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 2006

1 hour 15 minutes

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

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number and candidate number in the spaces at the top of this page.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

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

For Examiner's Use	
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Total	

This document consists of **10** printed pages and **2** blank pages.

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1 **(a)** Describe and explain how the boiling points of the tetrachlorides of the Group IV elements vary down the group.

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.....

.....

..... [3]

(b) The tetrachlorides are all covalent compounds. Draw a diagram showing the shape of a molecule of silicon tetrachloride, including values for bond angles.

[2]

(c) The noble gas xenon forms a tetrafluoride, XeF_4. Only four of xenon's outer shell electrons are used in bonding to the fluorine atoms.

(i) Draw a dot-and-cross diagram showing how the outer-shell electrons are arranged in XeF_4.

(ii) Predict the shape and the bond angles in XeF_4.

.....

.....
[4]

(d) Describe and explain how the reactions of CCl_4 and $SiCl_4$ with water differ. Write an equation for any reaction that occurs.

.....

.....

.....

..... [3]

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(e) Many tonnes of lead tetrachloride used to be produced to make the anti-knock petrol additive tetraethyl-lead, $Pb(C_2H_5)_4$, by the following reaction.

$$PbCl_4 + \ldots\ldots\ldots Na + \ldots\ldots\ldots C_2H_5Cl \longrightarrow Pb(C_2H_5)_4 + \ldots\ldots\ldots NaCl$$

Balance this equation and use it to calculate the mass of sodium needed to produce 1.0 kg of tetraethyl-lead.

.....

.....

..... [3]

[Total: 15]

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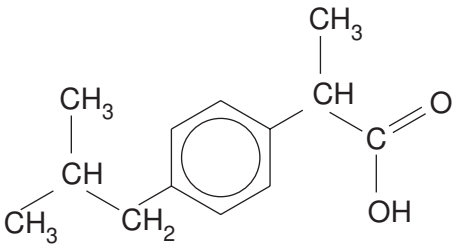
[Turn over

2 Ibuprofen is one of the most commonly used non-steroidal anti-inflammatory drugs, used to treat chronic arthritic pain caused by inflammation of the joints.



ibuprofen

(a) **(i)** Draw a circle around any chiral centre(s) in the above structure.

(ii) Write down the molecular formula of ibuprofen.

.....

(iii) Calculate the M_r of ibuprofen and use it to calculate how many grams are needed to make 100 cm^3 of a 0.15 mol dm^{-3} solution.

.....

.....

.....

(iv) Vigorous oxidation of ibuprofen produces a dibasic acid **A**. A solution containing 0.10 g of **A** required 12.0 cm^3 of 0.10 mol dm^{-3} NaOH for neutralisation.

Suggest a structure for **A**, showing your working.

.....

[7]

(b) The K_a value for ibuprofen is 6.3×10^{-6} mol dm^{-3}.

(i) Write an expression for K_a.

.....

(ii) Use the K_a value to calculate the pH of a 0.15 mol dm^{-3} solution of ibuprofen.

.....

.....

[3]

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(c) To avoid problems with digestive irritation over a long period of use, research is being carried out into ways of administering ibuprofen using skin patches. For this use the compound is dissolved in a hydrophilic gel which acts as a buffer.

(i) What do you understand by the term *buffer*?

.....

.....

The buffer used in the pharmaceutical preparation is a solution containing Na_2HPO_4 and NaH_2PO_4. These salts contain the HPO_4^{2-} and $H_2PO_4^-$ ions respectively.

(ii) Write equations to show how this buffer reacts with

H^+ ions, ...

OH^- ions. .....

(iii) A buffer solution containing equal concentrations of the two sodium phosphate salts has a pH of 7.20.

Calculate the pH of a pharmaceutical preparation containing 0.002 mol dm^{-3} of Na_2HPO_4 and 0.005 mol dm^{-3} of NaH_2PO_4.

[5]

[Total: 15]

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

.....

(ii) State and explain how the thermal stabilities of the nitrates vary down Group II.

.....

.....

.....

.....

[4]

(b) The nitrates of calcium, strontium or barium are often added to firework mixtures to produce red or green flames. The equation for the decomposition of one such mixture is as follows.

$$Sr(NO_3)_2(s) + 3C(s) \longrightarrow SrO(s) + N_2(g) + 2CO_2(g) + CO(g)$$

Calculate the volume of gas given off (measured at room temperature and pressure) when a 10.0 g sample of this mixture decomposes. [M_r: $Sr(NO_3)_2$, 211.6]

.....

.....

..... [2]

(c) Explain in detail how carbon monoxide, produced in this reaction, is poisonous.

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..... [2]

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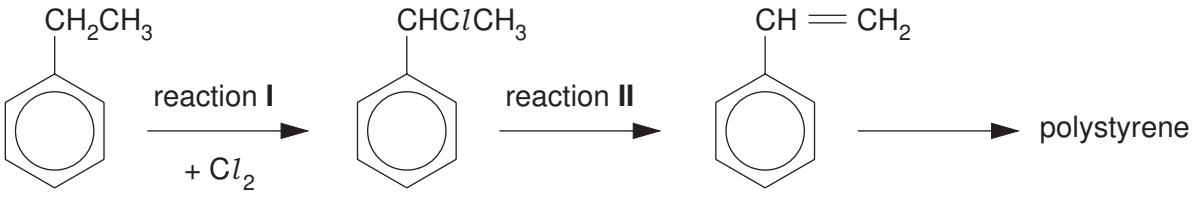
4 Ethylbenzene is an important starting material for making polystyrene (poly(phenylethene)).



ethylbenzene **B** phenylethene

(a) (i) State the conditions needed to carry out reaction **I** in the laboratory.

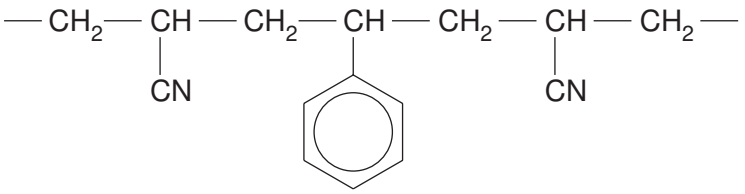
.....

(ii) State the reagent and conditions needed for reaction **II**.

.....

(iii) Draw the structure of the repeat unit of polystyrene.

(iv) There are several polymers that consist of phenylethene co-polymerised with other monomers. The following formula shows part of the chain of one such co-polymer.



Deduce the structural formula of the other monomer.

[5]

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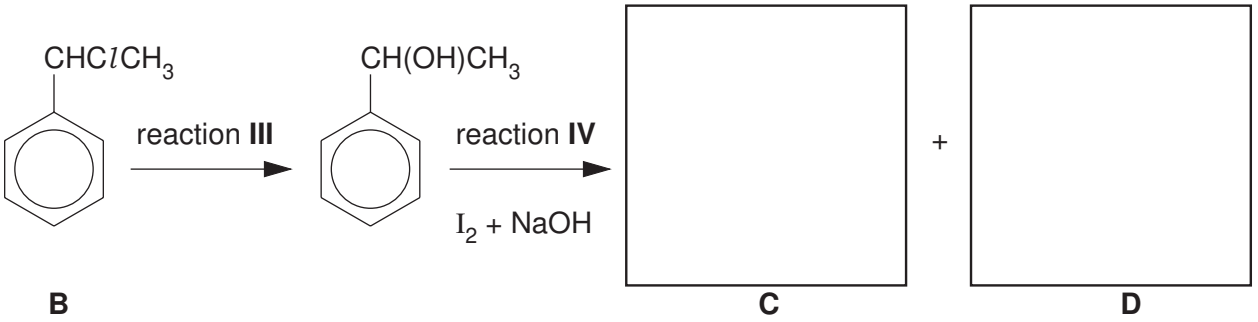
(b) Compound **B** undergoes the following series of reactions.



(i) Suggest reagents and conditions for reaction **III**.

.....

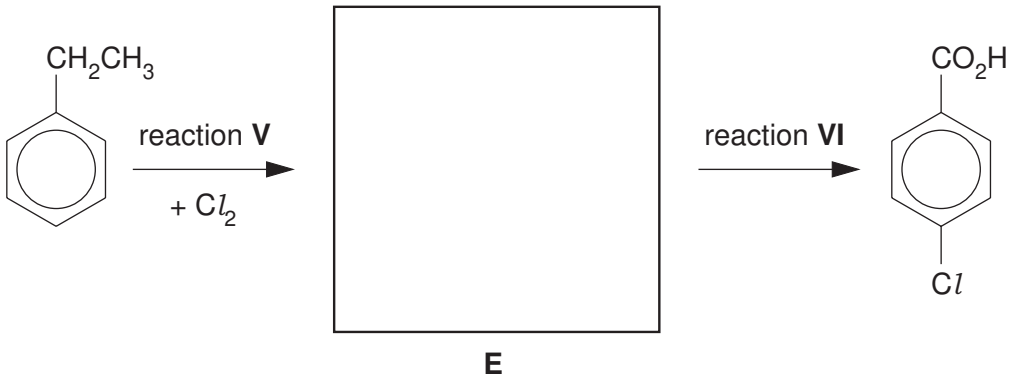
(ii) What would you see when reaction **IV** was carried out?

.....

(iii) Draw structures for **C** and **D** in the boxes above.

[4]

(c) Ethylbenzene can react with chlorine under a different set of conditions to give compound **E**, an isomer of compound **B**. Compound **E** undergoes the following reaction.



(i) Draw a structure for **E** in the box above.

(ii) Describe the conditions used for reaction **V**.

.....

(iii) State the reagents used for reaction **VI**.

.....

[3]

[Total: 12]

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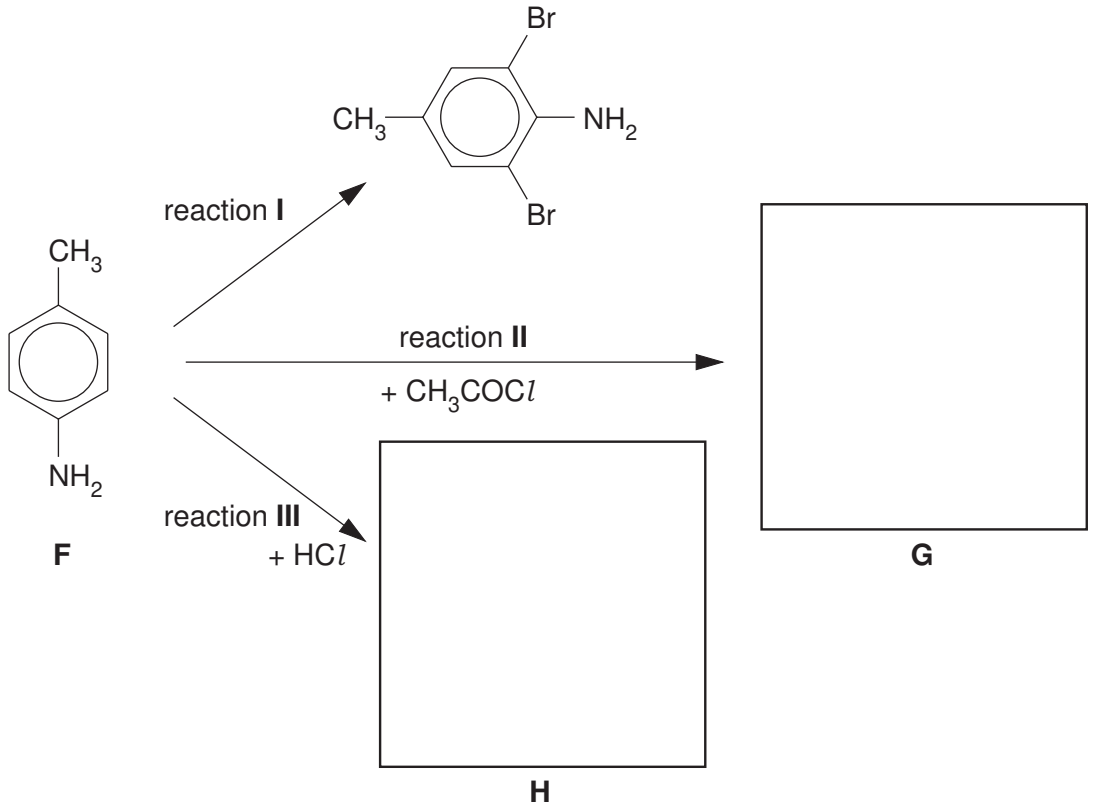
5 4-Amino-1-methylbenzene, **F**, is a useful starting material for making several dyes. The following chart shows some of its reactions.



(a) (i) Suggest reagents and conditions for reaction **I**.

.....

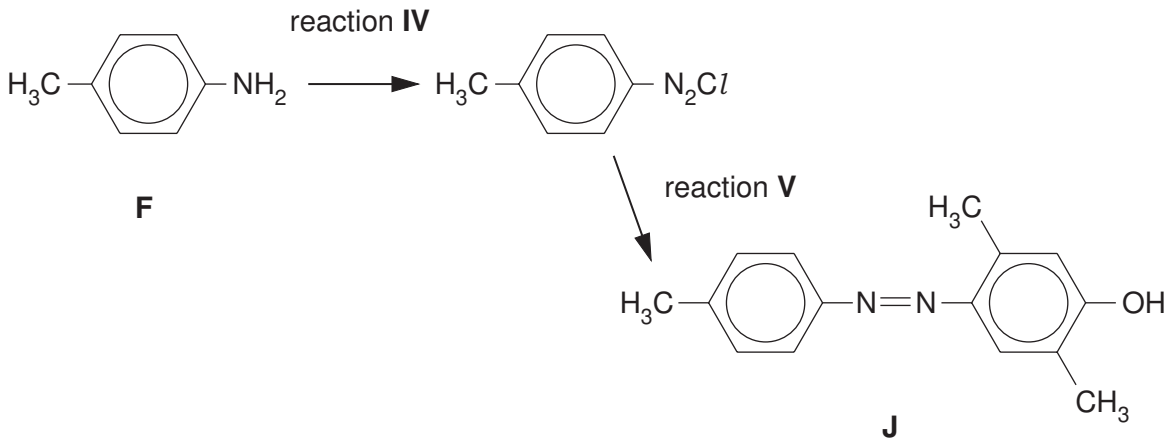
(ii) Draw the structural formulae of compounds **G** and **H** in the boxes above.

(iii) Name the functional group you have drawn in compound **G.**

.....

[4]

(b) The dye **J** can be made from **F** by the following series of reactions.



Suggest reagents and conditions for

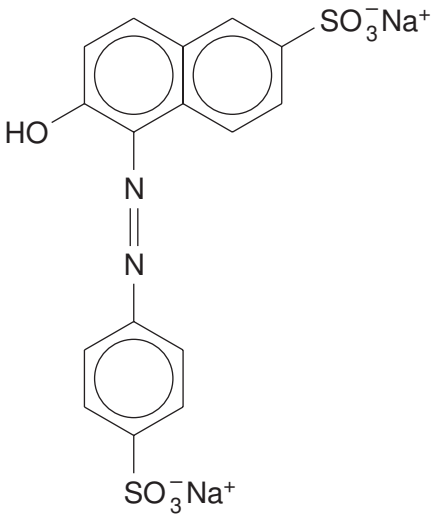
(i) reaction **IV**, ...

(ii) reaction **V**.

.....

[4]

(c) Many dyestuffs used as food colourings, such as Sunset Yellow, contain sodium sulphonate ($-SO_3^-Na^+$) groups attached to the rings. Suggest, with an explanation, a reason for this.



Sunset Yellow

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.....

..... [2]

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