Examiners' Report
Principal Examiner Feedback

October 2018

Pearson Edexcel
International Advanced Subsidiary Level
In Chemistry (WCH02)
Paper 01 Application of Core Principles of Chemistry

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General comment

Some learners were very well-prepared for this examination and scored high marks. Many learners 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 learners found the paper very 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 11.5. The highest scoring questions were 5 and 10, with over 80% of learners achieving these marks. The most challenging question was 1, with 25% of learners achieving this mark.

Section B

Q21

About half of the learners knew that butanoic acid is formed when butan-1-ol is completely oxidised and butanal was a common incorrect answer. A few learners did not read the instruction to give the **displayed formula** and lost a mark by drawing the skeletal formula. Some learners knew that sodium was the required reagent in (a)(ii) but sodium hydroxide, sodium carbonate and sodium hydrogencarbonate were seen.

Many learners struggled with (b)(i) and (ii) as they did not appreciate the two-step nature of the synthesis and did not realise that the amine can only be produced from a halogenoalkane. The majority of learners knew that ammonia was needed in (a)(iii) but some lost the mark by giving an incorrect formula. Some learners were able to suggest an acceptable reason for heating the reaction mixture in a sealed tube, although many did not realise that ammonia would not condense in a reflux condenser. Some learners realised that a gas would escape but they needed to specify which gas.
The majority of learners could draw the displayed formulae of the three structural isomers of butan-1-ol but some included butan-1-ol, some drew the same isomer more than once and a few gave incorrect numbers of carbon atoms.

Part (d) was intended to test learners' ability to use all of the information given in the question to deduce the identity of alcohol **Y** and it was pleasing to see that many learners rose to the challenge. Some learners did not read the information that Y is **not** butan-1-ol and some did not use the information that only one bond in the alcohol is broken to produce the fragment that gives a peak at m/e = 43.

Q22

The majority of learners could draw a dot-and-cross diagram of the ICl molecule, although some learners omitted the lone pairs of electrons. Learners found it more difficult to suggest how the electrons in the outer shell of iodine rearrange to form iodine trichloride. The most common mark scored was that there are three bond pairs and two lone pairs of electrons around the iodine. Some learners realised that iodine had 'expanded its octet'. Only a small minority of learners realised that this expansion occurs because a 5p electron is promoted to an empty 5d orbital. Many learners knew

that I-Cl bonds are polar but not all of them could explain this in terms of the different electronegativities of the atoms. Many learners thought that ICl_3 is a non-polar molecule because the dipoles cancel. Although the shape of the molecule was given, some learners wrote that it was trigonal planar or pyramidal.
Some learners could give the colour change at the end-point without using an indicator. There were many excellent answers to the calculation in (b)(ii), with the working clearly explained. Many learners scored 2 marks for calculating the numbers of moles of thiosulfate ions and Tl^{3+} ions. Some learners were confused between iodine molecules and iodide ions so they were unable to score the mark for the mole ratio. Some learners did not know how to use the mole ratio to deduce the final oxidation number of thallium and some omitted to give the final oxidation number.

Q23

There were many carefully drawn mechanisms for (a)(i). However, many learners drew inaccurate curly arrows and did not think about where they should start and end. A curly arrow represents the movement of a pair of electrons so should start from a bond or a lone pair of electrons and end at the atom that will be joined in the new bond. It is not necessary to distinguish between S_N1 and S_N2 mechanisms at AS and the most successful learners drew the simplified mechanism. A correct S_N2 mechanism could score full marks but many learners lost the mark for the intermediate as they omitted the charge and /or the dashed lines for the partial bonds. A correct S_N1 mechanism could score a maximum of 3 marks as 1-bromopropane is not a tertiary compound. A few learners lost marks by using an incorrect number of carbon atoms in the halogenoalkane, used 2-bromopropane instead of 1-bromopropane and did not show both products. Some learners showed a covalent bond in K-OH and/or K-Br, which is incorrect. The majority of learners knew that this was nucleophilic substitution.

The calculation in (b) was answered well by many learners. A few learners lost a mark as they rounded the answers to the intermediate steps too early and sometimes incorrectly, for example 4.068 was sometimes rounded to 4.06. Some learners just calculated the mass of propene and divided that by 0.50 g to get an answer of 6.3%. They scored just 1 mark for calculating the number of moles of propene as they should also have calculated the number of moles of 1-bromopropane.
Many learners knew that 1-iodopropane would give the fastest rate of reaction but they could not all explain the reason for this in terms of the carbon-halogen bond strength. Some learners just wrote generally about ‘weaker bonds’ and did not specify which bond in the molecule is weaker. Many discussions of electronegativities were seen and these answers were ignored. A small number of learners lost marks as they thought the halogenalkanes contained ions.
The majority of learners could draw the displayed formula of 1,1,2-trichloro-1,2,2-trifluoroethane. Common errors included hydrogen atoms in the structure and all the chlorine atoms attached to the same carbon atom. Some learners did realise that C-F bonds are strong so they do not break easily, although some just referred to strong bonds and did not specify which bonds. Learners found it more difficult to write the two propagation steps in the conversion of ozone to oxygen. Some included oxygen radicals, some used NO instead of Cl• and many wrote two equations that did not add up to the overall equation. Although many learners realised that a disadvantage of using butane as an aerosol propellant is that it is flammable, there were many general answers, such as ‘causes’ pollution’ and references to cost, that did not receive any credit.

Section C

Q24

Some learners did not read (a)(i) carefully and they explained why it was a redox reaction in terms of gain or loss of electrons or even gain or loss of oxygen or hydrogen instead of oxidation numbers. Some learners referred to the oxidation of ammonia and reduction of sodium chlorate(I) instead of specifying the nitrogen and chlorine in these compounds. Some learners thought that sodium, hydrogen or oxygen were oxidised or reduced and a few learners thought that both elements were oxidised or reduced. The calculation in (a)(ii) was generally well-answered although some learners used an incorrect mole ratio and some gave incorrect units.

The effect of an increase in temperature on the position of equilibrium was often well-described although some learners mixed up right and left and some just stated that the reaction is exothermic but didn't state in which direction. Many learners used the diagram of the Maxwell-Boltzmann distribution to show how the catalyst lowers the activation energy, although some did not mention that more of the molecules will now have energy equal to or greater than the activation energy. There was evidence of a misconception in some learners who thought that a catalyst increases the energy of the molecules. There were some clearly drawn and labelled reaction profile diagrams for the formation of ammonia.
Common errors included: showing an endothermic reaction, not labelling the products, not labelling the enthalpy change, confusing enthalpy change and activation energy and not drawing the arrows in the correct positions.

Few learners could write the balanced equation in (c)(i). Many learners could not write the formula for ammonium chloride and it was not uncommon to see just 'Cl' as the formula for chlorine. Learners should be encouraged to read the passage at the start of the question as that told them nitrogen trichloride is a liquid. Some learners were able to predict the shape of nitrogen trichloride and explain why it has that shape. Some did not work out that there are 3 bond pairs and 1 lone pair of electrons. Learners should understand that all electron pairs are arranged to minimise repulsion, not just the lone pairs. There were some excellent answers to (c)(iii) but some learners did not know where to start or thought that the covalent bonds are broken when these substances boil. Some learners were able to score the marks for identifying the intermolecular forces present in each substance but only a small minority of learners considered the relative strengths of these forces.

Summary of advice to learners

- 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
- learn the difference between ammonia and ammonium and their formulae
- show all your working for calculations
- be careful how you draw curly arrows and intermediates in organic mechanisms
- learn the reagents and conditions for the reactions in the specification
- learn how to draw accurate reaction profile diagrams.

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