



Diploma Programme  
Programme du diplôme  
Programa del Diploma

# Chemistry Higher level Paper 1B

16 May 2025

**Zone A** afternoon | **Zone B** afternoon | **Zone C** afternoon

Candidate session number

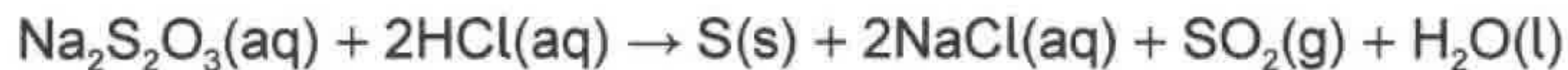
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2 hours [Paper 1A and Paper 1B]

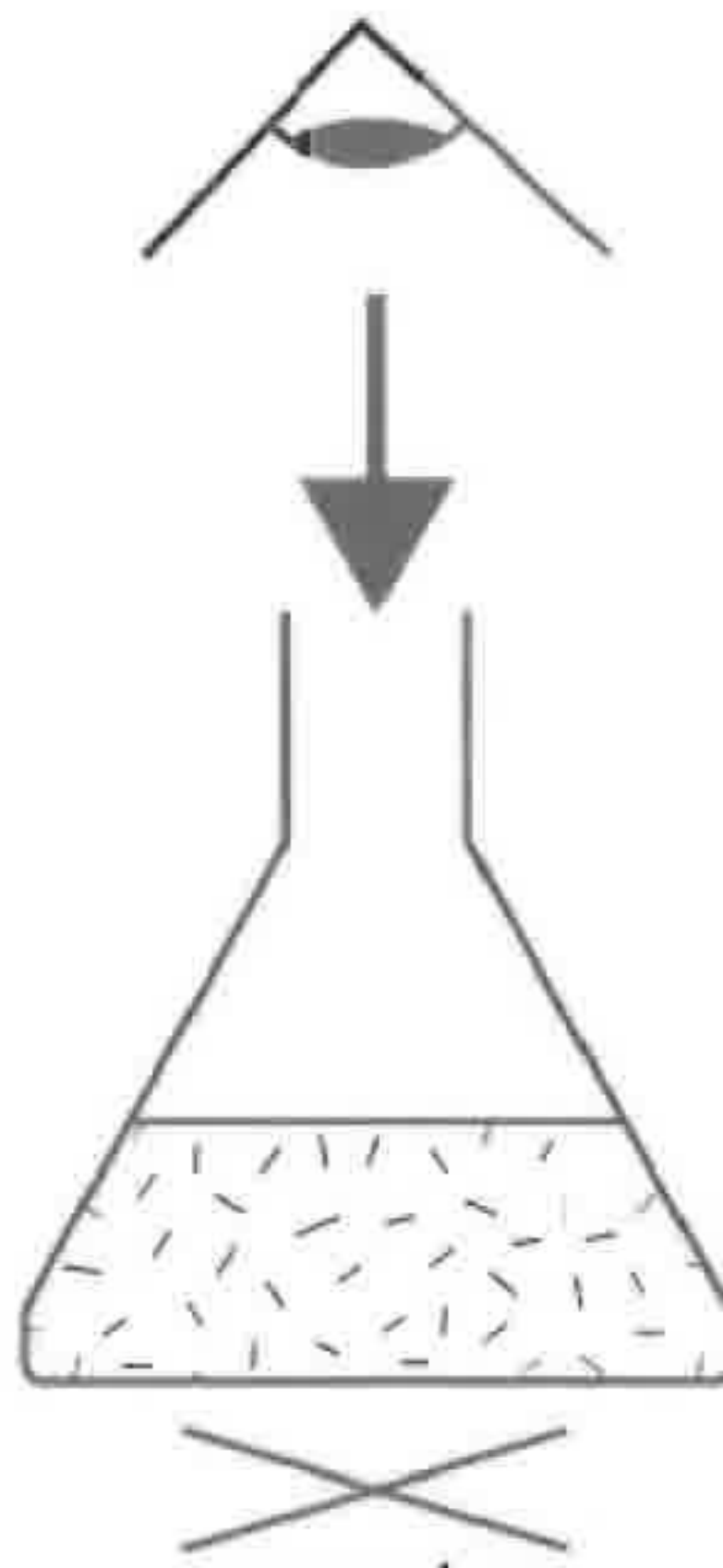
## Instructions to candidates

- 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

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,  $\text{HCl}$ .



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.



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- (a) Determine the mass of sodium thiosulfate needed to make  $500.0\text{ cm}^3$  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  $100.0\text{ cm}^3$  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.

| $\text{Na}_2\text{S}_2\text{O}_3$<br>concentration<br>( $\text{mol dm}^{-3}$ ) | Reaction Time<br>$\text{s} \pm 0.1\text{ s}$ |         |         |         |         |         |
|--------------------------------------------------------------------------------|----------------------------------------------|---------|---------|---------|---------|---------|
|                                                                                | Trial 1                                      | Trial 2 | Trial 3 | Trial 4 | Trial 5 | Average |

(d) The student recorded the following data.

| <b>Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub><br/>concentration<br/>(mol dm<sup>-3</sup>)</b> | <b>Reaction Time<br/>s ± 0.1 s</b> |                |                |                |                |                |
|---------------------------------------------------------------------------------------------|------------------------------------|----------------|----------------|----------------|----------------|----------------|
|                                                                                             | <b>Trial 1</b>                     | <b>Trial 2</b> | <b>Trial 3</b> | <b>Trial 4</b> | <b>Trial 5</b> | <b>Average</b> |
| 0.1500 ± 0.08 %                                                                             | 21.1                               | 19.7           | 18.1           | 17.3           | 19.4           | 19.1 ± 1.5     |
| 0.120 ± 0.1 %                                                                               | 26.4                               | 24.8           | 26.9           | 26.2           | 25.1           | 25.9 ± 0.9     |
| 0.0900 ± 0.1 %                                                                              | 33.8                               | 32.4           | 31.5           | 30.8           | 32.6           | 32.2 ± 1.2     |
| 0.0600 ± 0.2 %                                                                              | 48.3                               | 49.3           | 45.9           | 46.4           | 44.6           | 46.9 ± 1.9     |
| 0.0300 ± 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 ( $\pm 0.01$  g), rather than by dilution of a stock solution.

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

|                    |      |      |      |      |      |                |
|--------------------|------|------|------|------|------|----------------|
| $0.0600 \pm 0.2\%$ | 48.3 | 49.3 | 45.9 | 46.4 | 44.6 | $46.9 \pm 1.9$ |
| $0.0300 \pm 0.4\%$ | 96.2 | 95.8 | 97.9 | 95.9 | 93.7 | $95.9 \pm 1.0$ |

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 ( $\pm 0.01$  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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(ii) Estimate the rate of the reaction for  $0.1500 \text{ mol dm}^{-3}$ , giving the correct units.

[2]

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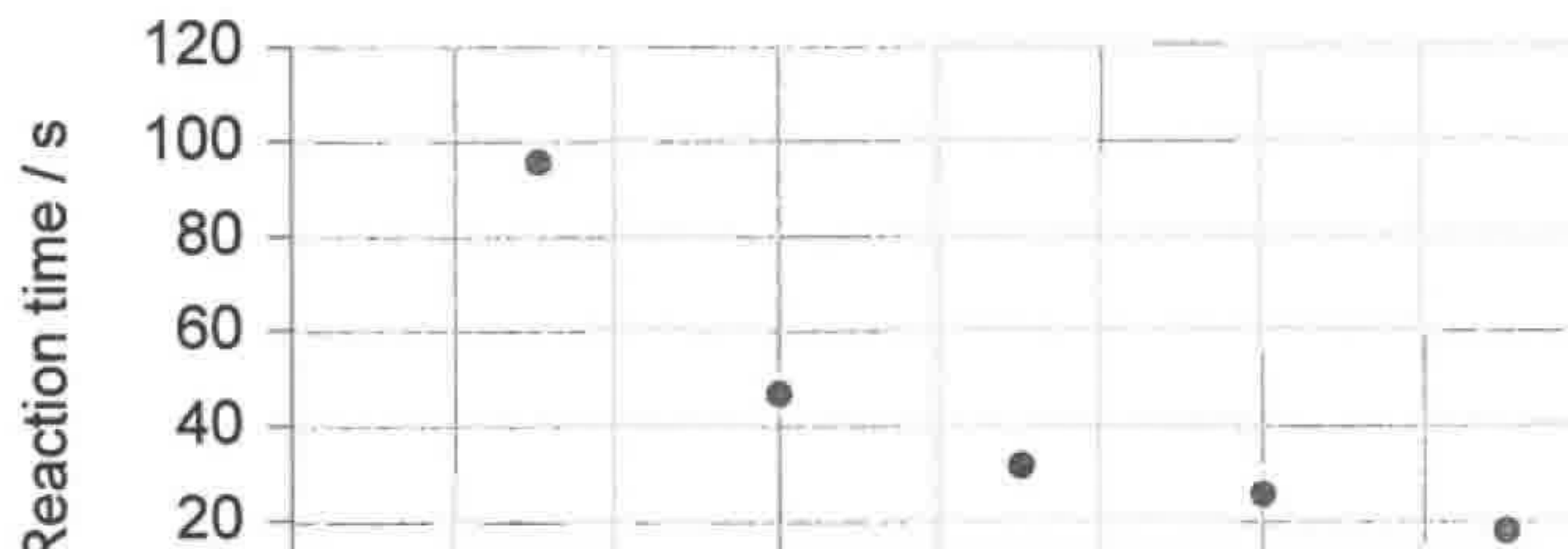
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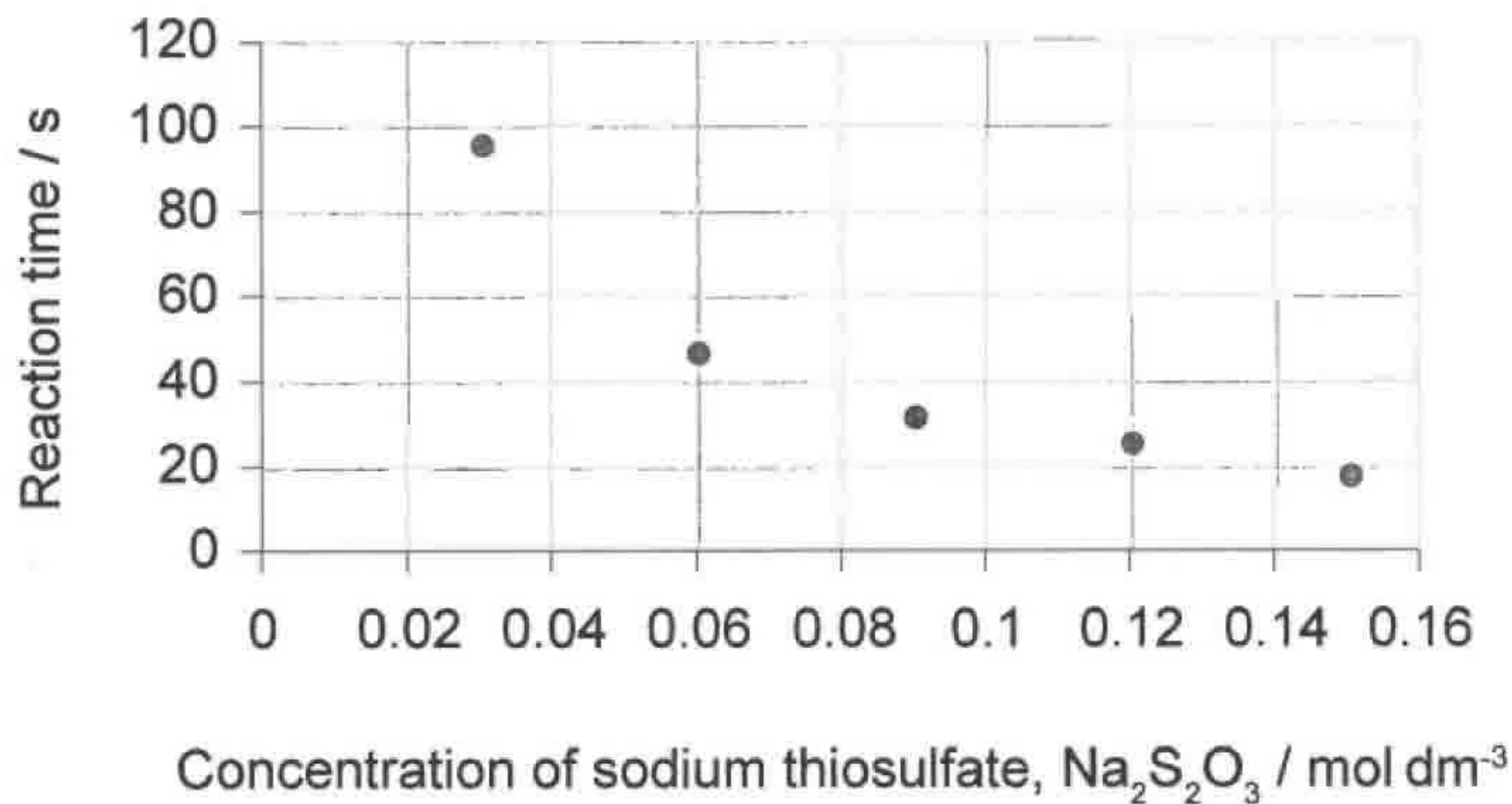
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(e) A graph of the average values was produced. Draw a curve of best fit through the data in the graph.

[1]



- (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.

| <b>Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub><br/>concentration<br/>(mol dm<sup>-3</sup>)</b> | <b>Reaction time / s ± 0.1 s</b> |
|---------------------------------------------------------------------------------------------|----------------------------------|
|                                                                                             | <b>Trial 1</b>                   |
| 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.

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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.

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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)

- (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

- (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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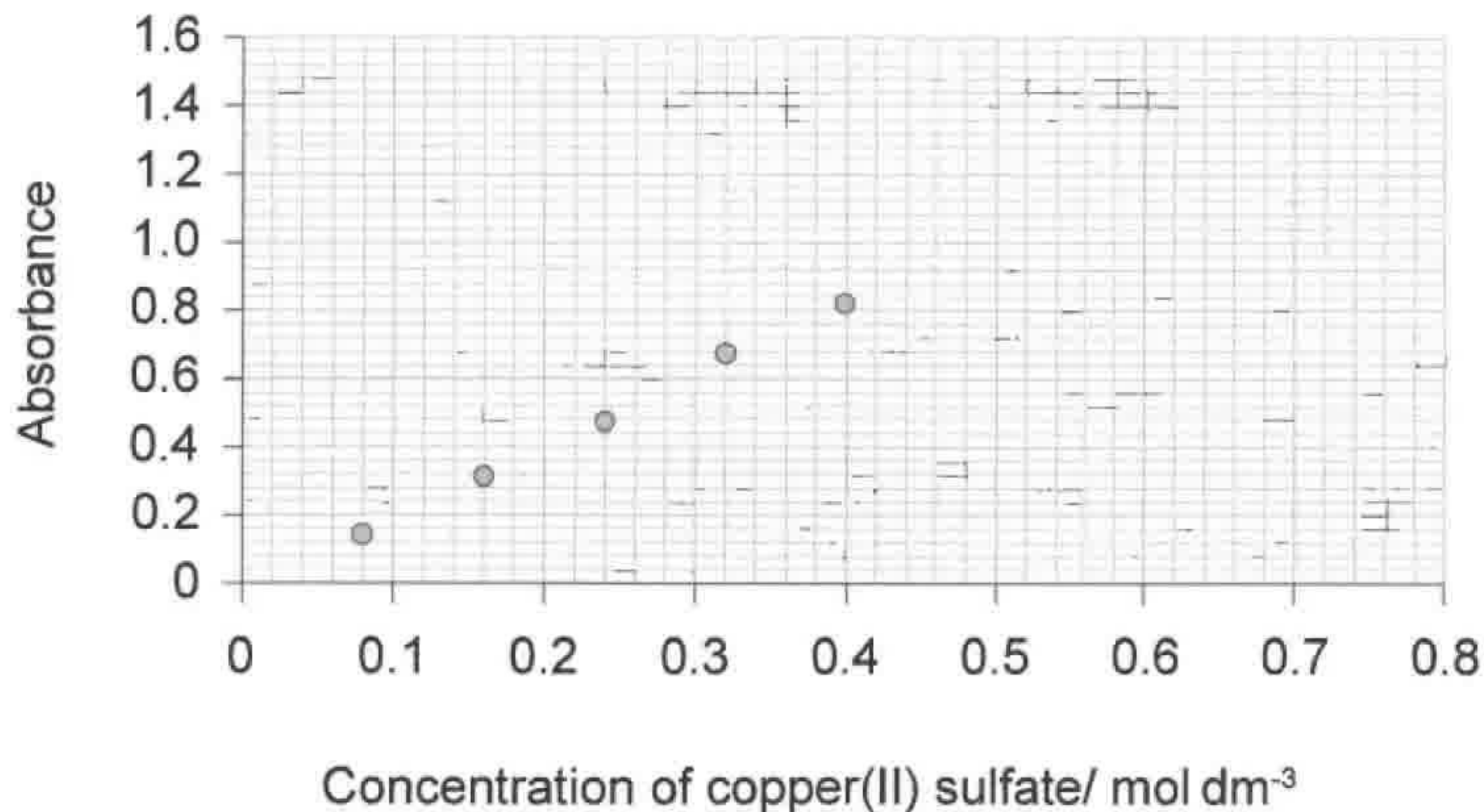
Physical property: .....

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3. A colorimetry experiment was conducted on a series of solutions of copper(II) sulfate,  $\text{CuSO}_4$ . 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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(This question continues on the following page)

**(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]

(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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