Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2020

Pearson Edexcel International Advanced Level
In Chemistry (WCH14)
Paper 1: Rates, Equilibria and Further Organic Chemistry

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Introduction

Overall the paper seemed accessible to all candidates with little evidence that they found themselves short of time. Calculations were, once again, a strength, particularly on familiar styles of calculation and topics. Students were well prepared for topics such as the comparison of theoretical and experimental lattice enthalpies and buffer solutions.

Section B

Question 16

This question proved to be have quite a range of marks. Some candidates were able to score very well, with perhaps an occasional slip, while others found much of the question quite challenging. It is important to read the questions with care to ensure that the correct question is being answered. This was particularly true here in (a)(i).

(a)(i) Correctly completing the Born-Haber cycle diagram proved quite challenging with many candidates not including electrons, despite having been specifically asked to do so. Some also included equations for each step rather than all the products on each line, though this was only penalised once.

(a)(ii) The calculation which followed was quite well done, though many candidates forgot to multiply the necessary values by 2. Few laid out the calculation as clearly as was desirable so trying to see what errors had been made when the incorrect final answer was given was difficult. Consequently this made awarding marks consequential on errors difficult. Many, however, had clearly practised these types of calculations and were able to produce the correct final answer.

(b) As mentioned previously, the comparison between experimental and theoretical lattice enthalpies was understood by many learners, although some still gave answers alluding to experimental errors and so scored no marks.

(c) The trend in theoretical lattice energies was quite well understood, though learners did not always give a full explanation, missing out one of the important points. It is worth noting here that the use of 'larger' or 'smaller' is not desirable when considering enthalpy or entropy changes as, particularly for negative values, it is difficult to be sure the candidate understand correctly. Using 'more exothermic', for example, is more precise and clearly demonstrates understanding.

(d) The final calculation was very well answered with many scoring both marks. Common errors included forgetting to multiply the hydration enthalpy of the chloride ion by 2.

Question 17

This broad ranging question on some isomeric structures was quite discriminating. Many learners could score well on the first part with a good number achieving 4 marks out of 4, but the context of the question, identifying unknown isomers, appeared to be challenging, particularly in (c).

(a) Those who recognised that the four isomers were carboxylic acids as they reacted with aqueous sodium carbonate were able to score 3 or 4 marks. It was good to see relatively few of the common errors such as missed off hydrogen atoms being seen in this question.
A mixture of different sorts of structure were given. It is worth noting that if more than one is given for any answer they must both be correct, so this is perhaps not a good idea in case of small slips.

(b)(i) Proton nmr is quite a well understood topic, but the style of this question may have slightly confused some candidates, although almost all had the right type of answers in each box. Most were able to score at least one mark and two or three marks was very common so this item scored quite well. The ranges proved the most difficult part of this item with some candidates leaving these blank.

(b)(ii) Carbon-13 nmr was less well known and the range of answers here was very large, and so this might be a topic on which teachers may focus a little time in the future.

(c)(i) was a relatively unusual style of question to identify three unknown compounds. Candidates dealt with this quite well, although sometimes missed out on full marks due to small errors. Propanol was quite often given as the name of Compound W rather than propan-1-ol. Some extremely good answers gave all available marking points and some further information about how they deduced the number of carbons in V and W.

(c)(ii) required both the reagent and the condition needed for the reduction of propanal to propan-1-ol. Many new the reagent was lithium tetrahydridoalminate(III) or one of the alternative acceptable names and of these many also new that dry ether was required.

(c)(iii) was also well understood with many knowing that sulfuric acid was a catalyst.

As usual intermolecular forces and boiling point proved challenging for all in (d) but the best candidates with some quite good answers missing vital information to explain clearly their choice of highest boiling isomer.

Question 18

Questions involving calculations are usually well answered and that was the case here. Candidates needed to read the questions with care, for example in (b)(ii) where they needed to discuss the correct dissociation.

(a)(i) Almost all candidates were able to score some marks in (a)(i) although some only attempted to calculate the hydrogen ion concentration or the hydroxide ion concentration, presumably often because they had not read the question with sufficient care.

The calculation in (a)(ii) was quite discriminating, with most candidates able to score at least one mark, but relatively few were able to score all four.

(b)(i) was much more accessible than (b)(ii) and candidates were able usually to identify the acids and bases. Some appeared confused as to how to link the pairs together. The use of numbers to link them, e.g.

$$\text{Acid 1} \quad \text{Base 2} \rightleftharpoons \text{Base 1} \quad \text{Acid 2}$$

may allow for more opportunities for error than the more common linking lines or use preferable use of the terms acid, base, conjugate base and conjugate acid.

In (b)(ii) candidates tended to talk about the fact that the acids were weak acids rather than focussing on the second dissociation as asked in the question. Some candidates were clearly well prepared for this question, however, giving very clear and accurate answers. This proved perhaps the hardest question on the paper.

The weak acid calculation in (c) was well answered. In (c)(i) some candidates included water in their expression for K_{a1} and so did not score this mark.

(c)(ii) was quite well answered with candidates able to score full marks using the assumption that the phosphoric(V) acid concentration was 0.500 $mol dm^{-3}$. It is worth noting that only a very few candidates were able to correctly determine the actual concentration of the phosphoric(V) acid solution and thus were able to give the best answer.

(d) Many candidates were well prepared for the buffer question giving answers matching those given in previous mark schemes for this type of question.

Section C

Question 19

Parts (a)(i)-(iv) are fairly typical of the start of an entropy based question in this section, and these were answered well. Part (a)(v) proved accessible to most candidates with the full range of marks being scored although disappointingly few were able to score the full six marks. Part (b) was relatively straightforward in parts (b)(i) and (ii) and whilst most candidates could score something in (b)(iii) few scored three marks.

The calculation in (a)(i) proved to be straightforward for many candidates although there were some slips regarding the number of times the values for the standard molar entropies of nitrogen and hydrogen needed to be multiplied. In this part, and in the calculations in (iii) and (iv) a disappointingly high number of candidates used incorrect units and lost some marks.

In (a)(ii) some marks were lost due to incomplete explanation of the negative sign. Many recognised it should be negative and that this was due to the number of gas particles but then did not link this to the distribution of energy quanta or to disorder.

(a)(iii) was well answered although sometimes the units were incorrect due to the value for enthalpy being normally given in kJ mol^{-1}, whist that of entropy is usually given in J $K^{-1}mol^{-1}$.

(a)(iv) was again well answered although the same issues with units were seen as in (a)(iii).

(a)(v) scored well for many candidates, with most scoring at least 1 mark. Common omissions included the idea of how the increase in the rate of reaction would affect the industrial process, either by increasing the amount of ammonia obtained in a given time, or by increasing the costs associated with maintaining the higher temperature. As mentioned previously, discussion of changes in entropy or enthalpy are best made using descriptions such as 'more exothermic' or 'less positive' rather than increases or decreases. It is also hard to justify full marks for any answer laid out as a bullet point list as these will tend to lack the reasoning required in this type of question.

(b)(i) had a disappointingly large number of learners using square square brackets (e.g. p[N_2]) in the K_p expression. In chemistry these brackets specifically mean concentration, which is not relevant in these expressions, so is incorrect.

The calculation in (b)(ii) was well done with most candidates including a unit as required in the question and thus able to get full marks. Quite a number used an incorrect value for the total pressure when calculating the partial pressure of ammonia. The value 225 atm was quite commonly used instead of 255 atm. Whether this was due to not reading the question carefully enough or fatigue as the examination paper was nearing the end is hard to say.

Despite (b)(iii) clearly asking for an explanation of the change in the position of equilibrium in terms of the effect of the change in pressure on K_p, there were still a number of candidates who resorted to explanations using Le Chatelier's principle who could not then achieve full marks.

Summary

In order to improve their performance, students should:

- read the question carefully and make sure that they are answering the question that has been asked
- write formulae and numbers carefully, checking their legibility
- show all working for calculations and give final answers to an appropriate number of significant figures using the correct units
- consider how their knowledge is applied in industrial situations such as the Haber Process
- check that their explanations clearly demonstrate the points they are trying to make fully
- try to avoid using 'bigger' or 'smaller' in questions involving explanations of enthalpy or entropy changes. Phrases such as 'more exothermic' and 'less endothermic' or 'more positive' or 'less negative' are more accurate and less prone to cause confusion for the candidate
- reread questions and answers, where time permits, to avoid careless mistakes.

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