Pearson
Edexcel

Examiners' Report
Principal Examiner Feedback

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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 and thus score very high marks. However, it was also evident from the significant number of blank answer spaces that there were 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 a real lack of understanding of fundamental chemical principles and how these could be applied. The lack of precision and clarity in a large number of responses resulted in lower totals than was desirable. It is certainly true that candidates would greatly benefit from more practice and this would undoubtedly result in a grealy improved exam performance.

Section A – Multiple Choice Questions 1 to 14

These questions provided less differentiation between candidates at the grade E and grade A boundary than previous years. The question which candidates found the most difficult was number 3 where the key point was to determine the mass of chlorine in the complex ion and not the compound. Surprisingly question 6(b) was also found to be very difficult but perhaps this is a reflection of the lack of practical experience that candidates have. The questions which were answered most often correctly were numbers 5 and 9. It was pleasing that candidates understood the meaning of amphoteric.

Section B

Question 15

The drawing of the hydrogen bonding between butylamine and water in part (a) proved to be straightforward to most candidates so this was an appropriate start to section B of this paper. Despite the instruction to label their diagram relatively few candidates did so which was disappointing.

Calculating the number of butylamine molecules in part (b) was generally done well, although some candidates did not correctly convert milligrams to grams or failed to appreciate the need to do this at all.

The question for part (c) had “displayed” in bold font and so the use of displayed formulae was essential and this was missed by a minority of candidates. The majority could draw the two reactants and the amide product but unfortuantely omitted the HCl product. Chemical equations should always be balanced and this fact must not be ‘lost sight of’ even when drawing lengthy displayed formulae.

Part (d) serves as a reminder to candidates that when a question asks for an explanation it is often important to include the meaning of terms used in such explanations. In this instance when explaning the difference in basicity, the first mark was essentially for stating the meaning of the word basicity. This should make sense because it gives the candidate the opportunity to more clearly explain the subject that they are referring to. It was to their credit that the majority of candidates did include this statement, although it was at times more implied that explicitly stated. The third mark for commenting on the 'electron-releasing' effect of the butyl group was also often awarded but the second mark of the effect of this was less so. A small number of responses incorrectly stated that the nitrogen became "more negative". The nitrogen atom does have more electron density but it does not become negative, nor does it have 'charge density'. The lone pair of electrons becomes more available as a result of this electron movement to accept a proton. The sequence of reasoning required allowed for effective discrimination between candidates as the more able scored higher marks. Some candidates confused the meaning of a nucleophile with that of a base.

Question 16

This proved to be a somewhat tricky calculation, with many candidates losing one mark at various steps of the process. For example, it was common to see an answer of 39.9 cm^3 where the factor of four was missing; a 25 cm^3 sample of the 100 cm^3 of solution was used. Another error frequently seen was the conversion of miligrams to grams which was done incorrrectly.

There are a number of alternative ways in which this calculation can be carried out and candidates do need to be sure that all of their working is clearly laid out. This was not always the case and so it made it challenging for the examiners to discern what the candidate had done if the correct answer was not determined.

It is worth highlighting the need for candidates to give their answer to an appropriate number of significant figures. The context given at the start of the question made it clear that this was about a dose of medicine that people take for anaemia. Almost all people in their homes would not be able to measure volumes very accurately and so an answer such as 9.956 cm^3 should have been clearly recognised as inappropriate but this was not always the case.

Question 17

The extended open response question in part (a) requiring a description of the electrochemical cell experiment was answered very well. This was at least partly due to the fact that most of the marks could be obtained from a suitably labelled diagram. However it is important to emphasise that the question asked for a description of the use of the equipment and chemicals in the experiment. Hence it was insufficient to simple label a line on a diagram as a salt bridge nor was it enough to label it with a salt such as potassium nitrate. In addition, it was necessary to state the salt used for the cobalt electrode. It was insufficient to simply put $Co^{2+}(aq)$ 1.0 mol dm^{-3} without indicating where the cobalt(II) ions came from. It was decided for this paper that if both IP3 and IP4 were not awarded because of these omissions then one IP would be awarded for two 'near-misses' but this may not be the case in the future so centres and their candidates should improve in this area.

All candidates should have done Core Practical 12 Investigating some electrochemical cells. In this experiment it is clearly stated how a salt bridge is made by soaking filter paper in a saturated solution of potassium nitrate. Hence candidates should have had first-hand experience of doing this activity and thus should have been able to draw on that activity. Unfortunately, this wasn't evident for the vast majority of candidates.

Further, a significant number of candidates suggested the use of $KMnO_4$ for the salt bridge which was not appropriate.

Part (b) was commonly misunderstood as illustrated by the comment "concentrated HCl is not able to acidify potassium dichromate" or by reference to HCl being unsuitable because the E_{cell} value calculated being negative. The point of the question was that for standard conditions the use of HCl would give a negative E_{cell} value and that use of concentrated acid would result in a shift in the equilibria to give a positive E_{cell} value. Candidates were generally better at understanding and describing this shift in the two equilibria but the significance of this in generating toxic chlorine was missed by the vast majority. This is the reason that concentrated HCl is not used as the acid with potassium dichromate(VI).

The use of bold font in part (c) was important because only the reduction half-equation was required. Some candidates wrote both half-equations but then omitted to identify which was the reduction half-equation and so did not get the mark. A large number of candidates seemed to not understand the conventional representation of an electrochemical cell and made a variety of incorrect suggestions, not all of which included electrons.

It would seem wise that candidates need more practice at writing such equations as required from the information given in part (d). It was rare to award both marks. Despite the question clearly referring to hydrogen ions and water, a sizeable number of candidates attempted to balance equations using hdyroxide ions. In addition, it was disappointing at this stage of their A Level programme that some many candidates gave an incorrect formula for methanol, with CH_2OH being very common.

Use of the mathematical expression provided in part (d)(iii) was generally handled well but sadly many candidates lost the mark due to rounding errrors.

Question 18

Poor command of English restricted the marks that some candidates scored. In the first part of (a) an explanation for colour of complex ions was required and then in the second part, an explanation for different colours was required. It was not unusual for candidates to include the requried information in the wrong question part. Also, the splitting of a singular d orbital continues to be an incorrect response which was frequently seen and the flame-test electronic transitions were confused with those responsible for the colour of transition metal complex ions. These are not uncommon questions but centres and their candidates would do well to keep practicing answering such responses. An additional point to note is that reference to the ‘energy gap’ is required when explaining the difference in the complex ion colours and not just the vague reference to different energy levels.

In the first part of (b) the dot-and-cross diagram of the thiocyanate ion proved discriminating with only the more able candidates giving acceptable answers. The most common incorrect answer was simply to move the ‘triangle’ symbol from the nitrogen to the sulfur. Credit was given to those candidates who could suggest a diagram with two of the three atoms having the right number of electrons and symbols.

The second part of (b) generally scored one mark for the two simple molar calculations and then less often the second mark for realisation of the 1:1 molar ratio. Unfortuately candidates then really struggled as to what to do next. It seemed that the idea of colorimetry experiments providing evidence for the formulae of complex ions was novel to them. The molar ratio showed that there was one thiocyanate ligand per iron(III) ion and only the very able appreciated that in an octahedral complex this meant that there must be five water ligands. A small number made this correct deduction but then forgot the single negative charge on the thiocyanate ion so gave an incorrect complex ion charge. There was a lot to do for the third mark.

The graphs were on the whole drawn very well for (c)(i). However it was surprising that the plotting of (1.10, 0.40) proved to be frequently done incorrectly. The reason for this was difficult to fathom because it was not difficult but serves as a useful reminder for candidates to check their work. It should have been easy to spot and to correct. It was pleasing to see the vast majority did show working on the graph for part (c)(ii) as per the instruction but relatively few could do the simple calculation of multiplying by five. Many candidates launched into quite complicated steps which were incorrect and gave a more dilute concentration for the final answer which should have ‘flagged up’ in a candidates mind that there was an issue.

In part (c)(iii) it was insufficient to simply refer to “extrapolation” without some justification. Acceptable answers stated that the data was only given up to 0.50 mol dm^{-3} and so beyond this figure the absorbance was unknown.

The familarity of (d)(i) was evident as the vast majority of candidates gave excellent answers and scored the mark.

Centres and their candidates seem to have improved in their answers to such questions as (d)(ii) on bidentate ligands which was pleasing to see. It was not usual to see the ligand redrawn with the two lone pairs of electrons to effectlively illustrate the point.

By contrast, (d)(iii) was not answered well. Essentially, this is application of knowledge and understanding from module one and so it was disappointing to see incorrect bond angles being suggested. This is perhaps a topic area that centres and their candidates would benefit from revisiting. It is worth emphasing that in this module the questions can draw on information from previous modules and so revision of the whole specification is necessary.

Section C – Question 19

Deducing the empirical formula from a skeletal formula is a task that continues to prove too challenging for many candidates. Only about a third of candidates were able to complete this task in part (a) successfully.

In previous series the drawing of an electrophilic substitution mechanism was becoming more accessible for most candidates. For some reason, the cohort in this series found the task in (b)(i) more challenging than usual. Nearly 40% of candidates scored zero and only about 15% scored all give marks. A common error was for candidates to include an extra carbon on the electrophile when they didn't really mean to because it then disappeared when they drew the carbocation intermediate. It is evident that candidates would benefit from additional practice in writing organic mechanisms using skeletal formulae.

The question in part (b)(iii) was also found to be more challenging than expected. Some examiners reported many blank answer spaces or referred to "too many steps", possibly misunderstanding the mechanism as a multi-step reaction. The key point was the fact that substitution could occur at other positions to result in an isomer to the desired raspberry ketone.

There were a significant number of blank answer spaces which made the examiners ask if the candidates had studied Grignard reagents. Previous synthetic route questions have posed real challenges for candidates and so this continues to be an area that centres should focus on. The inability to properly understand skeletal formulae also had an impact because a sizeable number of candidates tried to form a Grignard reagent using the starting compound provided. This did not score because the product would have ended up with an incorrect carbon chain length. Those candidates who did appreciate the need to use a halogenated methane usually scored highly, although the need to use distilation for the initial oxidation of the primary alcohol group was often missed.

It is an important ability to realise the effect that a reagent can have on a compound with more than one functional group. This was the point of part (d) but many candidates appeared to miss the reference to "choice" of reducing agent and simply referred to the reduction of the C=C bond. A small number of candidates incorrectly referred to the reduction of the phenol group which negated any previously made correct point. Hence another reminder that incorrect chemistry can result in a loss of marks so care need to be taken when answering such questions.

The exam papers are designed to increase in demand as the candidate progresses through the paper and so part (e)(i) on stereoisomerism was testing. Many candidates realised that a C=C bond can potentially have *E*/*Z* isomers but incorrectly referred to the C=C in the alicylic ring. There are no such isomers as a result of this bond and only the more able candidates appreciated this fact. The three marks allocated to this question should have prompted candidates to consider optical isomerism as well and a small number of candidates did spot the chiral carbon present in α-ionone only.

Part (e)(ii) also had many blanks or the carbon atom chosen appeared to be at random. Nonetheless, the more able candidates were able to demonstrate their understanding and gain the mark.

The final question (e)(iii) was correctly answered by about a quarter of the candidates although the examiners had to be rather generous in what was allowed as a justification. There needed to be more than just the correct answer of 12 but this could be shown by the relevant identification of the two equivalent carbon atoms.

Summary

To improve their performance, candidates should:

- make sure that all of the specification has been covered
- include core practicals in revision as they form an essential part of the specification
- draw on the practical work undertaken when answering questions
- be careful to correctly understand skeletal formulae so that any reactions of compounds represented in such a way can be properly answered
- take particular care with calculations so that the working is logical and coherent
- learn the relevant conventions or rules when writing a cell diagram and when giving an IUPAC name
- make time to read and then re-read the question to make sure that the answer given does actually address the one being asked
- always check the number of marks allocated to each question part so that the depth of the answer given and the number of points being made matches the demand of that 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
- remember that the demand of the paper progressively increases and so the depth of the answers should likewise increase
- reserve time at the end to check that all the answers are fully correct and that all chemical terminology used is correct in its context