Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

January 2020

Pearson Edexcel International Advanced Subsidiary Level in Chemistry (WCH12) Paper 01Energetics, Group Chemistry, Halogenoalkanes and Alcohols

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January 2020
Publications Code WCH12_01_2001_ER

Introduction

This paper was the third one for the International Advanced A Level WCH12. In the new specification, there is a requirement to ensure 20% of the marks available assess mathematical skills at Level 2 (GCSE equivalent). Many students displayed a good ability to apply their mathematical skills to problems, e.g. using titration data to determine the amount of water of crystallisation in a sample of sodium carbonate. Some students arrived at a final answer of ~150 and perhaps should have considered the possibility that they had made an error in their calculation. In these cases, answers that are clearly set out make the award of partial credit much easier.

Most students indicated a good understanding of the energy distribution of molecules in the gas phase and could apply this to explain the effect of a catalyst on the rate of the reaction, although it was unfortunate that, having drawn an excellent diagram, many students failed to refer to it in their explanation.

Once again, paper 2 contained a 6 mark extended writing question. Many students were very well-prepared for this style of question and scored well, showing a good understanding of the effect of intermolecular forces on boiling temperatures. Some responses scored well within the first few sentences, but students who wrote longer answers included incorrect statements which negated marks already scored.

The information provided in the questions is carefully designed to guide students in their responses. It is important to take careful notice of the instructions, especially those in bold.

Multiple Choice

The mean mark for the multiple choice questions was 12.7. The highest scoring questions were 11(a) and (b), with 85% of students achieving these marks. The most challenging questions were 2 and 12(b), with less than 30% of students achieving this mark. Surprisingly, there was some evidence that 10% of students failed to offer any response for Q12(b).

Question 15

(a)(i) Most students understood that the hydrated salt already contained water and scored the first mark. Significantly fewer responses used the information given in the table regarding the difference in mass of the crystals (4.5g) and the reduction in volume of added water (4.5cm^3). These should have been linked to conclude that the final volume of the solution should be the same for both experiments.

(ii) The full range of marks were awarded. Some students scored one mark, either for the calculation of Q or the number of moles of copper(II) sulfate.

Two marks were frequently seen, often because the calculation was done correctly but the negative sign was missing from the final value or because of the transfer error (TE) from the use of an incorrect mass, e.g. 8g or 58g used in the calculation of Q.

(iii) The proportion of responses where students failed to correctly complete the Hess's Law diagram was surprising especially given the similarity with the exercise in Core Practical 2.

(iv) Students with incorrect Hess's Law diagrams from (iii) struggled to score marks in (iv), but some managed to get the correct answer from their value in (ii) by subtracting $\Delta_{soln}H$ ($CuSO_4 .5H_2O$) from $\Delta_{soln}H$ ($CuSO_4$) even if the arrows were incorrect.

(b) Practical questions continue to present students with challenges. Answers relating to the difficulty of measuring the temperature change of a solid were frequently seen. Centres should be advised that to give the same reason for both the forward and the reverse reaction is unlikely to score both marks.
The mark scheme provided several alternative ways to score, but these were very rarely seen. The difficulty of measuring the temperature change while heating was seen as an acceptable answer for the reverse reaction reason and generally was given by the more able students.
A significant number of responses referred to the anhydrous and hydrated forms being at equilibrium. This implies that these students failed to appreciate that a reversible process is not necessarily at equilibrium. The two separate arrows shown in the equation, rather than the accepted notation, $\rightleftharpoons$, should also have indicated this difference.

(c) The second mark was scored far more often than the first, indicating that students were more familiar with the concept of hydration than the idea that the ionic lattice needs to be broken down and the ions dissociated. A significant proportion of students did not interpret this question correctly. Many described experimental observations of a white solid dissolving to give a blue solution.

(d) A fairly straightforward moles calculation in part (i) saw most students score at least one mark. A good proportion of these went on to score at least some of the marks in part (ii). Over a quarter of all responses scored all six marks. Both scoring routes were frequently seen and credited. Most answers were given incorrectly in whole numbers of x.

The most frequent error was neglecting to take into account the difference in volumes of the portion of the solution titrated (25.0cm^3) and that of the solution (250.0cm^3). TE was applied throughout in order not t disadvantage students.

Question 16

(a) This question offered students across all ability ranges a chance to demonstrate their knowledge and understanding of intermolecular forces. Marks were most often awarded for the London forces in methane, hydrogen bonding in the other molecules, and the greater strength of hydrogen bonding. Some students failed to score indicative point 2 (IP2) because they neglected to compare the relative strengths, just referring to 'weak' in the case of London forces or 'strong' in the case of hydrogen bonding. The numbers of hydrogen bonds formed between the molecules was less well-known and incorrect numbers sometimes negated an otherwise correct statement. The greater electronegativity of fluorine and hence polarity of the H-F bond leading to the greater strength of the hydrogen bonding was occasionally seen but sometimes only the differences in electronegativity were stated or the different hydrides were not compared. Some students failed to interpret "isoelectronic" correctly and ascribed differences in boiling temperatures to hydrides having a different number of electrons and therefore different strengths of London forces.

(b) Students should be reminded of the meaning of the command words used in questions. A 'compare and contrast' type requires similarities and differences. This was not always evident in the answers seen. It was often the more detailed responses where marking point 1 and marking point 3 were not scored as these points were given for KCl but the similarities with KBr were not stated and students went straight to the oxidation reaction products and observations. Many answers did make a correct comparison of the reducing power of Br^- compared with Cl^- leading to the production of sulfur dioxide and/or bromine but slips in terminology, e.g. describing chlorine as a weaker reducing agent led to some students losing marks.
Some students failed to gain credit by things such as unbalanced equations, incorrect products (hydrogen sulfide) and incorrect colours (brown for HBr). Many who correctly explained the chemistry behind the reactions failed to describe the misty fumes of the hydrogen halides or the brown colour of the Br_2 evolved. While this wasn't necessary to achieve all 4 marks, it did reduce the possibilities, although many students were able to score highly on this question.

Question 17

(a) An 'emboldened' word in the question is designed to highlight a key requirement. A sizeable minority of students did not display the methyl group and so did not score this mark.

(b)(i) Only 25% of students scored this mark. NaOH (with or without ethanol) was the choice of most and this indicated some confusion between this reaction of an alcohol and the elimination reaction of a halogenoalkane.

(ii) Many structures (60%) drawn here were incorrect. A significant proportion of incorrect structures were just 2-methylbut-2-ene rotated or flipped vertically. Students perhaps did not realise that they had drawn an identical structure to the isomer given.

(iii) A surprisingly high number of students failed to recognise that the alkenes did not show geometric isomerism, perhaps as a result of an incorrect response in (ii), although the mark scheme did allow a mark for a correct description of 2-methylbut-2-ene. Some responses indicated that a lack of rotation around the C=C double bond was the sole reason for geometric isomerism, failing to mention the substituent groups on those carbon atoms. In those responses where these groups were discussed, it was difficult to discern whether the student actually meant two **identical groups/atoms** on **one** of the carbons **in the double bond**. It would be a worthwhile activity for students to practise this.

(c) The structure mark was more often awarded than the reason mark. It was not unusual to see a response stating that the reason was due to the stability of the tertiary halogenoalkane rather than the tertiary carbocation. Responses which spoke of 'hydrogen choosing to bond with the carbon with the most hydrogens attached to it' or other versions of Markownikoff's rule did not score. Whilst, indirectly true, it is not sufficient in explaining why major/minor products form.

(d)(i) This was generally done well, with many students knowing the formulae of the products. Common errors seen were the formation of water rather than HCl and the wrong number of hydrogens in the halogenoalkane, namely $C_5H_{10}Cl$.

(ii) Nearly all marks scored were for stating that the reaction in (d)(i) was a 'one step reaction'. The equation for this was on the same page. The formation of two isomers in both steps in (b) and (c), which was on the two preceding pages, seemed to have been forgotten since it was rarely referred to.

(iii) Surprisingly, less than half the responses were correct. Most non- scoring responses either failed to give the bond at all or used -OH which implied the bond between the carbon and the oxygen was responsible for the IR wavelength stated rather than the oxygen-hydrogen bond in the alcohol group.

(e) A significant number of students incorrectly stated that the 2-methylbutan-2-ol compound was a secondary alcohol, and that on oxidation a ketone would form which would not be toxic. Those who were familiar with the oxidation of primary and tertiary alcohols did not always explain themselves clearly enough, for example simply referring to the production of the aldehyde, which had already been stated in the question instead of **oxidation** to the aldehyde.

Question 18

(a) Well over half the responses were fully correct. Occasional incorrect rounding of the final answer or an incorrect molecular mass calculation was seen.

(b) The information given in the question regarding the use of urea as a fertilizer was not fully understood by many students. Many answers focused on the reactions of urea with water rather than on the product of the hydrolysis, ammonia. Answers focusing on environmental issues such as acid rain and global warming were common. Some incorrect answers which said ammonia would make the soil acidic were seen. A minority ignored the context of the question and based their answers around discussing eutrophication, acid rain and global warming. There were some students who negated creditworthy comments about ammonia dissolving in the rice paddy fields by then stating that this was toxic to the crops.

(c)(i) Disappointingly, very few students scored all three marking points. The drawing of two curves, which might have been expected if the question had involved an increase in temperature, was seen in a surprising number of responses. Marks were also lost due to the curve not being asymptotic and having a long horizontal section at the end.

(ii) This question specifically asked for reference to the diagram drawn in (i), but this was very rarely seen and so the vast majority did not score the second mark, even when an accurate diagram had been reproduced.
The effect of the catalyst on the activation energy and the consequent rate of reaction was well known but very few related their answer about the increase in the number of molecules to the increase in the area under the curve at

higher energies than Ea. Some students who had shaded these areas on their graph then made no comment about what the shaded areas represented.

(iii) The effect of increasing pressure on an equilibrium was well-answered with over half the responses scoring both marks. It was not uncommon to see answers referring to “favouring” the right-hand side. This wording should be avoided. Students did not always give the reason for the movement of the equilibrium and so did not score the second mark.

(d)(i) Only the more able students appreciated the need for reference to no change in oxidation numbers. Answers simply stating that there was no oxidation nor reduction were very common.

(ii) Those students who took a kinetic approach to answer this question frequently scored the first mark. It was rare to see a response that went on to conclude that an increase in the rate of the reaction would also remove the pollutant more effectively. Those students who answered from a shift in equilibrium, having correctly assumed that this reaction was endothermic, scored both marks more often. Some students gave both and the higher mark was awarded.

(iii) This question was one in which a careful approach in assigning oxidation states was rewarded with all three marks. A common mistake was to identify the oxidation number of N in NH_3 as +3 rather than -3. This often led to an incorrect change in oxidation number for hydrogen. Some responses in which oxidation number changes were correct lost a mark for failing to confirm which was oxidation/reduction.
In the equation in this question, N in NH_3 is oxidised to N_2 and N in NO is reduced to N_2. Those students who stated that ‘the process was not disproportionation because no element was both oxidised and reduced at the same time’ failed to score the third mark.

(iv) Most responses scored 1 mark; the most common answer being acid rain. Many stated simply that NOx gases were toxic or harmful which is too vague to gain a mark. Many other random polluting effects were often listed.

Paper Summary

The students have been well prepared for this examination and can demonstrate their knowledge in familiar contexts. Those whose understanding of the subject is deeper are better equipped to successfully deal with unfamiliar questions.
Based on their performance on this paper, students are offered the following advice:

- read the information given in the question carefully, noting any instructions given in bold type
- note the command words used and make sure that you are answering the question that has been asked
- plan your answer to extended writing questions by breaking the question down into 2 or 3 smaller questions
- show all your working for calculations and make sure you round your final answer to an appropriate number of significant figures and check your answer is reasonable if you have time.

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