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]

(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.

Step 1: $Cu(s) + 2HNO_3(aq) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + 2NO_2(g) + 2H_2O(l)$

Step 2: $4I^-(aq) + 2Cu^{2+}(aq) \rightarrow 2CuI(s) + I_2(aq)$

Step 3: $I_2(s) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$

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 mol dm^{-3} $Na_2S_2O_3(aq)$.

(i) Calculate the amount, in mol, of $S_2O_3^{2-}(aq)$ used in the titration. [1]

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(ii) Determine the mole ratio of $S_2O_3^{2-}(aq)$ in step 3 to Cu(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	CH_3CH_2OH	78	Completely soluble
Propan-1-ol	$CH_3CH_2CH_2OH$	97	Completely soluble
Butan-1-ol	$CH_3CH_2CH_2CH_2OH$	117	9
Pentan-1-ol	$CH_3CH_2CH_2CH_2CH_2OH$	138	2.7
Hexan-1-ol	$CH_3CH_2CH_2CH_2CH_2CH_2OH$	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.

$$KHCO_3(s) + HCl(aq) \rightarrow KCl(aq) + H_2O(l) + CO_2(g)$$

(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} HCl(aq). [2]

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

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

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

(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 kJ mol^{-1}. Calculate the value of ΔH_1 using this value and your answer to part (c). [3]