# Chemistry

## Standard Level

Paper 1B — Mock Examination

## Mock Exam 3

Calculator required

Time allowed: **40 minutes**

Maximum mark: **25 marks**

**Candidate information**

Candidate name: .....

Session number: .....

Date: .....

Topic emphasis: thermochemical measurement of an enthalpy of neutralization, separation and identification by paper chromatography, and the determination of an empirical formula by combustion. Data processing, uncertainties, and the evaluation of experimental method are assessed throughout.

## Instructions to candidates

- Write your session number in the box on the cover.
- Do not open this examination paper until you are told 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 this examination paper is **[25 marks]**.

The mark allocation is shown in square brackets at the end of each question or part question. Where a numerical answer is required, values of constants and molar masses should be taken from the chemistry data booklet unless they are given in the question. Unless otherwise stated, all measurements were made at 298 K and 100 kPa.

## Mark allocation

| | | |
|---|---|---|
| Question 1 | (enthalpy of neutralization) | [9 marks] |
| Question 2 | (chromatography) | [8 marks] |
| Question 3 | (empirical formula) | [8 marks] |
| **Total** | | **[25 marks]** |

# Section B

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

**1.** A student determined the enthalpy change of neutralization for the reaction between hydrochloric acid and sodium hydroxide.

$$HCl(aq) + NaOH(aq) \longrightarrow NaCl(aq) + H_2O(l)$$

$50.0\,cm^3$ of $1.00\,mol\,dm^{-3}$ hydrochloric acid was placed in a polystyrene cup and $50.0\,cm^3$ of $1.00\,mol\,dm^{-3}$ sodium hydroxide solution was added. The temperature was recorded every 30 seconds, before and after mixing, and the two parts of the graph were extrapolated to the time of mixing.

| **Data for the neutralization reaction** | |
|---|---|
| Total volume of the mixture / $cm^3$ | 100.0 |
| Extrapolated temperature at the time of mixing / °C ($\pm$0.2) | 21.1 |
| Extrapolated maximum temperature / °C ($\pm$0.2) | 27.8 |

**(a)** Explain why the temperature was recorded for several minutes after mixing and the graph extrapolated back to the time of mixing. **[2]**

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**(Question 1 continued)**

**(b)** Determine the energy, in kJ, released by the reaction, using sections 1 and 2 of the data booklet. Assume the mixture has the same density and specific heat capacity as water. **[2]**

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**(c)** Determine the enthalpy change of neutralization, in $kJ\,mol^{-1}$, including its sign.

If you did not obtain an answer to part (b), use 3.00 kJ although this is not the correct answer. **[2]**

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**(Question 1 continued)**

**(d)** Calculate the percentage uncertainty in the temperature change. **[2]**

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**(e)** State one assumption made when calculating the enthalpy change in part (c). **[1]**

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**2.** A student used paper chromatography to separate the coloured components of a water-soluble food dye. A pencil start line was drawn 1.0 cm from the bottom of the paper and a spot of the dye was placed on it. The distances travelled from the start line were measured when the chromatogram was removed from the tank.

| **Distances travelled from the start line** | |
|---|---|
| Solvent front / cm | 12.0 |
| Yellow spot, **Y** / cm | 4.8 |
| Blue spot, **B** / cm | 8.4 |

**(a)** State why the start line was drawn in pencil rather than in ink. **[1]**

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**(b)** Calculate the retardation factor, $R_F$, of each of the two spots. **[2]**

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**(Question 2 continued)**

**(c)** The solvent used was much less polar than the paper. Deduce which of the two components, **Y** or **B**, is the more polar, giving a reason. **[2]**

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**(d)** A third component of the dye did not move from the start line. Suggest why this happened, and state one change to the method that could separate it. **[2]**

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**(e)** Suggest one reason why another student, analysing the same dye, might obtain different $R_F$ values. **[1]**

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**3.** A student determined the empirical formula of magnesium oxide by heating a coil of magnesium ribbon in a crucible fitted with a lid. The lid was raised briefly at intervals during the heating. All masses were measured on a balance with an uncertainty of $\pm 0.001$ g.

| **Data for the combustion of magnesium** | |
|---|---|
| Mass of crucible + lid / g | 21.348 |
| Mass of crucible + lid + magnesium / g | 21.588 |
| Mass of crucible + lid + contents after heating / g | 21.746 |

**(a)** Explain why the lid was raised briefly at intervals rather than left off or kept closed throughout. **[2]**

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*(This question continues on the following page)*

**(Question 3 continued)**

**(b)** Determine the empirical formula of the oxide from the data. **[3]**

**(c)** Calculate the percentage uncertainty in the mass of magnesium used. **[1]**

**(d)** Some of the white smoke produced during heating escaped from the crucible. Deduce the effect of this on the empirical formula obtained. **[2]**

**End of examination.**

Total: **25 marks**