Diploma Programme
Programme du diplôme
Programa del Diploma

Chemistry
Standard level
Paper 1B

16 May 2025

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

Candidate session number

1 hour 30 minutes [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 **[25 marks]**.
- The maximum mark for paper 1A and paper 1B is **[55 marks]**.

2225 – 6217

11 pages

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Answers written on this page
will not be marked.

Section B

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

1. The concentration of calcium ions, Ca^{2+}, in aqueous solution can be determined by titration with ethylenediaminetetraacetic acid (EDTA), or by atomic absorption spectrophotometry.

(a) EDTA solution must be standardized before use, by titrating it with a standard solution of calcium chloride.

An accurately weighed mass of powdered calcium carbonate was dissolved in concentrated hydrochloric acid and heated to remove all of the carbon dioxide. After cooling, the calcium chloride solution was made up to exactly 250.0 cm^3.

(i) State the most appropriate glassware to make 250.0 cm^3 of a Ca^{2+} solution. [1]

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(ii) Describe the steps involved in preparing the standard solution by dilution of the initial calcium chloride solution. [2]

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(b) Calcium chloride is not used to make the standard solution because it readily absorbs water.

Suggest how solid calcium chloride, $CaCl_2$, could be treated in the laboratory to remove all of the absorbed water. [2]

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(Question 1 continued)

(c) A sample of tap water was titrated against the standardized EDTA solution, using Eriochrome Black T as an indicator.

The following titration data were obtained.

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Final burette reading / $cm^3 \pm 0.05\,cm^3$	26.15	34.25	29.30	32.20
Initial burette reading / $cm^3 \pm 0.05\,cm^3$	0.00	10.00	5.00	8.00
Volume added / cm^3	26.15	24.25	24.30	24.20

(i) Suggest **two** reasons why the volume added in trial 1 is much larger than the other values. [2]

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(ii) State the name given to a value that differs significantly from others. [1]

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(Question 1 continued)

(iii) Suggest a reason why trial 1 should not be included when finding the mean volume of EDTA used. [1]

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(iv) Calculate the percentage uncertainty in the volume of EDTA used in trial 2. [1]

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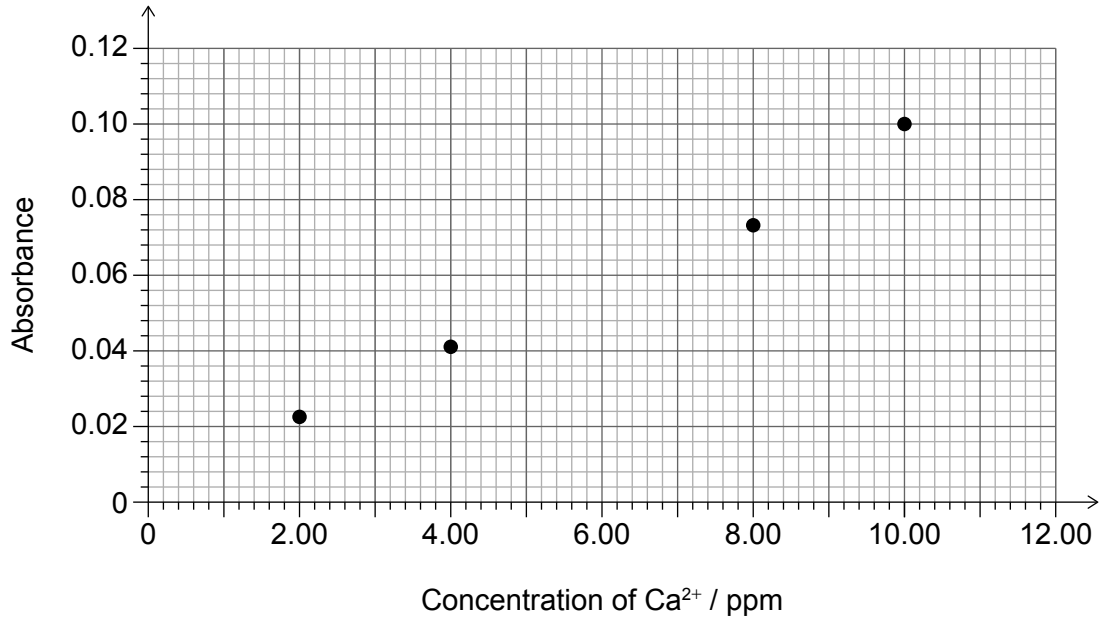
will not be marked.

(Question 1 continued)

(d) A standard stock solution of calcium chloride was diluted to produce several solutions with accurately known concentrations. The absorbance of these solutions was measured in a spectrophotometer that was calibrated with distilled water.

(i) Draw a line of best fit on the graph. [1]



(ii) Determine the concentration, in ppm, of Ca^{2+} ions in a sample of tap water with an absorbance of 0.090. [1]

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(iii) The 4.00 ppm solution was made by diluting 2.00 cm^3 of the stock solution to 25.00 cm^3. Calculate the concentration, in ppm, of the stock solution. [1]

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2. Spinach leaves were boiled in water for varying times. The water was cooled and tested for the presence of Fe^{2+} ions by titration with standardized potassium manganate (VII) solution, $KMnO_4$ (aq).

(a) Three trials were performed for each boiling time. In each trial, 10.0 g of spinach was boiled in a beaker containing 250 cm^3 of tap water for 5, 10, 15, and 20 minutes. The spinach was removed by filtration and the solution was bottled and stored in a refrigerator until titration was performed.

(i) State the independent and dependent variables. [1]

Independent variable: . . . . . .

Dependent variable: . . . . . .

(ii) Suggest **two** additional experimental conditions that should be controlled to ensure that the methodology of this investigation is valid. [2]

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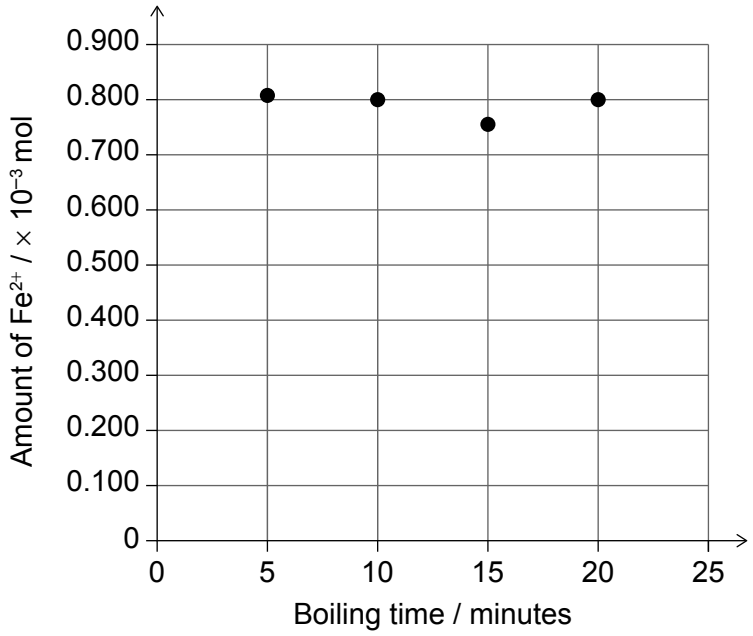
(b) The average results from (a) were graphed.



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(Question 2 continued)

(i) State the relationship shown in the graph between the amount of Fe^{2+} released from the spinach and the boiling time. [1]

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(ii) Comment on the range and quantity of measurements used in the investigation. [2]

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(c) The initial hypothesis was that more Fe^{2+} would be extracted from the spinach leaves as the boiling time increased.

(i) Evaluate, giving a reason, whether the results support the hypothesis. [1]

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(ii) Suggest **one** modification to the investigation that would make it more suitable for testing the hypothesis. [1]

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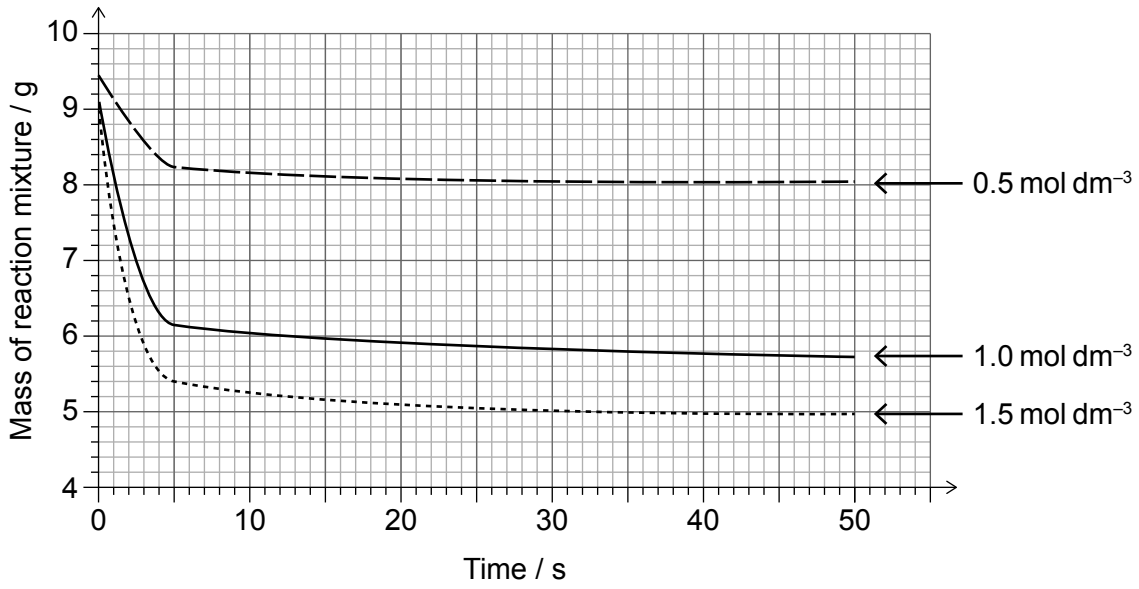
3. The reaction of solid sodium hydrogencarbonate, $NaHCO_3(s)$, with hydrochloric acid, $HCl(aq)$, was investigated using the same mass of solid and a constant volume of different concentrations of acid. A data logger was used to measure the mass of the reaction mixture every five seconds.

(a) The results were graphed.



(i) Determine, by annotating the graph, the initial rate of release of $CO_2(g)$, in $g\,s^{-1}$, with the $1.5\,mol\,dm^{-3}$ $HCl(aq)$. [2]

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(ii) Determine the average rate of release of $CO_2(g)$, in $g\,s^{-1}$, with $0.5\,mol\,dm^{-3}$ $HCl(aq)$ over the first 20 seconds. [1]

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(Question 3 continued)

(b) Suggest, with a reason, whether $NaHCO_3(s)$ **or** $HCl(aq)$ was the limiting reagent in the reactions using 0.5 and 1.0 $mol\,dm^{-3}$ $HCl(aq)$. [1]

Limiting reagent: . . . . . .

Reason: . . . . . .

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