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Examiners' report

CHEMISTRY B (SALTERS)

H433

For first teaching in 2015

H433/02 Autumn 2021 series

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

i	Reports for the November 2021 series will provide a broad commentary about candidate performance, with the aim for them to be useful future teaching tools. As an exception for this series they will not contain any questions from the exam paper nor examples of candidate responses.

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.

A full copy of the exam paper and the mark scheme can be downloaded from OCR.

Paper 2 series overview

H433/02 is one of the three examination components for GCE A Level Chemistry B. This component, entitled 'Scientific literacy in chemistry', links together different areas of chemistry within different contexts, some practical, some familiar and some novel. The paper also includes questions based on a pre-released advance notice article, included as an insert with the exam paper. The articles chosen for this insert are always linked to an area of the specification and are designed to engage students and to show how chemistry is being applied in our modern society. To do well on this paper, candidates need to have studied the pre-release material and to have researched some of the unfamiliar contexts included in this document. They also need to be comfortable applying their knowledge and understanding to unfamiliar contexts and be familiar with a range of practical techniques that they should recognise from completing the practical elements of the course.

Candidates who did well on this paper generally did the following:	***Candidates who did less well on this paper generally did the following:***
• Displayed a sound understanding of analytical techniques used to identify organic molecules, Questions 1(a), 1(b)(i), 3(a) and the Level of Response Question 3(f) • Described how they would measure an enthalpy change for the dissolving of potassium nitrate in detail as per the required practical element of the course, Question 4(a)(i) • Carried out all calculations precisely and made appropriate us of significant figures, Questions 1(g), 3(d)(ii), 3(e)(iii) and Q4(a)(ii) • Demonstrated a good understanding of electrochemistry both in terms of the underlying theory and the practical applications, Questions 2(a)(i), 2(a)(ii), 2(b)(i) and 2(b)(ii) • Correctly identified reaction types, Question 3(c).	• Struggled to clearly explain the steps involved in multi-step calculations and so did not score many marks. Questions 2(e), 3(d)(ii), 3(e)(iii), 4(a)(ii) and 4(b)(ii) • Struggled to correctly identify different types of intermolecular forces present in organic isomers and how these affect physical properties. Question 1(c) • Candidates could describe the appearance of an emission spectrum, Questions 5(b)(i), but not how these arose and could be used to identify different elements, Question 5(b)(ii).

Section overview

Question 1

This was generally completed fully by the majority of candidates. In part 1(b)(iii) few candidates scored more than 1 mark; most correctly identified that octane had the highest boiling point but were unable to link this to the degree of branching in the other isomers and the effect this had on the intermolecular forces present.

In part 1(e) candidates correctly stated that the double bond prevented rotation from occurring and then used a suitable diagram to illustrate the two stereoisomers to score both marks. The reaction sequence in 1(f) was generally well attempted and most candidates scored at least 3 marks. Where marks were lost was usually in drawing the repeat unit of the polymer with the omission of the CH_3 groups.

Question 2

Overall, this question was well answered. In part 2(a) candidates could balance the half equation and explain which species was being reduced correctly. Most candidates scored at least 2 marks in 2(b)(i) as they included a salt bridge and voltmeter in their circuit and correctly constructed each half cell. In part 2(c) most candidates correctly identified that the electrons flowed from zinc to iron and were able to explain why this happens. They could therefore state that the process of rusting was stopped as half equation 1 was reversed and not half equation 2 as stated in the stem of the question.

Question 2(d) was not very well answered; most candidates constructed an equation that used NaOH or OH^- ions, rather than showing the aerial oxidation of $Fe(OH)_2$ to $Fe(OH)_3$.

Question 3

Most candidates scored 1 mark in part (a), although there was no constant pattern to the responses produced with both peaks being identified correctly and incorrectly with equal frequency. Part 3(c) was well answered and there were no common incorrect responses. The origin of the yellow colour of nitro benzaldehyde in 3(d)(i) was usually discussed with some degree of accuracy. Candidates correctly stated that the complementary colour was being absorbed and as a result of this the colour seen was the frequency of light corresponding to yellow being reflected or transmitted.

The reaction mechanism in 3(e)(i) produced a mixed set of diagrams with very few candidates scoring more than 1 mark. Errors included: In step 1 the curly arrow going from the double bond of the CO group towards the CN group; or, in step 2, not including the charge on the intermediate ion. Very few candidates could identify the functional group in 3(e)(ii).

Question 4

Part (a)(i) was generally well answered. Although there was some confusion about when the initial temperature of the water should be measured, most methods produced would have resulted in the experiment being completed with some degree of success. Many candidates also scored at least 3 marks for the calculation in 4(a)(ii), even though some final responses were not given to an appropriate number of significant figures.

Questions 4(b)(i) and (ii) identified an area of the specification that candidates appeared to find challenging. The explanations provided in (b)(i) often simply stated that entropy is a measure of disorder (in a system) but did not link this to what was happening in the system given. In the calculation the most common error was in not recognising the difference in the magnitude of the two energy values given and so failing to convert from kJ to J.

Question 5

This was based around the advance notice article about smartphones and most candidates were able to engage with the questions set. Part (b)(ii) often started well with a good description of how emission spectra are produced, but very few candidates were able to explain how different elements produce their own unique spectra. Part 4(c) was proved difficult for candidates, with a full range of bond angles provided along with explanations that were incomplete. Parts 4(f) and 4(g) were attempted by the majority of candidates and most candidates scored at least 4 marks from these questions.

Comments on responses by question type

Level of response questions

There were two level of response questions on this paper and both were attempted fully by most candidates, with a full range of marks being seen.

Question 3f

This question was based around interpreting data from two types of spectra in order to identify an organic compound. It was well done with most candidates achieving a mark at Level 2. Candidates who did not reach Level 3 often produced a structure that was incorrect for compound A; but had correctly identified compound B. Provided that they had made a reasonable attempt to identify both compounds supported by relevant evidence from the spectra they usually scored at Level 2.

The most commonly seen incorrect structures were based around phenol, which was understandable given that candidates had been told that both compounds A and B contained 7 carbon atoms and they had deduced the presence of the aromatic ring from both the Infra-red spectrum and from the ^{13}C NMR spectrum. A common incorrect deduction was in failing to take into account that the starting compound for the reaction was benzaldehyde, which should have suggested that any structure based on phenol was likely to be incorrect. The evidence from this question seems to indicate that this is an area from the specification where teachers have taken on board comments from previous reports and made a conscious effort to strengthen candidate's knowledge and understanding in this area.

Question 4c(ii)

This question was intended to assess candidates knowledge and understanding about rates and equilibria, as these are areas of the specification that are often mixed up. They were given some information about a specific equilibrium system and asked to suggest and explain the conditions that could be used by a chemical company for the process. They should have identified that the reaction was endothermic in the forward direction and that there were an equal number of moles of gas on either side of the equilibrium expression, as these were key to providing an appropriate explanation and in suggesting suitable conditions for the company to maximise the yield of NO.

Most candidates scored at Level 2 as they correctly identified that the forward reaction being endothermic required a high temperature in order to maximise the yield and to increase the rate of reaction. However, most slipped up as they then went onto state that the system required a high pressure to increase the rate, but incorrectly stated that this would also increase the yield by moving the equilibrium to the right hand side as that had the fewest moles of gas. Pressure has no effect on the yield as there are equal moles of gas on both sides of the reaction. Therefore they could not match fully to the Level 3 descriptor but scored full marks at Level 2.

Common misconceptions

	Misconception	In Question 1(b)(i) candidates were asked to suggest a method used to identify compounds leaving the gas chromatograph and should have suggested a suitable form of spectroscopy, e.g. mass spectroscopy. A common incorrect response was fractional distillation, which is used to separate fractions of crude oil industrially but is not suitable in an analytical process. In Question 3(b) many incorrect responses saw candidates stating that the ring of electrons was in the centre of the benzene molecule rather than above the plane of the carbon skeleton. This is possibly due to a misunderstanding about the nature of the Kekulé structure used to represent benzene and other aromatic molecules. In Question 5(b)(ii), most incorrect responses seen were a result of describing how an absorption spectrum arises rather than how an emission spectrum is produced as asked for.

Key teaching and learning points – comments on improving performance

Structuring of work in multi-step calculations was not always clear. It is essential that candidates give some thought to structuring the steps in their calculations and set out their working indicating clearly what they are trying to achieve in each step. For example, in Question 3(d)(ii) candidates are asked to calculate the wavelength of light associated with a particular energy value and should have used the expressions $E = h\nu$ and $c = \lambda\nu$ in their working. These expressions were often omitted and replaced with a string of numbers that were then evaluated. Where this resulted in a correct final response full marks were given. However, if the final value was incorrect it was often difficult to find working or explanations that were creditworthy and so marks were lost.

Other examples where a lack of detail or explanation was seen was in Questions 3(e)(iii) and 4(b)(ii).

The advance notice article that is included as part of this component needs to be given time in order for candidates and teachers to identify areas that they believe may be assessed in the examination. A good way of tackling this is for students and teachers to come up with a set of questions that can be combined in order to produce a question bank to stimulate discussion and to identify areas where candidates feel confident if asked about a particular aspect, but also to identify areas where further investigation is needed in order to understand the key chemistry involved in the article.

In this particular case, ideas about emission spectra (vivid red, blue and green colours on the screen) and bond angles (fig.2 on page 4) could have been identified in advance and suitably revised. The section about smartphone displays introduces students to an area of development that they would have been unfamiliar with and as such may have required guidance and help in understanding some of the concepts described.

Guidance on using this paper as a mock

This paper provides a good opportunity for students to assess their progress if used as a mock examination once the majority of the specification has been completed. It is essential that some time is given to students to read through the pre-release article and to have time to discuss the content of this with their teachers, similar to how they would with their live exam piece.

The level of response questions are readily accessible and Question 3(f) in particular would demonstrate to candidates that it is possible to score marks at the highest level provided that they read the question carefully and construct their responses in a clear and logical manner.

The calculations on this paper would demonstrate to students the need to explain the steps involved and to show that simply using a calculator could cost them a significant number of marks if they consistently get their calculated final response wrong. Marks are always available for 'show your working' as this allows the examiner the scope to give credit and apply the error carried forward rule. For example, in Question 3(d)(ii) where there are 4 marks available, a candidate making an error in re-arranging the related pair of equations could lose the mark for this skill but could still score the other 3 marks provided that all of their working is shown and explained.

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