Chemistry

Standard Level

Paper 1B — Mock Examination

Mock Exam 2

Calculator required

Time allowed: **40 minutes**

Maximum mark: **25 marks**

Candidate information

Candidate name: .....

Session number: .....

Date: .....

Topic emphasis: quantitative analysis by colorimetry and the Beer–Lambert relationship, the measurement of reaction rate by gas collection, and the preparation and purification of a salt. 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	(colorimetry)	[9 marks]
Question 2	(rate of reaction)	[8 marks]
Question 3	(yield and purification)	[8 marks]
Total		**[25 marks]**

Section B

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

1. The concentration of a solution of potassium manganate(VII), $KMnO_4$, can be found using a colorimeter. A student measured the absorbance of five standard solutions of known concentration.

Concentration of $KMnO_4$ / 10^{-4} mol dm^{-3}	2.00	4.00	6.00	8.00	10.00
Absorbance ($\pm$0.01)	0.18	0.35	0.54	0.71	0.89

(a) Aqueous potassium manganate(VII) is purple. Explain why a green filter was selected for these measurements. **[1]**

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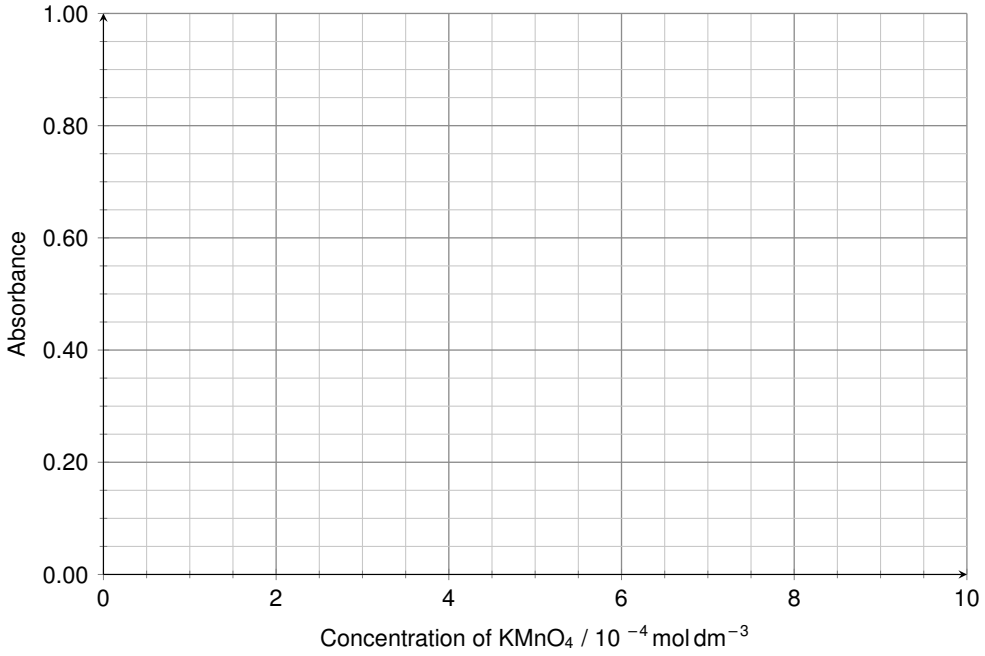
(b) Plot the data on the grid below and draw a straight line of best fit that passes through the origin. **[1]**



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(Question 1 continued)

(c) Determine the gradient of your line of best fit, giving its units. **[2]**

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(d) A solution of unknown concentration gave an absorbance of 0.55 under the same conditions. Determine its concentration, in $\text{mol}\,\text{dm}^{-3}$.

If you did not determine a gradient in part (c), use $8.00 \times 10^{2}\,\text{dm}^{3}\,\text{mol}^{-1}$ although this is not the correct answer. **[1]**

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(Question 1 continued)

(e) The standard solutions were made by diluting a stock solution of $0.0100\,\text{mol}\,\text{dm}^{-3}$ $KMnO_4$. Calculate the volume, in cm^3, of the stock solution needed to prepare $250.0\,\text{cm}^3$ of the $4.00 \times 10^{-4}\,\text{mol}\,\text{dm}^{-3}$ standard. **[2]**

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(f) The student handled the cuvette containing the unknown solution without wiping the fingerprints from its surface. Deduce the effect of this on the calculated concentration, and state whether the error is random or systematic. **[2]**

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2. A student investigated the reaction between a strip of magnesium ribbon and an excess of dilute hydrochloric acid.

$$Mg(s) + 2\,HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$$

The hydrogen produced was collected in a gas syringe of uncertainty $\pm 0.5\,cm^3$ and its volume was recorded every 10 seconds.

Time / s	0	10	20	30	40	50	60
Volume of H_2 / cm^3	0.0	18.0	32.0	42.0	48.0	50.0	50.0

(a) Calculate the average rate of reaction, in $cm^3\,s^{-1}$, over the first 20 seconds. **[1]**

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(b) Explain why the rate of reaction decreases as the reaction proceeds. **[2]**

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(Question 2 continued)

(c) Determine the mass, in g, of magnesium used, assuming the molar volume of a gas is 22.7 $dm^3\,mol^{-1}$ under these conditions. **[2]**

(d) Calculate the percentage uncertainty in the total volume of hydrogen collected. **[1]**

(e) Deduce **two** sources of systematic error that would make the measured volume of hydrogen smaller than the true value. **[2]**

3. A student prepared hydrated copper(II) sulfate crystals, $CuSO_4 \cdot 5H_2O$, by warming an excess of solid copper(II) oxide with 50.0 cm^3 of 1.00 mol dm^{-3} sulfuric acid, filtering the mixture, and then evaporating and crystallizing the filtrate.

$$CuO(s) + H_2SO_4(aq) \longrightarrow CuSO_4(aq) + H_2O(l)$$

(a) State why an excess of copper(II) oxide was used, and how the excess was removed from the mixture. **[2]**

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(b) Determine the theoretical yield, in g, of $CuSO_4 \cdot 5H_2O$. **[2]**

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(Question 3 continued)

(c) The student obtained 9.62 g of dry crystals. Calculate the percentage yield.

If you did not obtain an answer to part (b), use 11.50 g although this is not the correct answer. **[1]**

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(d) Suggest **two** reasons why the yield was less than the theoretical yield. **[2]**

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(e) The crystals were dried between sheets of filter paper rather than in a hot oven. Explain why. **[1]**

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End of examination.

Total: **25 marks**