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Chemistry

Standard level

Paper 1B

16 May 2025

Zone A afternoon | Zone B afternoon | Zone C afternoon

Candidate session number

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1 hour 30 minutes [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 **[25 marks]**.
- The maximum mark for paper 1A and paper 1B is **[55 marks]**.



Section B

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

1. Nitrogen dioxide, NO_2 , is a brown, toxic and corrosive gas. It can be made in a school laboratory by heating a group II metal nitrate or by the reaction of copper, Cu, with concentrated nitric acid, HNO_3 .

(a) (i) Suggest, with reasons, **two** different safety precautions that should be taken when performing both of these experiments. [2]

Precaution 1:

.....

.....

Reason:

.....

.....

Precaution 2:

.....

.....

Reason:

.....

.....

(ii) Deduce the coefficients in the equation for the reaction of Cu with concentrated HNO_3 . [1]

___ $\text{Cu}(\text{s})$ + ___ $\text{HNO}_3(\text{aq}) \rightarrow$ ___ $\text{Cu}(\text{NO}_3)_2(\text{aq})$ + ___ $\text{NO}_2(\text{g})$ + ___ $\text{H}_2\text{O}(\text{l})$

(iii) Calculate the mass, in g, of Cu required to make 0.0100 moles of NO_2 . Use section 7 of the data booklet. [1]

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(This question continues on the following page)



(Question 1 continued)

- (b) The NO_2 made was sealed in a glass vessel where the following equilibrium reaction occurred:



Suggest **two** measurements, other than colour change, that could be used to monitor the progress of this reaction over time and the expected results.

[4]

Measurement 1:
Expected result:
.....
Measurement 2:
Expected result:
.....

- (c) A sample of 0.0100 moles of NO_2 was placed in a 1 dm^3 sealed container and maintained at a constant temperature of 40°C .

- (i) Suggest how the constant temperature could be easily maintained in a school laboratory.

[1]

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.....

- (ii) The equilibrium concentration of NO_2 was monitored using colorimetry. A student started the experiment and recorded the absorbance value immediately.

Suggest why this may not give a reliable result.

[1]

.....
.....
.....

(This question continues on the following page)



Turn over

(Question 1 continued)

- (iii) Suggest how the problem identified in part (c)(ii) could be overcome. [1]

.....
.....

- (d) The experiment from part (c) was repeated at 0 °C. The equilibrium mixture in the container consisted of 0.00732 moles of NO₂(g) and 0.00134 moles of N₂O₄(g).

$$K = \frac{[\text{N}_2\text{O}_4]}{[\text{NO}_2]^2}$$

Calculate the equilibrium constant, *K*, for this reaction at 0 °C. Give your answer to **two** significant figures. [1]

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- (e) The initial amount of NO₂ was determined by titration. The oxide was first dissolved in water according to the following equation:



The solution was made up to 250.0 cm³ and 25.0 cm³ portions of this solution were then titrated against a 0.0500 mol dm⁻³ standard solution of sodium hydroxide, NaOH.

- (i) State the most accurate equipment for: [1]

Transferring 25.0 cm³ of the solution for titration:
.....
Adding the NaOH solution during the titration:
.....

(This question continues on the following page)



(Question 1 continued)

- (ii) Draw a table that can be used for recording the results of the titration experiment described in part (e). Include variables, units and any other relevant information in the header row(s) **and/or** header column(s), **but leave the data cells blank.** [2]

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- (iii) The equipment used for the titration of the analysed mixture with NaOH had an uncertainty of $\pm 0.05 \text{ cm}^3$. The average volume of the titrant was 20.05 cm^3 .
Determine the % uncertainty in this volume. [1]

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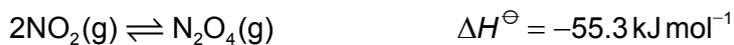
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Turn over

(Question 1 continued)

The experiment described in part (b) was repeated three more times at different temperatures. The following values for the equilibrium constant, K , were determined:



T (°C)	T (K)	K
0.0		Value from (d)
20.0		4.74
50.0		5.76×10^{-1}
100.0		3.64×10^{-2}

- (iv) Calculate the values for temperature, T , in degrees kelvin, K , and complete the table. [1]

- (v) Deduce if the results in part (e)(iv) are consistent with the enthalpy of reaction data given in part (b). [1]

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2. In a separate experiment, the rate of a reaction was studied using colorimetry. During the reaction, the mixture changed colour from orange to green.

Before the investigation could be carried out, it was necessary to construct a calibration curve for the colorimeter.

(a) Describe how a standard aqueous solution can be prepared. [3]

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(b) Describe how this solution can be used to construct a calibration curve. [3]

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(c) Explain how this curve can be used to determine the unknown concentration. [1]

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