Diploma Programme
Programme du diplôme
Programa del Diploma

Chemistry
Higher level
Paper 1B

31 October 2025

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

Candidate session number

2 hours [Paper 1A and Paper 1B]

Instructions to candidates

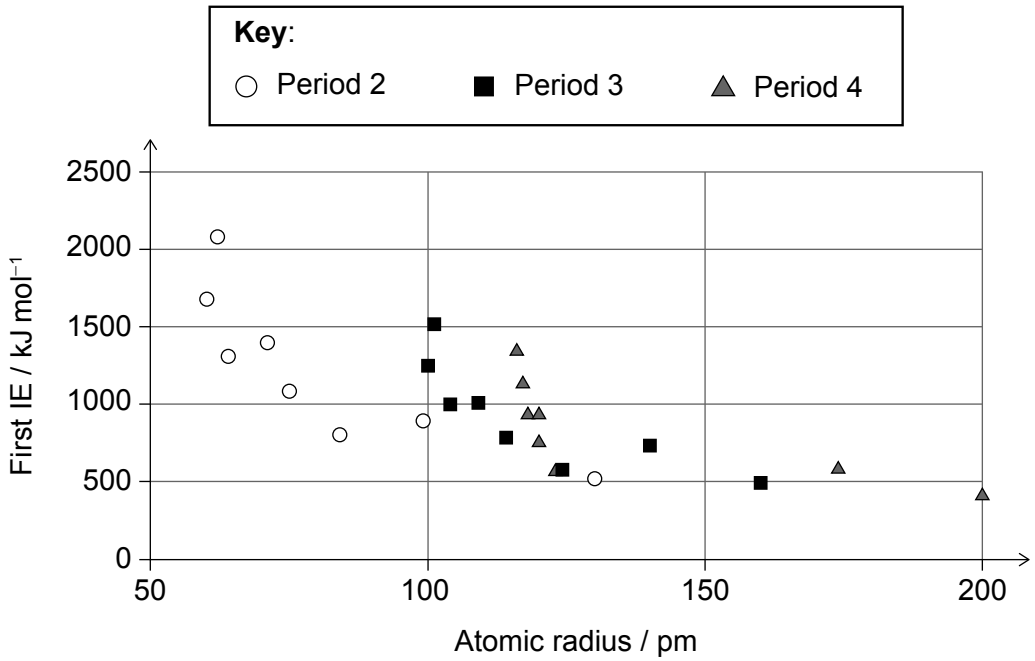
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- A clean copy of the **chemistry data booklet** is required for this paper.
- The maximum mark for paper 1B is **[35 marks]**.
- The maximum mark for paper 1A and paper 1B is **[75 marks]**.

8825 – 6220

Section B

Answer **all** questions. Answers must be written within the answer boxes provided.

1. The graph shows the variation of the first ionization energy with atomic radius for periods 2, 3 and 4 of the periodic table, with the d-block elements omitted.



(a) Annotate the graph with an additional data point, marked with a cross (X), for scandium. Use sections 9 and 10 of the data booklet. [1]

(b) Suggest why there might be a link between the two variables in the graph. [1]

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(Question 1 continued)

(c) The graph shows a relationship between first ionization energy and atomic radius.

(i) State the type of relationship between the variables. [1]

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(ii) Compare and contrast the trends shown by the different periods. [2]

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2. A teacher gave the class an experimental assignment to determine the concentration of aqueous sodium hydroxide, NaOH, using 2.00 mol dm^{-3} hydrochloric acid, HCl, a thermometer and laboratory glassware.

(a) **Student A** used a 50 cm^3 measuring cylinder to make the following mixtures of the two solutions in a 125 cm^3 conical flask and measured the highest temperature for each mixture.

Volume HCl ± 0.5 / cm^3	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0
Volume NaOH ± 0.5 / cm^3	50.0	45.0	40.0	35.0	30.0	25.0	20.0	15.0	10.0	5.0	0.0
Temperature ± 1 / °C	22	25	28	30	33	33	32	30	27	25	22

(i) Suggest **one** health and safety risk. [1]

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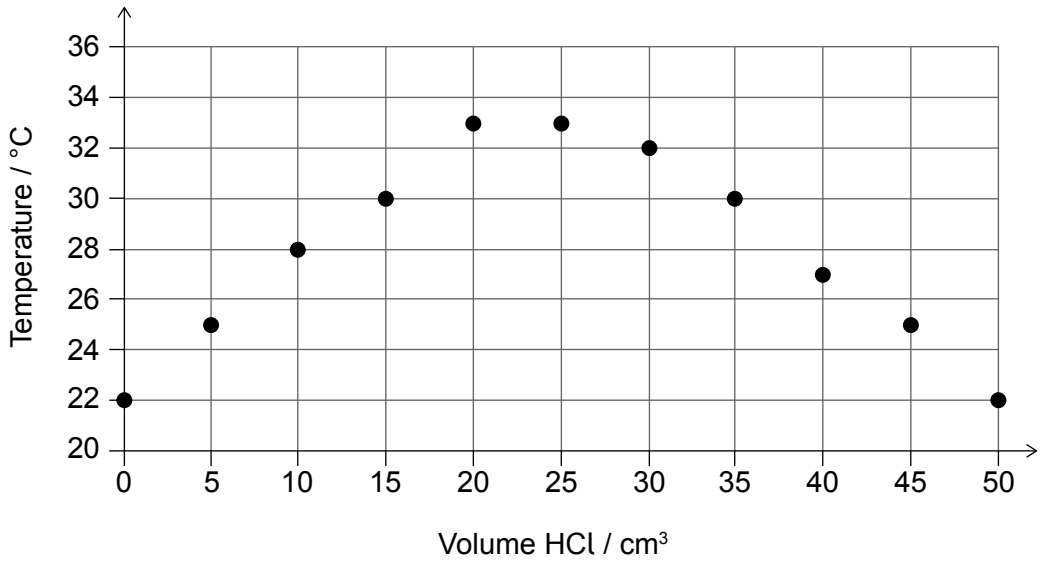
(ii) Use a ruler to draw straight lines of best fit through the increase and the decrease in temperature to show where they intersect. [1]



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(Question 2 continued)

(iii) The enthalpy change of the neutralization, ΔH, in $kJ\,mol^{-1}$, may be found from the temperature rise, ΔT, and the volume, V, of HCl in mixtures where HCl is the limiting reagent, using the expression:

$$\Delta H = \frac{50.0 \times 4.18 \times \Delta T}{2.00 \times V}$$

Determine the percentage uncertainty in the temperature rise, using the precision with which the temperature was measured. [2]

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(iv) State **two** assumptions that are made when using the formula in part (a)(iii) to calculate the enthalpy of neutralization. [2]

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(Question 2 continued)

(b) **Student B** used a slightly different technique, transferring 25.00 cm^3 of NaOH to a 125 cm^3 conical flask, using a pipette, and then adding the HCl, 5.00 cm^3 at a time from a burette, measuring the steady temperature at each step.

Volume HCl ± 0.05 / cm^3	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
Temperature ± 1 / °C	22	25	28	30	32	32	31	30	29	29	28

(i) Suggest, giving your reason, which student has the preferable method from a green chemistry perspective. [1]

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(ii) State, giving your reason, which student has the more precise results. [1]

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(iii) Deduce whether this difference in precision would significantly affect the uncertainty of the concentration of NaOH calculated from the point at which the lines intersect. [1]

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(Question 2 continued)

(iv) Comment on how the recorded temperature varies, with volume of HCl, for the two methods. [2]

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(v) Suggest why, when Student A added 45 cm^3 of HCl the temperature only rose to 25 °C but, when Student B added 45 cm^3 of HCl, the temperature rose to 29 °C. [1]

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(vi) Deduce, giving the reason, for which volume reading the temperature would be most affected by heat lost to the surroundings. [2]

Student: . . . . . Volume reading: . . . . . .

Reason: . . . . . .

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(vii) Suggest a change to the apparatus that would reduce this heat loss. [1]

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(viii) Suggest another advantage of the modification made in part (b)(vii). [1]

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3. Recrystallization is a technique frequently used to purify solids.

(a) Describe how the technique is carried out. [3]

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(b) State the most important factor to be considered when choosing a solvent for recrystallization. [1]

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(c) Outline how impurities with differing solubilities are separated from the desired product. [2]

Less soluble impurity removed: . . . . . .

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More soluble impurity removed: . . . . . .

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(Question 3 continued)

(d) The initial amount of solvent is critical. Deduce how using too much and too little solvent would affect the yield/purity of the product. [2]

Too much solvent: . . . . . .

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Too little solvent: . . . . . .

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(e) Chlorinated hydrocarbons were once widely used as solvents for recrystallization. State the specific environmental problem, other than global warming, which led to international agreements on limiting their use. [1]

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4. Half-cells such as

$$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$$

can be connected to other half-cells to form a voltaic cell.

(a) Describe how you would connect the $Fe^{3+}|Fe^{2+}$ half-cell to another half-cell to compare their potentials. [2]

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(b) The reduction potential, ***E***, of the $Fe^{3+}|Fe^{2+}$ electrode varies with the concentration of the ions according to the equation:

$$E = 0.77 + \frac{RT}{F} \ln \frac{\left[Fe^{3+}\right]}{\left[Fe^{2+}\right]}$$

Determine the reduction potential at 25 °C, if $[Fe^{2+}] = 1.37 \times 10^{-2}\,mol\,dm^{-3}$ and $[Fe^{3+}] = 3.25 \times 10^{-4}\,mol\,dm^{-3}$.

Use section 2 of the data booklet. [3]

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