Pearson Edexcel

# Examiners' Report
# Principal Examiner Feedback

## January 2019

Pearson Edexcel International Advanced Subsidiary
In Chemistry (WCH11)
Paper 01 Structure, Bonding and Introduction to Organic Chemistry

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## Introduction

This is the first examination in the Pearson Edexcel International Advanced Subsidiay Level in Chemistry Paper WCH11_01. The style of the paper is the same as that for the legacy paper WCH01_01 with Section A containing 20 multiple-choice questions and Section B containing 60 marks of structured questions.

There are just a few changes to the specification. The energetics topic has been split up and moved to Units 2 and 4. Shapes of molecules and ions has been moved from Unit 2 into Unit 1 and calculations using the ideal gas equation have been added.

Some candidates were very well-prepared for this examination and scored high marks. Many candidates were able to demonstrate that they had a sound knowledge of the topics in the specification and could apply this to the questions with just a few errors or omissions. A significant minority of candidates found the paper challenging and would benefit from much more preparation to ensure that they know the basic facts, can express their ideas clearly and carry out calculations, showing their working.

## Section A

The mean mark for the multiple choice questions was 15.2. The highest scoring questions were 2, 7 and 12, with over 90% of candidates achieving these marks. The most challenging question was 16, with 26% of candidates achieving this mark.

## Section B

## Question 21

Many candidates know that heptane burns less smoothly than branched chain or cycloalkanes but a lot of vague answers related to the difficulty in igniting it, incomplete combustion and auto-ignition were seen. Many candidates were able to draw the skeletal formula of 2,2,3-trimethylbutane but some had $CH_3$ groups drawn in and other structures had an incorrect number of carbon atoms. The equation for reforming heptane into cycloheptane was often correct but common errors included not using molecular formulae and omitting hydrogen as a product. The majority of candidates realised that oxides of nitrogen can form acid rain, but a significant number did not mention that they need to dissolve in water for this to happen. A few candidates wrote about sulfur dioxide, which was not relevant to this question.

The majority of candidates knew that the first step in the mechanism of the reaction of heptane with chlorine is an initiation step. Many candidates could write the equations for the propagation steps, although some produced incorrect radicals and did not balance the equations. It was disappointing that some candidates gave an incorrect formula for heptane as this was given at the start of the question. Candidates should be encouraged to read the questions carefully and use the information they are given. The majority of candidates could write the equation for the termination step which forms a hydrocarbon, however, some lost this mark as they gave additional termination steps which produce chlorine or a chloroalkane. Candidates found (b)(iv) the most challenging part of this question. Those who were most successful usually gave equations rather than trying to explain what happens in words. Some candidates thought that two chlorine atoms substitute at the same time, rather than one at a time and a few wrote equations producing hydrogen.

**Question 22**

It was surprising to see that a significant minority of candidates could not use their calculators to find the log of the ionisation values in the table. They could have looked at the values they were given and checked these on their calculators. Many candidates could draw an acceptable graph for 3 marks. Common errors included: not labelling both of the axes or including units for the log axis, not using a linear scale, plotting ionisation energy values instead of the log values and joining the points with a line that went through the origin. There is no ionisation number 0. Some candidates chose a complex scale for the y axis and this often led them to plot one or more points incorrectly. The majority of candidates realised that the range of ionisation energies is too large to fit on a graph and that the log values are smaller and easier to plot. Many candidates did not read the question in (a)(iv) carefully and they wrote about the group that nitrogen is in rather than its electronic structure. Some candidates did not link the large jump between the fifth and sixth ionisations to the start of a new quantum shell and many candidates did not state that there are two electrons in the first quantum shell. Although many candidates were able to explain why the first ionisation energy of oxygen is lower than that of nitrogen, some did not mention that there is a pair of electrons in one of the 2p orbitals, some did not specifically mention that the 2p sub-shell in nitrogen is half-full and some referred to just a half-full p orbital. Some candidates mentioned repulsion but did not make it clear which electrons were repelling. A significant minority of candidates thought that the outer electrons were in the 3p orbitals. The most successful candidates used the 'electrons in boxes' notation to illustrate their answer. Many candidates need to make sure that they understand the difference between a quantum shell, a sub-shell and an orbital.

The majority of candidates could draw a dot-and-cross diagram to show the bonding in a molecule of nitrogen but it was disappointing to see a significant minority with a single bond between the atoms instead of a triple bond. The calculation of the number of nitrogen atoms in 5.60 g of nitrogen gas was often well answered but many candidates calculated half or double the number as they were confused between atoms and molecules. The calculation in (b)(iii) was carried out correctly by many candidates and it was pleasing to see how many explained their working. Common errors included: not converting the volume of gas from

$cm^3$ into $m^3$, not converting the temperature into kelvin or doing this incorrectly, re-arranging the ideal gas equation incorrectly.

**Question 23**

The majority of candidates could give the empirical formula of 2-methylpropene but quite a few gave the molecular or structural formula. Many candidates found it difficult to express their ideas in (b). The simplest answer was to state that there are two hydrogen on one of the carbon atoms in the double bond.
The mechanism discriminated well between candidates of all abilities. Common errors included: not showing the dipole on the bromine molecule, inaccurate curly arrows that did not start or end at the correct places, an incorrect intermediate and an incorrect product. Some candidates did not read the question carefully and showed the mechanism using hydrogen bromide instead of bromine or used a different alkene to the one asked for in the question.
Many candidates found it difficult to draw the skeletal formula of the organic product **Q**. It would be acceptable for them to draw the displayed formula first and then draw the skeletal formula. The colour change in (d)(ii) was generally well-known, as was reagent **B** in reaction **2**. Many candidates thought that the major organic product in Reaction **2** was formed via a secondary carbocation instead of a tertiary carbocation. However, these candidates were able to score a transferred error mark if they then wrote that a secondary carbocation is more stable than the primary carbocation that would be formed for the minor product. A few candidates incorrectly wrote about the stability of the products instead of the intermediate carbocations.
The majority of candidates could draw two repeat units of poly(2-methylpropene), with just small numbers omitting one or both extension bonds or giving two separate repeat units.
The calculation in (f) was completed successfully by many candidates who explained their working clearly. A few candidates did not round their final answer to 2 or 3 significant figures. Some candidates did not convert the mass into moles and they did not receive any marks. Candidates will be penalised if they round their answers to interim steps to 1 significant figure. It is best if they carry all significant figures in their calculators until the final step and they round their answer to an appropriate number of significant figures. Candidates should also check the numbers they are given in the question carefully as it was not uncommon to see 6.58 g used instead of 6.85 g and 52.8 % instead of 58.2 %.

**Question 24**

Many candidates realised that the state symbols of the ions should be (aq) instead of (l) in the equation in (a), although some did state that the silver ions were solid and chloride gaseous. Fewer candidates knew that the charge on the silver ion and hence the formula of silver chloride were incorrect.
The majority of candidates were able to calculate the molecular formula of the compound in (b), although there were some who just calculated the number of

moles of each element and then did not know how to convert this into an empirical or molecular formula. A small number of candidates used atomic numbers instead of relative atomic masses for the elements and a few included oxygen in the formula instead of chlorine.
Some candidates gave very clear representations for the four molecular ions peaks of $NCl_3$ and calculated their mass/charge ratios correctly. Many candidates did not read the question carefully and they gave species with just one or two chlorine atoms and sometimes no nitrogen. Many candidates would benefit from more practice at working out the molecular ions formed from simple molecules. It was disappointing to see that many candidates did not realise that there would be three bond pairs of electrons in $NCl_3$ so their suggested shapes varied from linear to trigonal bipyramidal.
Candidates were told that aluminium chloride exists as an ionic lattice in the solid state so their explanation about why it has significant covalent character should have been based around the small and highly charged aluminium ion polarising the chloride ion. Many confused answers were seen to this question.
It was pleasing to see some clear diagrams showing two $AlCl_3$ molecules joined together with dative covalent bonds through chlorine atoms in (d)(ii). However, many candidates showed a lack of understanding of dative covalent bonding and showed the bond starting from the aluminium atoms. Many structures were drawn showing bonds between the aluminium atoms and/or the chlorine atoms. This example is in the specification so candidates should make sure that they understand it.

**Summary**

In order to improve their performance, candidates should:

- read the question carefully and make sure that you are answering the question that has been asked
- learn the meanings of all the key terms in the specification, particularly the difference between orbital, sub-shell and shell
- learn how to use your calculator to determine the log of an ionisation energy
- show all your working for calculations and do not round the answers to intermediate steps to 1 significant figure
- be careful how you draw curly arrows and intermediates in organic mechanisms
- learn about ionic compounds that have covalent character
- learn about dative covalent bonding.