Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5820052839

CHEMISTRY **9701/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2014**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Use of a Data Booklet is unnecessary.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **9** printed pages and **3** blank pages.

IB14 06_9701_52/7RP

CAMBRIDGE International Examinations

[Turn over

1 The liquids trichloromethane and water separate into two immiscible layers when shaken together and allowed to stand.
Ammonia can dissolve in both of these layers. The distribution of ammonia between these two solvents is called partition, where the concentration of ammonia in each solvent will be different. The partition coefficient represents the ratio of the distribution.

You are to plan an experiment, using a titration with sulfuric acid, to determine the value of the partition coefficient of ammonia between water and trichloromethane at room temperature.

The following information gives some of the hazards associated with trichloromethane and ammonia.

Trichloromethane:
Anaesthetic if inhaled. Dangerously irritating to the respiratory system.

Ammonia:
An aqueous solution with a concentration of less than 3 mol dm^{-3} may cause harm to eyes or in a cut. At greater concentrations aqueous ammonia should not be inhaled and it causes irritation to the eyes and skin.

You are provided with the following.

- trichloromethane
- aqueous ammonia of concentration 5.00 mol dm^{-3}
- sulfuric acid, of concentration 0.500 mol dm^{-3}
- distilled water for dilution of aqueous ammonia

(a) Explain why ammonia is likely to be more soluble in water than in trichloromethane.

....

....

....

.... [2]

(b) Define the partition coefficient, $K_{partition}$, for ammonia between water and trichloromethane. State whether the partition coefficient you have defined will be greater or less than 1.

[1]

(c) In the experiment, explain whether it is important that the volumes of water and trichloromethane are the same.

....

....

....

.... [1]

(d) Write an equation for the reaction of aqueous ammonia and sulfuric acid.

.... [1]

(e) **(i)** The partition coefficient for ammonia distributed between water and trichloromethane is approximately 25.
Calculate the concentration of aqueous ammonia that should be used so that a 25.0 cm^3 sample of the aqueous ammonia layer would require approximately 24.0–26.0 cm^3 of 0.500 $mol\,dm^{-3}$ sulfuric acid for complete neutralisation.
Then state the factor by which the 5.00 $mol\,dm^{-3}$ aqueous ammonia should be diluted to give that concentration.

[2]

(ii) Describe, in detail, how you would dilute 5.00 $mol\,dm^{-3}$ aqueous ammonia to make 250 cm^3 of aqueous ammonia ready for use in the experiment.

....

....

....

....

....

....

.... [2]

(f) Other than the use of eye protection and gloves, state one safety precaution you would take while setting up the experiment.

....

....

.... [1]

(g) State a suitable indicator for use in the titration of a sample taken from the experiment. Explain your answer.

....

....

....

.... [2]

(h) It is unnecessary to titrate both layers of the partition. Explain why it would be better to titrate a sample of the aqueous layer rather than the trichloromethane layer.

....

....

....

.... [1]

(i) Once a mean titre has been calculated, outline the steps you would take to calculate the partition coefficient.

....

....

....

....

....

.... [2]

[Total: 15]

QUESTION 2 STARTS ON THE NEXT PAGE.

2 Nitrogen(II) oxide, NO, can be oxidised by ozone, O_3, in the atmosphere to form nitrogen(IV) oxide, NO_2.

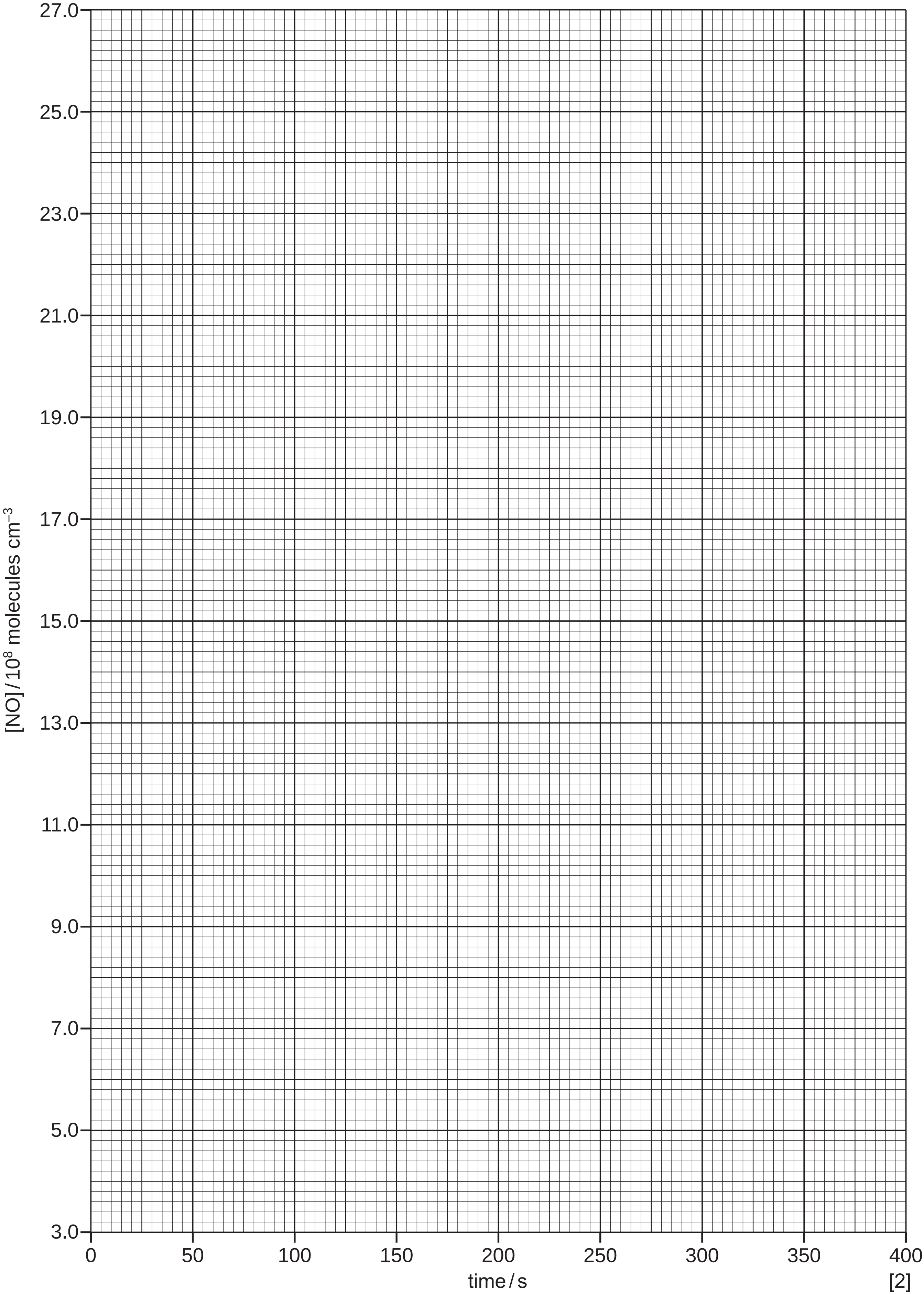
It is possible to simulate this process in the laboratory to measure the rate at which this reaction takes place.

In this experiment, nitrogen(II) oxide is reacted with ozone. Since the concentration of nitrogen(II) oxide, [NO], in the air is very low, specialist equipment is required and [NO] oxide is measured as the number of molecules present in a volume of $1\,cm^3$.

The results obtained from the experiment are shown below.

time / s	concentration of NO / 10^8 molecules cm^{-3}
0	27.0
30	21.9
60	17.7
90	14.4
120	13.2
150	9.45
180	7.66
210	6.21
240	5.03
270	4.08
300	3.31

(a) Use the results obtained to plot a graph to show the relationship between [NO] and time.



[2]

(b) On your graph circle the **single** result that you consider to be the most anomalous. Suggest a reason why anomalous results may occur during an experiment to measure the rate of a reaction.

....

....

.... [2]

(c) Use construction lines at concentrations of nitrogen(II) oxide equal to 13.5×10^8 molecules cm^{-3} and 6.75×10^8 molecules cm^{-3} to determine the order of reaction with respect to nitrogen(II) oxide.

Show the construction lines on your graph and your working.

[3]

(d) **(i)** Use your graph to calculate the initial rate of the reaction.

[2]

(ii) In the reaction between ozone and nitrogen(II) oxide the order of reaction with respect to ozone is 1.
In the experiment the initial concentration of ozone used was 4×10^{11} molecules cm^{-3}.

Calculate the value of the rate constant for the reaction and give its units.

[2]

(e) 1 mole contains 6.02×10^{23} particles.
Convert the initial rate in **(d)(i)** to a value with units of $mol\,dm^{-3}\,s^{-1}$.
(If you have no answer to **(d)(i)** you may use 3.0×10^{5} as the value of the initial rate.)

[2]

(f) The concentration of ozone used in the experiment is considerably greater than the concentration of nitrogen(II) oxide.
Explain why this is necessary for the experiment, in order to determine the order with respect to nitrogen(II) oxide.

....

....

....

....

.... [2]

[Total: 15]

BLANK PAGE

BLANK PAGE

BLANK PAGE