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**AS LEVEL**

**Examiners' report**

# CHEMISTRY A

**H032**

For first teaching in 2015

## H032/02 Autumn 2020 series

Version 1

ocr.org.uk/science

# Introduction

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

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| i | Reports for the Autumn 2020 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 question paper nor examples of candidate answers. |

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 question paper and the mark scheme can be downloaded from OCR.

# Paper 2 series overview

H032/02 is one of the two examination components for the AS Level examination for GCE Chemistry A.

This synoptic depth in chemistry paper links together content from all 4 modules and is worth 70 marks. Candidates answer all questions with a range of question styles including short answer (structured questions, problem-solving, calculations, practical) and extended response questions, including those marked using Level of Response mark schemes.

A small cohort of about 100 candidates sat the examination and comprised a mixture of abilities. Although there were some high-scoring scripts from well primed candidates, there was also a significant tail of candidates who scored low marks. To do well on this paper, candidates needed to apply their knowledge and understanding to unfamiliar contexts and be familiar with a range of practical techniques. This paper discriminated well and, in general, the standard of mathematical calculations was better than descriptive questions as seen last year. There was no evidence that the candidates had run out of time.

<table>
<tr><th>Candidates who did well on this paper generally did the following:</th><th>Candidates who did less well on this paper generally did the following:</th></tr>
<tr><td>
<ul>
<li>Performed calculations showing detailed working for each step, with no intermediate rounding of values, and gave answers to appropriate number of significant figures: 1(b)(i) calculating minimum volume of HCl required, 1(b)(ii) calculating volume of gas produced, 2(b) calculating the enthalpy change of combustion, 4(b)(iii) calculating concentration of NOCl from $K_c$ expression and 5(d)(i) calculating atom economy.</li>
<li>Produced clear and concise responses for Level of Response questions, including correctly balanced equations where needed: 1(c) and 5(f)</li>
<li>Demonstrated a good understanding of the relationship between chemical structure and physical properties: 3(a) and 3(c)(ii).</li>
<li>Responded appropriately to “state and explain” questions by giving a statement then reasoning for it: 1(b)(iii), 4(b)(iv) and 5(e).</li>
<li>Accurately drew the mechanism for an organic reaction: 5(d)(ii)</li>
</ul>
</td><td>
<ul>
<li>Working, if given for calculations, was unclear, which made it difficult to follow logic.</li>
<li>Produced responses that lacked depth. When asked to ‘explain’ concepts or reasoning given, showed a general lack of understanding of concepts.</li>
<li>Contradicted their responses. For example, 3(a) describing metallic bonding for Ca but then going on to discuss intermolecular forces or ionic bonding.</li>
<li>Struggled with practical based questions: 1(c) how to conduct qualitative ion tests and 2(c) evaluating experimental results.</li>
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## Key teaching and learning points – comments on improving performance

- Candidates should have a good understanding of the basics. OCR have produced a number of transition guides to help support the move from KS4 to KS5 (https://www.ocr.org.uk/qualifications/as-and-a-level/chemistry-a-h032-h432-from-2015/planning-and-teaching/#as-level). Make time for regular practice of concepts such as writing chemical formula, balancing equations and naming compounds (including use of oxidation states).
- Make sure candidates understand how to identify the command word when reading questions and are able to understand what command words mean. Common ones used in chemistry are explain, calculate, state, describe, draw, write.
- Encourage candidates to avoid using "it", "them" or "they" in their responses – be specific! For example, question 3(b)(ii) "It has a greater atomic radius" should be "Ba has a greater atomic radius".
- Candidates should use the correct language when referring to scientific measurement. Question 2(c) demonstrated that some candidates are unsure on what is meant by accuracy and the impact that uncertainties have.

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| | **OCR support** | OCR have produced an exemplar investigation to illustrate the use of measurement language in context. This can be found under teaching activities by following this link: https://www.ocr.org.uk/qualifications/as-and-a-level/chemistry-a-h032-h432-from-2015/planning-and-teaching/#as-level |

- Make regular use of the data sheet for information during lessons so that candidates become familiar with where to find information needed. For example, 1(c)(ii) molar gas volume, 2(b) specific heat capacity of water, 5(f) characteristic absorptions in organic molecules. Additional copies can be printed from this link: https://www.ocr.org.uk/Images/363792-unit-h032-and-h432-data-sheet.pdf
- Confident mathematical skills are essential in chemistry, with over 20% of the paper assessing L2 or above skills. Candidates should know how to set out calculations correctly by modelling good practice. Remind them to have individual steps to their calculations and only to use = when relevant. Using correct significant figures still cause problems for a number of candidates; this should be considered every time a calculation is performed. Further details can be found in the maths skills handbook: https://www.ocr.org.uk/Images/295468-chemistry-mathematical-skills-handbook.pdf

## Themes in candidate responses

It is essential that candidates read the questions very carefully and answer the question asked. There was significant evidence that this was not always the case and that candidates answered in the way they may have done for similar questions seen in past papers. For example, Question 1(a) justified using oxidation numbers rather than numbers of electrons and Question 3(b)(ii) giving the general trend in group 2 rather than comparing Ba and Ca.

Candidates should be encouraged to allow time at the end of the exam to review their answers to check for errors and/or omissions. A number of arithmetic errors were seen for calculations, particularly Question 5(d)(i) where $M_r$ values were added up incorrectly or final % did not equal the values given. Other small errors included missing charges, unbalanced equations and omission of 2 on $Cl_2$.

## Level of response questions

When answering this type of question, it is vital that candidates make use of **all** the information provided. They should read the question through twice before planning their response. Brief notes can be made alongside the question as pointers to remind themselves when answering. Continuous prose does not need to be used. Bullet points, tables and diagrams are all effective methods of communication in science. Candidates should be reminded to re-read the question when reviewing their work to make sure they have used all of the information provided and answered all parts of the question.

Some useful information can be found in this exemplar candidate work from 2017 papers:
https://www.ocr.org.uk/Images/285009-exemplar-responses-to-level-of-response-questions.pdf

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| i | **OCR support** | OCR have also produced a delivery guide for teaching about identifying unknowns, covering both qualitative ion testing and analytical technics (IR and MS): https://www.ocr.org.uk/Images/208563-identifying-unknowns.pdf |

## Common misconceptions

Candidates should understand the difference between physical and chemical properties, including the link to structure and bonding in substances. This was evident in some responses for question 3(a) with some candidates describing how calcium and bromine can react with other elements or detailing electron configuration.

The role of intermolecular forces in simple covalent structures was also often poorly understood (question 3(a) and question 3(c) (ii)). A number of candidates described intermolecular forces in metallic structures.

A useful resource produced by OCR to help explore these concepts can be found:
https://www.ocr.org.uk/Images/350445-bonding-and-structure-ks4-ks5.pdf

## Guidance on using this paper as a mock

This paper would be good preparation for AS Chemistry exams or at the end of the first year of the A Level course. Pay particular attention to the marking guidance on the mark scheme when reviewing students work.

## Comments on responses

### Comments on specific questions

### Question 1

**1(a)** A considerable number of candidates did not score the mark here despite knowing that it was an oxidation reaction. They either omitted to give the number of electrons lost or gave their justification using oxidation numbers. This question highlights the importance of reading the question carefully and answering the question asked, not one that may have been seen previously.

**1(b)(i)** Most candidates were able to make some progress with this calculation. Common errors included omitting to multiply by two to find the number of moles of $HCl$ or not multiplying their volume in $dm^3$ by 1000 to give an answer in $cm^3$.

**1(b)(ii)** More candidates struggled with this part of calculation. A significant number of candidates used the number of moles rounded to 3 SF but then gave a final answer to 4 SF, giving an answer of 78.48 $cm^3$. This was given credit as correct calculation had been carried out for one mark.

A couple of candidates correctly used the ideal gas equation and were given credit for this, but made it more complicated than necessary for one mark.

**1(b)(iii)** Very few candidates managed to gain marks here. Most did not recognise that $HCl$ was the limiting reagent in the reaction and suggested that a greater volume of $H_2$ would be produced, as same mass of Mg would give a greater number of moles.

**1(c)*** Very few candidates managed to score full marks for this question. Even the highest-attaining candidates struggled with writing balanced chemical equations. The most successful candidates used ionic equations with state symbols in their responses. A large proportion of candidates gave unnecessary details such as testing for $CO_2$ using limewater or the colours of other silver halide precipitates. The best responses broken down their response to cover each test in turn, giving clear and concise details for each.

### Question 2

**2 (a)** Most candidates managed to gain at least one mark for this question having learnt the definition. Some lost a mark for stating one mole of substance gives one mole of product, clearly confusing their definitions.

**2(b)** Nearly all candidates managed to gain at least one mark for correctly calculating the moles of cyclohexane burnt and the majority also used $q = mc\Delta T$. However, very few candidates managed to gain all 4 marks, most frequently losing the final mark for SF and sign. Other common errors included using the mass of cyclohexane in calculation of $q$, using Gas Constant R rather than specific heat capacity of water, or not using $\Delta T$ but using 293 K instead.

**2(c)(i)** A significant number of candidates struggled to correctly calculate the % uncertainties for the apparatus given or did not back up their claims with any calculations. Even the highest-attaining candidates often did not account for two measurements for temperature, or tried to calculate the % uncertainty for each temperature measurement taken.

**2(c)(ii)** Most candidates gained at least one mark here from one of the three acceptable responses. There was some evidence of candidates being confused here by the use of average bond enthalpies to find values of enthalpy of combustion. Others discussed human errors, need for repeat measurements or precision of equipment, demonstrating a lack of understanding with regard to the language used in scientific measurement.

**2(c)(iii)** This was a challenging question. Some candidates gained one mark for reduced accuracy due to increased heat loss or water evaporation. The responses given demonstrated that candidates often do not understand the factors that influence the accuracy in scientific experiments. Some indicated that repeating results would improve accuracy. Another common response was that a longer time would allow for complete combustion, failing to understand that degree of combustion is due to the availability of oxygen, not the time taken.

## Question 3

**3(a)** More able candidates scored well in this question, setting out their answers in a logical order. They often first discussed Ca and its bonding and structure, linking this to the physical properties and then doing the same for Br.

A number of candidates discussed the chemical properties of Ca and Br, such as their ability to bond with other elements, ionisation energy and their reactivity based on their position in the periodic table. Some candidates gave a good description of metallic bonding but then went on to discuss melting point in terms of intermolecular forces.

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| | **AfL** | A number of students still referred to Van der Waals forces in their answers. Van der Waals forces are a collective term for several different intermolecular forces (https://goldbook.iupac.org/terms/view/V06597), so when students intend to refer to specific intermolecular forces their specific names should be used. |

**3(b)(i)** Most candidates were able to give the correct diagrams for ionic bonding, although care needs to be taken that diagrams are well drawn with both charges given. Some gave diagrams for covalent bonding.

**3(b)(ii)** It was important to answer the question asked. A number of responses lost marks for describing the general trend down group 2 without making reference at all to calcium and barium. Most candidates managed to score at least one mark here but a considerable proportion missed the second marking point explaining that nuclear attraction was less in Ba.

**3(c)(i)** This was dependent on candidates' ability to give correct formula of aluminium hydroxide, $A\mathit{l}(OH)_3$. Writing correct formulae is an important skill in chemistry, which should be practised regularly in different topics to help candidates master the skill.

**3(c)(ii)** Most candidates were able to recognise that water had the higher boiling point due to hydrogen bonding. However, it was evident in a number of responses that they were unclear that this is an example of an intermolecular force and doesn't just refer to the covalent bond formed between O and H.

Most avoided discussing the intermolecular forces present in $H_2Se$ even although both London forces and permanent dipole-dipole interactions were accepted as they may not have come across this specific example and had not been given electronegativity data.

**3(d)(i)** Very few candidates scored this mark. Although a number of candidates did give sodium bromate as the answer (with the omission of the oxidation state), many other answers were seen suggesting candidates are not aware of naming conventions for inorganic compounds.

**3(d)(ii)** This is the first time in a reformed chemistry AS paper that the question space has been left unstructured for oxidation number changes. The highest-attaining candidates set out their responses clearly, dealing with changes for oxidation and reduction separately, and giving the correct oxidation numbers. Some struggled to obtain an oxidation state of Br in $NaBrO_3$ as +5, suggesting +1 instead.

## Question 4

**4(a)** This was a challenging example of predicting bond angles. Candidates often counted four pairs of electrons around the central atom, so based their bond angles on a tetrahedral arrangement (deducting 2.5 from 109.5°), losing this mark. Explanations were not always clear, but most candidates gained credit for describing electron pairs repelling. Many candidates state that they subtracted 2.5° rather than explaining why this is done in terms of electron pairs repelling.

**4(b)(i)** A wide range of responses, including addition signs, 2x, curved brackets, inverse. Candidates must take care to write the formulae correctly: C*l* rather than $Cl_2$ was seen a number of times.

**4(b)(ii)** Most recognised that the value for NO was 2 x $Cl_2$ but some struggled to explain why. Answers needed to show clear evidence that they had taken into account the stoichiometry of the equation. Some gave responses such as using moles and volume to calculate or to put values into the $K_c$ expression.

**4(b)(iii)** Those candidates that were able to give the correct expression in 4(b)(i) were often able to obtain the correct value here, demonstrating a good understanding of this topic. Some forgot to take the square root so only obtained one mark.

**4(b)(iv)** Candidates need to be well versed in how to tackle this type of question. Some, despite explaining what would happen, forgot to then state what would happen to the concentration of NO. Some said that the reaction would shift to the right but did not state that the reaction was endothermic. A small number of candidates thought that the reaction was exothermic, despite the + sign by the reaction, and some discussed other factors such as rate or changing pressure.

## Question 5

**5(a)** Generally this was well answered. However, some candidates only gave two responses where three were required, presumably because it was worth two marks.

**5(b)** A significant number of candidates did not gain the mark here as they incorrectly balanced the number of oxygens, forgetting that the alcohol contains an O atom i.e. 6.5 $O_2$ given rather than 6.

**5(c)** Nomenclature in organic chemistry takes lots of practice. Approximately half of the candidates did not score this mark. It was more challenging as they needed to work with skeletal structures but evidence of drawing out displayed formula was often seen.

**5(d)(i)** Most candidates were able to recall the formula to calculate atom economy, however a number made errors in working out $M_r$ values. However, some left this blank or just gave an answer without any working.

**5(d)(ii)** Mechanisms were often seen showing curly arrows going in the wrong direction and between the wrong bonds and atoms, charges and dipoles were often incorrect, and partial changes used where full charges were required. Writing mechanisms is an important skill in organic chemistry so it is vital that time is spent practising writing them out and fully understanding the significance of the curly arrow.

**5(d)(iii)** Many candidates gave the correct mechanism here, with common incorrect responses being other types of mechanism, substitution only, or isomerism.

**5(e)** Very few candidates gained both marks here. It was not enough here to just state faster/slower without specifying which haloalkane they were referring to. It was also important to specify the C-X bond not just vague reference to the chlorine or bromine bond. Many described the difference in bond polarity so had the wrong order. Some were more general and discussed the reactivity of bromine and chlorine themselves.

**5(f)*** This was a challenging problem-solving question, relying on candidates to make use of all of the information provided to determine the structure. Very few candidates made no attempt at all at this question.

The most common error was incorrectly identifying the peak at 3000 $cm^{-1}$ as O-H from a carboxylic acid, despite it being indicated on the data sheet that this would be a broad peak. It suggested that candidates were not familiar with looking at spectra and understanding what data it gave. Candidates should also be reminded when answering these types of question that they should give the structures, not just molecular formulae, where possible.

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