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A LEVEL

Examiners' report

CHEMISTRY B (SALTERS)

H433
For first teaching in 2015

H433/03 Summer 2019 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper 3 series overview

H433/03 is one of the three examination components for the A Level examination for GCE Chemistry B. This synoptic component links together different areas of chemistry within different contexts, some practical, some familiar and some novel. To do well on this paper, candidates need to be comfortable applying their knowledge and understanding to unfamiliar contexts and be familiar with a range of practical techniques.

H433/03 is much more application based than the other two A Level Chemistry Components, H433/01 and H433/02, which have a greater emphasis on knowledge and understanding of the assessment outcomes from the specification.

H433/03 also contains more questions set in a practical context, including an insert based on a practical procedure, than H433/01 and H433/02.

Candidates who performed well on this paper generally did the following:	***Candidates who did less well on this paper generally did the following:***
• Performed standard calculations showing clear working (which allowed error carried forward marks to be given), and used appropriate significant figures. • Produced clear, logical and concise responses for Level of Response Questions: 2(g), 4(d). • Produced clear explanations of practical procedures, including errors and uncertainty and health and safety precautions. 2(c), 2(e)(i)(ii), 3(e) and 4(c)(i)(ii). • Applied knowledge and understanding to questions set in a novel context: 1, 4.	• Found it difficult to apply what they had learnt to unfamiliar situations. • Produced responses that lacked depth, were sometimes peripheral to what had been asked, and sometimes simply repeating information provided. e.g. 2(g) 4(d). • Showed unclear setting out of unstructured calculations, e.g. 3(b),4(b)(ii). • Found it difficult to understand and utilise the observations and data included as part of the practical insert needed to answer Question 4.

The paper showed good discrimination with marks ranging from single figures to the mid-fifties.

Presentation continues to improve, and the layout of calculation workings, except for the lower ability candidates, was very good. In the "level of response" questions candidates often displayed good logic and reasoning in their answers but then lost marks by not fully complying with the requirements of the question, for example not identifying paracetamol in 2 (g).

There was no evidence that time constraints had led to a candidate underperforming. Scripts where there was no response to the final question also had large sections of the paper which had not been tackled.

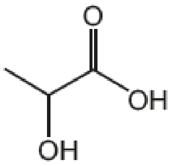
Note

From this series students have been provided with a fixed number of answer lines and an additional answer space. The additional answer space will be clearly labelled as additional, and is only to be used when required. Teachers are encouraged to keep reminding students about the importance of conciseness in their answers. Please follow this link to our SIU (https://www.ocr.org.uk/administration/support-and-tools/siu/alevel-science-538595/).

Question 1 (a)

1 A student taking A level chemistry and biology was researching the use of polymers in medicine. These are sometimes called biopolymers.

The student found that one of the most frequently used biopolymers is polylactic acid, PLA. PLA is made from lactic acid.



Lactic acid

(a) Lactic acid is a chiral molecule.

Explain the term **chiral** in this context and use 3-D structures to help your explanation.

Explanation ....

....

Structures

[3]

Many responses to this question were expressed in terms of the structure needed in a molecule for it to be chiral, rather than the properties of a chiral molecule such as lactic acid. Examiners were looking for the idea of non-superimposable mirror images (enantiomers) as well as correctly drawn 3D mirror image structures for the lactic acid molecule.

Question 1 (b) (ii)

(ii) State the strongest type of intermolecular bonding that occurs between PLA polymer chains.

Explain, in terms of electronegativity, how this intermolecular bonding arises.

....

....

....

.... **[2]**

The most common mistake made by a significant number of candidates in this question was to suggest hydrogen bonding was the strongest type of intermolecular bonding between the PLA polymer chains.

Question 1 (c)

(c) The industrial manufacture of PLA uses heterogeneous catalysts.

A simple model of heterogeneous catalysis has four steps.

Describe the four steps involved.

1 ....

....

2 ....

....

3 ....

....

4 ....

.... **[2]**

The most common error in answers to this question was to suggest that bonds between reactants (i.e. intermolecular bonds), rather than bonds within reactants (intramolecular bonds), were broken in step 2.

Question 2 (a)

2 A pair of chemistry students are asked to prepare a sample of paracetamol.
They use the reaction shown in **Fig. 2.1**.

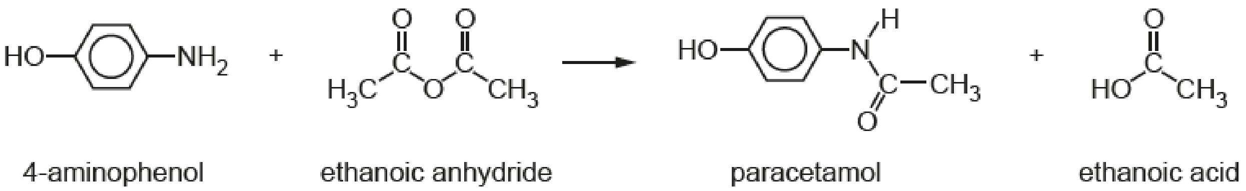


Fig. 2.1

(a) Identify the **two** functional groups in paracetamol, apart from the benzene ring.

1 ....

2 .... **[2]**

This question was generally well answered by a majority of candidates. The most common errors seen included 'alcohol', rather than 'phenol', and 'amine' rather than 'amide'.

Question 2 (c)

(c) **Fig. 2.2** shows some information found on a bottle of ethanoic anhydride.

The students use the information in **Fig. 2.2** to write a risk assessment for ethanoic anhydride.

Ethanoic anhydride	**Hazards**
	Flammable Harmful by inhalation and if swallowed Corrosive – causes burns

Fig. 2.2

Suggest **three** precautions that the students should take when using ethanoic anhydride.

1 ....

....

2 ....

....

3 ....

.... **[3]**

Most candidates showed a good knowledge of appropriate safety precautions, although the suggestion of using a 'gas mask', as suggested by a small but significant proportion of candidates, was a disproportionate precaution relative to the hazard presented by ethanoic anhydride.

Question 2 (d)

(d) The mechanism for the reaction for the formation of paracetamol is shown in **Fig. 2.3**.

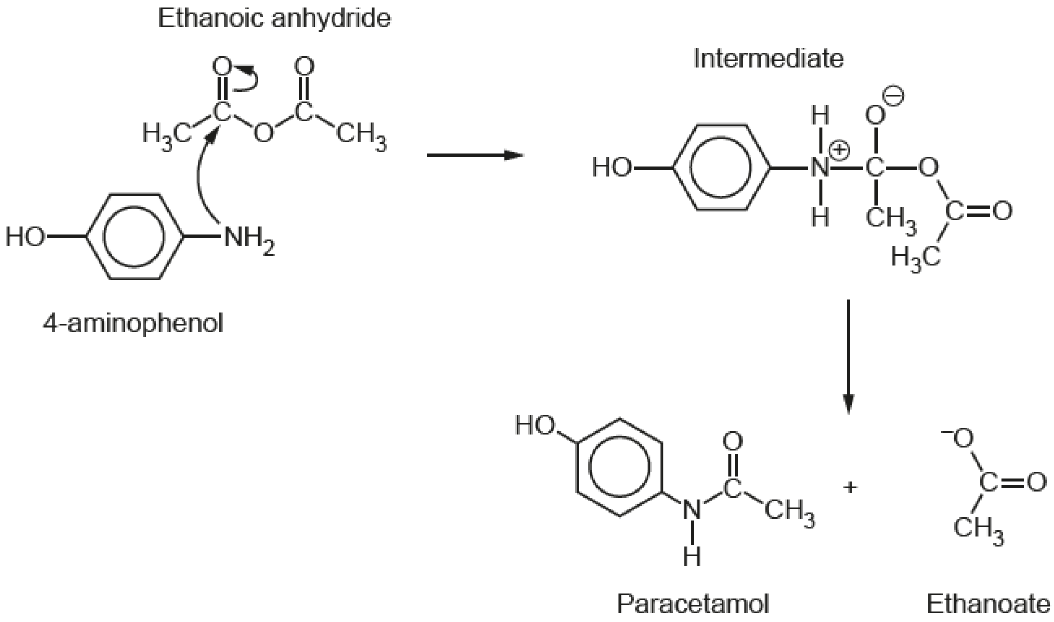


Fig. 2.3

Mark curly arrows to show the electron movements that occur in the **intermediate** to allow formation of the products in **Fig. 2.3**. **[1]**

This question proved very challenging and only higher ability candidates were able to show the electron movements.

	AfL	It may help in future teaching and learning practice if students are encouraged to work backwards in questions like this. For example, in the paracetamol molecule the C=O must mean a pair of electrons have moved to form the 'second' bond in this structure. Likewise the three bonds to the N atom in paracetamol from the four bonds in the intermediate must mean the two bonding electrons have moved to the top H atom in the intermediate.

Question 2 (e) (i)

(e) The students carry out the preparation using water as solvent. Paracetamol is insoluble in water.

The students use the apparatus in **Fig. 2.4** to separate the paracetamol from the reaction mixture.

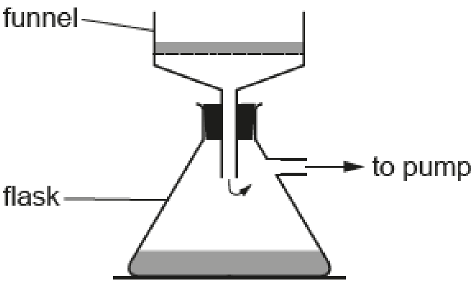


Fig. 2.4

(i) Name the technique in **Fig. 2.4** and explain how this apparatus is used to get a sample of impure solid paracetamol.

....

....

....

....

....

.... **[3]**

Many good responses contained a detailed explanation of the technique. Others were rather vague and suggested a weaker understanding e.g. 'pressure in flask decreases allowing liquid to pass through funnel' or 'the pump provides high pressure to make sure the water ends up in the flask'.

Question 2 (e) (ii)

(ii) Suggest a reason for using the technique in **Fig. 2.4** rather than simple filtration.

....

.... **[1]**

Many candidates recognised that vacuum filtration was faster, however others were often too vague, answering in terms of efficiency. (e.g. the simple statement, seen many times, 'technique is more efficient' did not score this mark).

Question 2 (f)

Fig. 2.1 is repeated below.

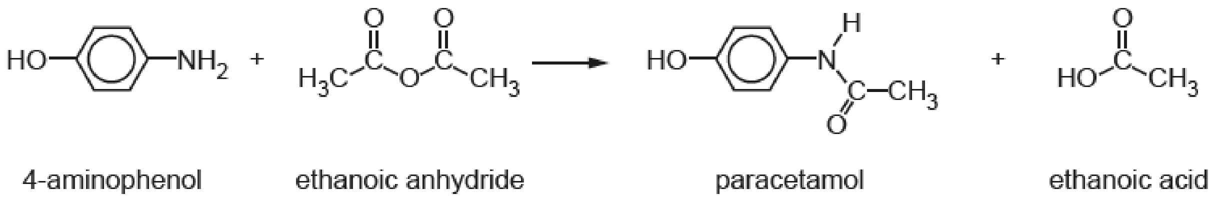


Fig. 2.1

(f) The students then recrystallised their paracetamol sample.

The students started with a mass of 2.1 g of 4-aminophenol and used excess ethanoic anhydride.

The mass of the dried recrystallised paracetamol produced was 1.5 g.

Calculate the percentage yield for the students' reaction.

Give your answer to an **appropriate** number of significant figures.

percentage yield = ... % **[3]**

This question was well answered by a majority of candidates, the most common error being the wrong choice of significant figures. Candidates should make sure they give answers to the number of significant figures specified in the question. In this case, the question asks for the answer to be given to the 'appropriate' number of significant figures – this should be interpreted as the smallest number of significant figures in the data provided for the question (in this case, two).

Question 2 (g)

(g) The students sent pure samples of their reagents and products to a university lab. Spectra of all the compounds were produced.

The spectra from **one** of the compounds are shown below.

Use pieces of evidence from **all** the spectra to identify the compound. **[6]**

....

A small, but significant, number of candidates did not read the question carefully enough and did not identify the compound at all, or produced a structure that was not one of the reactants or products. The best answers used all the spectra to not only to identify paracetamol as the compound, but also to explain why certain absorptions ruled out the other compounds featured in the synthesis.

Question 2 (h) (ii)

(ii) Suggest why there is a small peak at 61.

....

.... **[1]**

A majority of candidate answers correctly indicated the presence of a ^{13}C isotope; however some were unfortunately too vague, talking in general terms about 'different isotopes' being present.

Question 3 (b)

(b) K_a for ethanoic acid is $1.7 \times 10^{-5}\,mol\,dm^{-3}$.

Show by calculation that the initial pH in experiment **B** is 4.8.

[2]

Examiners were looking for students to realise that [ethanoate ion] = [acid] and that following on from that K_a = [H] and pK = pH (-log 1.7×10^{-5}).

Candidate responses just stating -log 1.7×10^{-5} = 4.8 were not credited.

Question 3 (c)

(c) Explain why the pH of sodium ethanoate in experiment **C** is alkaline.

Include an equation in your answer.

....

....

....

.... **[2]**

This question proved one of the most difficult on the paper. Very few appropriate equations were seen, with a common equation being the ionisation of sodium ethanoate in water. This was not credited.

The idea of a solution being alkaline because the concentration of hydroxide ions is higher than the concentration of hydrogen ions was often missing.

Question 3 (d)

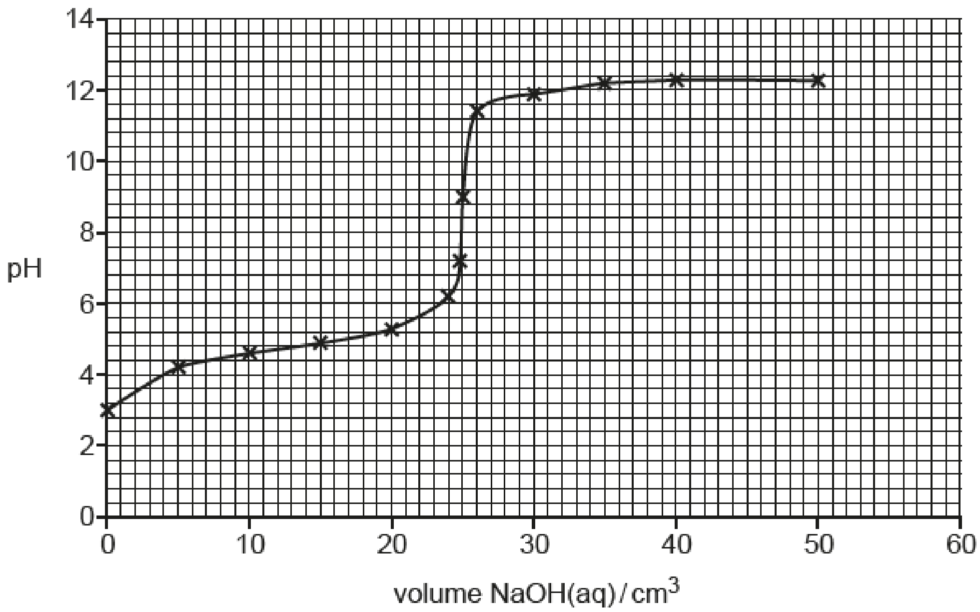
(d) Calculate the pH of the solution formed after the addition of sodium hydroxide solution in experiment **D**.

pH = ... **[3]**

Higher ability candidates tended to score 2 or 3 marks on this question - the third mark often dropped because the concentration of hydroxide ion used in the K_w expression had not been halved.

Question 3 (e)

(e) In a follow-up experiment, 25.0 cm^3 of the ethanoic acid solution is titrated with a solution of sodium hydroxide of unknown concentration and the following graph is obtained.



Suggest a suitable practical procedure that would enable this graph to be obtained.

....

....

....

....

.... **[3]**

This question proved challenging. Many responses involved a standard titration using indicators which does not relate to the procedure used in this question. Only a few candidates realised the addition of much smaller volumes of NaOH was required near the 'end point' where the pH starts to rapidly change.

	AfL	The extra emphasis on practical in this paper does require students to have hands on experience of practical techniques and procedures to be able to fully answer questions like the one above. Helpful written material on various practical procedures can be found in both the specification and in endorsed course textbooks, but these are no substitute ~~to~~ for the experience of carrying out and writing up these procedures.

Question 4 (a)

4 This question refers to the **Practical Insert** that is provided as an insert to this paper.

(a) Suggest why the titre values in **Table 2** increase from sample 1 to sample 4.

....

.... **[1]**

Careful reading of the Practical insert is a necessity to answer questions that follow from the practical procedure. It was clear that many candidates did not spot that the length of time the spinach was left in the acid was the crucial factor here.

Question 4 (b) (ii)

(ii) Foods 'high' in iron usually contain more than 4 mg of iron per 100 g of foodstuff.
A student states that the data in **Tables 1** and **2** show that spinach is 'high in iron'.

Comment on the student's statement.

Show calculations to support your comments, using the data for **sample 4**.

....

.... **[4]**

This was one of the most discriminating questions on the paper.

Clarity of working by many candidates allowed examiners to award a significant number of 'ecf' marks.

Common mistakes included failing to correct back to 250 cm^3 (but calculation often proceeded correctly thereafter); not converting to mg and/or not converting to 100g for the final step.

Question 4 (c) (i)

(c) A student suggests that the titre values in the experiment are too small and give an unacceptable error for the final answer.

(i) Calculate the percentage uncertainty in titre 1 for **sample 4**.

percentage uncertainty = ... % **[1]**

The idea of uncertainties arising from certain techniques and measurements is an important concept in science (Specification mathematical requirement M1.3). Candidates found this question challenging, suggesting that they find the calculation of percentage uncertainty difficult.

i	**OCR support**	The Practical Skills handbook contains information on the calculation of uncertainties (in Appendix 4, Measurements) which can be shared with students: https://www.ocr.org.uk/Images/208932-chemistry-practical-skills-handbook.pdf.

Question 4 (c) (ii)

(ii) The students want to reduce the percentage uncertainty in the titre values, while using the same equipment.

Suggest **two** ways in which they can do this.

1 ....

....

2 ....

.... **[2]**

This question differentiated well with higher ability candidates understanding how to reduce percentage uncertainty. Lower ability candidates often missed the statement in the question stem 'while using the same equipment', and provided answers about accuracy of apparatus. e.g. 'use a more accurate burette' or precision of measurements e.g. 'take more readings'.

Question 4 (d) (ii)

(d)* There are several d block metal ions, including complex ions, mentioned in the insert. These ions are different colours.

Explain the term **complex ion** and why different complexes of d block elements have different colours.

Give examples from the Insert. **[6]**

....

....

This was less well answered than LoR Question 2 (g).

Many candidates had a better idea of what constituted "colour" than what constituted a complex ion. Failure to give an example of a complex ion (from the insert) resulted in the loss of marks and "emission" as the cause of colour is still being seen frequently.

Exemplar 1 below is a response of a very good response given a Level 3.

Exemplar 1

The term complex ion denotes a transition metal which is bonded to ligands by coordinate covalent bonds. A ligand is a molecule /ion which has a lone pair of electrons which it can form covalent bonds with. Complex ions have coloured compounds, and this is because when ligands form coordinate bonds with transition metals, they cause the d orbitals to split as they gain energy, with the electrons usually occupying the lower energy orbital. As the electrons gain energy, (by absorbing light energy), they move up to the next orbital with the higher energy level ($\Delta E = h\nu$) and the complementary colour is transmitted. Difference in colours of complex ions is due to the difference of ΔE for each complex, which is affected by the type of ligand (as different ligands cause d subshells to split differently), type of metal ion, etc. An example seen in the test is the Fe^{2+} which

Additional answer space if required

can be shown as $[Fe(H_2O)_6]^{2+}$, which is green, whilst $[Fe(H_2O)_6]^{3+}$ (also written as Fe^{3+}) is orange. So, colours of complex ions can also be affected by oxidation state. Another example is $[Mn(H_2O_6)]^{2+}$, which is pink. The colours of these complexes differ due to different oxidation states or metal ions.

The exemplar above uses all the key chemistry expected to answer this question. It has a clear logical structure and avoids the pitfalls such as emission of light being responsible for the colour as well as giving clear examples. This is a Level 3 response.

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