Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Level
In Chemistry (WCH15)
Paper 1 Transition Metals and Organic
Nitrogen Chemistry

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Introduction

This paper was similar in style and standard to previous and parallel Unit 5 papers of this specification; a range of skills and knowledge was assessed and the levels of difficulty allowed good discrimination between the different grades, while allowing well-prepared students at all levels to demonstrate their abilities. Students were well prepared for standard types of question but found items requiring the application of knowledge and understanding more difficult. There were many excellent answers to the calculation questions with responses well presented and clearly explained. The questions involving organic synthesis proved challenging for many.

Multiple Choice Section (Questions 1−18)

This was the highest scoring section of the paper with a mean score of 11.9 marks out of 20. Question 10 was the most accessible, with 88% of students scoring the mark. The most difficult proved to be question 11, where just 12% of students gave the correct answer.

Question 19

Students usually attempted 19a with formulae rather than names, although oxidation states were often given in addition. The most common errors were incorrect numbers of ammine ligands in the two complexes although P was often given as iodine despite the question specifying that all the species contained copper. The focus of 19bii was the *difference* in the behaviour of the two ions and, despite the instruction in the question stem, there were many detailed explanations of the colour of transition metal ions. There were also many errors of detail such as reference to the splitting of a
d orbital. In 19biii the idea of oxidation and the role of oxygen in the air were well understood although some students did suggest that the shaking provided the energy for the chemical change. The common errors in 19c were the inability to write the ionic equation for the disproportionation reaction and selecting incorrect half-equations to evaluate its feasibility. There were many excellent solutions to the calculation in 19d. Students dealt confidently with the early stages of the problem but found evaluating the number of moles of water of crystallisation more of a challenge. Some students chose quite complex routes through this part but proved adept at navigating their way to a correct answer. Students still round intermediate values in a calculation and this should be avoided.

Question 20

Most students were able to identify the fragments required in 20a, the common errors being the omission of the charge and giving, in (a)(ii), a fragment with m / z = 43 or 57. A number of structures included the broken bond or an unpaired electron, implying that a radical rather than an ion gave rise to the peak; these were not penalised but they are incorrect. The reaction scheme in 20b involved descent of the homologous series and students who appreciated this and knew that the iodoform reaction was a way of achieving this were able to produce flawless sequences. Marks were still available for students who could see at least part of a sequence but many simply wrote down reactions of butanone such as reduction or HCN addition which gained no credit. 20c involved adding a carbon atom and required the use of a Grignard reagent. Once again, students who had some understanding of building a reaction scheme could score marks even when the sequence was incomplete. There were some excellent answers.

Question 21

Most students were able to make use of the data to identify F and G, or possibly work backwards from their knowledge of the dichromate(VI) ion.
A number of students lost a mark by failing to specify which ion was which. There were many correct overall equations but some students were unable to balance their equation while others placed the ethanal on the same side of the equation as the dichromate(VI) ion. The equation for the conversion of chromate(VI) into dichromate(VI) ion was only given correctly by 25% of students.

Question 22

The problem presented in part (a) proved too difficult for most students, with relatively few even understanding the significance of the gas volume reduction with potassium hydroxide. While there were a number of correct solutions to the calculation, alkene or alkyne structures were often suggested, disregarding the lack of any reaction with bromine.

Question 23

There were many concise accounts of the required systems with well-prepared students scoring 5 or 6 marks. Common errors were describing vanadium oxide as a homogeneous catalyst and failing to specify that it was the products being desorbed from the surface. Not many students gave both IP5 and IP6, general statements about changing oxidation state being common. Equations were not required, but it needed to be clear for each step of the reaction what the change in oxidation state was and which reactant was involved.

Question 24

In 24ai, while most students realised that the continuous ring indicated a delocalised electron structure, all too often it was referred to as 'benzene' despite the presence of the two nitrogen atoms. The idea of additional stability was frequently seen but relatively few students were able to suggest a second effect on the structure. 24aii showed the need for students to think about how best to structure their responses. While the general ideas of basicity and of the effect of delocalised systems on the availability of lone pairs seem to be appreciated, relatively few students were able to link these ideas in a clear, logical way. The simple definitions of bases as electron pair donors or proton acceptors were rarely used explicitly.

The method required for the calculation in 24bi was very well understood but few students scored full marks. The molar mass of caffeine was often calculated incorrectly; sometimes this was a small error such as 193 or 195 but much less plausible values such as 120 and 155 were also used. Most students were unable to give their answer to an appropriate number of significant figures, a skill that will be tested in the current specification.
The general rule is that the number of significant figures given in the final answer should be *one less* than the smallest number of significant figures used in the data. It is acceptable for the number of significant figures given in the final answer to be the *same* as the smallest

number of significant figures used in the data. In this problem an answer to one significant figure is best but using two significant figures is acceptable. The calculation in 24bii proved accessible to most students.

The mechanism for electrophilic substitution at a benzene ring is well known and this was reflected in some very good answers. The errors were in the details: incorrect placement of the curly arrows and incorrect Wheland structures. The generation of the intermediate was often understood in principle but the structure of 3-chloropropenoic acid was often incorrect. This was a particular issue when students attempted to convert the skeletal formulae in the question into structural formulae, often gaining or losing hydrogen atoms in the process.

Most students were able to work out the structure of quinic acid, the most common error being the omission of the OH group involved in the attachment to caffeic acid or its replacement by a chlorine atom.

There were many good responses proton NMR question in 24d. Some students were unaware that the OH proton generally neither splits nor causes splitting, otherwise the most common errors were the exclusion of the OH proton and the inclusion of the carbonyl group as proton environments.

Paper Summary

Based on their performance on this paper, students should:

- be aware that in this examination they will be tested, in part, on their ability to apply scientific knowledge and processes to unfamiliar situations
- remember to read questions carefully, be familiar with the meanings of command words and be alert for information that might be helpful in formulating their responses
- make sure that they understand the exact significance of curly arrows in organic mechanisms and ensure that they can draw the Wheland intermediate for the electrophilic substitution of benzene
- know how to choose the appropriate number of significant figures to use in giving the final answer in a calculation
- remember only to round the final answer to a calculation
- familiarise themselves with the basic principles of organic synthesis and, in particular, the standard methods in the specification for ascent and descent of the homologous series.

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