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

CHEMISTRY **9701/06**

Paper 6 OPTIONS

October/November 2003

1 hour

Additional Materials: Answer Paper
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number and candidate number on the front of any work handed in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your answers on the separate Answer Paper provided.

Answer **all** the questions on **two** of the Options.
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.

This document consists of **11** printed pages and **1** blank page.

BR (PW) S44893/2

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

[Turn over

BIOCHEMISTRY

Answer **both** questions on the paper provided.

1 Lysozymes are widely spread in nature. They catalyse the breakdown of all the major classes of biochemical macromolecules.

(a) Suggest what biochemical function lysozymes play, and what type of molecules they are. [2]

(b) Into what will each of the following molecules be broken down by lysozymes?

(i) carbohydrates

(ii) lipids

(iii) proteins

(iv) nucleic acids

[4]

(c) Give the structural formulae of the degradation products that are formed in **(b)(ii)** and in **(b)(iii)**. [3]

(d) State the type of reaction that takes place when these macromolecules break down. [1]

2

First position of codon	*Second position of codon*				*Third position of codon*
	U(T)	C	A	G	
U(T)	UUU, UUC } Phe UUA, UUG } Leu	UCU, UCC, UCA, UCG } Ser	UAU, UAC } Tyr [2]UAA, [2]UAG } Term	UGU, UGC } Cys [2]UGA } Term UGG } Try	U(T) C A G
C	CUU, CUC, CUA, CUG } Leu	CCU, CCC, CCA, CCG } Pro	CAU, CAC } His CAA, CAG } Gln	CGU, CGC, CGA, CGG } Arg	U(T) C A G
A	AUU, AUC } Ile AUA, [1]AUG } Met	ACU, ACC, ACA, ACG } Thr	AAU, AAC } Asn AAA, AAG } Lys	AGU, AGC } Ser AGA, AGG } Arg	U(T) C A G
G	GUU, GUC, GUA, [1]GUG } Val	GCU, GCC, GCA, GCG } Ala	GAU, GAC } Asp GAA, GAG } Glu	GGU, GGC, GGA, GGG } Gly	U(T) C A G

[1] is initiation.
[2] is termination.

(a) The above table is a code. Explain what it means. [8]

(b) Explain what is meant by the terms *initiation* and *termination*. [2]

[Turn over

ENVIRONMENTAL CHEMISTRY

Answer **both** questions on the paper provided.

3 **(a)** **(i)** The formula of a unit of kaolinite, a 1:1 layer silicate, is $Al_2Si_2O_5(OH)_4$ and the formula of a unit of pyrophyllite, another layer silicate, is $Al_2Si_4O_{10}(OH)_2$. Describe the structure of pyrophyllite.

(ii) Mica has the same fundamental structure as pyrophyllite but has the formula $K[Al_2(Si_3Al)O_{10}(OH)_2]$. Explain what has led to the difference in formula.

[5]

(b) **(i)** Ions such as ammonium and potassium are soluble in water. Explain why these ions are not completely washed out of soil as a result of heavy rainfall.

(ii) Write an equation to show how sulphur dioxide and nitrogen dioxide react in moist air to cause rainwater to become more acidic.

(iii) Acidic rainwater may cause some loss of ammonium and potassium ions from the soil. Explain how this could occur.

[5]

4 **(a)** Explain why **each** of the following processes is important in maintaining a healthy environment.

(i) temperature control in the incineration of waste

(ii) the treatment of water with $Al^{3+}(aq)$ prior to chlorination in the production of drinking water

[6]

(b) Phosphates are sometimes added to detergents to improve their efficiency.

(i) Explain the function of the phosphate ion when used in detergents.

(ii) Why is it desirable to limit the use of phosphates?

[4]

PHASE EQUILIBRIA

Answer **both** questions on the paper provided.

5 **(a)** Sketch the phase diagram for water. Label the areas, identifying any points of interest, and explain any anomalous behaviour shown by water. [4]

(b) Add to your sketch the vapour pressure curve of a solution of sodium chloride (salt) in water. Explain how the salt affects the freezing point and the boiling point of water. [4]

(c) A freshwater reservoir is located by the sea. Explain why the water in the reservoir will evaporate at a faster rate per square metre of surface area than water in the sea, when subjected to strong sunlight. [2]

6 Nitric acid (b.p. 87 °C) and water form an azeotropic mixture of boiling point 122 °C and composition 65 % by mass of nitric acid.

(a) Sketch the boiling point/composition curve for the nitric acid/water system, labelling both the vapour and liquid curves. [4]

(b) A nitric acid/water mixture containing initially 40% of nitric acid by mass is heated in a distillation apparatus fitted with a fractionating column.

State what will be the composition of

(i) the first distillate,

(ii) the final distillate.

Draw lines on your sketch to show how you obtained your answer to **(i)**.

[3]

(c) **(i)** State *Raoult's law*.

(ii) Comment on, and explain, why there is a deviation from this law for the nitric acid/water system.

[3]

[Turn over

SPECTROSCOPY

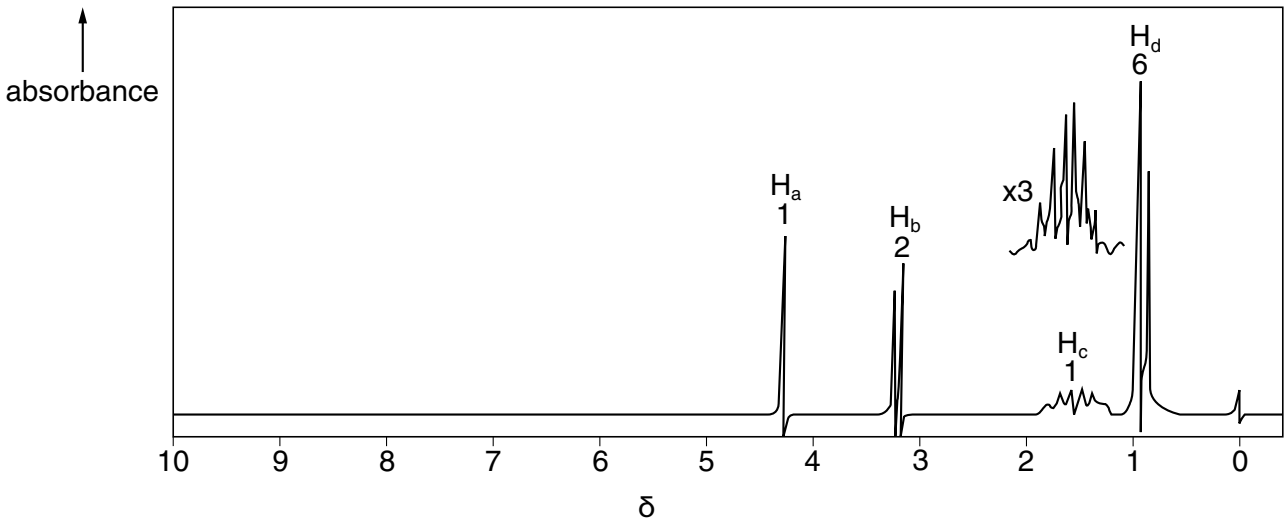
Answer **both** questions on the paper provided.

7 **(a)** **(i)** Outline the principles of nuclear magnetic resonance in protons, ^1H.

(ii) Using one of the methyl protons in ethanol as an example, describe the effects of adjacent protons on the magnetic field experienced by that proton.

[6]

(b) The nmr spectrum of an alcohol with the formula C_4H_9OH is shown below.



Draw the displayed formula of the alcohol and indicate, using the labels on the spectrum above, which type of proton is responsible for each group of peaks.

[4]

8 **(a)** An organic compound **E**, $C_xH_yO_z$, was found to contain 66.7% of carbon and 11.1% of hydrogen, by mass. **E** produced a strong infra-red absorption at 1720 cm^{-1} and its mass spectrum contained lines at *m*/*e* 72 (the M peak), 57 and 43.

Use these data to suggest a molecular structure for **E**, explaining your reasoning. [5]

(b) Different forms of spectroscopy are used to assist in various aspects of medical examination.

(i) Suggest why nmr spectroscopy is an important diagnostic tool in medicine, for example in body scanners.

(ii) Outline the use of atomic absorption spectroscopy to determine the concentration of sodium ions in blood serum.

[5]

TRANSITION ELEMENTS

Answer **both** questions on the paper provided.

9 **(a)** Explain why most compounds containing transition metals are coloured, whereas compounds of non-transition metals are usually colourless. [3]

(b) When the neutral V(II) complex $V(H_2O)_4Cl_2$ is added to water, the green complex dissolves to form a violet solution. Explain why this change of colour takes place. [2]

(c) State the colour and formulae of the aqueous ions of vanadium in oxidation states III and IV. [2]

(d) Titration of a sample containing 0.0010 mol of an oxychloride of vanadium, $VOCl_x$, required 20.0 cm^3 of 0.020 mol dm^{-3} $KMnO_4(aq)$ for its complete oxidation in acidic solution.

(i) Use $E^{\ominus}$ data from the *Data Booklet* to predict the final oxidation state of the vanadium after the titration.

(ii) Use the titration data given above to calculate the change in oxidation number undergone by the vanadium during the titration.

(iii) Hence deduce a value for x in $VOCl_x$.

[3]

10 **(a)** Name, and give a use for, one alloy **each** of chromium and copper, stating the other metal(s) contained in each alloy. [2]

(b) Suggest explanations for the following observations, writing relevant equations where possible.

(i) Adding aqueous barium chloride to an orange solution of sodium dichromate(VI) causes a yellow solid to be precipitated, and an acidic solution to remain.

(ii) Adding aqueous ammonia to a solution of copper(II) sulphate produces first a pale blue precipitate, then a deep blue solution.

(iii) Chromium(III) chloride crystallises in three forms, all having the formula $CrCl_3(H_2O)_6$. One form is violet, and another is green.

Adding aqueous silver nitrate to a solution of the violet form precipitates all the chloride it contains, but only two thirds of the chloride from the green form is precipitated.

[8]

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