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Chemistry Higher level Paper 1B

16 May 2025

Zone A afternoon | Zone B afternoon | Zone C afternoon

Candidate session number

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2 hours [Paper 1A and Paper 1B]

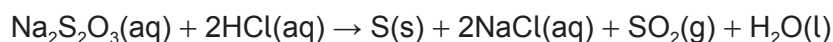
Instructions to candidates

- 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]**.

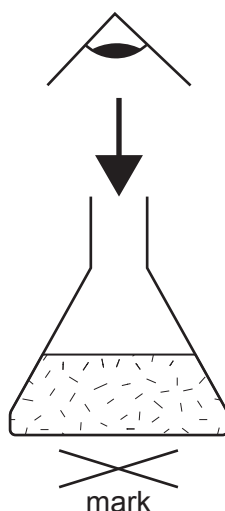


Answer **all** questions. Answers must be written within the answer boxes provided.

1. A student investigated the effect of concentration on the rate of reaction between sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$, and hydrochloric acid, HCl .



Since the solid sulfur product is insoluble, the rate can be determined by measuring the time it takes for the clear solution to turn off-white or pale yellow until the X mark on a white tile below the flask can no longer be seen.



- (a) Determine the mass of sodium thiosulfate needed to make 500.0 cm^3 of a $0.1500\text{ mol dm}^{-3}$ solution.

[2]

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- (b) Explain how to make the $0.1500\text{ mol dm}^{-3}$ solution in a volumetric flask.

[3]

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(Question 1 continued)

- (c) Suggest how to make a 100.0 cm^3 solution of $0.03000\text{ mol dm}^{-3}$ sodium thiosulfate from the original $0.1500\text{ mol dm}^{-3}$ solution.

[3]

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- (d) The student recorded the following data.

$\text{Na}_2\text{S}_2\text{O}_3$ concentration (mol dm^{-3})	Reaction Time $\text{s} \pm 0.1\text{ s}$					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average
$0.1500 \pm 0.08\%$	21.1	19.7	18.1	17.3	19.4	19.1 ± 1.5
$0.120 \pm 0.1\%$	26.4	24.8	26.9	26.2	25.1	25.9 ± 0.9
$0.0900 \pm 0.1\%$	33.8	32.4	31.5	30.8	32.6	32.2 ± 1.2
$0.0600 \pm 0.2\%$	48.3	49.3	45.9	46.4	44.6	46.9 ± 1.9
$0.0300 \pm 0.4\%$	96.2	95.8	97.9	95.9	93.7	95.9 ± 1.0

The solutions of sodium thiosulfate were in fact, all made as accurately as possible from the solid sodium thiosulfate by weighing the appropriate mass with a balance that can measure to one hundredth of a gram ($\pm 0.01\text{ g}$), rather than by dilution of a stock solution.

- (i) Explain why the percent uncertainties of concentrations increase as the concentrations decrease.

[1]

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(Question 1 continued)

- (ii) Estimate the rate of the reaction for $0.1500 \text{ mol dm}^{-3}$, giving the correct units. [2]

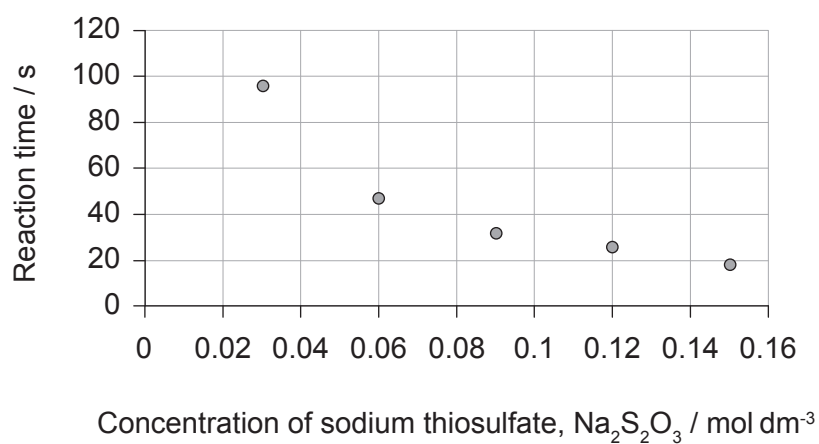
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- (e) A graph of the average values was produced. Draw a curve of best fit through the data in the graph. [1]



(This question continues on the following page)



(Question 1 continued)

- (f) Additional data were obtained by a different student using the same solutions and identical equipment.

Na ₂ S ₂ O ₃ concentration (mol dm ⁻³)	Reaction time / s ± 0.1 s
	Trial 1
0.1500 ± 0.08 %	24.2
0.120 ± 0.1 %	28.6
0.0900 ± 0.1 %	36.9
0.0600 ± 0.2 %	50.4
0.0300 ± 0.4 %	98.2

Suggest **two** reasons why these data differ significantly from those obtained by the first student.

[2]

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- (g) State one safety concern for a product of this experiment and a precaution that should be taken.

[2]

Safety Concern:

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Precaution:

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2. A student was given a mixture to separate and collect the individual components. The mixture contained sand, $\text{SiO}_2(\text{s})$, sodium chloride, $\text{NaCl}(\text{s})$, and iron filings, $\text{Fe}(\text{s})$. The student observed the original mixture and made the following hypothesis.

The iron would have the lowest percent by mass because it appeared to be present in the smallest quantity.

- (a) Suggest a set of experimental steps required to obtain pure samples of each component of the mixture.

[4]

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- (b) The following data were collected.

Substance	Mass in g $\pm$ 0.01 g	Percent Composition
Mixture before separation	5.62	N/A
Iron after separation	2.17	
Sand after separation	1.98	
Salt after separation	1.80	32.0 %

Calculate the percent composition of the iron and sand in the mixture

[1]

(This question continues on the following page)



(Question 2 continued)

- (c) The percentages in (b) add up to more than 100. Suggest a reason that would explain these results and how to reduce or eliminate it. [2]

Error:

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Reduce or Eliminate:

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- (d) The results did not support the original hypothesis. Suggest why the hypothesis was incorrect. [1]

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- (e) In a different experiment, the students needed to separate a mixture of methanol and butan-1-ol. State the best method to separate this mixture and the physical property used for the separation. [2]

Separation method:

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Physical property:

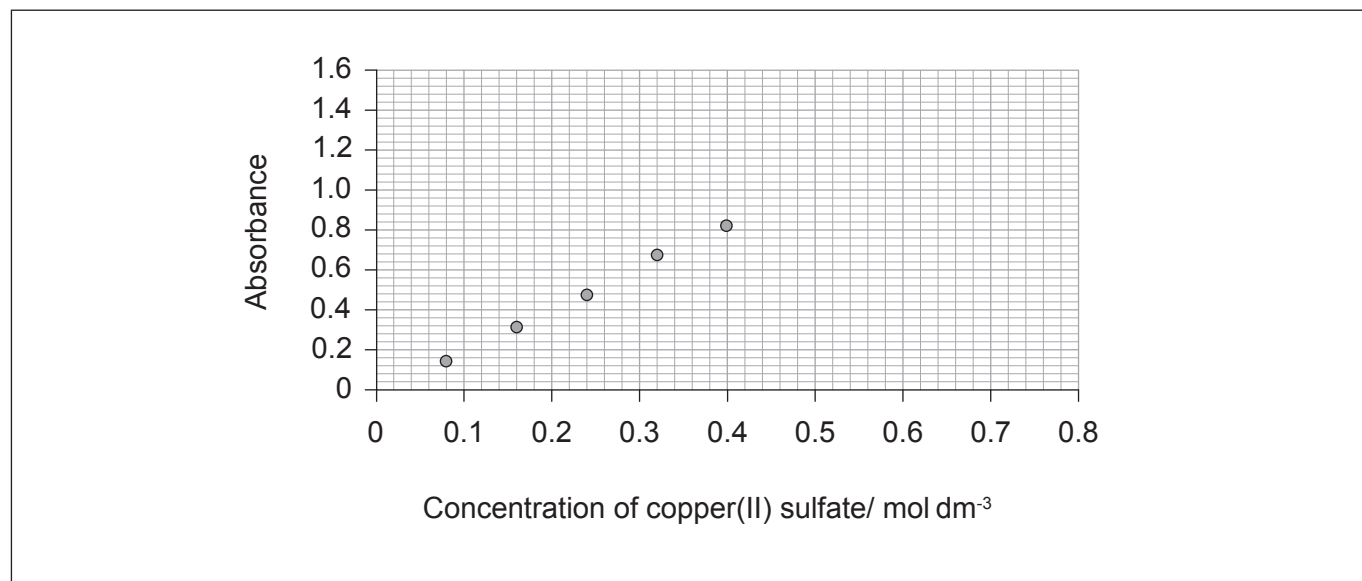
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3. A colorimetry experiment was conducted on a series of solutions of copper(II) sulfate, CuSO_4 . The absorbance versus concentration data were graphed.

(a) Draw a best fit line in the graph below, extrapolating beyond the data given.

[2]



(b) State the mathematical relationship between absorbance and concentration.

[1]

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(c) The instrument used can collect absorbance or percent transmittance at a specific wavelength. Outline why a specific wavelength must be selected.

[1]

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(Question 3 continued)

- (d) Deduce the equation that relates the absorbance to concentration including the value of the constant. [2]

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- (e) Estimate the absorbance value of a $0.600 \text{ mol dm}^{-3} \text{ CuSO}_4$ solution. [1]

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- (f) Predict the difference, if any, between reading the absorbance value for the $0.600 \text{ mol dm}^{-3} \text{ CuSO}_4$ solution from the graph and calculating it using the equation in (d). [1]

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- (g) The copper(II) sulfate solution is blue. Deduce the optimum wavelength to use for colorimetry, using section 15 of the data booklet. [1]

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12EP10

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