

Examiners' Report/ Principal Examiner Feedback

January 2015

Pearson Edexcel International
A level in Chemistry (WCH03)

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Overall Impressions

This paper produced a very wide range of marks. Some candidates were extremely well prepared, but others clearly lacked experience and understanding of laboratory work. The questions on organic chemistry, and in particular question 4 about the synthesis of an organic compound, caused the most difficulty. Candidates often produced the correct answers in numerical questions, but their work was very hard to follow. It was common to see figures scattered across the page with little or no explanation. This meant that it was sometimes difficult follow the logic sufficiently to give credit to those candidates who had lost their way, so if an error was made part way through a calculation they could lose all the marks.

Individual Questions

Question 1

Most candidates scored the first two marks on the paper by identifying ammonia and bromide ions. Bromide was sometimes incorrectly named as bromine, and not all knew that the precipitate of silver bromide would not dissolve completely in dilute aqueous ammonia. Some candidates did not read the question with enough care, and gave the formula of silver bromide instead of using their deductions to give the formula of ammonium bromide.

The questions about the organic compound in (b) were less well answered. Many candidates thought that if bromine was not decolourised, the compound must be an alkane, instead of concluding that carbon-carbon double bonds were absent. The answer "no double bonds present" was not allowed as this statement could refer to C=O bonds. A significant number of candidates did not write the formula of the functional group correctly in (b)(ii). Some gave a molecular formula or the general formula of an alcohol, some gave the formula of a hydroxide ion, and some gave a name even though a formula was required.

In (b)(iv) candidates were often able to link methanol to '32', the value of the heaviest m/e peak, with a reasonable degree of clarity. However many answers showed confusion between this mass spectrum, which showed fragmentation of an organic molecule, and the spectrum which would be obtained in isotopic analysis of an element. Answers suggesting phosphorus, sulfur and chlorine were not unusual. Other alcohols, especially ethanol, were also suggested on the basis that the peak at $m/e = 15$ could be CH_3^+ and the peak at $m/e = 29$ could be C_2H_5^+ . Other organic molecules e.g. alkanes and halogenoalkanes were also suggested, some of them quite large molecules. Many candidates clearly did not know how to find the relative molecular mass from the spectrum.

Question 2

Most candidates knew the test for carbon dioxide in (a), but a few were careless and used limestone instead of lime water, and some described the preparation of carbon dioxide rather than the test.

The diagrams in (b) were very variable in standard. Nearly half of the candidates omitted a stopper in the conical flask. Many showed a syringe, and though examiners did not expect drawings of a text book standard some of the offerings were of such an extraordinary shape that they were barely recognisable. Candidates could also gain full marks with a diagram showing the gas being collected by displacement of water in a burette or measuring cylinder. A tube without graduations such as a test tube or gas jar was not accepted. It was disappointing at this level to see diagrams showing delivery tubes leading the gas into an open beaker, or into a stoppered test tube.

Errors in the calculation in (c) often involved a random manipulation of 41 and 24000 (or 24). Multiplying the numbers led to a very small molar mass in (d) but

this did not seem to prompt candidates to recalculate. In (d) there were many correct calculations of the molar mass of the carbonate, but in (e) many candidates identified the metal present as strontium because they forgot to subtract the mass of the CO_3 group. There were also instances of candidates adjusting the figures to arrive at the molar mass of CaCO_3 . This certainly showed some understanding, but unfortunately did not match the data in the question. Of all the sections in Q2, part (f) proved to be the most challenging for candidates and not many realised that carbon dioxide dissolved in water or aqueous solutions. Common incorrect responses were the occurrence of side reactions, incomplete reaction and gas remaining in the flask.

In 2(g) incorrect references to a bright white flame were seen quite frequently. Candidates who suggested a Group 2 metal other than magnesium in (e) could score a mark here if the correct corresponding flame colour was given.

In Q2(h) there was much discussion of the relative strengths of hydrochloric acid and sulphuric acid, and many references to sulfuric acid as an oxidising agent which produced sulphur dioxide. Candidates who realised that an insoluble sulfate would form with sulfuric acid did not always finish the argument by stating that this would stop the carbonate reacting completely with the acid.

Question 3

A significant number of candidates did not know that a volumetric flask is used to make a known volume of solution, and pipettes and measuring cylinders were suggested on a regular basis. The colour change of phenolphthalein in a titration was well known, with only a few candidates getting the change the wrong way round. However in (b)(ii) candidates did not read the question carefully and so did not describe how a rough titration value is used when carrying out an accurate titration. Instead they just said that the rough value should not be used to calculate the mean. Careful use of English was needed here. It would be no use adding the solution from the burette drop by drop once the rough value was reached, which is what some candidates suggested, as by this stage it could already be overshoot.

In the percentage error calculation in (b)(iii) the most common error was to omit the factor of two, as two burette readings are taken for each titre. Many candidates make errors in rounding figures: 0.43 was accepted for 0.429 but 0.42 was not. In (b)(iv) an error which was seen was to average the final readings and not just the accurate titres. The moles of sodium hydroxide in (b)(v) were sometimes calculated as moles of gas by calculating $23.30/24000$. There were many correct answers to (b)(v) but candidates who calculated only the moles of sodium hydroxide and not the moles of H_2A usually failed to say what they were doing. Candidates have a better chance of scoring if they get into the habit of writing a few words with each number they calculate, such as "mol NaOH = ...". This would make the calculation easier to check by both the candidate and the examiners. The main error in (b)(vi) was to omit the scaling of the number of moles of acid in 25 cm^3 to the moles in 250 cm^3 , giving a molar mass of over 900.

Another helpful habit for candidates is to think whether their answers are sensible, and to check their working if they are not!

The errors in the answers to (c) were surprising. All sorts of compounds were mixed with potassium dichromate (VI) in the oxidation. Heating under reflux was often missing. The structure of H₂A, formed by oxidation of ethane-1,2-diol was often missing or incorrect. Some candidates showed the result of oxidation of only one of the OH groups in the diol. Even if the correct answer was deduced, careless drawing of the attachment of the OH group to carbon in the displayed formula stopped the mark from being awarded.

Question 4

This proved to be the most challenging question on the paper.

In (a) candidates were asked for an unwanted inorganic compound, but many named organic ones. The reaction produces hydrogen bromide which then reacts with the alcohol, so HBr was not an acceptable answer. Many candidates did not recognise that the reaction here was redox. Bromine forms by oxidation of the hydrogen bromide and sulfur dioxide forms by reduction of the sulfuric acid so these were the expected answers, though redox was accepted as the reaction type with either of these two products.

In past papers candidates have been good at drawing the direction of water flowing through a condenser, but in this paper they were not good at explaining the reason for the direction in (b)(i). Many just explained the principles of condensation. Others could not have understood the structure of a condenser as they talked about keeping the water out of the reaction flask. Others seemed to think there would be an increase of pressure in the condenser. A variety of answers was accepted, of which the most obvious is to make sure that the condenser is full of water and there are no airlocks or air bubbles.

Many candidates did not read (b)(ii) carefully and simply gave answers such as "concentrated sulfuric acid is corrosive". This is true but does not answer the question. If the reflux condenser was not fitted to the flask the corrosive acid spray might escape. Alternatively a flammable liquid or toxic gas might escape. A small number of answers resorted to 'spills' as the primary hazard as they presumably did not understand how the pieces of apparatus fitted together. Another popular suggestion was that an explosion might occur.

In (c)(i) the most common suggestion was to add a drying agent. This is the procedure for removing small quantities of water but not a water layer. Candidates often refer to transfer errors when asked why the yield in an organic preparation is low. However many did not seem to realise that, to avoid these, the distillate should not be transferred to another container more often than possible, and a teat pipette could be used in this situation. The washing would be done in a separating funnel. The aim is to prepare 1-bromobutane, which is the lower layer, and can then be run off through the tap. Those who had the right

idea often only scored one of the two marks in (c)(ii) as they failed to make use of the density data and assumed the product would be in the upper layer.

The majority of candidates understood the purpose of washing with sodium carbonate solution in (d) as it neutralises the excess hydrochloric acid. By this stage sulfuric acid will not be present.

In (e) the 1-bromobutane should be dried and then redistilled. Many candidates got these steps the wrong way round, which suggested a lack of understanding of the reasons behind the procedures. Another common error was to think that 1-bromobutane was a solid and to describe washing and filtering procedures.

There were many correct answers to (f)(i). In (f)(ii) a common error was to give the final answer to more than the two significant figures requested. Often responses were a mass of figures with very little to explain the processing of the numbers. Many candidates have little appreciation of significant figures and though the final answer was required to two significant figures they rounded the moles of butan-1-ol to one significant figure. This produced a transferred error in the moles of 1-bromobutane and hence the percentage yield, but often there was no understanding that using different numbers of significant figures at each stage was an incorrect procedure.

Advice to candidates

- Show what the numbers in your calculations refer to eg “number of moles of NaOH =” This will make them easier to check.
- Think whether your final answer is sensible and check your work again if not. e.g. could a Group 2 carbonate really have a relative molecular mass less than 1? Is 900 likely as the relative molecular mass of an acid?
- As a general rule keep at least three significant figures in the intermediate stage of calculations when an answer with two significant figures is required, and do not round numbers until the final stage.
- Find out why different processes are used during the preparation of an organic liquid. Make sure you understand how a condenser is constructed and how it works.

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