Examiners' Report/
Principal Examiner Feedback

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Pearson Edexcel International A Level in Chemistry (WCH04) Paper 01

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General

Some students were very well-prepared for this examination and scored high marks. Many students were able to demonstrate that they had a sound knowledge of the topics in the specification and could apply this to the questions with just a few errors or omissions. Some students would benefit from much more preparation to ensure that they know the basic facts, can express their ideas clearly and carry out calculations, showing their working.

Section A

The mean mark for the multiple choice questions was 14.36, which is similar to many other past papers. The highest scoring questions were 3 and 4, with over 90% of students achieving these marks. The most challenging question was 7, with just below 50% of students achieving this mark.

Section B

Question 21

A number of students were unable to suggest a practical method for following the progress of the reaction between iodine and propanone or they just gave generic statements such as 'change the concentration of iodine while keeping the concentrations of iodine and hydrogen ions constant'.
The most common answer was the colorimetry method, although there were some excellent descriptions of quenching followed by titration with sodium thiosulfate. Some suggested the iodine clock reaction which would not show the change in concentration of iodine.
The majority of students were able to deduce the orders of reaction, however, their explanations often lacked precision. Some students just stated that the graphs are straight lines, the gradient is constant or the rate increases as the concentration increases. These answers did not receive credit as they could refer to first or second order reactions. The rate equation was usually consequentially correct from the orders.
Many students could calculate the rate constant from the data given, although some rounded their answer incorrectly and a few did not include x 10^{-5}. A number of students were unable to work out the correct unit or made a slip, for example, they wrote s^{-} instead of s^{-1}.
Very few students scored 2 marks for part (v) as they were unable to write an equation for the rate-determining step. Many students knew that the reactants had to be propanone and hydrogen ions but either they did not attempt to write a product, they wrote a product without a charge or they added the hydrogen ion to a CH_3 group to form CH_4^+. Students should realise the H^+ ion will attach to the oxygen atom.
A number of students were unable to calculate the gradient of the graph in part (b) and many who did calculate it correctly omitted the sign and/or unit or gave an incorrect unit. Many students thought that ln*k* had a unit or was the unit for the y axis. Many students were able to calculate the activation energy but some did not round their answer to three significant figures, some had incorrect units, some had a negative sign and others did not realise how the Arrhenius equation given related to the straight line and

gradient in part (i) so they did not know what to do about the constant. Students should be encouraged to think about the units for their numerical answers. Energy is measure in J mol^{-1} or kJ mol^{-1} so if they deduce a different unit, they should go back and check their working.

Question 22

The first part of this question was poorly attempted. Many students just described the formation of the precipitate. Although this confirms a carbonyl group, it cannot confirm the identity. Marks were only scored by those students who described the purification of the derivative and comparing its melting point with the Data Book value. Some students who knew the precipitate had to be recrystallized, omitted to filter it first. A number of students stated that the boiling temperature had to be measured and did not realise that the derivative is a solid.
The majority of students knew that the reaction between butanone and cyanide ions is nucleophilic addition although some also included S_N1 or S_N2 in their answer and lost a mark. Many students knew the reagent and condition for the hydrolysis of a nitrile. Some students just stated 'acidic condition' without specifying which acid should be used and some omitted to heat under reflux. 'Warm' was not accepted. Some students stated 'sodium hydroxide' and 'hydrochloric acid' but did not specify that the nitrile is heated with sodium hydroxide first then the hydrochloric acid is added, so they lost both marks. A number of students thought that the nitrile need to be oxidized and used acidified potassium dichromate(VI) as the reagent. Some students answered part (iii) correctly but it was disappointing to see a large number of poorly drawn curly arrows. Students should think carefully about where the curly arrow starts and finishes. A curly arrow represents the movement of a pair of electrons so should start from a bond or a lone pair of electrons, not from a carbon atom in a ketone. Some students did not show the lone pair on the carbon atom of the cyanide ion and some lost a mark by showing full charges on some of the atoms.
Many students thought that butanone is a planar molecule, rather than it just being planar around the carbonyl group. The use of molecular models or 3-dimensional simulations should help them to visualise this. However, the majority of students knew there was equal probability that the nucleophile can attack from both sides of the plane so a racemic mixture is formed. There were some incorrect descriptions of planar intermediates or carbocations.
Many students could draw two repeat units of the required polymer, but there were a lot of incorrect structures drawn. Many students did not show an ester linkage and a number drew an anhydride in the middle of their polymer.

Question 23

The majority of students could explain the meaning of 'weak acid' and write the expression for the acid dissociation constant of dichloroethanoic acid. Most students could place the four acids in order of increasing strength, although some did not include all of the acids and a few chose completely

different acids. Fewer students were able to explain how they used the K_a data to decide on the correct order. Some students referred to pH and some used pKa incorrectly.
The majority of students could calculate the pH of ethanoic acid, although some used one of the chloroacids instead. The assumptions were generally correct, although some students gave the same assumption twice, once with an equation and once in words so they only scored 1 mark. Other incorrect assumptions included $[H^+] = [CH_3COOH]$ and $[H^+]_{initial} = [H^+]_{equilibrium}$.
The titration curve was not always sketched accurately and students should take more care in sketching this style of graph. The start and end pH values were usually correct but a significant number of students did not show the initial rise and buffering action as sodium hydroxide solution is added to ethanoic acid. Some of the vertical jumps started too low or finished too high. A small number of students did not read the question or axes on the graph correctly and they sketched a curve for adding ethanoic acid to sodium hydroxide solution. The majority of students selected a suitable indicator and explained a reason for the choice.
Many students did not use the Ka data to work out that trichloroethanoic acid is stronger than ethanoic acid so it will be the acid in the reaction and lose a proton. Some students made errors in the formulae, for example, CH_3COOH^+ or CH_3COOH_2 and they should be encouraged to check that their equations balance in terms of atoms and charges. Some students just wrote 'acid' or 'base' under the formulae and did not link them to show the conjugate acid-base pairs.

Section C

Question 24

The majority of students could write the expression for the equilibrium constant, with just a few omitting the water. Many students did not answer part (a)(ii) well. Some students just referred to Le Chatelier's Principle and some just wrote generally about change in entropy. Many stated that $\Delta S_{surroundings}$ was small because ΔH is small but did not mention that there would be little change in the value. A few students thought that the value for ΔH was large.
There were many excellent answers to the calculation in part (a)(iii), with the working explained clearly. Some students were able to work out the number of moles of sodium hydroxide solution used in the titration but did not use the fact that it reacted with the remaining ethanoic acid and the hydrochloric acid catalyst. Partial credit was given if they continued with the calculation. Some students ignored the water at the start and some attempted to convert the numbers of moles into concentrations, even though they were not given the total volume of the mixture. They did not realise that they can use just the numbers of moles when there are the same numbers of moles on each side of the equation so the volumes will cancel.
The molecular formula calculation was done well, although some students did not use all of the data and they omitted to use the molar mass given.

Many students could draw the displayed formula of the four possible alcohols, although some drew skeletal or structural formulae and some drew the same alcohol twice in two different orientations. Many students could suggest the structures of two species that could give a peak at m/e = 45 in the mass spectrum but a significant number omitted the charge on the ions or gave molecular formulae. Many students did work out that butan-1-ol and butan-2-ol could be alcohol **Y**. The students who deduced the 2 correct alcohols usually scored a mark for the 2 possible esters. It was pleasing to see many students scoring full marks for part (vi). They had to use the relative number of protons causing each peak and the splitting patterns and there were some excellent answers using all of the data and explained clearly. The students who thought the ester was formed from any of the other 3 alcohols with molecular formula $C_4H_{10}O$ were able to receive some credit if they identified the correct peaks and explained the splitting for them. Unfortunately, some students did not use the molecular formula for the possible alcohols and they suggested esters formed with alcohols containing 2, 3 or 5 carbon atoms.

In order to improve their performance, students should:

- explain how they deduced orders of reactions more precisely
- check the units for numerical answers
- check that they have given the numerical answer to the correct number of significant figures
- revise practical procedures
- think about where curly arrows should start and finish in mechanisms for organic reactions
- practice drawing titration curves accurately.

Grade Boundaries

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