Centre Number	Candidate Number

Candidate Name _____

CAMBRIDGE INTERNATIONAL EXAMINATIONS

General Certificate of Education Advanced Subsidiary Level and Advanced Level

CHEMISTRY 9701/2

PAPER 2 **OCTOBER/NOVEMBER 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.

A Data Booklet is provided.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
6	
TOTAL	

This question paper consists of 10 printed pages and 2 blank pages.

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Local Examinations Syndicate

[Turn over

1 **(a)** Draw a diagram to show the Boltzmann distribution of molecular energies. Label the axes.

[2]

(b) Comment on the shape of the distribution curve.

.....

.....

.....

.....[1]

(c) **(i)** Explain the meaning of the term *activation energy*.

.....

.....

.....

.....

(ii) Insert and label the activation energy in your diagram in **(a)**. [2]

(d) **(i)** Use a dotted line added to your diagram in **(a)** to show how the distribution of molecular energies changes at a slightly higher temperature (label this curve $+\delta T$).

(ii) Use this new line to explain why reactions are faster at a higher temperature.

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.....

.....

.....[3]

[Total : 8]

2 Ethanoic acid is a common ingredient in cooking. It is also used in industry as a reagent.

(a) Ethanoic acid is a weak acid.

(i) Explain, in Bronsted-Lowry terms, what is meant by an *acid*.

.....

.....

(ii) Explain, with the aid of an equation, the term *weak acid*.

.....

.....

[3]

(b) Ethanoic acid, CH_3CO_2H, reacts with ethanol, C_2H_5OH, to produce ethyl ethanoate and water. The reaction is an example of dynamic equilibrium.

$$CH_3CO_2H + C_2H_5OH \rightleftharpoons CH_3CO_2C_2H_5 + H_2O$$

(i) Explain what is meant by *dynamic equilibrium*.

.....

.....

(ii) Write an expression for the equilibrium constant, K_c, for this reaction.

[2]

(c) A mixture of 6.0 g of ethanoic acid and 6.0 g of ethanol was added to 4.4 g of ethyl ethanoate and the overall mixture allowed to reach equilibrium. It was found that 0.040 mol of ethanoic acid was present in the equilibrium mixture.

(i) Calculate the number of moles of each compound, both initially and at equilibrium. Place the results in the spaces provided.

	CH_3CO_2H	+ C_2H_5OH $\rightleftharpoons$	$CH_3CO_2C_2H_5$	+ H_2O
initially	.....	.....	.....	0.00
at equilibrium	0.040	.....	.....	.....

[Turn over

(ii) Calculate the equilibrium constant, K_c, for the reaction.

(iii) Explain why K_c in this reaction has no units.

.....[4]

[Total : 9]

3 The oxides of the third period include the following:

Na_2O; MgO; Al_2O_3; SO_2; SO_3.

(a) Showing outer electrons only, draw a dot-and-cross electron diagram for magnesium oxide, MgO.

[1]

(b) From the list above, identify one oxide (in each case) which fits the description given.

(i) An oxide that reacts with water forming a strongly alkaline solution.

.....

(ii) An oxide that is insoluble in water.

.....

(iii) An oxide that reacts vigorously with water forming a strongly acidic solution.

.....

(iv) An oxide that has a simple molecular structure.

.....

(v) An oxide that acts as a food preservative.

.....

[5]

For Examiner's Use

(c) Write equations for the reaction of

(i) aluminium oxide and dilute hydrochloric acid,

.....

(ii) sulphur dioxide and aqueous sodium hydroxide.

.....

[2]

(d) Antimony, Sb, has been known for about 6000 years. It is present in many ancient forms of bronze, but now its main use is to strengthen lead alloys.

Antimony is produced in a two-stage process from stibnite, a sulphide ore, Sb_2S_3.

The ore is first roasted in oxygen to form the oxide.

$$2Sb_2S_3 + \text{.....} O_2 \longrightarrow Sb_4O_6 + \text{.....}SO_2$$

(i) Balance the above equation.

The oxide is then reduced with carbon.

$$Sb_4O_6 + 3C \longrightarrow 4Sb + 3CO_2$$

(ii) What is the oxidation number of antimony in Sb_4O_6?

.....

(iii) Calculate the volume of carbon dioxide, measured at room temperature and pressure, that would be produced by the processing of 10 moles of Sb_2S_3.

[4]

[Total : 12]

[Turn over

4 Ammonia is manufactured from nitrogen and hydrogen by the Haber process.

Hydrogen is usually obtained by reacting methane and steam; the by-product is carbon monoxide.

(a) Construct a balanced equation for this production of hydrogen.

.....[1]

The reaction between nitrogen and hydrogen is exothermic and incomplete.

(b) (i) Write an equation for the Haber process.

.....

(ii) State the **three** conditions necessary for the efficient working of a Haber process plant.

1. .....

2. .....

3. .....

(iii) Draw a flow diagram to show how the gases pass through the plant. The part where the ammonia is formed should be called the **converter**. Label the flow diagram to explain the process.

[6]

(c) Explain why the pressure you have quoted in **(b)(ii)** is used.

.....

.....

.....

.....

.....[2]

(d) Most of the ammonia produced which is not used as fertiliser, is oxidised to nitric acid, HNO_3.

Construct an equation for the oxidation of ammonia by atmospheric oxygen to form nitric acid.

.....[1]

(e) Urea, $CO(NH_2)_2$, is a naturally occurring substance which can be hydrolysed with water to form ammonia according to the following equation.

$$H_2O(l) + CO(NH_2)_2(aq) \longrightarrow CO_2(aq) + 2NH_3(aq)$$

The standard enthalpy changes of formation of water, urea, carbon dioxide and ammonia (in aqueous solution) are given below.

compound	$\Delta H_f^{\ominus}$/kJ mol^{-1}
$H_2O(l)$	−287.0
$CO(NH_2)_2(aq)$	−320.5
$CO_2(aq)$	−414.5
$NH_3(aq)$	−81.0

Use these data to calculate the standard enthalpy change for the hydrolysis of urea.

[2]

[Total : 12]

[Turn over

5 Samples of the following compounds were labelled **A** to **E** as shown.

A $CH_3CH_2CH_2OH$

B $CH_3CH_2CH(OH)CH_3$

C CH_3CHO

D CH_3COCH_3

E $CH_3CH{=}CHCH_3$

Complete the table below by inserting the letter (or letters) of the compounds that correspond to each test.

reagent	observation	letter(s)
acidified potassium dichromate(VI)	green colour obtained on boiling	
acidified potassium manganate(VII)	ethanoic acid obtained on boiling	
hydrogen in the presence of a platinum catalyst	hydrogen absorbed	
Fehling's reagent	brown-red precipitate obtained on boiling	
2,4-dinitrophenylhydrazine	orange precipitate	
bromine in an inert solvent	solution decolourised	

[9]

[Total : 9]

For Examiner's Use

6 Pentan-1-ol, $C_5H_{11}OH$, is important in the synthesis of organic compounds.

(a) Give the structural formula of another primary alcohol which is an isomer of pentan-1-ol.

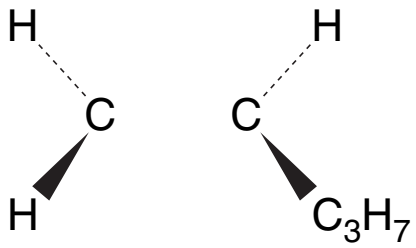
[1]

(b) **(i)** Write a balanced equation for the preparation of 1-bromopentane from pentan-1-ol.

(ii) This preparation gives a yield of 60%. Calculate the mass of pentan-1-ol required to produce 15.0 g of 1-bromopentane.

[3]

(c) Dehydration of pentan-1-ol produces pent-1-ene. Sketch on the diagram below the orbital overlap between the two carbon atoms. Label the bonds.



[2]

[Turn over

(d) The two compounds below are among many secreted by insects to attract members of the same species. Such compounds are used in traps to control insect populations. They need to be made synthetically.

For each synthesis outline how they could be prepared from pentan-1-ol, giving the necessary reagents and conditions.

(i) $CH_3(CH_2)_3CO_2H$

(ii) $CH_3CO_2(CH_2)_4CH_3$

[4]

[Total : 10]

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