



General Certificate of Education

Chemistry 2421

**CHEM4 Kinetics, Equilibria and Organic
Chemistry**

Report on the Examination

2010 examination - June series

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General Comments

There were many very pleasing performances across the whole range of questions and the paper discriminated well. The general performance in the organic sections was better than in the January 2010 paper, although still not as good as that in the physical questions.

Question 1

This question was generally well done although in part (a), fewer candidates than expected could name compound **X** correctly. Part (b) was answered very well but in part (c) many candidates did not read the full question and described what a racemic mixture contains rather than how one is formed in this reaction. Part (d) was answered very well except for part (d)(ii) where fewer than 50% of candidates could deduce that ethanal was acting as a proton donor in the reaction. The deduction required in part (e) was also found difficult despite the hint given that the required product contained six carbon atoms.

Question 2

This question was answered well. In part (a) most candidates calculated the amount of hydrogen in the equilibrium mixture correctly but many did not use the ratio in the equation so their answer to the amount of steam was wrong. The expression for K_c in part (b) was very well understood but it was clear that some candidates struggled to use their calculators correctly to raise values to the power of 2 or 4. In part (d), the effect on the equilibrium mixture of a change of temperature was answered better than the effect of a change of volume and therefore of pressure.

Question 3

In part (a)(i) several candidates failed to notice the emboldened **branched-chain** and incorrectly drew 2-bromopentane. More disappointing was the number who failed to describe compound **B** with its full IUPAC name including the geometric isomer descriptor, Z (or cis). By contrast, the infrared spectra questions in part (b) were very well answered. In part (c), a disappointing number lost the mark in the repeating unit by showing the ethyl group bonded via CH_3 instead of CH_2 and in the mechanism in part (d), a negatively charged ammonia made a frequent (but incorrect) appearance as the nucleophile. The structures of primary, secondary and tertiary amines are not well understood by many candidates and so the last three parts of this question proved difficult for them.

Question 4

Apart from part (b), this proved to be a relatively easy question with most candidates scoring well. In part (b), as a “stretch and challenge” exercise, the candidates were expected to deduce that there are five possible combinations of the 35 and 37 isotopes of chlorine and hence five molecular ion peaks for TCDD. If it is assumed that all of the chlorine atoms in the compound are the more abundant Cl-35 isotope, the value for its M_r is 320. Statistically, however, with four chlorine atoms present in the molecule, there is a greater likelihood that one of these chlorines will be a Cl-37 so the answer m/z of 322 was also accepted.

Question 5

Most of this question proved to be straightforward and few candidates lost marks in part (a). Part (c) was the most discriminating section with only the better candidates scoring all six marks. Many others either forgot that sulfuric acid is diprotic and so missed that the final mixture in the questions was acidic or failed to convert the number of moles of H^+ ions present into a concentration in order to find pH. Part (d) was answered well by most.

Question 6

Most candidates made a good attempt at this question. In part (a), only part (a)(iv) gave difficulty where many candidates did not protonate both amine groups in **M**.

In part (b)(i), fewer than 14% of the candidates recognised that the question involved the reaction of an amine with an excess of a haloalkane, so that the required product was a quaternary ammonium salt. The dipeptide required in part (b)(ii) was answered well.

Question 7

A few candidates were unsure of the names of the esters involved and confused butyl ethanoate with ethyl butanoate. In parts (a) and (b) a common error was the failure to balance the equations due to the omission of water or ethanoic acid respectively. Weaker candidates were also unsure of the structure of ethanoic anhydride.

The mechanism in part (c) was well answered although several omitted to give its name. The reaction in part (d) proved unfamiliar to many candidates; some attempted to answer the question in terms of alkaline hydrolysis of the ester to form soap rather than the reaction with methanol to form the mixture of methyl esters which make up biodiesel. The repeating unit was well answered in part (e).

Question 8

This question was generally well done; part (a) and the structure of the aldehyde in part (c) were the most challenging sections. In part (c), a number of candidates lost the mark for the reagent by giving an incorrect formula for the diamminesilver(I) ion even though the name Tollens' reagent was also correctly given.