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

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

* 3 7 1 3 9 7 1 9 7 2 *

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.

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1	
2	
3	
4	
Total	

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

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

For Examiner's Use

1 Ethene, C_2H_4, and hydrazine, N_2H_4, are hydrides of elements which are adjacent in the 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.

(i) What is the H-C-H bond angle in ethene?

.....

(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]

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(c) Explain, with the aid of a diagram showing lone pairs of electrons and dipoles, why hydrazine is very soluble in ethanol.

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[3]

Ethene and hydrazine each react with HC*l*.

(d) When ethene is reacted with HC*l*, C_2H_5Cl is the only product.

(i) Using structural formulae, give an equation for the reaction between ethene and HC*l*.

(ii) What type of reaction occurs between HC*l* and ethene?

.....

(iii) Explain why there is no further reaction between C_2H_5Cl and HC*l*.

.....

[3]

(e) When aqueous hydrazine is reacted with HC*l*, a solid compound of formula N_2H_5Cl may be isolated. When an excess of HC*l* is used, a second solid, $N_2H_6Cl_2$, is formed.

(i) Suggest what type of reaction occurs between hydrazine and HC*l*.

.....

(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*l*.

.....

.....

[3]

[Total: 16]

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

For Examiner's Use

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 298 K. The final volume of solution was V dm^3.

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

[4]

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

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(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.

alcohol / reagent(s) and conditions	$CH_3CH_2CH_2CH_2OH$	$CH_3CH_2CH(OH)CH_3$	$(CH_3)_3COH$
red phosphorus and iodine heat under reflux			
concentrated H_2SO_4 heat			
$Cr_2O_7^{2-}/H^+$ heat under reflux			

[5]

[Total: 11]

For Examiner's Use

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

(a) Complete the table below to show the electronic configuration of calcium atoms and of strontium ions, Sr^{2+}.

	1s	2s	2p	3s	3p	3d	4s	4p	4d
Ca	2	2	6						
Sr^{2+}	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]

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(c) Samples of magnesium and calcium are placed separately in cold water and left for some time. In **each case**, describe what you would see and write a balanced equation for each reaction.

(i) magnesium

observation .....

.....

equation .....

(ii) calcium

observation .....

.....

equation .....

[6]

(d) Strontium nitrate, $Sr(NO_3)_2$ undergoes thermal decomposition.

(i) State one observation you would make during this reaction.

.....

.....

(ii) Write a balanced equation for this reaction.

.....

[4]

[Total: 16]

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4 Commercial paint and varnish removers contain a mixture of dichloromethane, CH_2Cl_2, and methanol, CH_3OH.

(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 $AgNO_3$(aq) and the mixture left to stand.

observation .....

product responsible .....

(ii) CH_3OH is mixed with PCl_5.

observation .....

product responsible .....

(iii) CH_3OH 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_2O.

[2]

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(c) Compounds with the empirical formula CH_2O can have the molecular formula $C_2H_4O_2$.

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

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.

X	**Y**	**Z**

[3]

(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 $NaHCO_3$

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.

[2]

[Total: 17]

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