

Ø	UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS General Certificate of Education Advanced Subsidiary Level and Advanced Level	
CANDIDATE NAME		
CENTRE NUMBER	CANDIDATE U	D
CHEMISTRY	9701/02	

Paper 2 Structured Questions AS Core

May/June 2007 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 on all the work you hand in. 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.

DO NOT WRITE IN ANY BARCODES.

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.

DO NOT WRITE IN THE GREY AREAS BETWEEN THE PAGES.

For Exam	iner's Use
1	
2	
3	
4	
Total	

This document consists of 9 printed pages and 3 blank pages.



www.papacambridge.com Ethene,  $C_2H_4$ , and hydrazine,  $N_2H_4$ , are hydrides of elements which are adjacent in the 1 Periodic Table. Data about ethene and hydrazine are given in the table below.

	$C_2H_4$	$N_2H_4$
melting point/°C	-169	+2
boiling point/°C	-104	+114
solubility in water	insoluble	high
solubility in ethanol	high	high

- (a) Ethene and hydrazine have a similar arrangement of atoms but differently shaped molecules.
  - What is the H-C-H bond angle in ethene? (i)

.....

(ii) Draw a 'dot-and-cross' diagram for hydrazine.

(iii) What is the H-N-H bond angle in hydrazine?

- [4]
- (b) The melting and boiling points of hydrazine are much higher than those of ethene. Suggest reasons for these differences in terms of the intermolecular forces each compound possesses.

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

		444
		3
(c)		3 Plain, with the aid of a diagram showing lone pairs of electrons and dipole razine is very soluble in ethanol.
		[3]
Eth	ene a	and hydrazine each react with HCl.
(d)	Wh	en ethene is reacted with HCl, $C_2H_5Cl$ is the only product.
	(i)	Using structural formulae, give an equation for the reaction between ethene and HC <i>l</i> .
	(ii) (iii)	What type of reaction occurs between HC <i>l</i> and ethene? Explain why there is no further reaction between $C_2H_5Cl$ and HC <i>l</i> .
		[3]
(e)	Wh be i	en aqueous hydrazine is reacted with HCl, a solid compound of formula $N_2H_5Cl$ may solated. When an excess of HCl is used, a second solid, $N_2H_6Cl_2$ , is formed.
	(i)	Suggest what type of reaction occurs between hydrazine and HCI.
	(ii)	What feature of the hydrazine molecule enables this reaction to occur?
	(iii)	Suggest why one molecule of hydrazine is able to react with one or two molecules of HC <i>l</i> .
		[3]
		[5] [Total: 16]

2 Alcohols and esters are important organic compounds which are widely used as solv

www.papacambridge.com Esters such as ethyl ethanoate can be formed by reacting carboxylic acids with alcohols.

 $CH_3CO_2H + C_2H_5OH \rightleftharpoons CH_3CO_2C_2H_5 + H_2O$ 

This reaction is an example of a dynamic equilibrium.

(a) Explain what is meant by the term dynamic equilibrium.

.....[1]

(b) Write the expression for the equilibrium constant for this reaction,  $K_c$ .

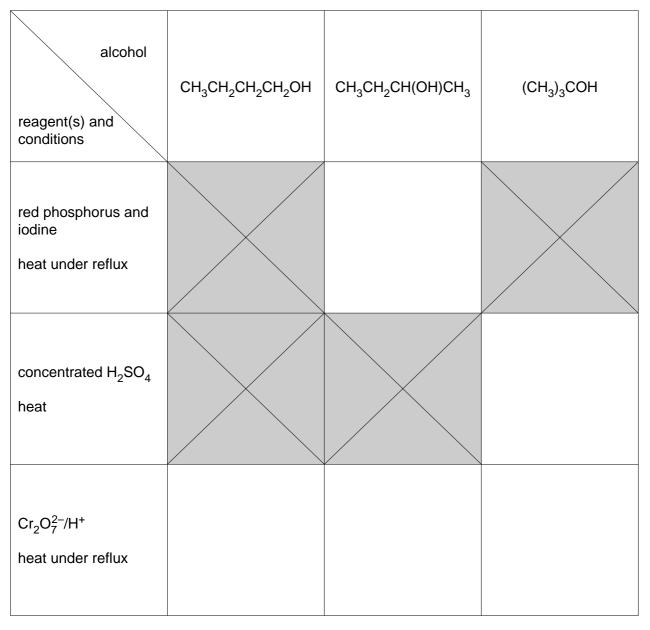
- [1]
- (c) For this equilibrium, the value of  $K_c$  is 4.0 at 298 K. A mixture containing 0.5 mol of ethanoic acid, 0.5 mol ethanol, 0.1 mol ethyl ethanoate and 0.1 mol water was set up and allowed to come to equilibrium at 298K. The final volume of solution was V dm<sup>3</sup>.

Calculate the amount, in moles, of each substance present at equilibrium.

www.papaCambridge.com Alcohols may be classified into primary, secondary and tertiary. Some reactions are a to all three types of alcohol. In other cases, the same reagent gives different prod depending on the nature of the alcohol.

(d) In the empty squares below give the structural formula of the organic compound formed in each of the reactions indicated.

If no reaction occurs, write 'no reaction' in the space.



[5]

[Total: 11]

Ca 2 2 6 Sr<sup>2+</sup> 2 2 6 [2] (b) Explain the following observations. (i) The atomic radii of Group II elements increase down the Group. ..... (ii) The strontium ion is smaller than the strontium atom. (iii) The first ionisation energies of the elements of Group II decrease with increasing proton number. ..... [4]

This question is about the elements in Group II of the Periodic Table, magnesium to 3

1s

2s

2p

www.papaCambridge.com (a) Complete the table below to show the electronic configuration of calcium atoms and of strontium ions, Sr<sup>2+</sup>.

3s

3p

3d

4s

4p

4d

		T	
(c)	som	7 nples of magnesium and calcium are placed separately in cold water and ne time. In <b>each case</b> , describe what you would see and write a balanced equi- each reaction. magnesium observation	a is
	(i)	magnesium	90.0
		observation	
		equation	
	(ii)	calcium	
		observation	
		equation	
		[6]	
(d)	Stro	ontium nitrate, Sr(NO <sub>3</sub> ) <sub>2</sub> undergoes thermal decomposition.	
	(i)	State one observation you would make during this reaction.	
	(ii)	Write a balanced equation for this reaction.	
		[4]	
		[Total: 16]	

- www.papaCambridge.com Commercial paint and varnish removers contain a mixture of dichloromethane, CH<sub>2</sub> 4 methanol, CH<sub>3</sub>OH. (a) What would be observed when the following reactions are carried out? In each case, give the name or formula of the reaction product which is responsible for the observation you have made. (i)  $CH_2Cl_2$  is reacted with NaOH(aq) and AgNO<sub>3</sub>(aq) and the mixture left to stand. observation ..... product responsible ..... (ii)  $CH_3OH$  is mixed with  $PCl_5$ . observation ..... product responsible ..... (iii) CH<sub>3</sub>OH is reacted with sodium. observation ..... product responsible ..... [6]
  - (b) When  $CH_2Cl_2$  is heated under reflux with an excess of NaOH(aq), a compound W is formed.

W has the following composition by mass: C, 40.0%; H, 6.7%; O, 53.3%.

Use this information and the Data Booklet to show that the empirical formula of W is CH<sub>2</sub>O.

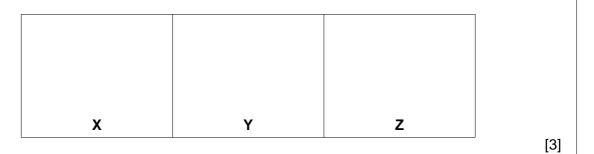
[2]

(c) Compounds with the empirical formula  $CH_2O$  can have the molecular formula  $C_2$ 

Two possible structural formulae for compounds with molecular formula  $C_2H_4O_2$  $HCO_2CH_3$  and  $H_2C=C(OH)_2$ .

www.papaCambridge.com In the boxes below, draw displayed formulae for three further structural isomers with the molecular formula  $C_2H_4O_2$ .

Do not attempt to draw any structures containing rings or O–O bonds.



(d) Identify which of your compounds, X, Y, or Z, will react with the following reagents.

In each case, state what you would observe.

(i) solid NaHCO<sub>3</sub>

compound .....

observation .....

(ii) Tollens' reagent

compound .....

observation ..... [4]

(e) One of the three compounds, X, Y, or Z, shows stereoisomerism.

Draw displayed, labelled structures of the stereoisomers of this compound.

[Total: 17]



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