Examiners' Report
Principal Examiner Feedback

October 2020

Pearson Edexcel International Advanced Subsidiary Level
In Chemistry (WCH12)
Paper 1: Energetics, Group Chemistry, Halogenoalkanes and Alcohols

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Introduction

Many students were well prepared for this examination and were able to demonstrate that they had a sound knowledge of the topics in the specification.

Section A

Multiple Choice

These were mostly answered well with the most common incorrect answers appearing for 5(b) and 11(c)

Section B

Question 13

(a)(i)(ii) The arrows and coefficients were inserted correctly by most candidates but some responses showed that the coefficients had not been applied to the calculation. The enthalpy change of combustion was also missing in some answers indicating that Hess's Law had not been understood.

(b)(i) Few candidates scored both marks for this question. Many recognised that the alkanes formed a homologous series but even those who also added that each molecule differed by CH_2 were unable to appreciate that the increase in enthalpy of combustion was due to similar bonds being broken and made during combustion. There was often confusion between boiling and combustion with increasing intermolecular forces being cited as a reason for the increase.

(ii) This question was misinterpreted by many candidates who suggested that experimental error might be the cause. Some recognised the change from negative to positive boiling temperatures but did not appreciate that butane boils below 25^{0}C and so is a gas at r.t.p. but pentane is a liquid at r.t.p. Some of the energy released during the combustion of pentane is used to change pentane to a gas prior to combustion.

(iii) This was a familiar question on the relationship between the increase in boiling temperatures and the increase in carbon atoms of the alkanes. Many scored all three marks but it was disappointing to see marks lost by those who did not state that the increase in the number of electrons was responsible for the stronger London dispersion forces. The final mark for linking the energy needed to the breaking in intermolecular bonds was frequently not scored. It is important that candidates note how many marks are available for questions and give the appropriate number of different points.

Question 14

(a) Both marks were scored in a high percentage of scripts.

(b) The titration calculation gave a good percentage of all-correct responses. Those candidates who perhaps had not had much experience of the technique frequently muddled the volumes given or neglected to include the factor of 2 which represents the stoichiometry of the reaction between calcium hydroxide and hydrochloric acid.

(c) The effect of the differing solubilities of calcium hydroxide and magnesium hydroxide in the titration with hydrochloric acid was not often reasoned. A more frequent response indicated that the titres would be the same as both were in group 2 so the volumes reacting would be the same.

Question 15

(a)The redox equation had a familiar format and many responses showed that assigning oxidation states was well known. The frequent error in assigning a value of +9 as the oxidation state of silver in silver nitrate was difficult to understand. It is important for candidates to state clearly the element being oxidised or reduced as phrases such as "NO_3^- changes from 5 to 4" were often seen and could not be given credit.

(b)(i) There were several common mistakes in the thermometric determination of a solution concentration. Some responses indicated that candidates' knowledge was insecure and they inserted the value given for $\Delta_r H$ into $Q = mC_p\Delta T$ and thought that they had calculated the mass of silver nitrate used in the reaction. It is a common misconception that the mass represented by "m" refers to the mass of reactant in solution rather than the total mass of solution which is heated or cooled. However, having calculated an incorrect mass, those candidates who went on to convert the mass into a solution concentration in mol dm^{-3} and express this to an appropriate number of significant figures gained marking points 3 and 4.

(ii) In contrast, the calculation using the gravimetric method was completed successfully more often. The most common error seen was division of the precipitate mass by the M_r of silver nitrate rather than that of silver bromide but once again, the second mark could be awarded where the working was clearly shown.

(iii) The critical analysis of practical results is still an area that is very weak amongst most candidates and it would be beneficial to concentrate more on this area during practical work.

Many students stated generic errors such as zero errors or non-standard conditions in experiments which were not consistent with the results. The response which scored most often was heat loss. Often students did not make clear which experiment they were referring to.

Question 16

16(a) The type of reaction was often all correct. Reagents were often incompletely stated e.g. cyanide or hydroxide, thereby not gaining credit.

(b) The IUPAC name for butanenitrile was frequently given as propanenitrile or cyano propane. It would appear that many candidates do not realise that the carbon of the -CN group should be counted.

(c) A lack of detail was evident in many mechanisms with dipoles not drawn and bromide ions in M2 or protons as leaving groups not shown. The final arrow often pointed towards hydrogen as the candidate drew the direction of movement of the hydrogen rather than the movement of the electrons. Many candidates lost M1 as they showed ammonia as a charged ion, frequently negative, presuming perhaps that nucleophiles must have a negative charge.

(d) Most common indicative marks missed out were the first and second. The vast majority of responses completely lacked any reference to nucleophilic substitution. Some mentioned hydrolysis instead which was given in the question. Indicative points 3 and 4 were most often scored but some candidates referred to the reactivity of the halogens themselves rather than focussing on the C-Hal bond strength. References were often made to the electronegativity difference being proportional to the bond strength.

The relationship between the structure and reactivity was also well known, but indicative points 5 and 6 were often not scored due to candidates inexact language. References to “branched” halogenalkanes were not accepted and references to the halogenoalkanes as being primary/secondary/tertiary carbocations rather than to the fact that these were formed from the respective halogenoalkane during the reaction were incorrect.

Responses that just restated all the facts that they had been given in the question or repeated the same point for several lines did not score well. Many candidates did not check that they had addressed each of the bullet points in the question with the type of reaction being frequently omitted. Candidates should re-check the question after their answer to ensure that they have not missed anything.

In contrast, many high-scoring responses were succinct; these candidates summarising the necessary information in little more than the first page. Sometimes those who wrote at length, added material that negated marks already gained.

Question 17

(a)(i) The effect of increased pressure on the equilibrium in a gaseous reaction was well known but some candidates missed out on marks by not stating which side had a smaller number of gaseous molecules. Just stating that the position of equilibrium moved towards the side with fewer molecules was insufficient. A number of candidates referred to gaseous atoms and thus lost marks. The increase in the number of collisions was crucial to gaining marks for those responses using kinetic arguments.

(ii) Most candidates gained the first marking point by realising the forward reaction is exothermic but many then did not score marking point 2 by incorrectly stating a higher temperature would give a higher yield. The concept of a compromise temperature to balance the kinetic demands (higher temperature) with equilibrium demands (lower temperature) was not often seen but the realisation that a high temperature would increase the rate was sufficient to score marking point 3.

(iii) This question regarding the use of the catalyst required a link to the sustainability of the process rather than just a standard definition of a catalyst.

(b)(i) This was answered correctly very often. Marks were lost by those candidates who neglected to include the acid.

(ii) This equation was not well known. Many responses gave CH_3COOH as the product ignoring the increase in carbon atoms compared with the reactant side.

(iii) Many candidates did not know the test for a carboxylic acid, losing marks by discussing indicators. A number of candidates referred incorrectly to testing with PCl_5 or Na.

(iv) Many candidates gained M1 and marking point 2 by correctly identifying key IR peaks in spectra of both alcohols and carboxylic acids. marking point 3 was far more elusive as it required the understanding that the alcohol peaks would disappear or be absent if the oxidation was complete.

(c)(i) The combustion of petrol and/or methanol which releases carbon dioxide was well known. Some candidates lost marks by not indicating that it was the burning of the fuel that produced CO_2.The fact that the added methanol had been derived from carbon capture and was therefore essentially carbon neutral was not appreciated by most candidates which meant that marking point 2 was not scored often.

(ii) This calculation was straightforward and completed successfully by many respondents.

(iii) Many candidates succeeded in calculating the reduction of the mass of petrol but then failed to calculate the reduction in CO_2 which resulted.

Summary

In order to improve their performance, students should:

- read the question carefully and make sure that they are answering the question that has been asked
- write concisely and avoid making the same point multiple times
- make sure that comparisons are made when required
- write formulae and numbers carefully, checking their legibility
- be careful with the precision of curly arrows in organic mechanisms
- show all working for calculations and give final answers to an appropriate number of significant figures
- consider suitable precautions when working with hazardous substances
- make sure they understand the difference between reagents and conditions, including when catalysts are involved
- reread questions and answers, where time permits, to avoid careless mistakes.

Grade Boundaries

Grade boundaries for all papers can be found on the website at:
https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html