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

A	N	S	W	E	R	S	(	?)	

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]**.

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8 pages

8825–6208

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Section B

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

1. A student needed to make 500.0 cm^3 of a 0.2500 mol dm^{-3} solution of sodium hydroxide, NaOH, from the solid for a titration.

(a) Calculate the mass of sodium hydroxide needed. [1]

$n = cV = 0.2500\ \text{mol dm}^{-3} \times 500\ \text{cm}^3 / 1000\ \text{cm}^3\ \text{dm}^{-3}$

$= 0.1250\ \text{mol}$

$m = n \times mm = 0.1250\ \text{mol} \times (22.99 + 1.01 + 16) = 5.00\text{g}$ (1)

(b) Describe the process of preparing a standard solution from a solid using a volumetric flask. [3]

1) On a scale, tare beaker and add 5.00g of NaOH(s) (1)

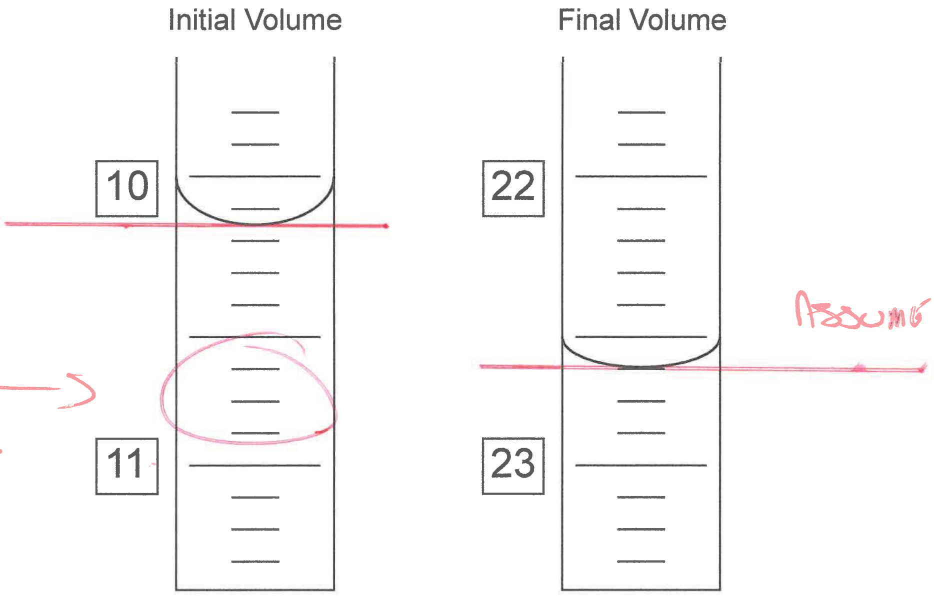
2) Dissolve NaOH by adding <150 cm^3 of distilled water. (1)

3) Transfer to 250.00 cm^3 vol. flask and add distilled water up to graduated line. Seal and mix contents. (1)

(c) A 10.00 cm^3 sample of the sodium hydroxide solution was titrated with 0.2000 mol dm^{-3} solution of hydrochloric acid, HCl (aq).

10.15 cm^3

ERROR! SHOULD BE → 4 increments.



ASSUME: 22.60 cm^3

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(Question 1 continued)

Determine the actual concentration of the sodium hydroxide solution for this titration trial. Record the initial and final volume in the data table to the correct number of significant figures. [2]

	NaOH trial
Initial volume / cm^3	10.15
Final volume / cm^3	22.60
Volume used / cm^3	12.45

Concentration: $n_{HCl} = 0.2000 \times 12.45/1000 = 2.490 \times 10^{-3}$ mol/dm^3

$n_{NaOH} = n_{HCl}$ $\therefore n_{NaOH} = 2.490 \times 10^{-3}$ (1)

$c = n/V = \dfrac{2.490 \times 10^{-3}}{10.00/1000} = \underline{0.2490 \text{ mol dm}^{-3}}$ (1)

4 sig. fig.

(d) Calculate the percentage error for the concentration of the sodium hydroxide based on the calculation from (c) and the intended value of 0.2500 mol dm^{-3}.

If you did not determine a concentration value for (c) use 0.2155 mol dm^{-3} although this is not the correct answer. [1]

$\left|\dfrac{0.2500 - 0.2490}{0.2500}\right| \times 100\% = \underline{\underline{0.4\%}}$ (1)

(e) Explain why the sodium hydroxide solution must be standardized. Assume there are no systematic errors. [2]

NaOH is hygroscopic and will be impure due to absorbing H_2O or reacting with atmospheric CO_2 (1). As a result the concentration calculated will be more dilute than expected (1)

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(Question 1 continued)

0.2490 mol dm^{-3}

(f) The standardized sodium hydroxide solution from (c) was used to titrate a propanoic acid solution of unknown concentration.

(i) Calculate the concentration of the propanoic acid if 15.00 cm^3 of its solution was neutralized with 20.00 cm^3 of standardized sodium hydroxide.

If you did not determine the concentration of sodium hydroxide in part (c), use 0.2155 mol dm^{-3} although this is not the correct answer. [1]

$n_{NaOH} = 0.2490 \times 20/1000 = 0.00498$

$n_{acid} = n_{OH} = 0.00498$

$\therefore c_{acid} = 0.00498 / 15.00/1000 = 0.3320$ mol dm^{-3} (1)

(ii) Determine the pH of the propanoic acid from (f)(i). Propanoic acid has a p*K*a of 4.87.

If you did not determine a concentration for the propanoic acid in (f)(i) use 0.2755 mol dm^{-3} although this is not the correct answer. [2]

$K_a = 10^{-4.87} = \frac{[A^-][H^+]}{[HA]} = \frac{[H^+]^2}{0.3320}$

$\therefore [H^+] = \sqrt{0.3320 \times 10^{-4.87}} \doteq 0.002116$ (1)

$pH = -\log(0.002116) = \underline{2.67}$ (1)

(iii) Evaluate the use of an indicator versus a pH probe to determine the end point of the titration of propanoic acid with sodium hydroxide. [3]

	Pros	Cons
pH probe	more precise, continuous readings	calibration, maintenance, expensive, temp. sensitive (1)
INDICATOR	simple, quick, cheap	less precise, colour change subjective (1)

Overall: probe better for accuracy, indicator acceptable but less precise (1)

(iv) State the name of an indicator which could be used for the titration of propanoic acid with sodium hydroxide using section 18 of the data booklet. [1]

Weak acid/strong base → phenolphthalein (1)

2. A student was asked to identify an unknown metal with a mass of 1.28 g using calorimetry. The metal was placed in beaker **A** with boiling water at 100.00 °C until the metal reached the same temperature as the water. The metal was then quickly transferred to beaker **B** with 5.65 g of water which had an initial temperature of 25.00 °C. The final temperature of the water in beaker **B** and the metal was 26.77 °C.

Data for unknown metal sample	
Mass of unknown metal / g	1.28
Initial temperature of metal / °C	100.00
Mass of cool water in beaker **B** / g	5.65
Initial temperature of water in beaker **B** / °C	25.00
Final temperature of water in beaker **B** and metal / °C	26.77

(a) Determine the amount of energy transferred from the metal to the water in beaker **B** using sections 1 and 2 of the data booklet. [2]

$q = mC\Delta T$ $\therefore q = 5.65g \times 4.18 Jk^{-1}g^{-1} \times (26.77 - 25.00)$ (1)

$= 41.8\ J$ (1)

(b) Determine the specific heat capacity of the metal assuming the heat absorbed by the water in beaker **B** in (a) is equal to the heat released by the metal.

Use section 1 of the data booklet.

If you did not get an answer to (a) use 40.5 J although this is not the correct answer. [2]

$q = mC\Delta T$: $41.8J = 1.28g \times C \times (100 - 26.77)$

$= 93.7\ k \cdot g\ C$ (1)

$\therefore c = \frac{41.8J}{93.7 kg}$ $= \underline{0.446\ Jk^{-1}g^{-1}}$ (1)

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(Question 2 continued)

(c) State the name of the unknown metal using the table. [1]

Metal	**Specific heat capacity ($J\,g^{-1}\,K^{-1}$)**
Lead	0.129
Silver	0.235
Iron	0.449
Aluminium	0.897

Iron (1)

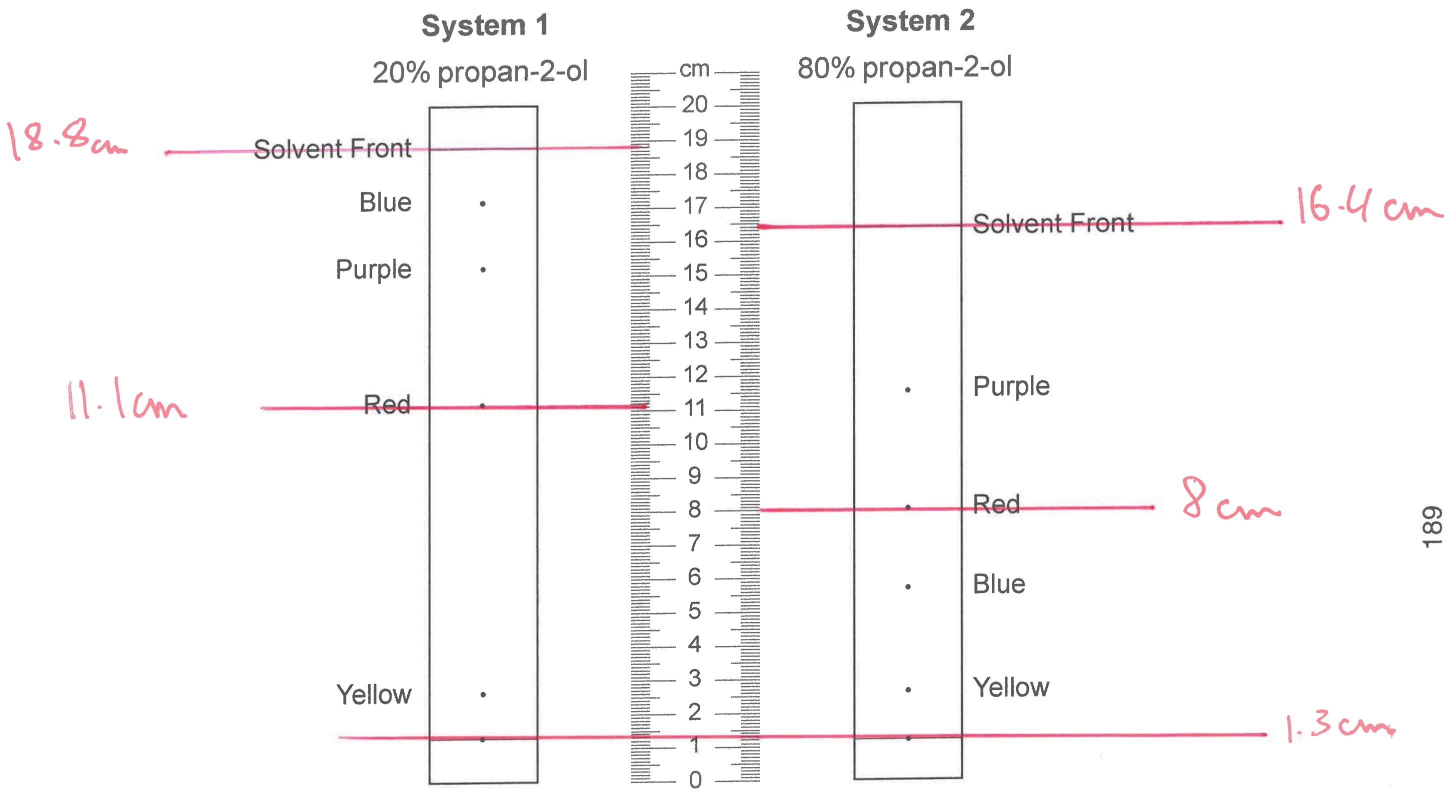
(d) Deduce **two** sources of systematic error for this experiment based on the results. [2]

- Heat capacity of apparatus (e.g. beaker or thermometer) (1)
- Heat loss to the surroundings (air) during transfer from beaker A to beaker B. (1)

(e) State another physical property that could be used to identify the metal without damaging the sample. [1]

Density. Record the mass of equal volumes of metal samples. Density value can be calculated using density = mass / volume. (1)

3. A student wanted to determine what colour inks were mixed to produce black ink and their relative polarities using paper chromatography. The student decided to use two different solvent systems for the separation, both a mixture of propan-2-ol and water. System 1 was 20% propan-2-ol and system 2 was 80% propan-2-ol.



(a) Chromatography chambers are sealed while the solvent is moving up the paper.

Explain why it is important to seal the chamber for proper experimental design. [2]

Evaporation of solvent as propan-2-ol is a volatile liquid. (1) Loss of solvent will vary the solvent concentration causing the pigment interaction with solvent to vary, (1) ∴ difficult to accurately compare Rf values.

(b) Explain why it is important to keep the start line horizontal and above the solvent level when running the chromatograph [2]

Horizontal start line: So all spots begin at the same location to provide equal path lengths for Rf calculation (1)

Above the solvent level: So sample does not dissolve directly into solvent, and sample travels with rising solvent / mobile phase (1)

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20% : $R_f = \frac{11.3 - 1.3}{18.8 - 1.3} = 0.56$

80% $R_f = \frac{8.0 - 1.3}{16.4 - 1.3} = 0.44.$

(Question 3 continued)

(c) Calculate the retardation factor, R_F, of the red ink in both chromatograms. [2]

Substances	R_F values
Red ink separated with 20% propan-2-ol	0.56
Red ink separated with 80% propan-2-ol	0.44

(1)
(1)

(d) Deduce, with a reason, which coloured ink is more polar, red or blue. [2]

Blue is more polar (1). In the less polar solvent (80% propan-2-ol) blue travelled a shorter distance, thus had a greater affinity for the polar paper than the less polar red. (1)

(e) The student hypothesized there were more than four coloured inks in the mixture.

Suggest how the student could modify this chromatography experiment to evaluate the hypothesis. [1]

Use a different solvent by further varying the ratio of propan-2-ol or, use a different stationary phase e.g. TLC paper (1)

(f) Explain how the separation of inks is achieved using paper chromatography. [2]

Dyes partition differently between stationary phase (water bound to cellulose/paper surface) and mobile phase (solvent using capillary action) (1). The dye more soluble in the mobile phase travels further, one that more strongly interacts with stationary phase travels less (1)