Diploma Programme
Programme du diplôme
Programa del Diploma

Chemistry
Higher level
Paper 1B

15 May 2026

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

Session number

2 hours [Paper 1A and Paper 1B]

Instructions to students

- 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]**.

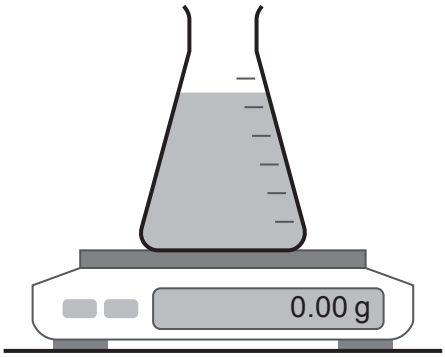
2226 – 4229

11 pages

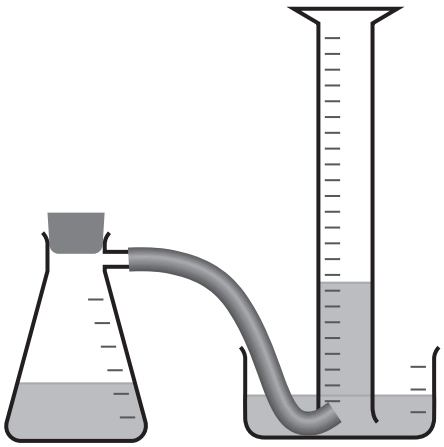
Section B

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

1. A student studied the reaction of hydrochloric acid, HCl, with solid calcium carbonate, $CaCO_3$, using two different methods.



Method 1



Method 2

(a) (i) Write an equation, including state symbols, for the reaction. [2]

. . . . . .

(ii) Deduce the feature of the reaction that allows the rate to be measured with both methods. [1]

. . . . . .

(iii) The experimental design required calcium carbonate, $CaCO_3$, to be in excess.

Calculate the minimum mass of $CaCO_3$, in g, required when 50.0 cm^3 of 0.15 mol dm^{-3} HCl are used. Use section 7 of the data booklet. [2]

. . . . . .

. . . . . .

. . . . . .

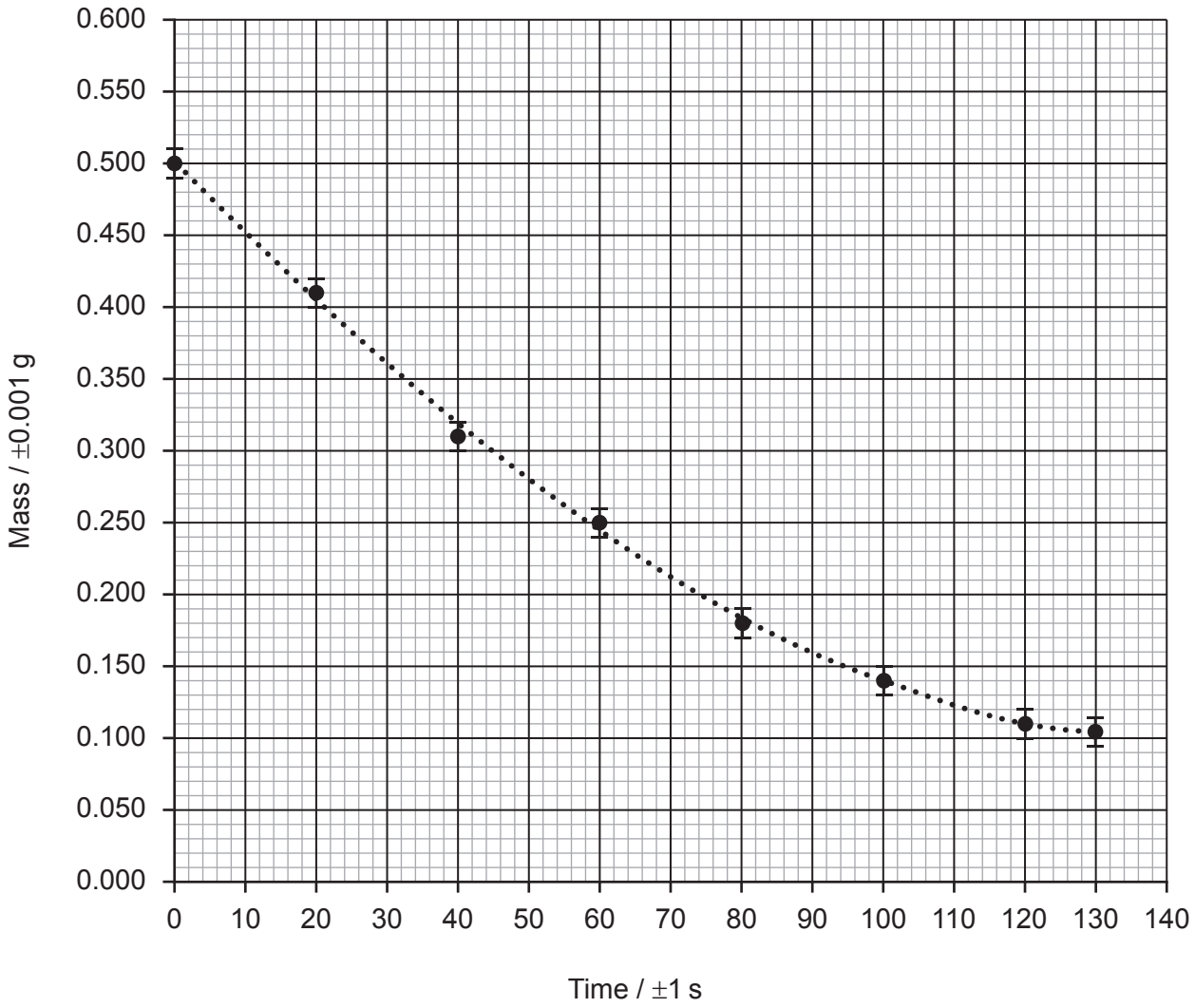
. . . . . .

(This question continues on the following page)

(Question 1 continued)

(b) Using method 1, the student placed the flask with the aqueous HCl on the balance and zeroed the balance before adding 0.500 g of $CaCO_3$. The mass was recorded every 20 seconds until the end of the reaction.

The student plotted the results of the average of three trials with uncertainties obtaining a graph.



Determine the initial rate of reaction, showing your working on the graph. [2]

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 1 continued)

(c) The student repeated the experiment using method 2.

(i) Calculate the volume of gas collected in the measuring cylinder when the reaction goes to completion at $T = 20\,^{\circ}C$ and $P = 1.00 \times 10^5$ Pa. Use section 1 of the data booklet and your answer to part (a)(iii).

If you did not get an answer in part (a)(iii), use 0.250 g, although this is not the correct answer. [2]

. . . . . .

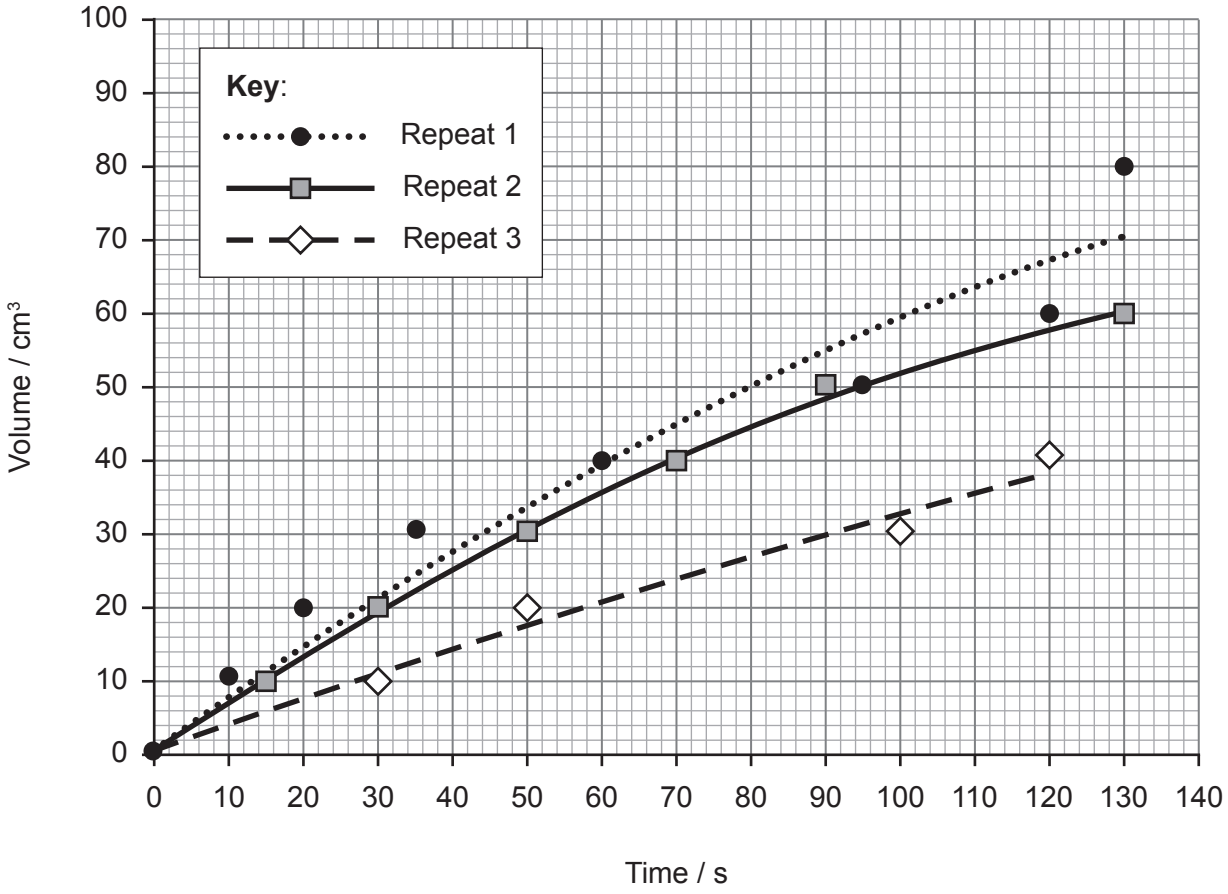
. . . . . .

. . . . . .

(This question continues on the following page)

(Question 1 continued)

(ii) Using method 2, the student transferred the aqueous HCl solution to the flask, added the $CaCO_3$ powder, and immediately sealed the flask. The time taken to collect each 10 cm^3 of gas was recorded until no further gas was collected. The experiment was repeated three times and raw data was plotted.



Suggest, with a reason, which method is more precise. Consider the data in part (b) and part (c)(ii). [1]

. . . . . .

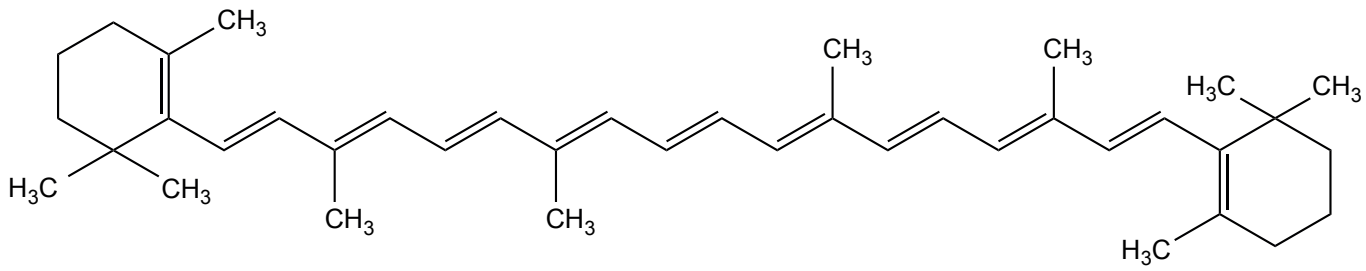
. . . . . .

(iii) State the type of error responsible for the lower precision in the selected method in part (c)(ii), indicating a possible reason for this error. [1]

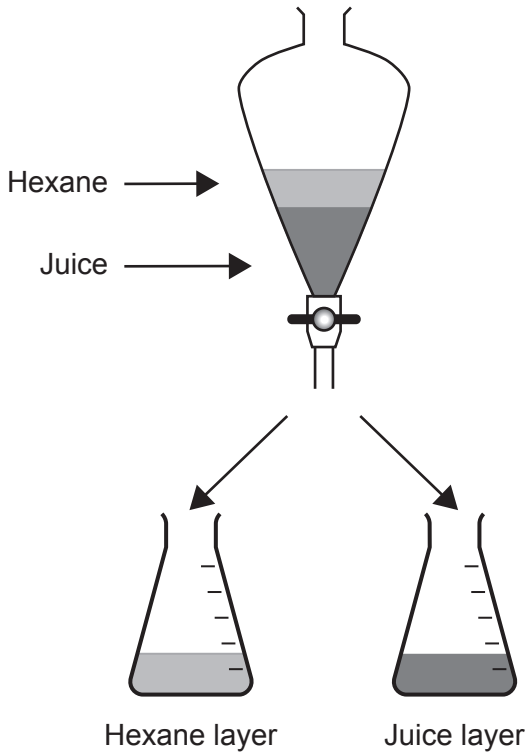
. . . . . .

. . . . . .

2. The carotenoid content of fresh tomato juice was studied using colorimetry. The structure of one of the carotenoids in a tomato, β-carotene, is shown.



(a) To separate the carotenoids, the filtered tomato juice was placed in a separating funnel with hexane, C_6H_{14}. After swirling the contents, the two immiscible solutions were collected in separate flasks.



Predict, in terms of intermolecular forces, in which solution the carotenoids will be found. [1]

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 2 continued)

(b) An absorption spectrum was used to select the wavelength at which the samples were to be analysed.

(i) Describe the contents of the required solutions. [2]

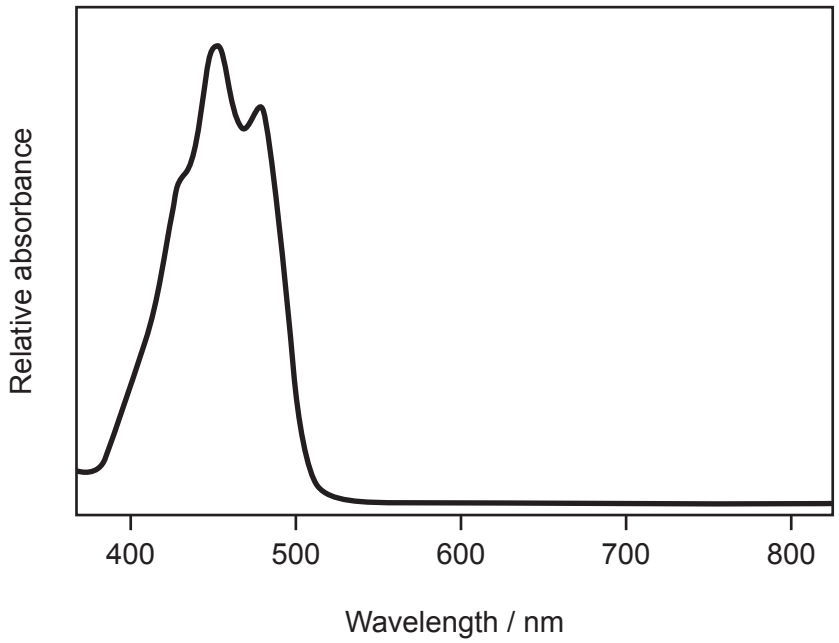
Reference solution: . . . . . .

. . . . . .

Blank: . . . . . .

. . . . . .

(ii) The obtained absorption spectrum is shown.



Suggest, with a reason, the most suitable wavelength for the determination of β-carotene. [2]

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 2 continued)

(iii) The quantitative determination of the carotenoids required the construction of a calibration curve. Suggest **two** requirements for a reliable calibration curve. [2]

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) Tomatoes also contain ascorbic acid, $C_6H_8O_6$.

(i) The student determined the content of ascorbic acid by titration with iodine, I_2. This method is based on the following redox reaction:

$$C_6H_8O_6(aq) + I_2(aq) \rightarrow C_6H_6O_6(aq) + 2I^-(aq) + 2H^+(aq)$$

Deduce which species acts as an oxidizing agent writing a half-equation to justify your conclusion. [1]

. . . . . .

(ii) Starch is added towards the end of the titration.

Explain, with a reason, the use of starch in this titration. [2]

. . . . . .

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 2 continued)

(iii) For the titration, 10.000 g (±0.010 %) of tomato juice were placed in a conical flask and diluted with 50 cm^3 of water. The titration was performed using a standardized 0.500 mol dm^{-3} (±0.30 %) solution of iodine, $I_2(aq)$, and a 25.00 cm^3 burette (±0.05 cm^3). The average volume of titrant was 1.20 cm^3.

$$M(C_6H_8O_6) = 176.14\,g\,mol^{-1}$$

Calculate the mass percentage concentration of ascorbic acid. [3]

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

(iv) Calculate the percentage uncertainty of the volume of the titrant showing your working. [1]

. . . . . .
. . . . . .

(v) The percentage uncertainty of the final result was determined to be 8.6 %. State the final concentration of ascorbic acid with percentage uncertainty and the final concentration of ascorbic acid with absolute uncertainty.

If you did not obtain an answer in part (c)(iii) use 2.0 %, though this is not the correct answer. [2]

Result from (c)(iii)	With percentage uncertainty	With absolute uncertainty
. . . . .	. . . . .	. . . . .

(This question continues on the following page)

(Question 2 continued)

(vi) Suggest **one** change in the method to reduce the major source of uncertainty. [1]

. . . . . .

. . . . . .

(d) Experimental results could be compared to those in a database. Suggest **two** factors that must be considered when comparing **these** experimental results to data from a given source. [2]

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

3. The dissociation constant, K_a, of ethanoic acid was determined experimentally by measuring the pH of a standardized 0.01 mol dm^{-3} ethanoic acid solution with a calibrated pH probe.

The following pH values were obtained:

Trial	pH (±0.1)
1	3.5
2	3.3
3	3.4

(a) Determine the K_a for Trial 1, by completing the table. Use section 1 of the data booklet. [3]

Trial	pH (±0.1)	$[H_3O^+]$	$[CH_3COOH]$	K_a
1	3.5	. . . . .	. . . . .	. . . . .

(b) A student calculated the K_a values for the other two trials and their experimental error.

Determine the experimental error for trial, considering a theoretical value of 1.7×10^{-5} for the K_a of ethanoic acid. Use the value 9.0×10^{-6} if you did not get a value in part (a). [1]

Trial	pH (±0.1)	K_a	Experimental error (%)
1	3.5	. . . . .	. . . . .
2	3.3	3×10^{-5}	77
3	3.4	2×10^{-5}	18

(c) Comment on the impact of the uncertainty of the pH probe on the accuracy of the results. [1]

. . . . . .

. . . . . .

References:

2.(b)(ii) With permission from Harvard Forest.