Examiners' Report
Principal Examiner Feedback

January 2019

Pearson Edexcel International Advanced Level
In Physics (WCH04)
Paper 01 Rates, Equilibria And Further Organic Chemistry

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

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

January 2019
Publications Code WCH04_01_1901_ER

Introduction

This paper was similar in style and standard to previous and parallel Unit 4 papers of this specification with a range of skills and knowledge being assessed.
The levels of difficulty of the questions allowed good discrimination between the different grades. Well-prepared candidates at all levels were able to demonstrate their abilities. Candidates seemed far better prepared for the straightforward and familiar type of question rather than those requiring application of knowledge and understanding. Many candidates lost marks as a consequence of failure to read the question with precision and accuracy, and, as a result, not answering the question that had been set and instead answering one they anticipated.

Multiple Choice Section (Questions 1-10)

The mean mark for the multiple choice section was just over 14 marks with the most commonly correct item being Q3, whilst Q1 proved the most challenging.

Section B

Question 21

The first question in Section B gave most candidates an opportunity to show good understanding of these parts of the specification. The calculations in a)i)-iv) in particular were very well understood with a very good number of candidates getting the four parts completely correct. It was very pleasing to see that most candidates gave units with their answers and these were almost always correct. In a)ii) a few candidates failed to multiply the entropy of hydrogen as there was more than one mole present, and some forgot to allow for the different in units between enthalpy and entropy as usually calculated, so did not multiply 49 by 1000 in iii). In part v) a number of candidates thought that the higher temperature was linked to the yield of product rather than to an increase in the rate of the reaction.

21b) began with an equation. Most candidates were correct in identifying the reactants and products, but very many could not balance this very straightforward equation. This was disappointing, and is an area which would benefit from greater focus and practice. Those who were able to balance the equations chose to do so as if it were the equation showing the enthalpy of combustion

$$CH_3OH + 1\tfrac{1}{2}O_2 \longrightarrow CO_2 + 2H_2O$$

This was, of course, perfectly acceptable. The increase in the number of moles of gas from reactants to products was often recognised, as was the fact that combustion reactions are exothermic but quite a number of candidates did not put this together in a logical way to fully answer ii). This question gave a good range of marks with some learners able to really demonstrate their understanding,

whilst others did not make the link between thermodynamic feasibility and entropy.
In 21(c) some candidates were not able to express an understanding of carbon neutral, and instead were writing about greenhouse gases and global warming.

Question 22

This question explored the chemistry of pentane, butanal and propenoic acid.

There were parts of this question that were very accessible for all. The structures in the first two parts and the conditions and structure in iii) were well answered, though candidates must be sure they know what type of structure to draw. The key is to identify words in bold in the question. The displayed formula in i) was well answered. The skeletal structure in ii) was often given, but sometimes the double bond was missing. The name for the ester was well known for many and these two questions scored well. In iii) any structural formula was acceptable and was often given correctly, though some learners gave a structure which had two OH groups. The condition for the reducing agent was well known as dry ether, but some added an additional solution in water, for example acid solutions, at the same time, which would not be effective. 22a(iv) was less well answered with many candidates trying to form a condensation polymer using the carboxylic acid groups rather than an addition polymer from the carbon to carbon double bond.

It is common in this paper to be required to provide data from the data booklet. In this instance, the data had to be looked up and then converted from Kelvin into Centigrade. Many candidates were comfortable with this, but a large number used the data in Kelvin. The number of electrons in propenoic acid was often given correctly. In the next question, the boiling temperature of the three substances was explained using intermolecular forces. Many learners knew that propenoic acid formed hydrogen bonds between molecules, with many knowing that they were often linked together in pairs. The fact that butanal had permanent dipoles and therefore permanent dipole-permanent dipole attractions between molecules was also well understood. The presence of London forces between molecules of pentane was also known and these intermolecular forces were linked to boiling temperatures. The importance of the similar number of electrons and therefore the similar contribution of London forces to boiling point was poorly understood however and so relatively few scored all three marks. Some were able to say that more electrons meant that the London forces would be bigger so were able to score the mark in that way. Common misconceptions include the fact that boiling of a liquid results in the breaking of bonds within the molecule which is not correct. Other statements which appeared quite commonly were that butanal formed hydrogen bonds, which it cannot as it does not have a significantly positive hydrogen and that both butanal and propenoic acid form hydrogen bonds with water, which is true but plays no part in their relative boiling temperatures. The precise role of intermolecular forces in chemistry is still poorly understood by many candidates and would be another area which could benefit from greater study at this level. The use of acronyms such as id-id, pd-pd or LDF without explanation is to be discouraged and will often not score marks as was the case in this question.

The next part of this question was generally very well answered, with most candidates scoring well here. The test for aldehydes and for carboxylic acid or alkenes were well known. One surprisingly common mistake was to say that using 2,4 dinitrophenylhydrazine would give a positive result with propenoic acid.

The use of spectroscopy as an alternative to chemical tests is common in the chemical industry. The next few parts explored this in relation to the three chemicals. Infra-red spectroscopy will successfully separate them. The infra-red spectrum of pentane in di) was often recognised, but the explanation for why there were so few peaks sometimes needed greater clarity. In dii) the most common mistake was to assign the pear at Q to a C=O group, but this still allowed 2 of the 3 marks to be scored.

Question 23

This question required learners to use their knowledge of reaction mechanism to explain a reaction which they were not familiar with. Candidates were able to demonstrate their understanding of the concepts rather than simply remembering information.

In a) the name of 3-hydroxybutanal was often given correctly, with 2-hydroxybutanal a common incorrect answer. In part b) the role of ethanal in step 1 was poorly understood. Recognising that the mechanism involved nucleophilic attack, many thought it was acting as a nucleophile. In fact, a hydrogen is being released to react with the OH^- ion, so the ethanal is acting as an acid or a proton donor. It was pleasing to see how many candidates were able to translate their knowledge of nucleophilic addition of hydrogen cyanide to a carbonyl compound to this similar example. The mechanistic arrows were often given correctly, though some looked a little rushed and lacked precision. The role of the hydroxide ion as a catalyst was quite well understood, but some learners focussed on the role solely in step 1, rather than overall as the question asked. In the final part b the formation of a racemic question in the reaction of hydrogen cyanide with an asymmetrical carbonyl is a well-practised question in this examination so many candidates were successful, but some answered thinking the hydroxide ion attack was the key step rather than the attack of the ion from the ethanal to the second ethanal molecule which is planar around the carbonyl group.

The final section of the question looked at the kinetics of the reaction under particular conditions. The calculation and units were correctly answered by many candidates and this item scored very well across the range of candidates. The final question was highly discriminating with many candidates recognising that the first step involved the hydroxide ion and ethanal as did the rate equation. This was not sufficient, however. The order of reaction of a species tells you the number of the species present up to and including the rate determining step, and in this reaction the order of both ethanal and hydroxide ion is one, so the first step fits with the rate equation because the order for both is one and one of each appears in this step. Many candidates recognised that the correct species were involved but did not understand the importance of the number of each.

Section C

Question 24

Part a) of this question focussed on the calculation of a value for K_p, its units and the use of this value to determine ΔS_{total}. In a)i) the major source of mistakes was in the calculation of the molar quantities of the gases at equilibrium. The question described the equilibrium molar quantity of nitrogen as a percentage reduction. Since 1 mole of nitrogen was present a 20% reduction would give a loss of 0.2 moles, and hence 0.8 moles would be left. Since 1 mole of nitrogen reacts with 3 moles of hydrogen the reduction in hydrogen would be 0.6 moles, hence 2.4 moles were left, whilst the amount of ammonia formed is twice the amount of nitrogen lost so this would give 0.4 moles. After this step many candidates, whether they had the correct equilibrium moles or not, were able to work through the processes required to reach the final answer. This part was very well answered with many using an easy to follow table showing the steps in their calculations. Providing learners could recall the relationship required in part ii) they were able to give the correct answer.

In b) ammonium chloride was formed by the neutralisation of ammonia with hydrochloric acid. The calculation of volume of hydrochloric acid required was straightforward for many. The equation and the resulting expression for K_a however were poorly understood. The calculation in iii) was very well answered with the value of pH of 4.83 seen very often. These values led to a graph for the titration of ammonia with the hydrochloric acid. Several points on the graph were given either in the question, for example the initial pH of 10.6, or in the calculations. The vertical portion of the graph should be at 40cm^3 from b)i) and the vertical portions should be centred around pH 4.83 from b)iv). As this was a weak base vs strong acid titration the final pH at 50cm^3 was expected to be quite low and at least below pH 3. Graphs given were very variable. Some candidates clearly did not read the question carefully enough and drew graphs for the titration of hydrochloric acid with ammonia and so they were the wrong way round. Others drew graphs more reminiscent of a strong base and strong acid titration.

Summary

Based on their performance on this paper, candidates should

- read the question carefully to ensure that their answers match the requirements of the question
- practice writing equations for chemical reactions which commonly appear in this specification, for example combustion reactions
- practice answering questions expaining properties using forces between particles avoiding the use of unexplained acronyms
- ensure that mechanistic arrows start clearly from bonds or lone pairs of electrons and go clearly to an atom
- remember that in calculation questions answers from previous parts will often be required to answer later ones.

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom