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Pearson Edexcel International A Level in Chemistry (WCH05) Paper 01

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General

This paper was a reasonable balance of standard and higher demand questions, the latter often requiring students to apply their knowledge and understanding in unfamiliar situations. It 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. Although this was A2 and therefore had a synoptic element, for the most part, students seemed far better prepared for the straightforward type of question. Calculation work was usually carried out confidently and generally well-presented, with the logical steps easy to follow. In multi-step calculations there are still students who round intermediate values for use in the subsequent stages of the problem; while this practice is not in itself penalised, it leads to inaccurate final values and is a frequent source of transcription error. Students found the writing of ionic equations particularly difficult, with many examples of equations in which charges did not balance. It was evident that, even at this level, students do not take sufficient care in reading questions and context material before framing their responses.

Multiple Choice Section (Questions 1–20)

This was the highest scoring section of the paper with a mean score across all students of 53.5%. Over 80% of students gave the correct answer to question 3, while less than 40% of students gave the correct answer to questions 1, 2 and 18.

Question 21

Students seemed familiar with the use of the Data Booklet to obtain the ionic half equations and standard electrode potentials required for 21(a). Some selected the wrong equations, typically the reduction of nitrate(V) to nitrous acid and the reduction of copper(II) to copper(I), but errors involving the omission of charges or electrons were far more common. Writing the overall equation posed few problems although some students failed to check that the charges balanced. The calculation of the E_{cell} value was usually correct. The mark for 21(a)(iii) was most likely to be gained from 'blue solution' of 'effervescence' suggesting that few students had actually seen this reaction.

The calculation in 21(b) caused far fewer problems than writing the ionic equations or explaining the relationship between the amounts of copper(II) ions and thiosulfate ions. Some of the equations involved incorrect charges on the thiosulfate and tetrathionate ions, incorrect species, such as sulfate and peroxodisulfate, or no redox reaction. Even when all these were correct, students frequently (as in 21(a)) wrote equations in which the charges did not balance. While there were some excellent answers to 21(b)(iii), many students simply rewrote the equations or re-stated the question.

The most common error in the calculation was the omission of the factor of ten; weaker students also divided their moles of copper by 63.5.

21(c) required students to apply their knowledge and proved discriminating at the higher levels. In 21(c)(i) many just re-stated that iodide ions would otherwise be oxidized, apparently guessing whether the percentage of copper increased or decreased. Better students sensibly calculated the percentage effect of the addition of urea but only the very best understood the relationship between this value and the typical experimental uncertainty.

Few students were able to define a d-block element, commonly suggesting that the outer or valence electrons were in the d subshell. The term 'transition element' was better known; the most common error being to refer to the electronic structure of the element rather than its ions. Well-prepared students scored extremely well on 21(d)(iii) but the usual errors cropped up, with indiscriminate use of the key terms, 'orbital', 'orbitals', 'subshell' and 'shell'. Weaker students referred to electrons dropping to lower levels and emitting light. A small number of students stated that 'degenerate' orbitals had different energies. In 21(d)(iv) some students thought that there was no splitting of the 3d subshell of zinc(II) because it was full.

Question 22

The electrophilic substitution of benzene is familiar ground so most students were able to suggest the electrophile and write the mechanism for 22(a). However it was clear from 22(a)(i) that not all students understood the term 'electrophile', suggesting instead a variety of compounds, and many of the mechanisms were marred by errors of detail such as the positioning of the curly arrows and the orientation of the horseshoe in the Wheland intermediate.

The reagents needed for the cyanohydrin formation were generally well known. Most students knew that the hydrolysis required an aqueous strong acid, although a number suggested carboxylic acids. Students need to be aware that if a reagent is required then a specific substance needs to be identified. 21(b)(i) proved a good discriminator across the grade range. Good students identified the alcohol required and accurately drew its structure and, once the esterification had been spotted, realised that the reaction needed an acid catalyst. Surprisingly, fewer students gained the heat under reflux mark. 22(b)(ii) proved less straightforward than might be expected from its frequent appearance in one form or another on this type of paper. The best students appreciated the point of 22(b)(iii) but there were far too many routine responses that gained no credit, such as the cost and toxicity of PCl_5 or the environmental hazards of HCl.

Identifying the asymmetric carbon atoms in cyclandelate in 22(c)(i) proved a real challenge and few students found all three. The carbonyl carbon was the commonest incorrect answer but all the other carbon atoms in the structure were suggested by at least one student. In 22(c)(ii) students frequently failed to make clear that individual enantiomers might have different biochemical properties, with responses suggesting that the compound or the chiral centres might have undesirable properties or effects.

Question 23

Many students successfully completed the calculation in 23(a), and a variety of methods were used. Common errors included incorrect factors of two, which resulted in the relative atomic mass being halved or doubled, and starting the calculation from the premise that **T** was iron. Students often calculated the moles of O_2 (rather than O); this was not penalised but did make the introduction of an extra factor of two more likely. The mark for 23(b)(i) proved surprisingly difficult to score, with many students correctly identifying the molecular ion peak on the spectrum but then omitting the molar mass or estimating it incorrectly. Others wrote down the molar mass but failed to label the peak. Some students labelled the wrong peak, with the peak at m /e = 45 being the most popular alternative. Only a minority of students were able to identify **M** and **N**. 23(c) reinforced the impression that only the better students were confident in writing chemical equations, especially ionic equations. A significant number of students were unable to give the formula of the cation in **P**. While some of these gave the name or the symbol of the element rather than the ion, the majority were unable to identify the ion from its flame test colour. The formula of **P** was only known by the best students.

Question 24

The importance of London forces in determining the boiling temperature of amines was generally appreciated. However, only a minority of students went on to relate the magnitude of these forces to the number of electrons or surface area. Some suggested that ammonia had no London forces. The role of hydrogen bonds in the water solubility of amines was well known and the decrease in solubility was generally discussed in terms of the hydrophobic character of the alkyl group. As a consequence, the final mark of 24(a)(ii) was rarely scored. The equation showing the basic character of an aqueous solution of methylamine was generally well known with the omission of the positive charge being the common error in otherwise correct attempts. Otherwise, there were a number of responses with methanol and ammonia as the products, and several in which the oxonium ion was formed. Students showed a good general understanding of the basicity of amines but marks were lost through a lack of precision. The role of the lone pair of electrons was often implied rather than stated as was its location on the nitrogen atom. Similarly, the nature of the interaction between the nitrogen lone pair and the π electrons of the benzene ring was rarely described in those terms. A very common error was to describe the change in basicity in terms of an increase in the electronegativity of the nitrogen.

24(b) exposed some significant inadequacies in understanding what curly arrows actually represent. Some descriptions of electron pair movement did not differentiate between bonding electrons and lone pairs. Furthermore, in a number of responses, the lone pair on the nitrogen atom was moved to the carbon atom rather than the C−N bond. The resulting structure, even after correct electron pair movement, was often incorrectly represented, for example, with the charges that did not balance or with a single bond between the carbon and nitrogen atoms. Only the best students appreciated the consequent effect of the movement of electrons on the reactivity of the amide carbonyl group. The most common response was that 2,4-dinitrophenylhydrazine only reacted with aldehydes and ketones. In 24(c)(i) few students could accurately represent the structures of the two dipeptides. Sometimes ester linkages were used or atoms were missing from the molecules. It seemed that a number of students failed to read the question fully. Some gave only one structure and others drew polymer structures. The mark for 24(c)(ii) was awarded almost exclusively for noting the formation of zwitterions and there was little evidence of a mechanistic understanding of the consequences of this. There were some excellent descriptions of the use of thin-layer chromatography in 24(c)(iii). However, some students described the process in no particular order (for example spraying the chromatogram with ninhydrin prior to the separation). A recurring error was to describe dissolving the amino acid mixture in the mobile phase.

Advice to students

Read the questions carefully. In reaction sequences involving an unknown (such as Q23) and in Section C, try to ensure that you are aware of all the information that has been given.

Use technical terms with precision. The terms 'shell', 'subshell' and 'orbital' have distinct meanings.

When writing ionic equations and half ionic equations, remember that both mass and charge must balance.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
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