleophilic additions with the use of aqueous/alcoholic KCN without any acid in the nucleophilic substitution needed here.