

Chemistry
Higher level
Paper 1B

2 hours [Paper 1A and 1B]

Instructions to candidates

- Do not open the examination paper until instructed to do so.
- Answer all questions
- Answers must be written in 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]**.

Section B

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

1. A student is conducting a series of tests to classify four solutions, labelled A, B, C and D, as weak or strong acids or bases.

(a) The results of the first test, electrical conductivity, are shown in the table.

| Solution | Brightness of bulb |
|----------|--------------------|
| A | Bright |
| B | Dim |
| C | Dim |
| D | Bright |

Classify A and B as weak or strong bases. Give a reason for your answer. [2]

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(b) In the second test, the student measures the pH of the solutions. The results are shown in the table.

| Solution | pH |
|----------|----|
| A | 14 |
| B | 9 |
| C | 5 |
| D | 1 |

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- (i) Calculate the $[H^+]$ in solutions A and C. [2]

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- (ii) Use your answer to part (i) to determine the difference in $[H^+]$ between solutions A and C. [1]

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(c) The final test involved the student adding small pieces of magnesium to solutions C and D.

- (i) Predict the rate of reaction of magnesium with solutions C and D. [1]

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- (ii) Classify C and D as weak or strong acids, giving a reason in each case. [2]

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- (iii) Suggest why the student did not add magnesium to solutions A and B. [1]

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2. Brass is an alloy composed of copper and zinc.

- (a) Explain how brass is harder than pure metals such as copper or zinc. [2]

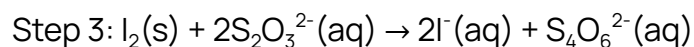
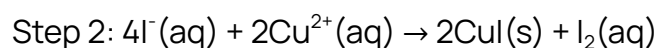
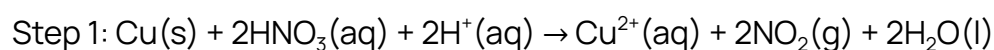
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- (b) A student carries out an experiment to calculate the percentage by mass of copper in a sample of brass with a mass of 0.750 g. The three steps of the reaction are shown.



Deduce the change in the oxidation state of the copper and the reducing agent in step 2. [2]

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(c) The I_2 produced in step 3 is titrated with 31.50 cm^3 of $1.00 \text{ mol dm}^{-3} \text{ Na}_2\text{S}_2\text{O}_3(\text{aq})$.

- (i) Calculate the amount, in mol, of $\text{S}_2\text{O}_3^{2-}(\text{aq})$ used in the titration. [1]

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- (ii) Determine the mole ratio of $\text{S}_2\text{O}_3^{2-}(\text{aq})$ in step 3 to $\text{Cu}(\text{s})$ in step 1. [1]

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- (iii) Determine the mass of copper in the sample of brass. [2]

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- (iv) Calculate the percentage composition by mass of copper and zinc in the sample of brass. [2]

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3. The boiling points and solubilities of five members of the alcohol homologous series are shown in the table.

| Alcohol | Formula | Boiling point (°C) | Solubility (g / 100 g) |
|-------------|---|--------------------|------------------------|
| Ethanol | $\text{CH}_3\text{CH}_2\text{OH}$ | 78 | Completely soluble |
| Propan-1-ol | $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ | 97 | Completely soluble |
| Butan-1-ol | $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ | 117 | 9 |
| Pentan-1-ol | $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ | 138 | 2.7 |
| Hexan-1-ol | $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ | 158 | 0.6 |

- (a) State the general formula of the alcohol homologous series. [1]

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- (b) Explain the increase in the boiling points of the five members of the alcohol homologous series. [2]

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(c) Suggest a reason why the solubility of the alcohol decreases from ethanol to hexan-1-ol. [1]

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(d) Predict the boiling point and solubility of decan-1-ol, the tenth member of the alcohol homologous series. [2]

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4. Potassium hydrogen carbonate, KHCO_3 , reacts with hydrochloric acid as shown.



(a) Determine the limiting reactant in the reaction if 6.96 g of KHCO_3 is reacted with 50.0 cm^3 of 2.00 mol dm^{-3} $\text{HCl}(\text{aq})$. [2]

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- (b) Determine the heat released, in J, for the reaction using the data in the table below. [2]

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|---|------|
| Initial temperature of solution / °C | 25.5 |
| Final temperature of solution / °C | 15.5 |
| Specific heat capacity of solution / J g ⁻¹ °C | 4.18 |

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- (c) Calculate the enthalpy change, ΔH , for the reaction in kJ mol⁻¹. [2]

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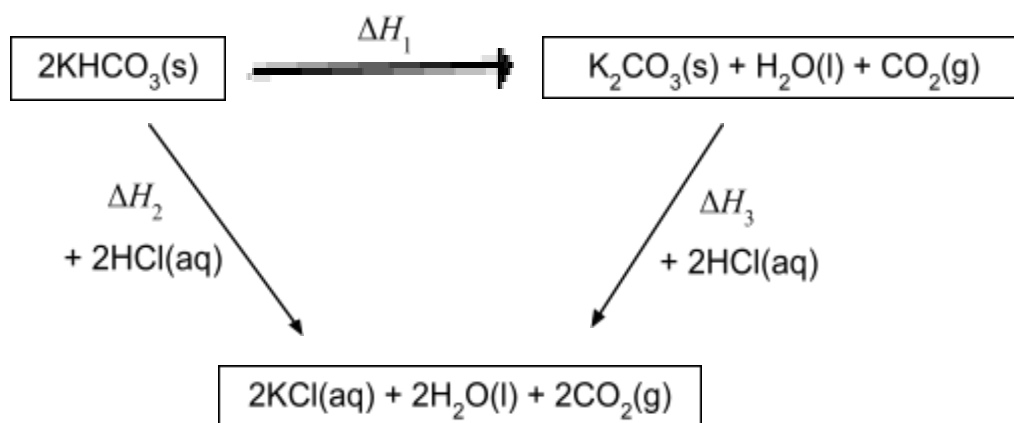
- (d) Suggest the main source of error in the experiment. [1]

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- (e) An energy cycle for the reaction is shown below. The enthalpy change for ΔH_3 was determined to be $-34.0 \text{ kJ mol}^{-1}$. Calculate the value of ΔH_1 using this value and your answer to part (c). [3]



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