Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2023

Pearson Edexcel International Advanced Level In Chemistry (WCH15)
Paper 01: Transition Metals and Organic Nitrogen Chemistry

General Comment

It was clear that there were some very well-prepared candidates who were able to give a clear demonstration of their chemical knowledge and understanding. However, it was also evident that there was a significant number of candidates who appeared not to be fully prepared for the demands of a paper designed for candidates at the end of their A Level programme. Many of the responses revealed an inadequate understanding of key chemical principles and how they could be applied. The lack of precision and clarity in a large number of responses resulted in lower totals than obviously was hoped for. Candidates would certainly benefit from more practice and their exam performance will inevitably improve from doing so.

Section A – Multiple Choice Questions 1 to 17

These questions provided some differentiation between candidates at the grade E and A boundaries, with the former achieving a mean of about 11 whilst the latter had a mean of roughly 18. The question which candidates found the most difficult was number 8 which is somewhat surprising given that if the candidates had checked their Data Booklets carefully then the answer would have been obvious. However, the topic of electrode potentials was also found challenging in question 10. The only other question with a sizeable number of incorrect options chosen was question 17 on molar volumes of gases. The questions which were answered most often correctly were numbers 1 and 7. It was pleasing that the first question was found to be straightforward because that can help to calm the candidates nerves.

Section B

Question 18

The drawing of an electrochemical cell apparatus in part (a) proved to be one of the more challenging questions on this paper, with a mean of less than 3 out of 5. Candidates demonstrated some confusion with the drawing of the standard hydrogen electrode as evidenced by the flow of hydrogen gas occasionally being drawn away from the platinum electrode. It was disappointing that some of the easier features such as the pressure of the hydrogen gas and the concentration of hydrogen ions were often missing. The question did ask for a labelled diagram and so the salt bridge needed a label which was not always present. At times there was no liquid shown in one or both of the electrodes and so apparently nothing for the salt bridge to dip into.

Part (b)(i) was answered to a better standard but it is worth highlighting to centres and their candidates that it is vital to make it clear which of the equilibria are being referred when two or more equilibria are given. The lower abiity candidates showed their lack of understanding by simply stating that despite the emf of the cell being negative the reaction was still feasible because the conditions were non-standard.

The conventional representation of the half cells in a cell diagram also proved to be a major difficulty for the majority of candidates. It was very rare for both marks to be awarded. Key points to note are that the molar ratios of the species are required, both water and hydrogen ions should be included as also should the platinum electrodes. It was good to see that the inclusion of electrons was rarely observed. It may help candidates to remember that the 'r''s go together, in other words the reduction half cell species always go on the right which means that the oxidation species must go on the left.

The calculation in part (c) was frequently awarded one mark for the two molar quantities. The remaining marks for the ratio and then the subsequent effect on the change of the oxidation state of X were given less often. This allowed the more able to demonstrate their greater understanding.

Question 19

In part (a) the vast majority of candidates were able to correctly determine the empirical formula.

Part (b)(i) was signficantly lower-scoring than expected because of the sizeable number of candidates that referred to the repulson between negative "molecules" which was not allowed. The ionic equations in part (b)(ii) were effective discriminators for the 'top end' of the ability range, with the skill of being able to balance equations proving too difficult for most.

The lack of precision in many candidate responses resulted in the loss of marks in both (c)(i) and (ii). In part (i) the lone pair of electrons for the dative covalent bond needed to be clearly stated that its origin was the oxygen atom rather than the water molecule. Similarly, in part (ii) the octahedral shape needed to be linked to the six areas of electron density repelling to give maximum separation. Unusually even the more able candidates disappointed in this regard. The key principles behind this question are from unit 1 and so centres and their candidates do well to remember to revise or review the work from previous units.

One mark was frequently obtained in part (d) for the stronger bonding of the carbon monoxide to the iron(II) ion compared to the oxygen molecule. However the other mark was more demanding because candidates had to explicitly refer to ligand exchange or the carbon monoxide substituting for the oxygen in the complex.

In part (e) marks were more easily obtained but again molecules instead of ions were frequently referred to. In addition, entropy was frequently stated to be positive, yet entropy is always positive. The key point is that it is the enthropy **change** which is positive. Again the lack of precision in the language used by candidates often resulted in a loss of marks.

The calculation in part (f) was generally done well and candidates of all abilities were able to achieve some marks. The poor layout of candidates working, the incorrect intermediate units and the failure to make clear exactly which value was being used, all presented examiners with difficulties when marking. Candidates do not help themselves in this way and a key lesson remains for candidates to work on this aspect of their work.

Question20

The drawing of the electrophilic substitution reaction mechanism in part (a)(i) was generally very well done, probably from the practice that many past papers have provided. It continues to be an effective discriminator because the less able candidates are still making straightforward errors in the placement of the curly arrows and in the drawing of the structure of the intermediate.

It was surprising that the extended open response of (a)(ii) proved to be very challenging for almost all candidates, with only a handful scoring all six marks. This was not a novel topic area and the subject matter has been examined on more than one occasion in the past. It was not uncommon for candidates to state that benzene was not able to decolourise bromine but that cyclohexene (and phenol) did. This demonstrates a fundamental misunderstanding of the situation and is surely a matter for the centres to address. The lack of precision again resulted in a loss of marks. Oftentimes candidates would state that benzene would react with an electrophilic subsitution mechanism and then only refer to cyclohexene undergoing addition. Candidates needed to refer to electrophiles to all three susbtances in the question and it was not acceptable to expect the examiner to infer into the answer. The key point most often missing was that of the localisation of the electron density in the cyclohexene carbon-carbon double bond. Candidates and their centres would definitely benefit from further practice at these 'compare and contrast' type questions.

Synthetic route questions continue to pose real problems for candidates with many responses to part (b) being very poor. Many candidates benefitted from transferred error in the marking of this question. For example, a significant number started their synthesis with the 'supposed' reaction of benzene with a cyanide which is incorrect but they could thereafter be given credit if their nitrile product was hydrolysed to form benzoic acid. It was disappointing to see a large number of candidates add ammonia to benzoic acid in an attempt to make benzamide. Centres and their candidates would surely benefit from a review of the reactivity of the carboxylic acid group and the formation of ammonium salts when ammonia is added.

The questions on polymers in part (c) were answered better than the previous parts of this question. Although, in part (ii) a correct reference to hydrogen bonding by the polyamide was frequently negated by stating that this interaction was to water. The question was clearly about the melting temperature of the polymer and not its solubility so this type of reference was penalised. It was also common to see answers that referred to the strength of the amide bond compared to the carbon-carbon bond or that the London forces of the polyamide are stronger than those of the polyalkene. Neither of this type of response gained any credit.

Section C - Question21

The use of nomenclature rules for giving the IUPAc name of an organic molecule remains a task that candidates find very challenging. This proved an effective discriminator for the higher ability candidates with only just over one quarter of candidates scoring the mark for part (a).

Likewise the naming of functional groups in part (b)(i) was beyond many. Oftentimes there were two correct groups given but not the third and this then failed to score the one mar. The identification of the ester functional group proved the most challenging. The equation required for (ii) was similar in that candidates could transfer the salicylic acid and the ethanoic anhydride structures from the stem but failed to score the mark due to an inability to balance the equation with ethanoic acid. By contrast, the percentage yield task in part (iii) was completed fully correct by the majority of candidates.

The dissociation of salicylic acid questions in parts (c) were not answered well. The equation in part (i) should have been a relatively straightforward mark but was often lost due to the omission of the hydrogen ions. It is worth highlighting that the use of H_3O^+ ions is acceptable but obviously must be balanced by the inclusion of a water molecule as a reactant. In part (ii) even the relatively straightforward mark to be gained from stating that there was greater dissociation in the small intestine was rarely achieved. It would appear that the candidates found the application of the topic area to this novel situation too much for them. The WCH15 papers will always contain questions involving the application of chemical principals and so this should be an area for centres and their candidates to focus on.

Further practice at using the NMR information in the Data Booklet is strongly recommended in light of candidates performance on part (e). Two thirds of all candidates failed to score any marks which was very disappointing given that the information is there at their fingertips. There were responses where the ranges given were too wide and so a review of the acceptable values would be very useful. It was not unusual to see single values given despite the clear request for ranges and at times these were given alongside ranges. Another reminder to RTQ^2 (Read The Question Twice) so that the response given does match that which is required. Examiners endeavoured to mark positively and if there were three correct single values then one mark was awarded.

The calculation in part (f) to finish the paper produced the full spectrum of marks. There was no evidence of candidates running out of time. The points raised in Q19(f) about candidate layout etc apply equally here.

Summary

To improve their performance, candidates should:

- make sure that all necessary details are included in an answer, such as conditions of concentration and pressure
- be careful to make it clear in an answer which reaction or equilibrium is being referred to
- learn the relevant conventions or rules when writing a cell diagram and when giving an IUPAC name
- practice calculations ensuring that the layout of working is clear, that any intermediate units are correct and to only round-up any values at the end of the calculation
- make time to read and then re-read the question to make sure that they are answering the question being asked
- always check the mark allocation of the question so that the depth of the answer given and the number of points being made matches the demand of the question
- see how key chemical principles are applied to different situations which will help when a new or novel situation becomes the subject of a question
- practice use of the Data Booklet, especially the proton NMR information
- take time to check an answer is fully correct and that all chemical terminology used is correct in its context