Centre Number	Candidate Number

Candidate Name _____

CAMBRIDGE INTERNATIONAL EXAMINATIONS

General Certificate of Education Advanced Level

CHEMISTRY 9701/4

PAPER 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	

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

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Local Examinations Syndicate
[Turn over

For Examiner's Use

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 mol dm^{-3} NaOH(aq).

.....

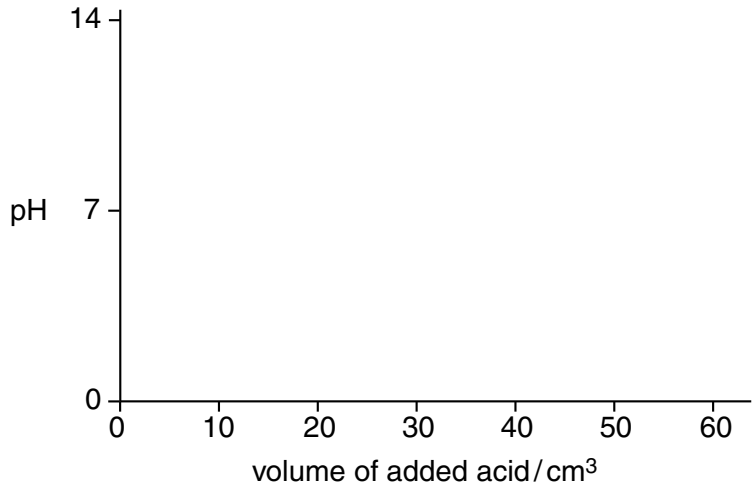
..... [2]

(c) The pH of 0.200 mol dm^{-3} NH_3(aq) is 11.3. Explain why this answer differs from your answer in **(b)**.

.....

..... [1]

(d) A 20.0 cm^3 sample of 0.200 mol dm^{-3} NH_3(aq) was titrated with 0.100 mol dm^{-3} HC*l*. 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 **one tick only** 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 $NH_3(aq)$ and $NH_4Cl(aq)$ 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.

.....

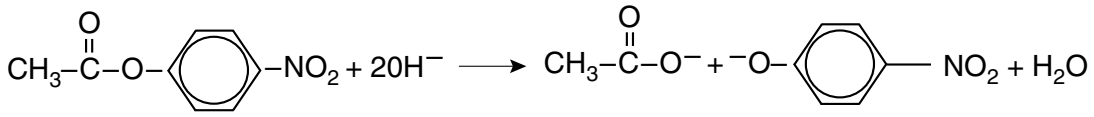
.....

.....

..... [2]

[Total: 10]

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



colourless yellow

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

.....

.....

.....

.....

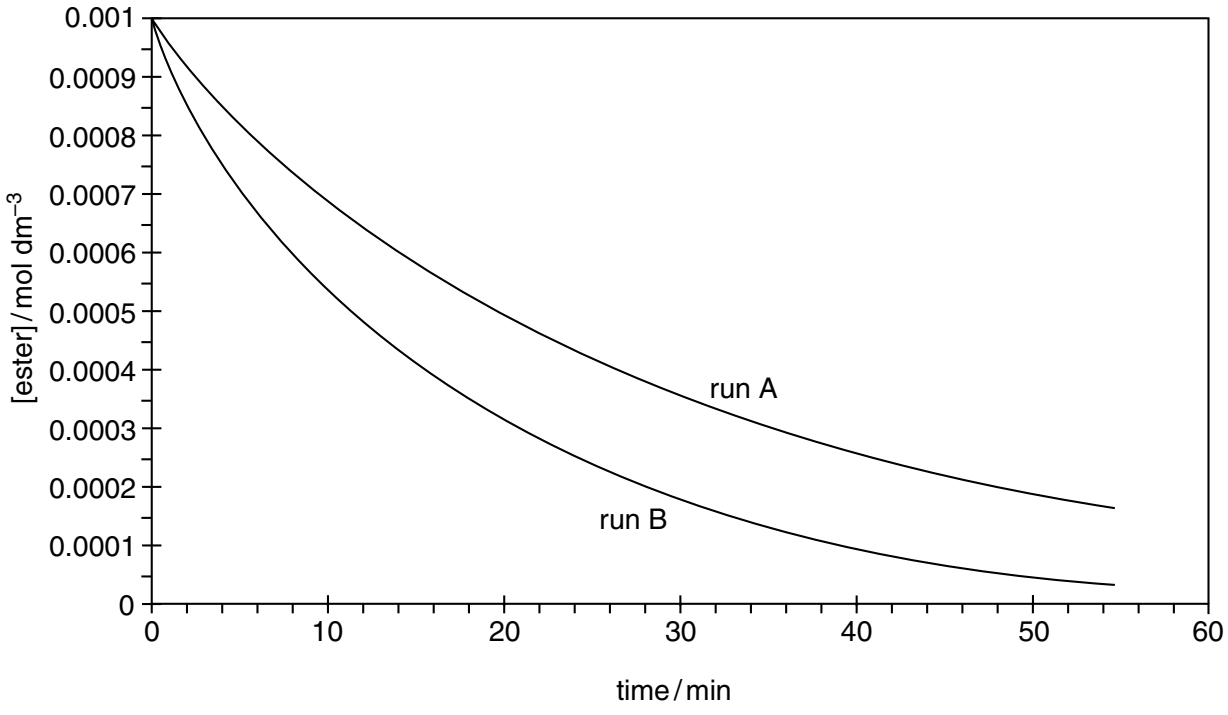
.....

..... [4]

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

run A: $[OH^-] = 0.20$ mol dm^{-3}
run B: $[OH^-] = 0.40$ 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 $[OH^-]$.

..... [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]

For Examiner's Use

3 **(a)** Write an equation to represent the thermal decomposition of calcium nitrate, $Ca(NO_3)_2$.

..... [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, **M**NO_2 (**M** = Na, K, Rb or 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 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 Cl_2, Br_2, I_2,

.....

.....

(ii) the transition metal ions Cr^{3+}, Fe^{3+}, 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 $E^{\ominus}_{cell}$.

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

.....

.....

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

.....

.....

(iii) $Cr^{2+}(aq)$ and $I_2(aq)$

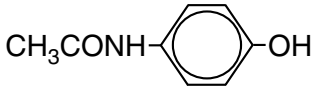
.....

.....

[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

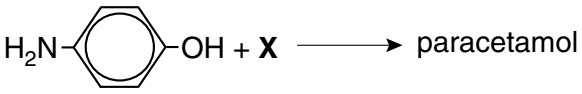
(i) $Br_2(aq)$,

(ii) NaOH(aq) in the cold,

(iii) NaOH(aq) under reflux.

[3]

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



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

.....

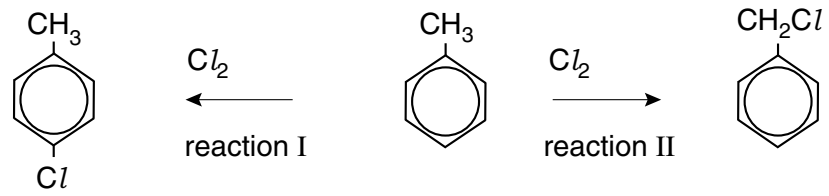
(ii) What reagent would you use to convert ethanoic acid, CH_3CO_2H, into **X**?

.....

[2]

[Total: 7]

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



A **B**

(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.

.....

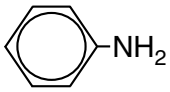
.....

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

[2]

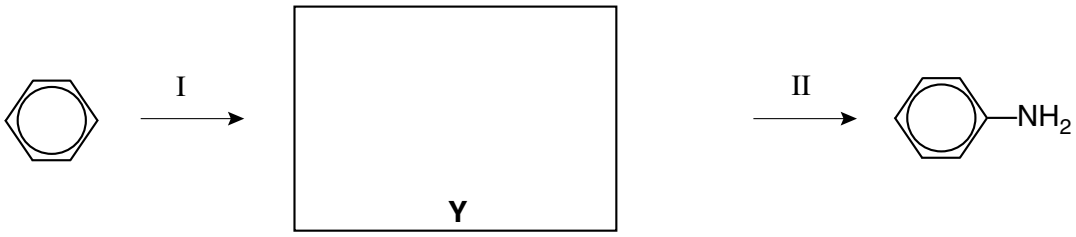
[Total: 4]

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?

.....

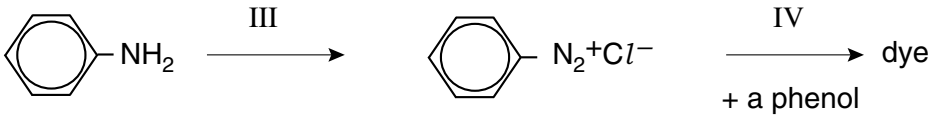
(iii) Explain the reasoning for your answer in **(ii).**

.....

.....

[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]

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