



GCE A LEVEL EXAMINERS' REPORTS

**CHEMISTRY
A LEVEL**

AUTUMN 2020

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CHEMISTRY

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COMPONENT 1 - PHYSICAL AND INORGANIC CHEMISTRY

General Comments

This examination was attempted by a very small number of candidates and, given the context of this exam session, it was not surprising to see that none gained very low marks and none approached full marks. Despite this a good range of marks was seen, and all candidates found sections of the examination accessible.

It was pleasing to see some candidates accessing the highest band marks on the two QER questions despite the small number sitting the exam. Most of the questions requiring higher level mathematical skills, such as exponentials and logarithms were answered well, which builds on a good standard of mathematical reasoning seen across the calculation questions.

Comments on individual questions/sections

Section A

Most Section A questions were answered well, however there were a few areas that challenged some candidates.

- Q.2 Few candidates recalled that NaHSO_4 was one of the products of this reaction.
- Q.3 Almost all candidates correctly identified the three half-lives and gained a mark but most then gave the mass of ^{24}Na remaining rather than the mass of ^{24}Mg produced.
- Q.5 The answers to this question were of a lower standard than seen usually. Many candidates did not identify the correct types of intermolecular forces, and it was rare to see the words 'intermolecular' or 'between molecules' in answers.
- Q.6 Electrochemistry questions are often answered poorly, and this was the case here. Many discussed the values as if they were calculating the EMF for the reaction between iron metal and the halogen, rather than the $\text{Fe}^{2+}/\text{Fe}^{3+}$ interconversion.

Section B

- Q.7 Candidates performed the calculations well and were able to understand the relationship between K_a values and acidity. They found making three corrections to the method more challenging. Most identified the use of a measuring cylinder as an issue, however very few understood that the indicator was not appropriate and that the concentrations used would lead to very small volumes of sodium hydroxide.
- Q.8 The answers to this question were poorer than the previous questions. Metallic bonding and its effect on melting temperatures was poorly described in part (a) with some answers discussing ionic bonding or van der Waals forces. Answers to (c)(ii) were also poor, with the shielding in magnesium and lack of shielding in sodium usually absent. In both questions, weaker answers lacked comparison, with

answers referring to one element only. These weaknesses were balanced by generally good calculations in part (d).

- Q.9 There were several calculations in this question and they were generally answered well. Part (b)(ii) offered the highest number of marks and many found it challenging. Most were able to identify the importance of atom economy, but fewer were able to explain why the solubility of the lithium salt favours the chloromethane over the bromomethane. It was common for candidates to state that bromomethane was cheaper without realising that the cost per mole was greater.
- Q.10 This question required candidates to recall many areas of transition element chemistry and most succeeded to some extent. The QER question was more challenging with few able to write equations for the equilibria occurring, and even fewer able to link the addition of dilute hydrochloric acid to addition of water and protonation of NH_3 .
- Q.11 Once again the calculations in this question were done well by most candidates. The poorest calculation was in part (d) where most candidates gained some marks for their methods but made simple errors resulting in incorrect final answers. The QER question here included both explanation and calculation. Most candidates chose the correct line of the spectrum for the calculation although a few used the difference between the first and last lines labelled (1875 – 91 nm). The most common calculation error was forgetting Avogadro's number and hence calculating the energy for one atom rather than per mole of atoms. The explanations given in some cases were vague and few linked the patterns in a series to the energy levels in the atoms becoming closer together. A similar lack of precision was seen in (d)(iii). Stating that 'not everything is in its standard state' was not acceptable. Noting that the equation contains $2\text{CH}_3\text{OH}$ without explaining why this is a problem gained no credit.
- Q.12 This was answered well by many candidates. Most were able to use the Arrhenius equation, although some candidates did not change the units of the activation energy. A few answers in (c)(ii) did not gain the mark as they referred to carbon or lead only and not to both.
- Q.13 This question challenged many candidates with most giving **B** as the unknown in part (a). It was not uncommon to see nitrate suggested as an answer in place of hydroxide or sulfate. Almost all candidates recognised the halides and the carbonate ion and hence gained two out of four marks. In part (b) most candidates knew that all common sodium compounds are soluble but few could explain how to modify the method. The calculation in part (c) was unfamiliar and even some of the better candidates struggled. The final part of the question was generally well answered but it was disappointing to still see candidates unfamiliar with flame tests. Many stated that magnesium gives a white flame and others gave red or lilac as the colour of the sodium flame.

Summary of key points

Questions which require comparisons are common throughout chemistry exam papers and in many cases candidates are not explicit enough in their responses. Answers which refer to one of the elements/compounds/reactions in the question and fail to mention the other are unlikely to gain credit. Examples of this were seen in questions 8(a) and 12(d)(ii).

Practical work is a key part of the course and AO3 questions which expect candidates to evaluate and/or improve methods are part of all exam papers, not just component 3. Simple answers where candidates suggest more precise measuring devices are usually answered well but when candidates are required to analyse a method more deeply, many struggle to identify areas that need improvement.

In QER questions it is important to include all the content required. It may be useful to underline key points included in the question wording. In both QER questions on this paper, one element of required content was missing from most answers. Appropriate equations were often omitted in the first one and there was no explanation of why the pattern forms in the second one.

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COMPONENT 2 - ORGANIC CHEMISTRY AND ANALYSIS

General Comments

The very small number of candidates found this paper accessible and responses were generally good. Some found calculations requiring an element of application quite difficult. Responses to the two QER questions were generally good and nearly all candidates showed that they had a good grasp of the reasoning required to obtain marks in the 3 to 6 range. Comments on individual questions have been restricted to those where a weaker response was sometimes seen.

Comments on individual questions/sections

Section A

- Q.2 A molecular formula as required in part (a) should be given in the form $C_5H_{12}O_5$ rather than a form which suggests something of a structure e.g. $C_5H_7(OH)_5$. In part (b) not all candidates provided the reasoning required to gain both marks.
- Q.3 Sodium tetrahydridoborate(III) will not reduce a carboxylic acid.

Section B

- Q.6 (a) In part (ii) reference to ionic bonding present in the zwitterion and the need for relatively more energy was needed to gain full credit.
(b) Not every candidate provided enough information about the NMR spectrum to gain full credit in part (i). Responses to part (ii) were disappointing. If candidates were unable to deduce that compound **T** was an aldehyde, they had difficulty in giving the correct formulae for compounds **U** and **V**.
- Q.7 (a) This was a more challenging question for several candidates. The best approach was to treat each hydrocarbon separately but a number of candidates did not do this and ran into difficulty as a result. Some used the molar volume as 24.0 dm^3 rather than the 24.5 dm^3 given in the data sheet, but this was not penalised.
(d) Although there were a number of acceptable answers to this 'environmental' question, few candidates gained more than 2 marks out of 4.
(f) A number of candidates gave the correct structure for the isomer of C_5H_{12} but fewer gave correct reasoning for their answer.
- Q.8 (a) In general the answers to this 6-mark QER question were well reasoned. The question required them to relate their response to 2-methylundecanal and this was not always clearly done.
(b) In part (iii) several candidates did not read the graph correctly when finding the concentration of lycopene. In addition there was some confusion about changing from dm^3 to cm^3 . This was sometimes done the wrong way round

- resulting in the concentration of lycopene in a tomato being unrealistically high.
- (d) This question was not well answered. Some candidates did not provide the obvious comment that the largest peak in the HPLC must be produced by lycopene, whose concentration was very high when compared with the other coloured compounds present.
- Q.9 (a) The equation for the reaction between phenol and bromine was required in part (i). Although a number of candidates correctly gave the mole ratio of phenol to bromine as 1:3, some did not show that the other product made is hydrogen bromide.
- (c) In part (i) although most candidates could explain why 2,4-dichlorophenol was relatively acidic, not everyone then mentioned ethanol in their response, as was required.
- (d) This question proved to be challenging for most candidates. They found it difficult to suggest reasons why the percentage of chlorine in the sample of 2,4-dichlorophenol was close to the calculated value, although the sample was impure.
- (e) In part (i) most candidates correctly wrote about the relative stability and ease of formation of the secondary carbocation, compared with the primary carbocation and explained that this leads to a low yield of 1,6-dichlorohexane when hexa-1,5-diene is reacted with hydrogen chloride. Part (iii) required candidates to complete and balance the equation. Not many managed both parts.
- Q.10 (a) The calculation in part (i) was generally well done although several candidates lost a mark by not realising that malic acid is a dibasic acid,
- (c) The explanation of the term 'stereoisomerism' was not always clear in part (i). Some did not write that it was the 'same compound' whose atoms took up different positions in space. Comments about 'having the same molecular formula and taking up different positions in space' were seen as inadequate.
- (d) Part (iii) asked for an equation. Although phenylamine was often correctly given as a product, many did not show sodium ethanoate as the other product.
- Q.11 (a) The calculation in part (ii) proved to be challenging but most candidates gained some credit.
- (b) This was the second of the 6-mark QER questions and most candidates gained at least 3 of the 6 marks. Only a few deduced a satisfactory structure for compound **G**.

Summary of key points

In general this paper was well answered. Questions requiring interpretation of unfamiliar graphs and those involving multi-stage calculations continue to be weak areas. Recall of key organic reactions is still a problem for a good proportion of candidates.

Responses to QER questions continue to improve.

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COMPONENT 3 - CHEMISTRY IN PRACTICE

General Comments

This paper proved successful in that it differentiated well. Some marks were accessible to almost all candidates whilst others were gained only by a few.

Good attempts were made at most of the calculation questions, where many candidates set out their answers sufficiently clearly to be able to see what was being calculated at each stage, allowing partial credit to be given when final answers were incorrect.

There was no indication that candidates had a problem with the length of the paper.

Comments on individual questions/sections

- Q.1 (a) Poorly answered, with very few candidates giving the correct names for both compounds.
- (b) It was surprising to see how few candidates were able to draw 3D diagrams of optical isomers in part (i). In part (ii), the most common incorrect answer seen was 'rotate the plane of polarised light in different directions'. In part (iii), whilst the majority of candidates were able to identify a reagent for a reaction common to both optical isomers, only a very small minority were then able to give the structural formula of the organic product.
- (c) It was surprising to see that some candidates' only correct answers here were the observations made with Tollens' reagent and in the iodoform reaction. The strongest candidates scored all 8 marks. A few candidates gave sodium dichromate(VI) as a reagent to distinguish between a primary alcohol and a halogenoalkane but with no mention of acidification or heating. They were not awarded the mark. Some gave 'iodoform' as a reagent to distinguish between $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ and $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$ and of course this gained no credit.
- (d) In part (i), only a small minority of scripts referred to the need to heat/reflux the reaction mixture. In part (ii), the majority of candidates were able to draw the ester formed but a few forgot to include water as the other product.
- Q.2 (c) In part (i) most candidates recorded titre values to 2dp and correctly calculated the mean titre. A minority did not record the titre values to 2dp. In part (ii), a surprisingly large number of candidates did not identify titration 2 as having the largest percentage error in the volume of hydrochloric acid used. The common error was identifying titration 1 as it is a non-concordant value.
- (d) The majority of candidates gained at least 2 marks in part (ii) for correctly calculating the total number of moles of aqueous sodium carbonate added and the number of moles of HCl in the mean titre. A number of candidates scaled up to 250 cm^3 rather than 200 cm^3 and some gave their final answer in mol dm^{-3} rather than g dm^{-3} . They must read the question carefully. In part (iii) some used the relative mass of barium or barium chloride rather than that of barium carbonate in their calculation.

- Q.3 (a) Candidates found this question challenging with very few using **all** the information provided to suggest the identity of element **X**. Where candidates incorrectly identified element **X** as calcium or barium, marks were awarded for the corresponding ionic equations.
- (b) The majority of candidates successfully used the ideal gas equation to calculate the relative mass of the chloride of **Y** and used this to deduce that the chloride must be SiCl_4 and that element **Y** is silicon. There was poor knowledge of the structures of its oxide and chloride.
- Q.4 (b) In part (i) candidates calculated rates correctly but some struggled to deduce reaction orders. Explanations were often confused and lacked supporting evidence from the results table. The rate equation was well done and marked using 'error carried forward' where orders were incorrect. Barely any calculated the correct value for the rate constant. The vast majority used incorrect concentrations after neglecting the fact that the total volume was 500cm^3 . Given that data provided was expressed to 3 significant figures it was expected that the final answer was expressed similarly. The graphs in VI were drawn correctly by most candidates.
- Part (ii) was the QER question on this paper. This proved more challenging than had been anticipated.
- The most common weaknesses were:
- not stating that the reaction was repeated at a number of different temperatures with the same initial concentrations of all reactants
 - not stating that the time needed for the methyl orange indicator to be bleached was measured
 - not stating that the time taken at each temperature is then converted to rate for a rate constant value to be calculated at each temperature
 - not stating that the temperature in Kelvin must be used in analysis of the results
- Where candidates gave the Arrhenius equation, the majority were able to rearrange it and show that the gradient of the line is equivalent to $\frac{-E_a}{R}$ meaning that E_a can be calculated.

Summary of key points

- As noted previously, more marks are lost for shortcomings in basic recall than in dealing with data given in new situations. Recall of organic functional group tests and the relevant observations is essential. Being able to name and draw the structure of the organic product formed in a positive test is also essential.
- Questions must be read carefully to ensure
 - good understanding of what the question requires
 - that the correct values are used in calculations
 - that answers are expressed using the correct units and to the appropriate number of significant figures



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