

Candidate  
Number

Centre Number

Candidate Name \_\_\_\_\_

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**CAMBRIDGE INTERNATIONAL EXAMINATIONS**  
**General Certificate of Education Advanced Level**

**CHEMISTRY**

PAPER 4

**9701/4**

**MAY/JUNE SESSION 2002**

1 hour

Candidates answer on the question paper.

Additional materials:

Data Booklet

**TIME** 1 hour

**INSTRUCTIONS TO CANDIDATES**

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

**INFORMATION FOR CANDIDATES**

The number of marks is given in brackets [ ] at the end of each question or part question.

You may lose marks if you do not show your working or if you do not use appropriate units.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
6	
7	
TOTAL	

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

Answer **all** the questions in the spaces provided

- 1 (a) Write an expression for  $K_w$ .

..... [1]

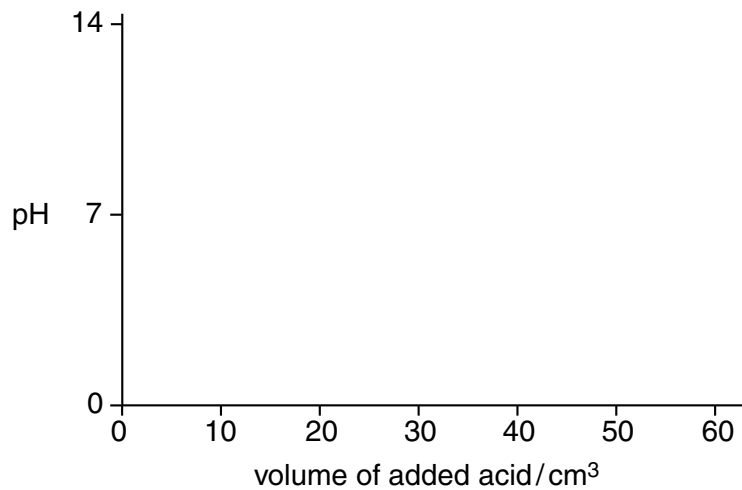
- (b) Use your expression to help you calculate the pH of  $0.200 \text{ mol dm}^{-3} \text{ NaOH(aq)}$ .

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

- (c) The pH of  $0.200 \text{ mol dm}^{-3} \text{ NH}_3(\text{aq})$  is 11.3. Explain why this answer differs from your answer in (b).

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

- (d) A  $20.0 \text{ cm}^3$  sample of  $0.200 \text{ mol dm}^{-3} \text{ NH}_3(\text{aq})$  was titrated with  $0.100 \text{ mol dm}^{-3} \text{ HCl}$ . On the following axes, sketch how the pH changes during this titration. Mark clearly where the end point occurs.



[3]

- (e) From the following list of indicators, put a tick in the box by the side of the indicator you consider most suitable for this titration.

indicator	pH at which colour changes	place <b>one tick only</b> in this column
methyl violet	0.0 - 1.6	
methyl orange	3.1 - 4.4	
bromothymol blue	6.0 - 7.6	
phenolphthalein	8.3 - 10.0	

[1]

- (f) A solution containing  $\text{NH}_3(\text{aq})$  and  $\text{NH}_4\text{Cl}(\text{aq})$  acts as a buffer solution, resisting changes in pH when acids or alkalis are added.

Explain with the help of equations how this mixture acts as a buffer.

.....

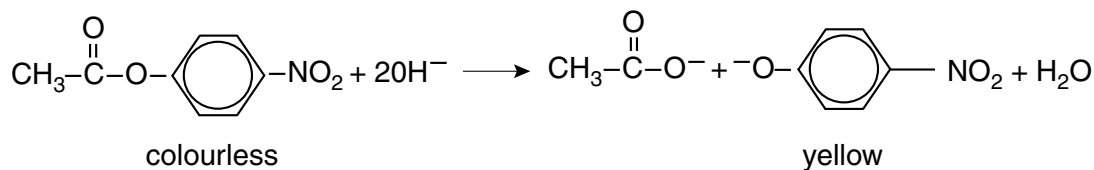
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.....

..... [2]

[Total: 10]

- 2 The ester 4-nitrophenyl ethanoate hydrolyses in alkaline solution according to the following equation.



- (a) Suggest, and briefly describe, a suitable experimental technique for studying the rate of this reaction.

.....

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.....

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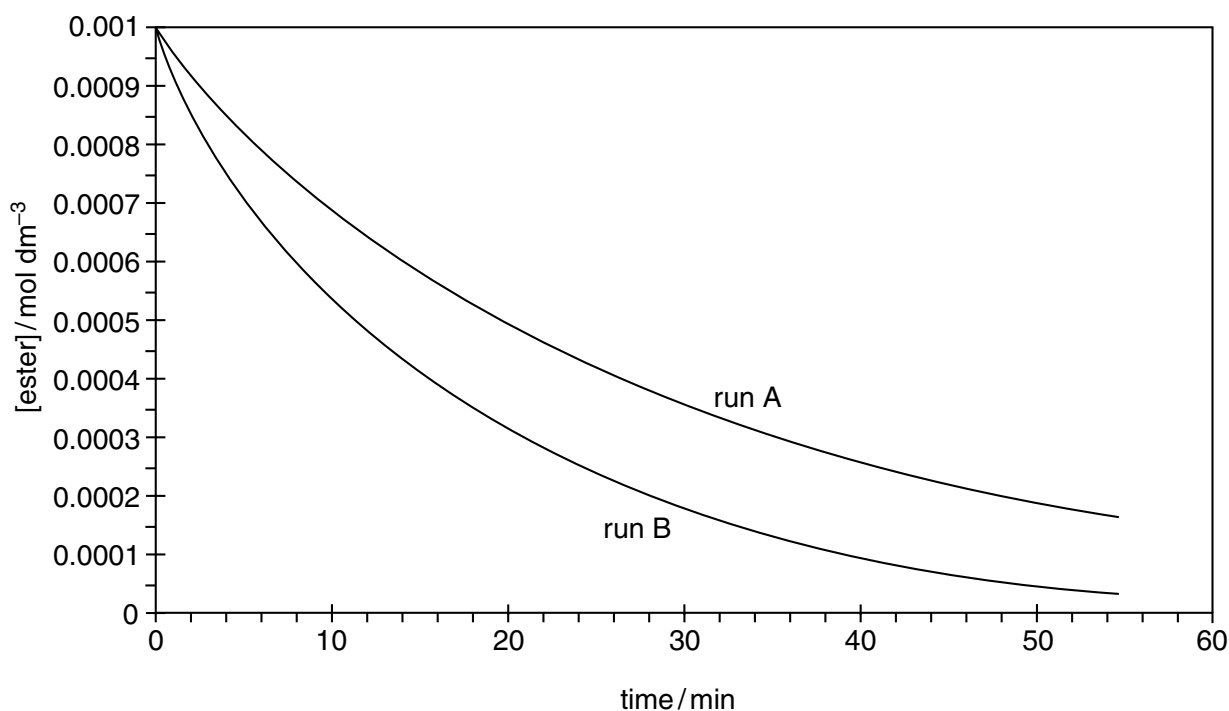
[4]

- (b) The reaction rate was studied using two solutions of different hydroxide ion concentrations.

run A:  $[\text{OH}^-] = 0.20 \text{ mol dm}^{-3}$

run B:  $[\text{OH}^-] = 0.40 \text{ mol dm}^{-3}$

The following graphs show how the concentration of the ester, 4-nitrophenyl ethanoate, varied over time in the two runs.



- (i) By drawing tangents on the graphs, measure and calculate the initial rates of reaction during the two runs. Give the units in each case.

initial rate of run A .....

initial rate of run B .....

[3]

- (ii) By using your results, calculate the overall order of reaction with respect to  $[\text{OH}^-]$ .

..... [1]

- (iii) From the curve of run B, determine the order of reaction with respect to [ester].

..... [1]

- (iv) Explain how you arrived at you answer in (iii).

.....

..... [1]

- (v) Write a rate equation for the reaction.

..... [1]

- (vi) Use your rate equation and the initial rates to calculate a value for the rate constant, including units.

.....

..... [2]

[Total: 13]

3 (a) Write an equation to represent the thermal decomposition of calcium nitrate,  $\text{Ca}(\text{NO}_3)_2$ .  
..... [1]

(b) Describe and explain how the thermal stabilities of the Group II nitrates vary down the group.

.....  
.....  
.....  
.....  
..... [3]

(c) When a molten nitrate of a Group I metal is heated strongly, it evolves oxygen and leaves the metal nitrite,  $\text{MNO}_2$  ( $\text{M} = \text{Na}, \text{K}, \text{Rb}$  or  $\text{Cs}$ ).

(i) Write a balanced equation for this reaction.

.....

(ii) When a particular Group I metal nitrate was heated in this way until no further change occurred, it lost 10.85% of its mass. Calculate the  $A_r$  of the metal and hence identify it.

[3]

[Total: 7]

- 4 (a) Complete the electronic configuration of the  $\text{Fe}^{3+}$  ion.

$1s^2 2s^2 2p^6 3s^2 3p^6$  ..... [1]

- (b) By quoting suitable data from the *Data Booklet*, explain how  $E^\ominus$  values can be used to show the relative oxidising abilities of

- (i) the halogens  $\text{Cl}_2$ ,  $\text{Br}_2$ ,  $\text{I}_2$ ,

.....  
.....

- (ii) the transition metal ions  $\text{Cr}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Co}^{3+}$ .

.....  
.....

[3]

- (c) Use these  $E^\ominus$  values to predict whether a reaction will occur when the following pairs of aqueous solutions are mixed. If a reaction occurs, write a balanced equation and calculate the  $E^\ominus_{\text{cell}}$ .

- (i)  $\text{Fe}^{3+}(\text{aq})$  and  $\text{Cl}^-(\text{aq})$

.....  
.....

- (ii)  $\text{Co}^{3+}(\text{aq})$  and  $\text{Br}^-(\text{aq})$

.....  
.....

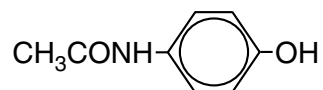
- (iii)  $\text{Cr}^{2+}(\text{aq})$  and  $\text{I}_2(\text{aq})$

.....  
.....

[4]

[Total: 8]

- 5 The common analgesic drug paracetamol has the following structure.



- (a) Name the **two** functional groups in the paracetamol molecule

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

- (b) Draw the structural formulae of the molecules or ions formed when paracetamol reacts with

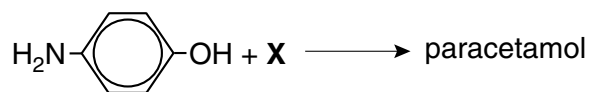
(i)  $\text{Br}_2(\text{aq})$ ,

(ii)  $\text{NaOH}(\text{aq})$  in the cold,

(iii)  $\text{NaOH}(\text{aq})$  under reflux.

[3]

- (c) Paracetamol can be synthesised by reacting 4-aminophenol with compound **X**.



- (i) Suggest a possible identity of **X**.

.....

- (ii) What reagent would you use to convert ethanoic acid,  $\text{CH}_3\text{CO}_2\text{H}$ , into **X**?

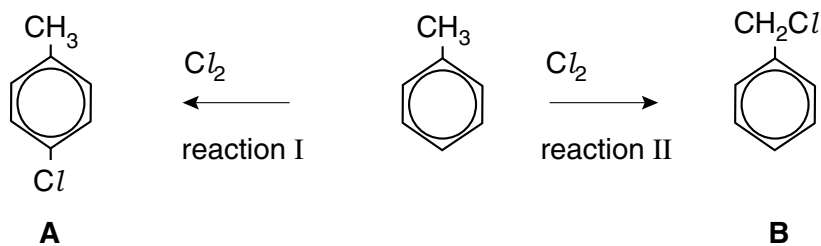
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[2]

[Total: 7]



- 6 Methylbenzene can react with chlorine in two ways, depending on the conditions of the reaction.



- (a) State the condition needed for

(i) reaction I,

.....

(ii) reaction II.

.....

[2]

- (b) One of the two compounds **A** and **B** reacts with NaOH(aq), but the other is inert.

(i) Which one (**A** or **B**) does **not** react? Give a reason for your answer.

.....

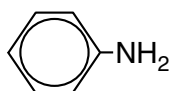
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(ii) Write an equation for the reaction with NaOH(aq) that does occur.

[2]

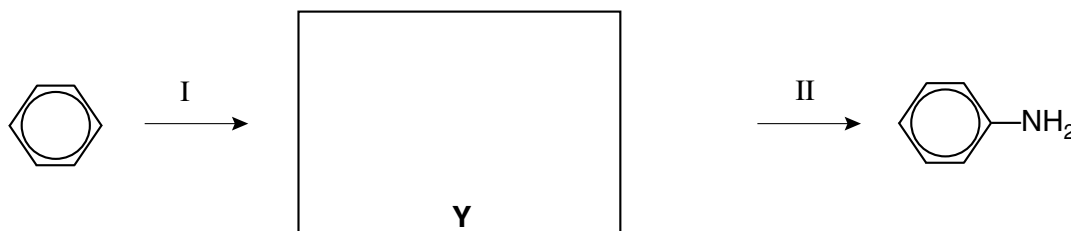
[Total: 4]

7 Phenylamine is an important intermediate compound for the production of dyes.



phenylamine

- (a) Phenylamine can be synthesised from benzene in two steps. Draw the structural formula of the intermediate **Y** in the scheme below, and suggest reagents and conditions for steps I and II.



reagent + conditions for step I .....

reagent + conditions for step II .....

[4]

- (b) Phenylamine is a weak base.

(i) Write an equation showing phenylamine acting as a base.

(ii) How would you expect its basicity to compare with that of ammonia?

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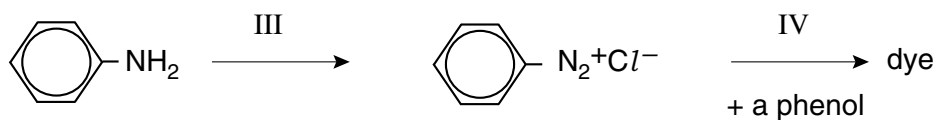
(iii) Explain the reasoning for your answer in (ii).

.....

.....

[3]

- (c) Dyes can be made from phenylamine by first converting it into benzenediazonium chloride, and then coupling this with a phenol.



- (i) State the reagents and condition needed for step III.

.....

- (ii) What reagent is the phenol dissolved in for step IV to be effective?

.....

- (iii) Suggest the structural formula of the dye formed when benzenediazonium chloride is coupled with 2-methylphenol.

[4]

[Total: 11]

