

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY

Unifying Concepts in Chemistry

Wednesday

18 JUNE 2003

Afternoon

1 hour 15 minutes

2816/01

Candidates answer on the question paper.

Additional materials:

Data Sheet for Chemistry

Scientific calculator

Candidate Name	Centre Number	Candidate Number											
	<table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> </tr> </table>							<table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> <td style="width: 20px; height: 20px;"></td> </tr> </table>					

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry*.
- You are advised to show all the steps in any calculations.

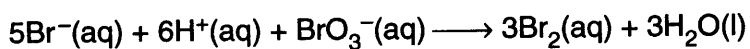
FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	14	
2	14	
3	13	
4	10	
5	9	
TOTAL	60	

This question paper consists of 11 printed pages and 1 blank page.

Answer all the questions.

- 1 Bromine can be formed by the oxidation of bromide ions. This question compares the rates of two reactions that produce bromine.

- (a) Bromine is formed by the oxidation of bromide ions with acidified bromate(V) ions.



This reaction was carried out several times using different concentrations of the three reactants. The initial rate of each experimental run was calculated and the results are shown below. In each case, initial concentrations are shown.

experiment	$[\text{Br}^-(\text{aq})]$ /mol dm ⁻³	$[\text{H}^+(\text{aq})]$ /mol dm ⁻³	$[\text{BrO}_3^-(\text{aq})]$ /mol dm ⁻³	initial rate /10 ⁻³ mol dm ⁻³ s ⁻¹
1	0.10	0.10	0.10	1.2
2	0.10	0.10	0.20	2.4
3	0.30	0.10	0.10	3.6
4	0.10	0.20	0.20	9.6

- (i) For each reactant, deduce the order of reaction. Show your reasoning.

$\text{Br}^-(\text{aq})$

.....

.....

$\text{H}^+(\text{aq})$

.....

.....

$\text{BrO}_3^-(\text{aq})$

.....

.....[6]

- (ii) Deduce the rate equation.

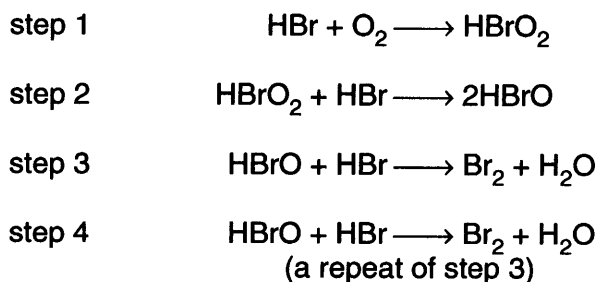
.....[1]

- (iii) Calculate the rate constant, k , for this reaction. State the units for k .

rate constant, k units[3]

- (b) Bromine can **also** be formed by the oxidation of hydrogen bromide with oxygen.

The following mechanism has been suggested for this multi-step reaction.



- (i) Explain the term *rate-determining step*.

.....
.....[1]

- (ii) The rate equation for this reaction is: $\text{rate} = k[\text{HBr}][\text{O}_2]$.

Explain which of the four steps above is the **rate-determining step** for this reaction.

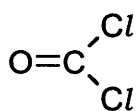
.....
.....
.....[2]

- (iii) Determine the **overall** equation for this reaction.

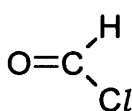
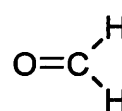
.....[1]

[Total: 14]

- (c) Phosgene is a polar molecule. The diagram below shows a molecule of phosgene and two related molecules, **A** and **B**.



phosgene

**A****B**

- (i) Add the partial charges ($\delta +$ and $\delta -$) to the diagrams of the three molecules above. [2]

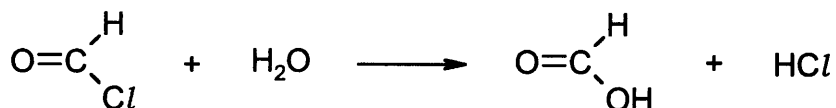
- (ii) Molecule **A** is the most polar of the three molecules.

Suggest why this is so.

.....

 [2]

- (iii) Compound **A** reacts with water as follows.



Phosgene also reacts with water.

Suggest an equation for this reaction.

[2]

[Total: 14]

3 Hydrogen chloride is used in the manufacture of many chemical compounds, including those used in metallurgy and food processing.

- (a) There are two main industrial methods for preparing hydrogen chloride:
- by direct combination of chlorine and hydrogen gases,
 - as a by-product of the chlorination of many organic hydrocarbons.

Write equations to show the formation of HCl from

- (i) chlorine and hydrogen

.....[1]

- (ii) chlorine and hexane, C_6H_{14} .

.....[1]

- (b) Hydrochloric acid is usually sold as a solution prepared by dissolving hydrogen chloride gas in water.

A science technician bought 15.0 dm^3 of 8.00 mol dm^{-3} hydrochloric acid which had been made by dissolving hydrogen chloride gas in water.

1 mol of gas molecules occupies 24.0 dm^3 at room temperature and pressure, r.t.p.

- (i) Calculate the volume of hydrogen chloride gas at r.t.p. that dissolved to produce this hydrochloric acid.

[2]

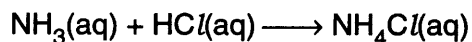
- (ii) Outline, with quantities, how the technician could make up 1.00 dm^3 of $0.0200 \text{ mol dm}^{-3}$ hydrochloric acid from the 8.00 mol dm^{-3} stock solution of hydrochloric acid.

[2]

- (iii) Calculate the pH of $0.0200 \text{ mol dm}^{-3} \text{HCl(aq)}$.

[2]

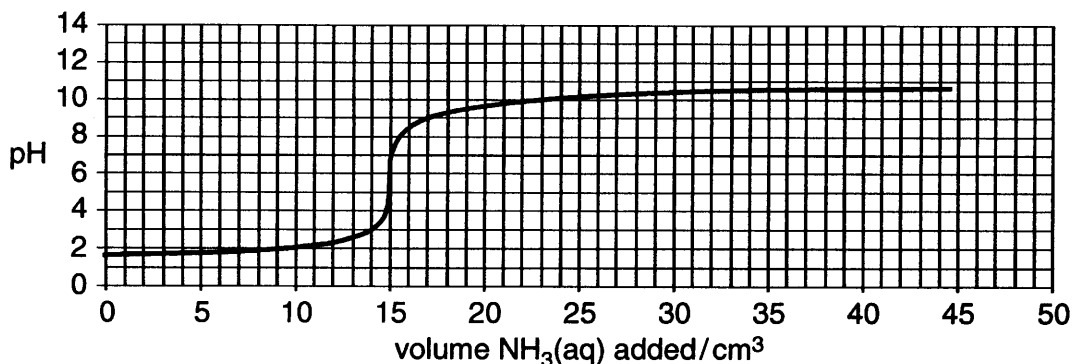
- (c) Hydrochloric acid can be neutralised with aqueous ammonia to form ammonium chloride.



The technician titrated the $0.0200 \text{ mol dm}^{-3}$ hydrochloric acid prepared in (b)(ii) with aqueous ammonia.

A 20.0 cm^3 sample of the $0.0200 \text{ mol dm}^{-3} \text{HCl}(\text{aq})$ was placed in a conical flask and the $\text{NH}_3(\text{aq})$ was added from a burette until the pH no longer changed.

The pH curve for this titration is shown below.



- (i) How can you tell from this pH curve that aqueous ammonia is a weak base?

.....
[1]

- (ii) Use the information above to calculate the concentration, in mol dm^{-3} , of the aqueous ammonia.

[2]

- (iii) The pH ranges in which the pH changes for three indicators are shown below.

indicator	pH range
alizarin yellow	10.1–12.0
methyl yellow	2.9–4.0
chlorophenol red	4.8–6.4

Explain which of the three indicators is most suitable for this titration.

.....

[2]

[Total: 13]

[Turn over

