



AS

Chemistry

7404/2 Organic and Physical Chemistry

Report on the Examination

7404
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General

This examination of the AS specification highlighted some key points about students' performance that may prove useful.

- There remains significant confusion about matters relating to greenhouse gases and ozone. Students are mixing up the issues and often quoting ideas from (social) media rather than correct scientific information. Students may need to approach studying these topics without pre-conceived misconceptions.
- There are issues with students combining what should be separate steps of mathematical working into one step and so writing statements that are neither chemically nor mathematically correct as a consequence. Students need to show each step on a separate line and with some wording or symbols to show what each line represents.
- When some students determine an amount of moles of a substance, they are incorrectly dividing by the stoichiometric coefficient in the balanced equation as part of their calculation of the amount in moles.
- Some students are rounding numbers incorrectly during or at the end of calculations. The most common error is to drop all numbers after the final number rather than rounding to the closest number.
- There is very significant confusion about how the stability of a carbocation intermediate affects the identity of the major product in electrophilic addition reactions of alkenes. Many students refer to the stability of the product rather than the carbocation intermediate, while many think that the product is a carbocation.
- Few students understand percentage yield in a reaction. Many incorrectly believe it is the mass of product formed divided by the mass of reactant(s) as a percentage, rather than mass of product formed divided by the expected mass of product as a percentage.
- Few students understand Cahn-Ingold-Prelog priority rules for alkenes, with little understanding of how to use the atomic numbers of the atoms attached to the C=C.

Section A**Q1 Analysis of organic compounds**

- 1.1 This question looked at chemical tests for common organic functional groups. Students answered this quite well, but some confused the test for aldehydes using Fehling's solution with the Tollens' test.
- 1.2 This question required students to determine the empirical formula of a compound from data. Some students struggled to convert the amount in moles of each element into the simplest whole number ratio.

Q2 Infrared spectra

- 2.1 Students struggled with this question which required them to identify functional groups from IR spectra and then suggest the structure of two compounds. Some confused the alcohol O-H signal with the carboxylic acid O-H peak, and some confused the C=O and C=C peaks. Also, some students did not appreciate that there are several ways to represent the structural formula of a compound. Many tried to write condensed formulas (e.g. $\text{HOCH}_2\text{CH}=\text{CHCH}_2\text{OH}$) but sometimes

omitted the C=C. Any correct type of structural formula was acceptable including displayed and skeletal formulas.

- 2.2 Many students did refer to the use of the fingerprint region of the IR spectrum to identify the compound, but some were mistaken as to where this region is, and few mentioned looking for an exact match of the fingerprint region to a known sample.
- 2.3 This question required students to use the IR spectrum of methane to explain why methane acts as a greenhouse gas. Only a minority of students referred to the absorption of IR radiation. Some confused absorption and transmission, while others referred, incorrectly, to the absorption of UV light.

Q3 CFCs and ozone

- 3.1 Many students struggled to name the CFC according to IUPAC rules. The most common errors were with the spelling of fluoro-.
- 3.2 Students did this question quite well, showing two propagation steps in the production of CFCl_3 by free radical substitution.
- 3.3 This question required one equation to show the breakdown of a CFC to form Cl free radicals. Many students did appreciate that the breakdown formed two free radicals.
- 3.4 This question asked for the two equations for the breakdown of ozone by chlorine free radicals. It was generally well done but a significant number did not know these equations despite being given in the specification.
- 3.5 Students had to explain why ozone in the upper atmosphere is important to life on Earth. Answers showed much confusion about ozone and many answers related to global warming rather than the absorption of harmful UV light.

Q4 Alkenes

- 4.1 This question showed that students have poor understanding of what stereoisomers are in general. It also showed that very few students knew how the Cahn-Ingold-Prelog priority rules work. These rules are based on the atomic number of the atoms joined to C=C and not to the relative atomic mass of these atoms nor the " M_r " of the groups attached.
- 4.2 Students had to show the mechanism for the formation of the major halogenoalkane product from electrophilic addition to an alkene. This was generally very well done.
- 4.3 In this question students had to explain why more of one product was formed than the other in the electrophilic addition reaction. Students showed much confusion. Many students referred incorrectly to the stability of the products rather than the carbocation intermediates, while many think that the products are themselves carbocations.

Q5 Gas volumes

- 5.1 This question discriminated well. At the start of the question, students had to work out the amount in moles of two substances, one from a mass and one from the volume of a solution. Some students incorrectly divided their amount in moles by the stoichiometric coefficient in the balanced equation. They then had to determine and justify the limiting reagent and many struggled to justify this, some using these incorrect amounts. The second part of the question that

determined the gas volume using the ideal gas equation was generally well done, but some struggled to determine the amount in moles of hydrogen formed. Some could not convert temperature and pressure into SI units. Some did not realise that their answer was in m^3 and added a final incorrect conversion factor.

- 5.2 Students did well on this question. Most could write the balanced equation for the complete combustion of propane, and most could then use this to find the volume of oxygen reacting.

Q6 Rate of reaction of halogenoalkanes

- 6.1 Most students could identify the silver iodide precipitate.
- 6.2 This question required students to plot a graph including a best-fit line. Most could do this and draw a suitable curve. Students then had to extrapolate the line and determine the time taken at another temperature. Many could extrapolate the line, but few realised that the time taken was the reciprocal of the reading from the line.
- 6.3 Most students knew that bromoalkanes react slower than iodoalkanes. Fewer students could explain why by comparing the strength of the C-Br and C-I bonds. The final part of the question was very demanding, and few students could predict that the line on the graph would be lower than the original line.

Q7 Synthesis of propanoic acid

- 7.1 Most students could state the colour change when propan-1-ol is oxidised by acidified potassium dichromate(VI). Some only gave the final colour rather than the colour change.
- 7.2 Most students could identify propanal as a second organic product.
- 7.3 Many students could draw a hydrogen bond between a molecule of propanoic acid and a molecule of water. However, many did not show the oxygen lone pair in their hydrogen bond.
- 7.4 In this question students were required to show the mechanism for the reaction of sodium cyanide with bromoethane. Many students failed to show the CN^- correctly attacking the bromoethane.
- 7.5 Some students could explain why water was not a suitable solvent, although some incorrectly stated that NaCN was insoluble in water.
- 7.6 Most students could give the K_c expression for the equilibrium.
- 7.7 Many students correctly calculated K_c and its units. The most common error was using amounts in moles rather than concentrations. A significant number of students rounded 0.0516666 to 0.0516 which led to an answer that was outside the accepted range.
- 7.8 In this question students had to predict the effect of increasing temperature on the position of an equilibrium. This was done well, but some students did not refer to how the position of equilibrium shifted, while others did not appreciate that a negative enthalpy change represents an exothermic reaction.

Section B**Q8 Percentage yield**

Students struggled with this question with few students understanding percentage yield in a reaction. Many incorrectly believe it is the mass of product formed divided by the mass of reactant(s) as a percentage, rather than mass of product formed divided by the expected mass of product as a percentage.

Q9 M_r from a skeletal structure

This was answered correctly by a majority (73.4%) of students.

Q10 How a catalyst works

This was answered correctly by the vast majority (89.2%) of students.

Q11 Curly arrows in an unfamiliar mechanism

This was answered correctly by a majority (73.2%) of students.

Q12 Elimination from halogenoalkanes

Students struggled to deduce which alkene could be formed by elimination of HBr from a halogenoalkane.

Q13 Apparatus for production of an aldehyde from an alcohol

This was answered correctly by a majority (65.6%) of students.

Q14 Equation for chlorination reaction

Students found this question difficult, with confusion about whether H_2 or HCl is a by-product.

Q15 Polymer structure

This was answered correctly by a majority (66.9%) of students.

Q16 Equation for cracking reaction

This was answered correctly by a majority (74.2%) of students.

Q17 Relative boiling points of alkanes

This was answered correctly by a majority (67.1%) of students.

Q18 Use of high-resolution mass spectrometry to distinguish compounds

Students found this question harder, possibly failing to deduce the correct molecular formula of each compound from its name.

Q19 Enthalpy of combustion calculation

This was answered correctly by a majority (57.1%) of students.

Q20 Enthalpy change calculation

Students found this question harder, possibly due to it being a less familiar type of Hess' cycle.

Q21 Percentage atom economy

This was answered correctly by a majority (67.8%) of students.

Q22 Avogadro constant

Students found this question difficult, possibly due to it involving the Avogadro constant and/or not taking into account that data in the question gave the number of C atoms rather than the number of molecules.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the [Results Statistics](#) page of the AQA Website.