



A-level **Chemistry**

7405/2 Organic and Physical Chemistry

Report on the Examination

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Question 1 Rates of reaction

- 1.1 Students were expected to draw a curve with reducing gradient as the reaction was second order overall. Relatively few gained this mark.
- 1.2 This familiar question was very well answered with about half the students scoring all 5 marks.
- 1.3 This unfamiliar mechanism question was well answered and discriminated well. The best students were able to deduce the correct curly arrows from the information given.
- 1.4 Students needed to link the fact that step one involved both the reactants that were also in the rate equation, and most answers were not explicit enough to score the mark.

Question 2 Equilibrium

- 2.1 Over 60% of students scored both of these marks. Those who got the amount of P wrong were able to score a consequential mark for converting their amount into a concentration.
- 2.2 The most common mark lost here was because students failed to divide the amount, in moles, of each reagent by the total volume of solution in the equilibrium expression, but the question scored highly with around 75% gaining at least three of the four marks.
- 2.3 Despite being a relatively unfamiliar application of Le Chatelier's principle, the best students were able to apply the idea to this context. Around 40% scored at least 1 mark here.

Question 3 Hydrocarbons

- 3.1 A surprising number of students gave C_6H_{18} as their answer for M1 when the correct answer was $3C_2H_6$. Clearly those students had simply deduced the number of carbon and hydrogen atoms needed to balance the equation, without considering if their answer was a viable compound. The second mark was well known.
- 3.2 Students found this difficult. Only around 40% were able to link the number and chemical shifts of peaks in the ^{13}C NMR spectrum to the number of different C environments in the options. Only option B has 5 different carbon environments, so this had to be the correct answer matching the 5 peaks in the spectrum.
- 3.3 This was well known and over 70% scored the mark for alkenes.
- 3.4 The calculation of gas volume proved challenging, and few were able to access the top marks here. Relating the mole ratio in the balanced equation to a gas volume ratio was unfamiliar to many students. M1 was often the only mark scored. Some attempted to use the ideal gas equation despite not being given explicit temperature and pressure values. This approach could score the marks, but it was a far more difficult route to take and those who did often made mistakes.
- 3.5 The vast majority scored at least 1 of these two marks. Acid rain was very well known.

Question 4 Required practical 10 Preparation of an organic liquid

- 4.1 The esterification equation proved difficult, especially the structure of the ester itself. Those who got the ester wrong were able to access M2, consequentially, if they had drawn an ester with 5 carbon atoms.
- 4.2 This question required students to describe the reflux technique. It was quite well answered but also discriminated very well with an index of 0.61 showing that only the best were able to access level three. Diagrams were better than in some recent papers although many students didn't show equipment as clearly cross-sectional. Safety precautions were well known but some didn't gain credit because they didn't explain why the precaution suggested was appropriate.
- 4.3 Most were able to score at least 1 mark here, but few scored all 3 marks.
- 4.4 Around 57% of students scored the mark for knowing that magnesium sulfate is a drying agent.
- 4.5 It was surprising that only around 30% of students knew that purity is linked to a sharp boiling point that is close to the known value from a data source. Either of these points would have gained the mark.

Question 5 Organic tests

- 5.1 The marks for this question were lower than expected. Students did not know that an acid chloride will produce misty fumes of HCl and give an immediate white precipitate of AgCl on addition of silver nitrate solution. More knew that there would be no immediate visible reaction with the 1-chloropropane, followed by the slow formation of a white precipitate. Either of these would have gained the second mark.
- 5.2 This was much better answered than Q5.1 and most students scored at least 2 of the 3 marks.

Question 6 NMR

- 6.1 This equation was quite well answered but also differentiated well.
- 6.2 Again this was quite well answered with nearly 50% gaining the mark for a structure with an asymmetric carbon atom.
- 6.3 This proved to be quite a demanding question although over 30% gained both marks. If the structure was correct, then the integration ratio was often correct too.
- 6.4 M2 was well known for explaining why peaks are singlets in ^1H NMR. Over half the students scored at least 1 mark but the structure proved more challenging than the explanation of singlets.

- 6.5 This proved to be a very demanding question. There were straightforward marks available for relating the chemical shifts given to structure fragments from the data booklet. However, students often failed to copy these fragments clearly enough or contradicted them with different answers.

Question 7 Calculation

- 7 Despite being unfamiliar, this calculation was reasonably well answered with nearly 40% gaining all four marks. A variety of methods could be used to get to the final formula and any valid working could gain full credit. Those who didn't score the marks often worked out the mass of water and carbon dioxide formed. This could have gained credit if they went on to relate this to the mass of carbon and hydrogen in L, but students who went down this route didn't often make this link. The best students used the mole ratio to work out how many C and H atoms there were in L. Going down this route usually led to the correct final answer although there were marks awarded for those who only got part way through.

Question 8 Synthesis and mechanism

- 8.1 Nearly 70% of students scored both marks showing that the reaction between an alkene and HBr was very well known.
- 8.2 Students often scored for the reagent but not the conditions here.
- 8.3 This fairly standard mechanism was well answered but also differentiated very effectively, with a discrimination index of 0.67.
- 8.4 Students often stated that the C=O bond is planar without including the other atoms attached to the C. As such, M1 was often missed although M2 and M3 were available. As a consequence, only around 12% scored all 3 marks but over 43% scored 2 marks.

Question 9 Amines

- 9.1 Most were able to score at least 1 mark for giving a correct methylamine structure to balance the equation. A variety of amine naming approaches are valid and so the mark scheme reflected this by allowing several variations. Despite this approach, the second mark was seen far less frequently.
- 9.2 Over half the students got at least 1 mark and the skeletal structures seen were much better attempted than in some past papers.
- 9.3 Most students got at least 2 of the 3 marks here. The final mark was often the one lost and drawing a fully displayed amine formed from a nitrile proved difficult for many. Common mistakes included having too few carbon atoms, and missing hydrogen atoms despite being given the balanced left-hand side of the equation.
- 9.4 This question required students to explain amine base strength. Many students got started, but the care needed in use of language meant that the question differentiated very well.

Question 10 Aromatic Chemistry

- 10.1 This extended response question on the structure and bonding in benzene had a mean mark of almost 3 out of 5. Virtually all of the students were able to score some of the marks, and almost 40% gained at least 4 marks.
- 10.2 The reagents were well known but equations often had errors, despite this question being set on several occasions in the past.
- 10.3 This familiar mechanism allowed over 80% of students to score at least 1 mark but only 32% scored all 3. Common mistakes in drawing the intermediate have been covered many times in reports on past papers so it was surprising to see so many students making the same errors.
- 10.4 The reagents required for the reduction of a nitro- compound to form an aromatic amine were quite well known and around 50% scored this mark.
- 10.5 The specification states that aromatic amines are used to manufacture dyes. Many students stated that the amines themselves are used as dyes and so failed to gain this mark. Less than 10% scored the mark here.

Question 11 Energetics

- 11.1 This relatively straightforward calorimetry calculation saw over 40% scoring all 4 marks. A significant number, however, failed to gain the final mark because the answer given was positive.
- 11.2 An extended response question with around 40% scoring at least 3 out of 5 marks. The comparison between standard enthalpy of combustion and a value derived from calorimetry was well done. Many also appreciated that mean bond enthalpies are derived from a range of compounds, but very few recognised that a calculation based on mean bond enthalpies does not account for the enthalpy changes in the transition from a liquid to a gaseous state and vice versa.

Mark Ranges and Award of Grades

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