



A-Level Chemistry

7405/2

Report on the examination

Version: 1.0
June 2025

Further copies of this report are available from aqa.org.uk

AQA retains the copyright on all its publications. However, registered centres for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to centres to photocopy any material that is acknowledged to a third party even for internal use within the centre.

General

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

- Skeletal formulae can prove to be challenging for students to work with, and many prefer to translate these into abbreviated or displayed structures making errors in doing so.
- Students should take care to lay out their calculations in a stepwise manner and clearly state what each line of working represents. Many students have a jumbled mess of numbers that do not follow on from each other.
- Students struggle with calculations that relate stoichiometric ratio to volume ratio in gas phase reactions.
- Students struggle on questions that test understanding of practical work, especially organic preparations. Students need to understand why they do what they do in a practical rather than simply following a series of steps.
- Students are improving at mechanisms, including ones which are unfamiliar, but precision in drawing the arrow when a bond breaks is a key area to address. This includes the direction of the arrow as well as where it starts and ends (e.g. breaking N-H in an $^+\text{NH}_2$ group attached to two adjacent C atoms)

Q1 Reactions of halogenoalkanes

- 1.1 This question required students to recognize that free radical substitution was involved and requires UV light as the condition. It was well answered but those who failed to score often confused the reaction with nucleophilic substitution.
- 1.2 Students had to complete a radical substitution mechanism. Many did it well but few used the skeletal formulae expected. Students clearly prefer to translate skeletal structures into fully displayed or abbreviated structures. The most common error was to use molecular formulae which are ambiguous in terms of the position of substitution.
- 1.3 Students were asked to suggest why the yield from the radical substitution would be low. Good numbers recognized polysubstitution and the possibility of positional isomers. Those who did not score were often too vague referring to other products rather than giving specific types or examples.
- 1.4 Students had to recognize that reaction 2 was an elimination reaction and give a suitable reagent and condition for this. Lots were able to suggest a strong alkali and give hot ethanolic as the conditions. The most common errors were in suggesting aqueous conditions.
- 1.5 Students were asked to deduce that chlorine would be required to convert but-1-ene into 1,2-dichlorobutane via electrophilic addition. It was generally well answered but some thought that HCl could be used as the reagent.
- 1.6 The question required students to see that reaction 2 also gives but-2-ene as a product and this would go on to give 2,3-dichlorobutane in reaction 3. It proved difficult for many and quite a high number did not attempt the question.

Q2 Stereoisomerism

- 2.1 The requirement to include Z- before the rest of the name of the geometric isomer given was often missed, but students were much better at explaining the reason why geometric isomers exist. Students who did not score the final mark were often imprecise in their use of language to describe the requirement for both carbon atoms in the C=C double bond to be attached to two different groups.
- 2.2 This question required students to move the C=C double bond but keep the carbon skeleton the same to deduce that compound M existed as stereoisomers because it has a chiral centre. This proved very challenging and fewer than expected were able to get started here.
- 2.3 Students were asked to complete an electrophilic addition mechanism with an unsymmetrical alkene. This proved straight forward for many. Those who lost marks often did so because that drew a secondary carbocation intermediate rather than the tertiary one that would lead to the major product.

Q3 Polymers

- 3.1 Students were asked to deduce the structure and name of the monomer used from a section of the structure of PVC. This proved straight forward for many.
- 3.2 Students were asked to state why PVC is not biodegradable. Many were able to identify the strong non-polar C-C bonds as the reason but significant numbers were unable to see this and suggested incorrectly that strong C-H or C-Cl bonds were responsible.
- 3.3 Students were asked how a plasticiser modified the properties of a polymer. Despite not being asked in recent papers, this was well known. Those who did not score sometimes tried to describe how the plasticiser works rather than answering the question directly.
- 3.4 In this challenging question students were required to complete an equation by deducing the structure of an alcohol that reacts with the anhydride given to form a diester. Many students scored a mark for deducing that water was formed as the other product but far fewer could deduce the alcohol required. The name of the mechanism was well known but the empirical formula proved tricky to work out from the skeletal structure given for lots of students.
- 3.5 Here students were asked to identify an alcohol that would react with hexanedioic acid to form another diester used as a plasticiser. This was quite well answered with students scoring for either a correct name or structure.
- 3.6 Students were given data about the mass of plasticiser absorbed by foods with different fat and water contents. Many could see the link between the amount of fat and the amount of plasticiser but far fewer were able identify that both fats and the plasticiser are non-polar and so form van der Waals' forces between the molecules. The most common error was to focus on the ester links and state that the plasticiser was polar, or to say that hydrogen bonding between fat and plasticiser was the intermolecular force responsible for the trend shown.
- 3.7 This fairly routine nucleophilic addition elimination mechanism was well answered by students who had learned the standard curly arrows and were able to apply them in the context given. Some lost marks for drawing curly arrows in the wrong direction; in particular for the proton loss from the intermediate. Others added charges to the starting materials.
- 3.8 Students were given the first steps in an unfamiliar mechanism and asked to deduce the curly arrows and relevant lone pairs of electrons to complete the scheme. This was well answered by many showing a good understanding of mechanistic ideas covered elsewhere in the course.

Q4 Preparation of an organic solid

- 4.1 Students showed good understanding of risk assessment here by identifying reasons for carrying out the method in a fume cupboard.

- 4.2 Students struggled to identify the role of the concentrated nitric acid as an oxidizing agent, clearly failing to recognize that HNO_3 had been reduced to N_2O in the reaction equation given.
- 4.3 Students were required to outline the details of how to carry out a recrystallisation. Those who had learned this required practical were able to score high marks. Common errors included lack of details like the use of a 'minimum volume of hot solvent to dissolve' the crude product. Hot filtration was often missed and some did not answer the final part of the question by failing to say how the crystals would be dried.
- 4.4 The majority of students were not able to suggest that water at room temperature could dissolve some of the solid product leading to a reduced yield.
- 4.5 Students were given a diagram of a flawed method used to determine a melting point. Many were able to see that the sample and thermometer bulb were not at the same level so the thermometer temperature reading would be different from the temperature of the sample. Far fewer noted that water boils at a temperature below that of the solid and should be replaced by oil. Some showed good knowledge of the improvement a D tube (Thiele tube) would make in place of the boiling tube given. Common errors suggested by students included those who said that the thermometer should be in the melting point tube, or that the rubber ring would melt or prevent the thermometer reading being taken. Others said that a bung should be added to the boiling tube.
- 4.6 Students were shown details of an alternative two stage synthesis of the product and asked to justify it being more or less sustainable. Many observed that biological/natural sources were used but did not state that these are renewable to justify the process as more sustainable. The use of energy from fossil fuels to achieve high pressures was the most common answer given credit as a justification for the process being less sustainable. Large numbers focused on the temperature used but this was almost identical to the temperature used in the original method outlined at the start of the question.

Q5 Preparation of TNT

- 5.1 Students were quite good at showing the formula of TNT having been given its IUPAC name but far fewer could balance the equation with 3HNO_3 on the reactants side and $3\text{H}_2\text{O}$ on the products side.
- 5.2 This question asked for a calculation of the mass of TNT produced from a given volume of methylbenzene along with density and yield information. Many students were able to tackle this problem effectively scoring high marks. Those who failed to score well often presented workings that lacked 'narrative' and structure.
- 5.3 The mechanism for nitration was well known. Despite being given the formula of the nitronium ion as O_2N^+ in the question significant numbers of students lost the first mark in the mechanism for not showing the + on the N.

Q6 Biochemistry

- 6.1 Students were required to deduce why D₂O is used instead of CCl₄ or H₂O when obtaining a ¹H NMR spectrum for lysine. Many were able to score here for relating the polar nature of the lysine to the fact that would not dissolve well in non-polar CCl₄ or that D₂O does not give its own signal in a ¹H NMR spectrum.
- 6.2 Students were given the structure of a tripeptide bonded to a copper(II) ion, and asked to determine the structure of the histidine amino acid. Significant numbers of students made this more difficult by trying to draw the fully displayed structure and making errors like too few or too many H atoms bonded to the carbons. Those who tackled the question by simply extracting the structure from the tripeptide as shown in the question did much better.
- 6.3 Large numbers of students were able to identify the alpha helix and beta pleated sheet as required in this question which proved to be very accessible.

Q7 Spectroscopy

- 7.1 Students were given precise *M_r* data for an unknown hydrocarbon. Some were able to deduce the molecular formula but did not score as no workings were shown. Cyclohexane was the most commonly drawn correct structure but far fewer were able to deduce that 2,3-dimethylbut-2-ene was the other possible structure for C₆H₁₂ that gives only one singlet peak in its ¹H NMR spectrum. The most common error was to give an alkene that had more than one peak in the ¹H NMR spectrum. The final marks were quite well answered by suggesting the presence or absence of the C=C bond absorption at 1620-1680 cm⁻¹ in the infrared spectrum.
- 7.2 Students were given the ¹³C and ¹H NMR spectra for an unknown compound and asked to explain what could be deduced from the spectra about its structure. Students often did well on the chemical shift analysis but less well in addressing the splitting patterns in the ¹H NMR. The final mark of the 7 available here was for deducing the structure of the dione and this was quite well done by those who had done a thorough analysis of the spectral data. The question was marked with a levels of response mark scheme and differentiated very well.

Q8 Gas volumes

- 8.1 This routine ideal gas equation calculation was well done by many students. Common errors included the failure to convert the pressure and/or the volume before substituting into the rearranged expression. In common with Q05.2 some students lost marks when the way their calculation was set out proved impossible to follow.
- 8.2 Students were required to calculate the percentage uncertainty in the use of the balance. Many did not appreciate that the balance was used twice to determine the

mass of volatile liquid transferred. Consequentially those students did not double the uncertainty before working out the uncertainty as a percentage of the mass transferred. The second part of the question was quite novel and required students to apply the percentage uncertainties in three measurements to generate a range of possible M_r values. This proved difficult for some but the best students were able to determine the range.

- 8.3 This question was well answered and students were often able to give prevention of loss of volatile liquid as the reason a cap on the hypodermic syringe will improve the experiment.
- 8.4 This proved to be a challenging question that few students were able to see a way into. The best students set up simultaneous equations to determine the volume of each hydrocarbon in the mixture. Those who got started here usually went on to score all the marks. Other approaches were possible but rarely seen. For those who made an incorrect attempt the final mark for two volumes that added up to 40 cm^3 was often the only mark scored.

Q9 Reaction kinetics

- 9.1 This question was well answered and students were often able to give precipitation of silver bromide as the reason that the cross on the boiling tube became invisible
- 9.2 Students were asked to suggest another control variable in the method. Many focused on the nature of the equipment used which was already controlled as it was stated that the method was repeated at different temperatures. A range of reasonable suggestions were given credit but the question proved to be difficult for many.
- 9.3 This question was well answered with students being able to show they could manipulate the appropriate temperature data given to calculate $\frac{1}{T}$ in K^{-1} . Those who got this wrong had often rounded incorrectly.
- 9.4 Students were required to add an appropriate scale to the x axis and significant numbers did not score this mark as the scale chosen did not allow the graph drawn to cover at least half the grid space provided. Data plotting was generally well done with a suitable line of best fit through the points. The calculation of E_a from the graph proved tricky for some but a reasonable number of students were able to score all the marks. A common mistake was to give the gradient of the line as a positive value. Whilst the question proved difficult overall a majority of students were able to access at least three of the five marks available.
- 9.5 This question asked students to relate a rate equation given to a possible mechanism. The question was quite well done in general.
- 9.6 Students were asked to explain in terms of bond polarity why the bromoalkane and KOH react. Many scored at least 1 of the two marks for stating the correct polarity of the C-Br bond but some lost the mark because they just focused on the electronegativity difference without actually stating that carbon is delta positive and bromine is delta negative. The second mark was for explaining why the OH^- ion is attracted either to the delta positive carbon or to the C^+ formed in the mechanism in Q09.5. A common error here was to miss the negative sign in the formula of OH^- .

Mark Ranges and Award of Grades

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