Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

January 2024

Pearson Edexcel International Advanced Level
In Chemistry (WCH14) Paper 01:
Rates, Equilibria and Further Organic Chemistry

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General Comments

Many learners demonstrated a good knowledge and understanding of the material covered in Unit 4 of the specification. Calculations, especially those of a standard nature were well dealt with and predominantly answers were clear and well structured. Questions where the application of understanding to novel situations was required proved challenging for many. Some resorted to reproducing learned answers to similar questions in previous papers, which did not answer the question posed.
There was very little evidence that learners experienced problems with having insufficient time.

The mean mark for the multiple-choice section was 13. The most challenging question in this section was Q11a, where 34% achieved the mark and the highest scoring question was Q5, where 96% achieved the mark.
The mean mark for the paper was 51

Question 16
(a)(i) The blue-black colour of the starch-iodine complex was well known.
(a)(ii) Although a "clock reaction" is part of Core Practical 9, this item was not answered well. Few responses showed an understanding that, in order to determine an **initial** rate of this reaction, the concentration of the reagents involved should not change appreciably before the colour change i.e. when the thiosulfate is used up. However, some learners were aware that, in order to observe a colour change, the sodium thiosulfate must be used up and consequently scored one mark.
(**b)(i)** The determination of the order of a reaction with respect to individual reagents by inspection was well done. Some responses correctly stated the orders but without justification, losing two marks. The ten-fold difference in the concentration of $[H^+]$ between mixtures 1 and 4 was missed in a surprisingly large number of responses which frequently led to a correct order being quoted but without a suitable explanation.
(**b)(ii)** The rate equation following on from the orders of reaction was very well done with very few omissions of the rate constant.
(b)(iii) The calculation of the amount of iodine which had reacted was correctly evaluated in many cases.
(b)(iv)(v) The majority of the responses to the final two items in this question indicated that learners were unsure how to proceed. Some realised that a concentration was needed so correctly divided their value from (iii) by the volume of the mixture (0.05 dm^3) but then failed to also divide by the time taken i.e. 195 seconds to produce a rate for the reaction. A significant number scored a mark in (b)(v) for stating the units of the rate constant correctly.
c(i). The most common errors in the labelling of a familiar graph were to omit K^{-1} as units for the x-axis or use ln k instead of ln rate for the y-axis. Just "rate" or "T" were seen and 1/T was mistaken for 1/time and units of s^{-1} were given. A surprisingly large number of candidates joined the points free hand. There were several

instances of non-linear scales. Despite these, the overall performance on this item was good, with the measurement of the gradient and subsequent determination of the activation energy being within the allowed range.
c(ii). Many learners did not read the question carefully and merely identified the anomalous temperature instead of providing a corrected one.

Question 17
a(i)(ii). The majority of learners found the completion of the Born-Haber cycle straightforward. A very common error was failing to double the atomisation energy to give the enthalpy change for the production of **two** moles of chlorine atoms after having correctly identified all the processes involved in the cycle. This error was sometimes carried forward into the calculation of the electron affinity of chlorine. Some learners also failed to realise that the final value calculated represented 2×electron affinity. Where working was clear, transferred error could be given.
(a)(iii). Few learners identified that the third ionization energy for magnesium would be very high and simply explained the formation of $MgCl_2$ rather than $MgCl_3$ in terms of balancing charges e.g. magnesium ion is 2+ so can only bond with two singly negative chloride ions. The idea that any likely exothermic lattice energy would not compensate for the highly endothermic ionisation processes was rarely seen.
(a)(iv). The majority of responses scored both marks. Relatively few learners failed to double the hydration enthalpy for the chloride ion.
(b). The average score for this six-mark question was three, with many learners scoring five or six marks. There was a tendency to focus on the difference between the experimental and lattice energies as an indication of the degree of covalent bonding which was well known. There was evidence that learners have improved their understanding of the polarisation by the cation and the polarizability of the anion. The most common errors were failing to use the comparative values for all three compounds to comment on the strength of the bonding so failing to score IP2, and applying properties to compounds e.g. the ionic radius/greater charge of MgF_2 compared with NaF.

Question 18
(a). Most gained one mark. Step 2 seemed to prove more elusive than Step 1 with oxidising agents being used rather than a named dilute mineral acid.
(b)(i) This mechanism was well known with nearly half the responses scoring all four marks. The most common mistakes seen were an absence of a lone pair of electrons on the carbon of the cyanide ion or the oxygen of the intermediate.
(b)(ii). The racemic mixture was given by most as the explanation for lack of optical activity, but many went no further than this. Some gave excellent explanations but missed out the fact that the nucleophile is equally likely to attack from both sides. Just stating that an equal number of each enantiomer is formed scores M1 as that is the definition of a racemic mixture. A few learners referred to planar carbocations and so failed to score M2.
(c)(i). The majority of responses were correct

(c)(ii). This question was not as straightforward as expected with less than 25% responses scoring the mark. Many repeat units showed alcohol groups or carboxylic acid groups and sometimes both.
(d)(i)(ii). Many fully correct answers were seen with marks sometimes being lost for only identifying one of the methyl ester protons as M or identifying both sets of protons but not making clear which was L or M in (i).

Question 19
(a)(i). Many learners did not include the solution volume, or refer to volumes cancelling, in their substitution into the expression for K_c. Also, many lost the final mark by not giving the final answer to an appropriate level of precision despite the instruction in the question.
These errors resulted in a number of responses with a numerically correct answer (but to 4 or more significant figures) only scoring 2 out of 4 marks.
(a)(ii). This question proved difficult for many. Some responses showed an appreciation that the bonds in question in the reactants and products were similar but failed to identify which were broken and which made. There were very few references to the bonds being in different molecules and so would therefore have slightly different bond enthalpies and M2 was scored very infrequently.
(a)(iii). There was evidence that the very small enthalpy change of the reaction had not been noted by learners. Many were able to recall the relationship $\Delta S_{surr} = -\Delta H/T$, thus securing M1. A significant number then opted for a generic description of the effect of a change in temperature on ΔS_{surr} in an exothermic or endothermic reaction. What was required was an appreciation that if ΔH was close to zero then ΔS_{surr} and ΔS_{sys} would be essentially unchanged and since $\Delta S_{total} = R\ln K$, there would be very little change in the equilibrium constant.
(b)(i)(ii)(iii). Many learners seemed to know the difference between a strong and a weak acid but referenced pH or equilibrium rather than dissociation or ionisation. Instances of only describing dissociation in either weak or strong acids were seen. The calculation of the pH of a strong acid was successfully completed by the vast majority of learners and the determination of the pH of a weak acid was also correct in about 75% of responses.
(c)(i). Despite the expectation that learners would have completed Core Practical 11, a significant number or responses showed a lack of recognition that the pH at the half-neutralisation point could be used to find the pK_a of a weak acid.
(c)ii). The drawing of the titration curve revealed a lack of attention to detail in many responses. Despite the successful calculation of the pH of propanoic acid and the stated concentration of the alkali, many curves did not start or end at an appropriate pH. The section around the neutralisation point was often not vertical or straight and sometimes the plot showed the reverse experiment i.e. the addition of an acid to an alkali.
(c)(iii). The selection of a suitable indicator was usually correct but the justification for the choice often referred to the indicator changing colour at the equivalence point rather than the range over which the indicator changed colour, which was often quoted, being wholly within the vertical section of the graph.

Paper Summary

Based on their performance on this paper, candidates should:

- Read all of the questions carefully and use the information provided to help you frame your answer.
- Do not round intermediate values of calculations and show your working clearly to enable partial credit to be awarded.
- Take note of the command words used in questions.
- Understand the underlying priciples of practical exercises and practise drawing graphs and calculations associated with them.
- When drawing mechanisms, ensure that curly arrows start and end in the correct place and remember to show lone pairs.

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