Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/04**

Paper 4 Structured Questions A2 Core

October/November 2004

1 hour 15 minutes

Candidates answer on the Question Paper.
Additional Materials: Data Booklet

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 in the spaces provided on the Question Paper.
You may use a pencil for any diagrams, graphs or rough working.
You may use a calculator.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

For Examiner's Use	
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4	
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6	
7	
Total	

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1 Sulphuric acid is a strong dibasic acid, which ionises in solution as follows.

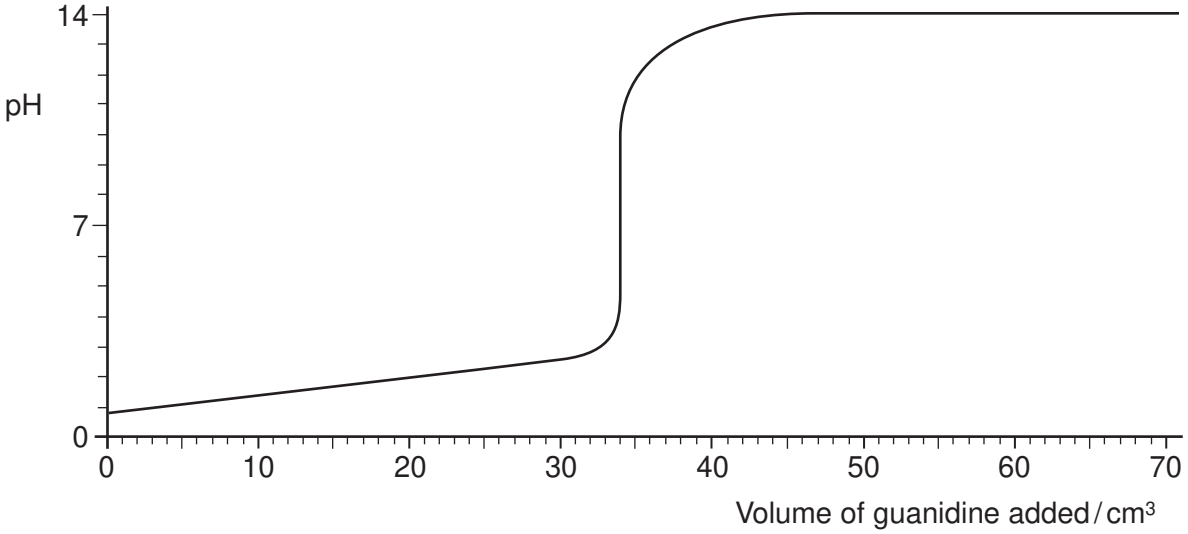
$$H_2SO_4(aq) \rightleftharpoons 2H^+(aq) + SO_4^{2-}(aq)$$

(a) The organic base guanidine contains carbon, nitrogen and hydrogen. Its reaction with acids can be represented as follows.

$$B(aq) + H^+(aq) \rightleftharpoons BH^+(aq)$$

where *B* represents the molecule of guanidine.

When a 25.0 cm^3 sample of dilute sulphuric acid was titrated against a solution of guanidine, the following titration curve was obtained.



Use this curve to answer the following questions.

(i) Is guanidine a strong or a weak base? Explain your answer.

.....

.....

(ii) The pH at the start of the titration was 0.70. Calculate the $[H^+]$, and hence the concentration of sulphuric acid, at the start of the titration.

.....

.....

.....

.....

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(iii) Calculate the concentration of guanidine in the solution in mol dm^{-3}.

.....

.....

.....

(iv) The guanidine solution contained 8.68 g of the base per dm^3. Use your answer to **(iii)** calculate the M_r of guanidine.

..... [6]

(b) One of the major industrial uses of sulphuric acid is to convert phosphate rock (calcium fluorophosphate(V)) into 'superphosphate' for use as a fertiliser. The process can be represented by the following partially balanced equation.

$$2\ Ca_5(PO_4)_3F + 7H_2SO_4 \longrightarrow \text{.....}\ CaSO_4 + \text{.....}\ Ca(H_2PO_4)_2 + \text{.....}\ HF$$

'superphosphate'

(i) Balance the above equation.

(ii) Use your balanced equation to calculate the mass of H_2SO_4 required to manufacture 1.0 kg of superphosphate fertiliser.

.....

.....

.....

..... [4]

(c) Solutions of hydrogenphosphates make useful buffers for biochemical experiments.

$$H_2PO_4^- \rightleftharpoons HPO_4^{2-} + H^+$$

(i) Explain what is meant by the term *buffer solution.*

.....

.....

(ii) Calculate the pH of a buffer solution that contains 0.20 mol dm^{-3} NaH_2PO_4 and 0.10 mol dm^{-3} Na_2HPO_4. [K_a ($H_2PO_4^-$) = 6.3×10^{-8} mol dm^{-3}]

.....

.....

..... [3]

[Total: 13]

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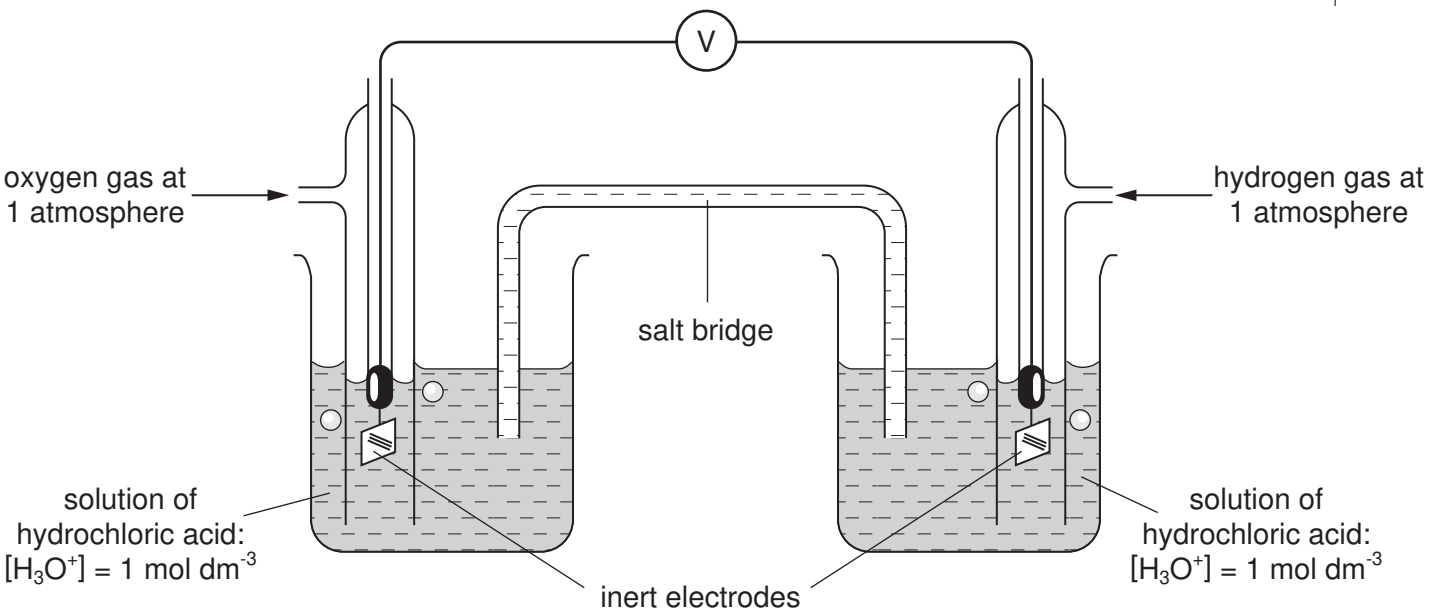
2 The diagram shows a laboratory illustration of a simple hydrogen-oxygen fuel cell.



(a) Write the half equation for the reaction occurring at the left hand (oxygen) electrode when the cell operates.

.....

..... [1]

(b) State the polarity (+ or –) of the left hand (oxygen) electrode. ..... [1]

(c) Use the *Data Booklet* to calculate the voltage produced by this cell.

..... [1]

(d) Only a very small current can be drawn from this laboratory cell. Suggest **one** way in which it could be modified to enable a larger current to be drawn from it.

.....

..... [1]

(e) A fuel cell in an orbiting satellite is required to produce a current of 0.010 A for 400 days. Calculate the mass of hydrogen that will be needed.

.....

.....

..... [3]

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(f) State **one** advantage, and **one** disadvantage of using fuel cells to power road vehicles compared to hydrocarbon fuels such as petrol.

advantage: .....

.....

disadvantage: .....

..... [2]

[Total: 9]

3 Calcium sulphate is a major by-product of flue gas desulphurisation, which is an important method of decreasing the emission of acid-rain gases from power stations. It is used extensively in plaster and cement. Both magnesium sulphate and barium sulphate find uses in medicine.

Describe and explain the variation in the solubilities of the Group II sulphates in water.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 4]

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4 **(a)** Explain what is meant by the term *transition element.*

.....

..... [1]

(b) **(i)** How do the atomic radii of the transition elements vary from chromium to copper?

.....

(ii) Predict, with a reason, the variation in the densities of the transition elements from chromium to copper.

.....

..... [3]

(c) Complete the following electronic configuration of the Cu^{2+} ion.

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

(d) Copper ions in aqueous solution are pale blue, due to the formation of a complex ion.

(i) Explain what is meant by the term *complex ion*.

.....

.....

(ii) Draw the structure of the complex ion formed in a solution of $Cu^{2+}(aq)$.

[2]

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(e) When dilute aqueous ammonia is added to a solution of $Cu^{2+}(aq)$, the colour changes as a new complex ion is formed.

(i) State the colour of the new complex .....

(ii) Write an equation showing the formation of the new complex.

..... [2]

(f) When concentrated hydrochloric acid is added to a solution of $Cu^{2+}(aq)$, the colour changes to yellow-green. On adding water, the colour returns to pale blue.

Suggest an explanation for these changes.

.....

.....

.....

.....

.....

.....

.....[3]

[Total: 12]

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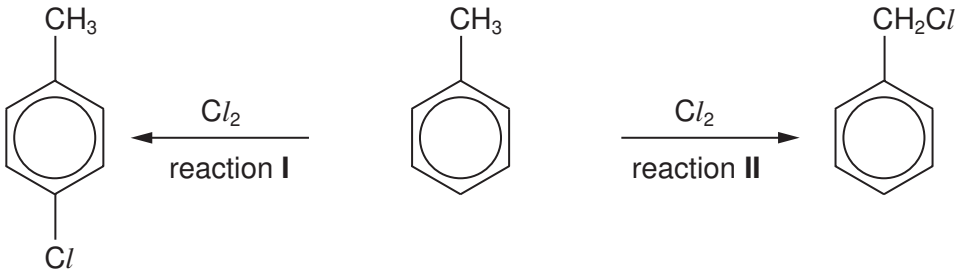
5 This question is concerned with organochlorine compounds.

(a) State the conditions needed to produce the two compounds **A** and **B.**



A **B**

(i) conditions for reaction **I**

.....

(ii) conditions for reaction **II**

..... [2]

(b) State the reagent needed to carry out the following reaction.



C

reagent for reaction **III**: ..... [1]

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(c) The three chloro-compounds **A**, **B** and **C** vary in their ease of hydrolysis.

(i) Place a tick in the box corresponding to the correct relative rates of hydrolysis. [the symbol '**>**' means 'faster than']

	place **one** tick only in this column
A > **B** > **C**	
A > **C** > **B**	
B > **A** > **C**	
B > **C** > **A**	
C > **B** > **A**	
C > **A** > **B**	

(ii) Suggest an explanation for these differences in reactivity.

.....

.....

..... [3]

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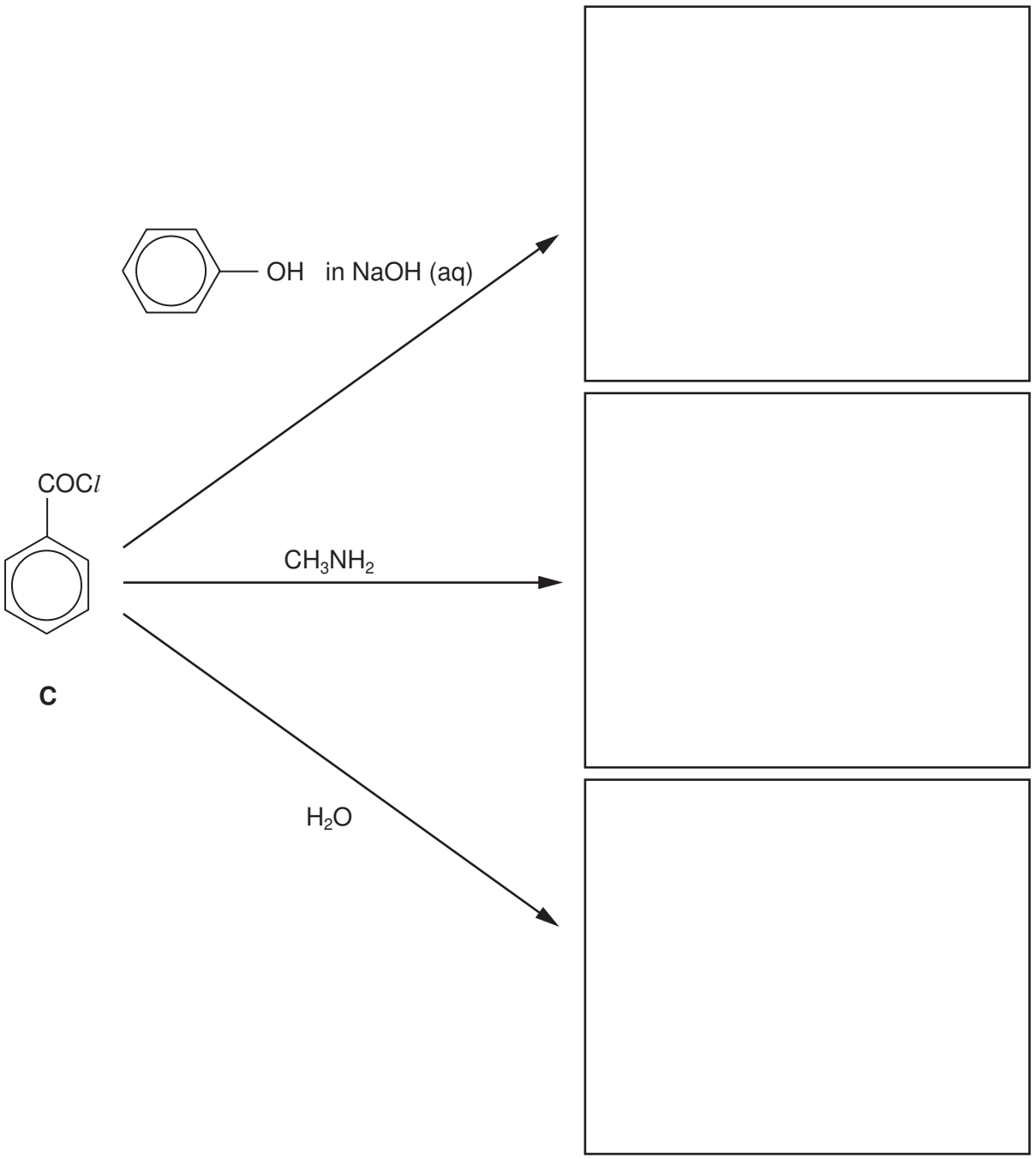
(d) Draw the structural formulae of the organic products of the following reactions of compound **C**.



[3]

[Total: 9]

6 Compounds **D** and **E** are both ketones.

$CH_3CH_2COCH_2CH_3$	$CH_3CH_2CH_2COCH_3$
D	**E**

(a) State which one of these compound reacts with alkaline aqueous iodine, and draw the structural formulae of the products formed during this reactions.

(i) compound (**D** or **E**) .....

(ii) products

..... [3]

(b) The reduction of **D** with $NaBH_4$ produces just one alcohol, but a similar reduction of **E** produces two isomers in equal amounts. Explain these observations, drawing structures where appropriate.

.....

.....

[3]

[Total: 6]

7 Both phenol and phenylamine react similarly with aqueous bromine.

(a) State **two** observations you would make when these reactions take place.

.....

.....

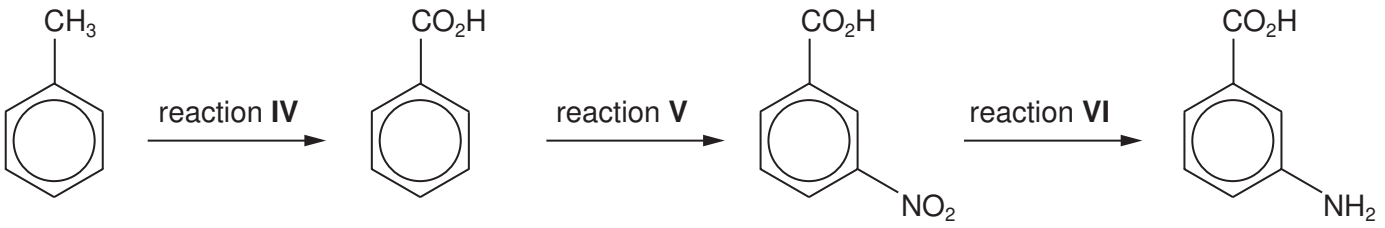
..... [2]

(b) Describe a simple test-tube reaction you could use to distinguish between phenol and phenylamine.

.....

.....[1]

(c) The compound 3-aminobenzoic acid can be prepared by the following series of reactions.



Suggest suitable reagents and conditions for

reaction **IV**, ...

reaction **V**, ...

reaction **VI**. ..... [4]

[Total: 7]

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