



A Level Chemistry

7405/3

Report on the examination

Version: 1.0
June 2025

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General

Overall, this paper discriminated well with an average discrimination index for section A of 0.49 and for the overall paper 0.41. Students are again reminded of the importance of clear explanations when showing working for calculations. It is very difficult to give credit when the working area is covered with calculations and numbers but with no indication of what the student thinks the numbers represent. Examples of this were seen in Q2.4 where students often neglected to indicate whether a number calculated represented the number of moles of thiosulfate, iodine, or iodide, and in Q4.3 where a clearly labelled ICE (Initial, Change, Equilibrium) table is recommended to show the working.

There were also several questions where students were restricted in their ability to access the marks by not reading the question carefully. Examples of this included: Q2.1, where the question stated that the amount of thiosulfate used was the same in each experiment and asked for three *other* control variables, but many students nonetheless suggested amount of thiosulfate; Q2.2 where an explanation was asked for how the order with respect to iodide was found – but many students described how the orders for all three species were determined; Q2.7, where the question stated that the experiments were repeated with the same stopwatch and the same concentrations and volumes of the three reactants – but many students suggested changes to the stopwatch or to reactant concentrations as a way of reducing the uncertainty; Q3.4, where the question described a reaction between iron filings and copper(II) sulphate but many students wrote equations and gave explanations based on reactions between other species; and Q5.1 where the question stated that the oxidation was done using distillation and asked for reference to the IR spectra of the original samples – but many students discussed products of oxidation under reflux and IR spectra of oxidation products rather than of the original samples.

Question 1

- 1.1 This proved a relatively easy start with more than 50% of students achieving the mark. As with all enthalpy changes, the equation can be derived from the definition which in this case refers to the enthalpy change when one mole of an ionic compound is dissolved in water to form an infinitely dilute solution.
- 1.2 This calculation discriminated very well with more than 50% achieving full marks and less than 5% failing to score. Typical mistakes included omitting to use the amount of KOH and the enthalpy of solution to calculate q , with many students assuming that the enthalpy of solution was equal to q . A second mistake was seen in the work of those students who calculated the temperature change and then converted 12.3 into Kelvin by adding 273. Because this is a temperature *change* it can be calculated as either the difference between 30.4 and 18.1 or the difference between 303.4 and 291.1 – in both cases an answer of 12.3 is obtained. As in any question, ECF was possible from incorrect calculations of amount of KOH, of q and of ΔT – but, as mentioned above, this is only possible when the working is clear.
- 1.3 Almost 75% of students scored 2/2 here so this calculation is generally well understood. Most who failed to score or only scored 1 mark were also those who did not start by drawing a cycle to show the relationship between the values given.

- 1.4 Over 50% of students correctly referred either to heat losses or incomplete dissolving of the solute. A common incorrect response referred to partial covalency, showing confusion between this situation and a Born-Haber cycle being compared with a theoretical lattice energy.

Question 2

- 2.1 Over 60% of students scored 2 or more marks here with a common incorrect suggestion for a control variable being pressure – which only has an effect on the rate in gaseous systems.
- 2.2 Only around 25% of students scored all 3 marks here with many neglecting to mention the importance of the concentrations of H_2O_2 and H^+ being constant when deciding the effect of $[\text{I}^-]$. Misuse of terminology also cost some students a mark with references to the rate halving when $[\text{I}^-]$ doubled showing confusion between the concepts of rate and time. Alternative answers were possible based on pairs of results other than experiments 3 and 4 but the necessary explanations in such cases are trickier to produce.
- 2.3 ECF was allowed here from the orders given in Q2.2 and for the units from the rate equation itself. Nearly 50% of students scored both marks.
- 2.4 The surprise in this question was the number of students who demonstrated confusion between iodine (I_2) and iodide (I^-). Students were asked to determine the rate of production of iodine, but many attempted calculations based on the amount and concentration of iodide rather than the amount and concentration of iodine. As mentioned in the general comments, this was a question where many students would have benefitted from clearer explanation of their working. For example, ECF from M1 could be applied if it was clear that students thought they had calculated the amount of iodine in the first step – but many did not make this clear.
- 2.5 Just over 50% of students scored this mark with many other answers ‘close’ but lacking clarity – many students just offered ‘human error’ as the answer but this needs to be elaborated as to the nature of the source of the error.
- 2.6 This question required students to make use of the total uncertainty in the times recorded, which was given in Q2.5, together with the time recorded for experiment 3 in Table 3. Many students either overlooked this data or added the two uncertainties from Q2.5 – despite one of them being described as the ‘total’.
- 2.7 Nearly 50% of students appreciated that the way to reduce the percentage uncertainty in the times recorded is to increase the time for the reaction, but only around 15% were also able to suggest a suitable way of achieving this – by increasing the amount of thiosulfate or lowering the temperature. As noted above, many students suggested options that were excluded by the information given in the question.

Question 3

- 3.1 Around 60% of students scored at least 2/3 marks here with many recognising that the Fe electrode should be Pt and the NaOH should be KNO₃. For the third mark many students missed it by not referring to the concentration and instead implying that it was the choice of acid itself that was the mistake rather than its concentration being wrong.
- 3.2 Most students made the correct choice here.
- 3.3 Approximately 30% of students were able to give the correct equation for the overall cell reaction with many reversing the equation or attempting a half-equation. The information given in the question is that the Fe³⁺/Fe²⁺ electrode is the positive electrode which should allow students to work out: Fe³⁺ + e⁻ → Fe²⁺ and, conversely, H₂ + 2e⁻ → 2 H⁺. Combining these gives the answer of 2 Fe³⁺ + H₂ → 2 Fe²⁺ + 2 H⁺.
- 3.4 There were many confused answers here with many students not paying enough attention to the information given in the stem of the question. The stem describes that iron filings are reacted with copper(II) sulfate, which should point students to their equation needing to start with Fe(s) and Cu²⁺(aq) as the reactants. Table 4 provided the data for this question and included 2 half-equations containing 3 different iron species and 3 equations containing 3 different copper species. Students therefore need to be very specific about which half-equations they are referring to and this is best done by referring, as on the mark scheme, to the fact that the electrode potential for the Fe³⁺/Fe²⁺ electrode is more negative than that for the Cu²⁺/Cu electrode. Overall the question discriminated very well with close to 30% of students achieving at least 4/6.

Question 4

- 4.1 Nearly 90% of students were able to give the correct expression for K_c with the commonest mistakes being the use of '+' symbols and missing subscripts or superscripts on symbols.
- 4.2 Over 50% of students scored at least 1/2 but a lack of clarity in the answers meant that less than 5% scored 2 marks. A majority of students realised that the 'quenching' would stop the reaction but failed to be clear about the explanation of this being that the equilibrium would not then shift to compensate for the iodide being removed during the titration.
- 4.3 Students are strongly recommended to use an ICE chart to organise the working for this type of calculation – and to spread it across the page to give room for clear working, e.g.

	2 Fe ³⁺	+	2 I ⁻	⇌	2 Fe ²⁺	+	I ₂
I / mol	n Fe ₂ (SO ₄) ₃ = $\frac{50 \times 0.015}{1000}$ so n Fe ³⁺ = 7.5 × 10 ⁻⁴ × 2 = 1.5 × 10 ⁻³		n KI = $\frac{50 \times 0.015}{1000}$ so n I ⁻ = 7.5 × 10 ⁻⁴		0		0
C / mol	-4.5 × 10 ⁻⁴ (1:1 ratio with I ⁻)		7.5 × 10 ⁻⁴ - 3 × 10 ⁻⁴ = -4.5 × 10 ⁻⁴		+4.5 × 10 ⁻⁴ (1:1 ratio with I ⁻)		+4.5 × 10 ⁻⁴ /2 (1:2 ratio with I ⁻)
E / mol	1.05 × 10 ⁻³		3 × 10 ⁻⁴		4.5 × 10 ⁻⁴		2.25 × 10 ⁻⁴

The key to using this layout correctly is to remember that the ratios shown in the balanced equation apply to the changes. Nearly 50% of students scored at least 5/6 with many failing to recognise that the amount of Fe³⁺ is twice the amount of Fe₂(SO₄)₃.

Question 5

- 5.1 This is the Levels of Response question and almost 25% of students were able to access level 3 while around 65% accessed Level 2 or above. Students were strong on stage 2, with most including all three pieces of indicative content in that stage. However, in stage 1 many students found it tricky to produce properly balanced equations for oxidation of the alcohols with [O] and many forgot water as the second product. In stage 3, as mentioned above, many students failed to read the question carefully enough and produced an answer that discussed the IR spectra of the carbonyls instead of the IR spectra of the original alcohols. 3b and 3c were still accessible in such cases for a clear description of how to use the fingerprint region.
- 5.2 The drawing of apparatus diagrams continues to be a skill that needs more practice although most students did attempt a cross-sectional line diagram. The inclusion of a thermometer is a mistake in a reflux apparatus, and this cost many students M2.
- 5.3 Over 60% of students attained this mark which now seems to be a more familiar answer.

Question 6

- 6.1 Although alternative options such as 'geometric isomerism' or 'cis-trans isomerism' were allowed on the mark scheme, it was surprising how often these answers were seen given that the specification does not use that terminology as it has been replaced by the idea of *E-Z* isomerism. Including the alternative answers, however, nearly 80% of students achieved this mark.
- 6.2 Close to 60% of students scored at least 2/3 but many failed to recall a suitable use.
- 6.3 Only 25% of students scored full marks here with lots of slips in presenting the formula.

Section B

Some students need to pay more careful attention to the instructions given at the start of Section B about how to complete the answers by shading in the lozenge, crossing out an incorrect answer and then circling a crossed-out answer if it is then decided to be correct.

There were again quite a few instances of crossed out and circled answers alongside shaded lozenges – which must be treated as two answers and so marked incorrect.

The most accessible items (answered correctly by more than 80% of students) were questions 10, 15, 18 and 25.

The least accessible questions (< 55% success rate) were 8, 12, 14, 21, 31, 35 and 36.

Unfortunately, an erratum notice had to be issued for Question 11 due to a typo in one of the distractors, option D: SiO₂ had to be substituted for the incorrect SiO₃. The vast majority of students thankfully had the erratum notice delivered to them; detailed analyses showed that there was no discernible difference in the performance on this question between that majority of students and the small minority who were not told about the error. The question, answered correctly by just over 75% of students, had one of the best discrimination indices of all the Section B questions, and so functioned well.

Mark Ranges and Award of Grades

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