AQA

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CHEMISTRY

7405/2 Paper 2 Organic and Physical Chemistry
Report on the Examination

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General Introduction to the 2022 Series

Entry patterns returned to those normally seen in the summer, but students had a different experience in preparation for these exams. To account for the effects of the covid 19 pandemic, advance information about a significant amount of content covered in the questions had been provided. As such it is therefore somewhat more difficult to make meaningful comparisons between the range of student responses seen in this series and those seen in a normal summer series. That said, the responses to questions were generally comparable to those seen in series prior to the covid 19 pandemic.

In this report, senior examiners will summarise the performance of students in this series in a way that is as helpful as possible to teachers preparing future cohorts while taking into account the unusual circumstances and evidence available.

Overview of Entry

The entry was similar to that in the summer series prior to the covid 19 pandemic.

Comments on Individual Questions

Question 1 Rates of reaction and organic structures/mechanism

01.1 Most students scored for the structure but some failed to use a number prefix for the iodo substituent on carbon 1.

01.2 Students had to substitute values and rearrange the supplied rate equation to calculate the rate constant. This is a familiar type of question and was generally well answered.

01.3 Again this familiar style of question was well answered although significant numbers of students took the less elegant approach of using the rate constant and substituting values into the rate equation, rather than simply multiplying the original rate by a quarter.

01.4 The required observation (colour change from brown to colourless), when all the iodine had reacted, was not well known.

01.5 The final mark was for explaining that <u>many</u> more particles have energy greater than (or equal to) the activation energy, linked to the exponential increase in the rate with temperature. Few students scored full marks and for the most part it was the final mark for the explanation that was not detailed enough.

01.6 Most students were able to score this straightforward mark.

01.7 This question proved more accessible than questions from this part of the specification in the past. Those who set out their answers clearly and carefully were able to perform the required

value substitution, evaluation and rearrangement using the supplied equation. A large proportion of students scored all 5 marks but the question did also discriminate well.

01.8 This question had a very high discrimination index and the best students were able to score full marks. Common errors included poor drawing of curly arrows and mistakes in the structure of the intermediate.

Question 2 Equilibrium

02.1 A familiar type of equilibrium question that students answered well.

02.2 This was a very straightforward equilibrium constant expression that the vast majority of students were able to answer correctly.

02.3 Although many students were able to score full marks here, significant numbers failed to use the volume when substituting values into the K_c expression.

02.4 This question required students to apply Le Chatelier's principle and most were able to score high marks here.

02.5 This question required students to recognise the role of chlorine radicals in the decomposition of ozone. It was surprisingly poorly answered.

Question 3 Alkenes and isomerism

03.1 The second mechanism on the paper also had a high discrimination index and the best students were able to score full marks here. Most students were able to get started but mistakes in the structure of the tertiary carbocation intermediate were quite common, as were errors in representation of the sulfuric acid, and subsequent attack on the carbocation by the hydrogensulfate ion.

03.2 The final mark for this question proved to be very demanding with few students being precise enough about the number of electron donating alkyl groups in the dominant tertiary carbocation.

03.3 Fewer than half the students scored here. Mistakes included not drawing the structure skeletally as demanded by the question and failing to recognize that the functional group isomer of the alkene would be a cycloalkane.

03.4 This very straightforward question wasn't as well answered as expected. Both the type of polymerisation and the repeating unit were sources of mistakes but the better students were able to score, as shown by a high discrimination index.

Question 4 Biochemistry

04.1 Very well answered with the vast majority able to identify this type of structure as primary.

04.2 The peptide link was often correct but many failed to gain the second mark, usually because a dipeptide was drawn rather than a section of a protein.

04.3 Most students were able to identify water as the other substance formed when amino acids react together to form a protein chain.

04.4 This question about R group interactions in the protein structure differentiated very well. A full range of marks was seen but only the best students scored all four marks. Whilst disulfide bridges between cysteine R groups, and hydrogen bonds between aspartic acid and serine R groups were well known, far fewer students were able to identify the disulfide bridges as stronger and explain this by reference to the fact that these are covalent bonds.

04.5 This question was very poorly answered and few students were able to identify ionic bonding as the interaction between lysine and aspartic acid R groups.

Question 5 Practical – preparation of a pure organic liquid

05.1 This question was well answered and students were able to suggest one of a range of appropriate safety precautions.

05.2 Removal of water-soluble impurities as the correct reason for adding distilled water was less well known.

05.3 The use of $MgSO_4$ to dry the liquid product was better known.

05.4 Diagrams for reduced pressure filtration were generally poor and few scored full marks. The most common errors were apparatus not shown in cross section and the absence of a collar or bung between the flask and (Buchner) funnel.

05.5 Identifying hexan-1-ol as the most likely impurity was not well answered and few scored this and the explanation in terms of the two alcohols having similar boiling points.

05.6 Most students were able to get started on this relatively straightforward calculation but large numbers failed to follow the instruction in the question to give the final answer to 1 decimal place. The question had a high discrimination index.

Question 6 Structure determination

This question was marked using a levels of response mark scheme. Most students were able to get started and could identify some structural features using the infrared spectrum and the data

booklet. The best answers also showed a logical and systematic approach in analysis of each signal in the ^{13}C NMR spectrum and the table of data relating to the ^{1}H NMR spectrum. Students often failed to reach the highest level because their answers lacked sufficient detail, despite arriving at the correct overall structure.

Question 7 Ester hydrolysis

07.1 This question required students to deduce and add three curly arrows to an unfamiliar incomplete mechanism. As with similar questions in the past, this discriminated well between the most able and weaker students.

07.2 Despite being a term taken directly from the specification, hydrolysis was not well known and few students scored this mark.

07.3 The specific role of the methoxide ion as a base/ proton acceptor was better answered than Question 07.2.

07.4 Almost half the students knew that soap was the use of the product when vegetable oil is hydrolysed with sodium hydroxide.

Question 8 Aromatic chemistry

08.1 Whilst this question concerned a familiar electrophilic substitution reaction, a disappointing number of students were able to write the equation for the reaction and to name the organic product.

08.2 Students did better with this question and the majority scored both marks when asked to identify the catalyst used and to write an equation to show the generation of the given electrophile.

08.3 A good proportion of students scored all 3 marks for this familiar mechanism and most were able to score some marks here.

Question 9 Practical titration in the context of an organic reaction

09.1 The first mark was very rarely scored here. Students weren't able to suggest that a smaller target titre would lead to a larger percentage uncertainty. The second mark for calculating the amount of bromine was scored by the vast majority of students.

09.2 The discrimination index for this question was high and only the best students scored full marks. The most common error was to fail to appreciate that Y would react with bromine in a 1:5 ratio. Weaker students also found it hard to gross up the mass of Y to give the mass of oil at the end and many did the opposite by calculating 85% of their mass of Y. Consequential marking meant that, despite these common mistakes, several other marks were still possible and most scored at least two marks.

09.3 This practical procedure question was quite well answered despite the slightly novel context of weighing a liquid rather than the more familiar solid.

09.4 This question was quite well answered with a good proportion of students able to suggest that the volumetric flask is inverted to make sure the mixture is homogeneous.

09.5 The question demanded that students show their working. Whilst it was well answered overall, many failed to score both marks. The first mark required students to show that the M_r was one less than 345, but this was often omitted despite the question stating that each molecule gains a hydrogen ion (H^+) during electrospray ionisation.

Question 10 Synthesis and amines

10.1 Few students scored all three marks despite the reactions being very common in previous papers.

10.2 Despite being tested on a large number of past papers, fewer than expected were able to name the mechanism in step **3** as (nucleophilic) addition elimination.

10.3 Most students scored at least one mark but ultraviolet light as a necessary condition was often incorrect or omitted.

10.4 This question was poorly answered and only a small proportion were able to score full marks by explaining that amine B can go on to react further and form other amines, while amine A is the only organic product in step 2.

10.5 The explanation of base strength in terms of the availability of a lone pair of electrons on the nitrogen has been asked numerous times but this question still discriminated well.

Concluding Remarks

Overall the questions in this paper proved to be of a similar standard to those in previous series. The paper differentiated well, and students were able to complete the questions in the time available. All questions were correctly answered by a good number of students.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.