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Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Level In Chemistry (WCH01) Paper 1 The Core Principles of Chemistry

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General Introduction

The paper contained questions which were accessible to all students, but there were also challenging questions which gave the more able students a chance to display what they could do. The standard of numerical answers was generally good, though methods of calculation were not always easy to follow, and the organic chemistry sections were often answered well. However, knowledge and understanding of practical procedures was often limited, and good explanations for very fundamental ideas about the Periodic Table were not often seen.

Question 21

The ionic equation in Q21(a)(i) was a difficult one. Many students thought that the iron ions were spectators, despite the change from iron(II) to iron(III). Even if the iron ions were correct there were many other errors. Some students included sulfate ions on one side but not the other. Other students thought that nitrate and sulfate ions split completely into their elements when they ionised.

Errors in calculation of the molar mass of iron(II) sulfate -7-water occurred frequently in Q21(a)(ii). A common mistake was to multiply the mass of hydrogen atoms in water by seven and forget to do the same for oxygen. However, a mark could be scored in Q21(a)(iii) if the incorrect molar mass was then used correctly. In Q21(a)(iv) most students scored one mark for calculating the number of moles in 12.5 cm^3 of 2.0 mol dm^{-3} sulfuric acid though frequently they did not specify the method. This was regularly followed by the statement "0.025 x 2 = 0.050" which is certainly true, but does not provide an explanation. To score the mark there had to be some indication that the mole ratio in the equation was being used.

The answers to questions about preparation of the crystals gave the impression that many students had no practical experience. Suggestions for a piece of apparatus to use when adding 1 cm^3 portions of concentrated acid to a boiling mixture included spatulas, "a glass", and often burettes. Few students recognised the reaction in Q21(b)(vi) as precipitation, and there were many errors in the formulae of ammonia and ammonium sulfate. The tests suggested to detect a slight excess of ammonia in a solution were often unworkable e.g. using concentrated hydrochloric acid and looking for white fumes, or boiling with sodium hydroxide and testing for ammonia gas. The test needed is one which will not reduce the yield of crystals, and adding a drop of mixture to red litmus paper was the expected answer. The aim was to produce hydrated crystals, but in Q21(c)(ii) many answers said that the solution should be heated until it was completely dry or reached constant mass. In Q21(c)(ii) the question was about obtaining pure dry crystals after the mixture is filtered. Many answers referred to heating the solution obtained, but the filtrate would not have contained the desired compound. Making a salt is one of the core practicals in this unit, and students should be prepared for questions about these practicals. The calculation of the final yield was done reasonably well, apart from answers using the wrong molar mass, even though it was supplied in the question.

Question 22

Most students gave the empirical formula correctly in Q22(a)(i). A few gave the molecular formula or a general formula. Careful wording was needed in Q22(a)(ii) to explain why the prefix "2" in 2-methylpropane is not essential, and one of the clearest ways of giving the answer was to say that if a methyl group is attached to either end of the chain, the molecule would be named as a butane. However, many other ways of expressing this idea were allowed.

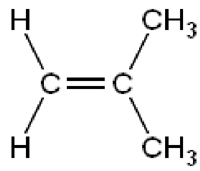
The combustion equation in Q22(b)(i) was usually given correctly and could be written with either one molecule of 2-methylpropane, or the doubled up version which then had a whole number of oxygen molecules. Many students recognised the safety hazard of 2-methylpropane, but there were also poor answers such as "it is corrosive so gloves must be worn."

The reaction of 2-methylpropane with chlorine was well known, and many students scored all the marks in Q22(c). Those who used a structural formula in Q22(c)(ii) often ended up with the wrong product, by drawing the free radical at the end of the molecule instead of on the middle carbon.

The term "structural formula" in Q22(d)(i) was not well understood, and many students gave a fully displayed formula. The answer $(CH_3)_3CC(CH_3)_3$ was given very rarely, and other versions were allowed, but not if they contained fully displayed methyl groups. The termination step in Q22(d)(ii) was usually named correctly, and many students could explain in Q22(d)(iii) that 2,2,3,3-tetramethylbutane formed as a result of two $C_4H_9^{\bullet}$ radicals reacting. Students who tried to use displayed or semi-displayed formulae in their explanations often made errors here.

Students who did not read question Q22(e)(i) carefully thought that the reaction was hydrogenation. Answers which did score called it dehydrogenation, more often than elimination. The general path of the mechanism in Q22(e)(ii) was usually known, but getting the detail right was a challenge. The curly arrows had to be clearly drawn in the right places to score; the carbocation intermediate had to have the charge on the correct atom; the bromide ion had to be shown with a full charge and a lone pair while the hydrogen bromide had to be shown with partial charges. A significant number of answers lost one mark because they drew a mechanism for propene, not 2-methylpropene.

The skeletal formula of 2,2,4-trimethylpentane was often shown correctly in Q22(e)(iii) but very few students managed to work out the structure of the dimer of 2-methylpropene. In this example, they might have been more successful if they had done rough work using a structural formula first, showing the groups round the double bond.



Most students knew in Q22(f)(i) that the important feature of isooctane was the branched chain. In Q22(f)(ii) there were many guesses about the advantage of a high octane fuel and vague generalisations. "More efficient combustion" was allowed, but just "more efficient" was not enough. Reference to "they produce more energy" are meaningless unless they are based per mole or per litre. Answers   about cost, greenhouse gases and rate of combustion also appeared and did not score.

Question 23

Argon is a monatomic gas, and this had to be clear for the marks in Q23(a)(i). Everything is made of atoms, but this is not the same as existing as single atoms, so the answer had to be worded carefully. Comments on lack of reactivity were true, but not relevant to the question.

The next part of the question was not well answered, and students often did not read the question carefully enough. They had to refer to the information in the table at the top of the page. If elements were placed in order of increasing atomic mass then potassium would come before argon, and be in the same group as the inert gases. Argon would be in the same group as the alkali metals and properties of potassium and argon would not be similar to other elements in their groups. Many students just said that the atomic mass sequence was due to the existence of isotopes. They did not use the data or answer the question.

Careful reading was also needed for Q23(b)(i). The question was about the particles in the nucleus, but many answers included electrons. However, these students usually scored the second mark for the correct meaning of the term isotope.

About half the students did the calculation in Q23(b)(ii) correctly. It looked as if the others had not seen a calculation like this before, as they simply tried to calculate an average using numbers in the question.

The equation in Q23(c)(i) for the first ionisation of chlorine was well done. The main errors were equations based on chlorine molecules, formation of negatively charged ions and omission of state symbols. The explanation in Q23(c)(ii) scored less well. Surprisingly few students made the points that an argon atom has one more proton than a chlorine atom, but the outer electrons experience a similar amount of shielding. Some answers simply said that full electron shells are stable. Others tried to argue an answer based on whether electrons were paired in orbitals. Answers based on atomic radius were not accepted as the Van der Waals radius of argon is actually bigger than for chlorine. Despite the frequent references to orbitals, many students did not seem to have an idea of their shapes when it came to Q23(c)(iii). There were a lot of dot and cross diagrams, electron in box diagrams and answers left blank. The outermost electron in argon is in a p orbital, but answers showing all three p orbitals were allowed. However answers showing two p orbitals overlapping to form a pi bond were not.

All electrons were required in the dot and cross diagram of potassium chloride in Q23(d)(i), but students who showed the outer shells only could score one mark. Diagrams showing covalent bonding did not score. The similarity of potassium ions, chloride ions and argon was an easy question which nearly everyone got right.

Hess's Law is applied in the Born-Haber cycle, and in Q23(e)(i) the law could be worded in different ways as long as it was based on the entropy change of a reaction. However "the change in a reaction is independent of the route" is meaningless and did not get the mark. A few students said the entropy change was the same regardless of the direction, which is also incorrect.

The first mark in Q23(e)(ii) was for labelling the cycle correctly, and was awarded even if the unknown electron affinity was not shown by name or symbol. Students who put all the data on the cycle nearly always calculated the electron affinity correctly. Some students thought that the enthalpy of atomisation of chlorine had to be multiplied by two, even though it was shown for half a chlorine molecule.

Paper Summary

Based on their performance on this paper, student should:

- make sure you know and understand the procedures used in the core practicals.
- always read the question carefully. There were at least five parts of questions in this paper where it was obvious that they had not been read carefully.
- show your method in calculations. If you just write down numbers without saying what they refer to you may not get the marks.

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