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

CHEMISTRY **9701/06**

Paper 6 Options

October/November 2004

1 hour

Additional Materials: Answer paper
Data Booklet
Graph Paper (1 sheet)

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 in the spaces provided on the Question Paper.
You may use a 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** 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.
You may use a calculator.

This document consists of **8** printed pages.

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International Examinations

[Turn over

BIOCHEMISTRY

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

1 **(a)** Write a simple equation to represent the hydrolysis of ATP. [1]

(b) The following results were obtained at different concentrations of ATP for the rate of hydrolysis of ATP in the presence of the enzyme myosin.

[ATP] / mmol dm^{-3}	0.025	0.050	0.075	0.100	0.150	0.200	0.300
rate / mmol dm^{-3} s^{-1}	0.0065	0.0115	0.0140	0.0158	0.0176	0.0187	0.0196

(i) Use graph paper to plot these results. Plot [ATP] on the *x* axis and rate on the *y* axis.

(ii) Use your graph to determine the Michaelis constant, K_m, for this reaction.

(iii) State the units of K_m.

[5]

(c) Suggest and explain how the rate of this reaction would be affected by the presence of approximately 0.05 mmol dm^{-3} ADP.

Mark the graph with a dotted line to indicate the new rate of the hydrolysis of ATP in the presence of ADP. [4]

2 **(a)** The principal function of glucose in living organisms is to provide an instantaneous source of energy.

(i) Write the equation for the complete oxidation of glucose, $C_6H_{12}O_6$.

Lipids and fatty acids are also used to provide energy. Stearic acid is the commonest fatty acid.

(ii) Write the equation for the complete oxidation of stearic acid, $CH_3(CH_2)_{16}CO_2H$.

[2]

(b) The heat of combustion values per gram for these two molecules are given below.

	Heat of combustion / kJ g^{-1}
glucose	17
stearic acid	39

(i) Comment on and explain the difference between the two heat of combustion values per gram.

(ii) Calculate the molar enthalpy change of combustion for each of the two molecules.

[5]

(c) Explain what will happen to glucose molecules in plants and in animals, when glucose is surplus to energy requirements. [3]

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ENVIRONMENTAL CHEMISTRY

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

3 **(a)** Ozone is an important gas in the Earth's atmosphere. Discuss its role and chemistry in

(i) the stratosphere, and

(ii) the troposphere.

[6]

(b) Describe, with the use of equations, how lean-burn engines and catalytic converters can reduce the pollutant emissions from petrol-driven vehicles. [4]

4 **(a)** In the preparation of drinking water there are three main stages.

I the separation of solid material,
II precipitation (flocculation) of suspended material,
III the removal of bacteria.

(i) What is added to water in stage II to aid precipitation (flocculation)?

(ii) What is added to the water to kill bacteria in stage III?

(iii) What potentially hazardous materials can be formed in stage III?

(iv) Even after treatment, the water may still contain high concentrations of phosphate and nitrate ions. How do these impurities originally get into the water?

[5]

(b) The disposal of solid domestic waste is a major problem in many countries.

Discuss the use of landfill and incineration as possible disposal methods, highlighting the problems associated with each. [5]

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[Turn over

PHASE EQUILIBRIA

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

5 Silver jewellery is shaped by the craftsman and then has to be soldered. Sometimes a silver-gold solder is used, on other occasions an aluminium-copper solder may be used. Very small amounts of solder are used to preserve the appearance of the jewellery.

(a) The melting point/composition curve of silver/gold mixtures is the straight line joining the melting points of the two components. The melting point of silver is 960 °C and that of gold is 1063 °C.

Sketch the melting point/composition diagram, labelling the axes and areas on your sketch. [2]

(b) Aluminium and copper have a different type of melting point/composition curve as a eutectic of melting point 535 °C is formed at 67% copper by mass. The melting point of aluminium is 660 °C and that of copper is 1080 °C.

Sketch the melting point/composition diagram, labelling the axes and areas on your sketch. [3]

(c) State **two** advantages of using the aluminium-copper solder in preference to the silver-gold solder. [2]

(d) The atomic radius of silver is 0.144 nm and that of gold is 0.146 nm.

(i) Use these values and others from the *Data Booklet* to suggest why silver and gold do not form a eutectic, but aluminium and copper do.

(ii) Suggest how the solid alloys silver-gold and aluminium-copper might differ in their appearance under a microscope.

[3]

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6 Ethanoic acid and water are completely miscible in all proportions.

(a) **(i)** Use the data below to plot the boiling point/composition curve for the ethanoic acid/water system.

b.p. at 1 atm. / °C	118	114	108	104	102	100
ethanoic acid in liquid / mole fraction	1.00	0.90	0.70	0.50	0.30	0.00
ethanoic acid in vapour / mole fraction	1.00	0.84	0.58	0.38	0.18	0.00

(ii) A mixture containing 0.80 mole fraction of ethanoic acid is distilled using a fractionating column which has an efficiency equivalent to three theoretical plates.

On your graph construct lines to show three theoretical plates and use these to predict the composition of the distillate.

[5]

(b) **(i)** Sketch and label the **two** similar curves which would be obtained if another acid, **A**, (b.p. 119 °C) and water formed an azeotrope containing 0.70 mole fraction of **A**, and having a maximum boiling point of 125 °C.

(ii) Suggest what kind of interaction has occurred between **A** and water to produce this azeotrope.

(iii) State the products which would be obtained first from the totally efficient fractional distillation of aqueous solutions containing the following mole fractions of **A**.

- 0.90
- 0.70
- 0.50

[5]

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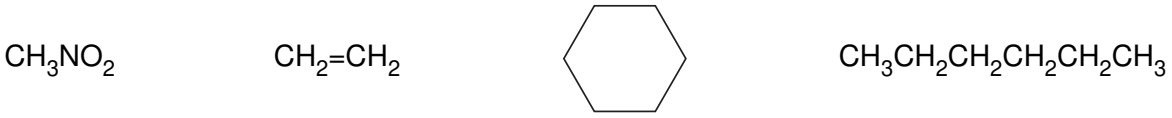
SPECTROSCOPY

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

7 **(a)** Which **two** of the molecules **A**, **B**, **C** and **D** will absorb energy in the uv/visible part of the spectrum.

Explain your choice.



A **B** **C** **D**

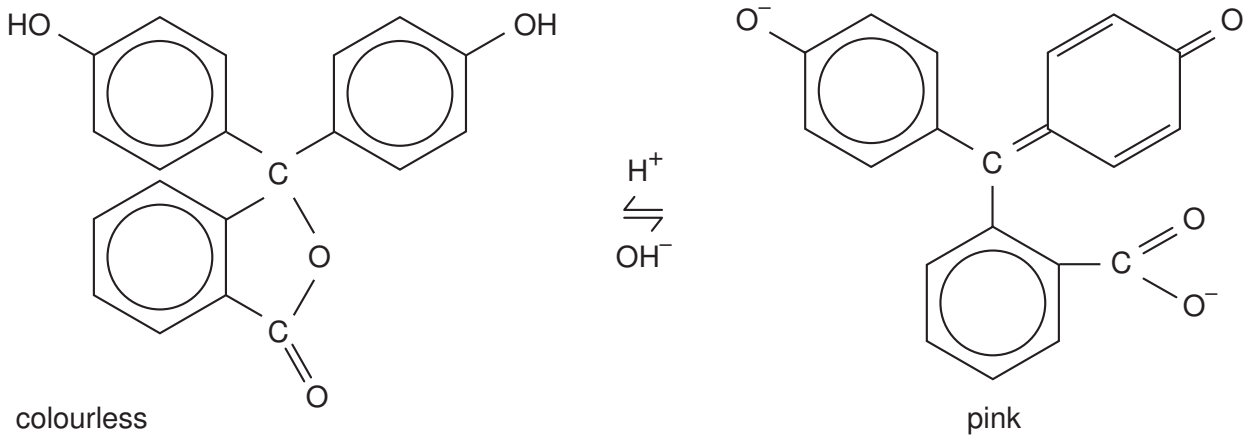
[2]

(b) In the mass spectrum of compound **E**, C_nH_{2n}, the ratio of the M : (M+1) peaks was 7.3 : 0.48.

Calculate the number of carbon atoms present in **E**, and hence deduce its formula. [2]

(c) When the indicator phenolphthalein is added to alkali, it changes from colourless to bright pink.

Explain what has happened to cause this change.



colourless pink

[3]

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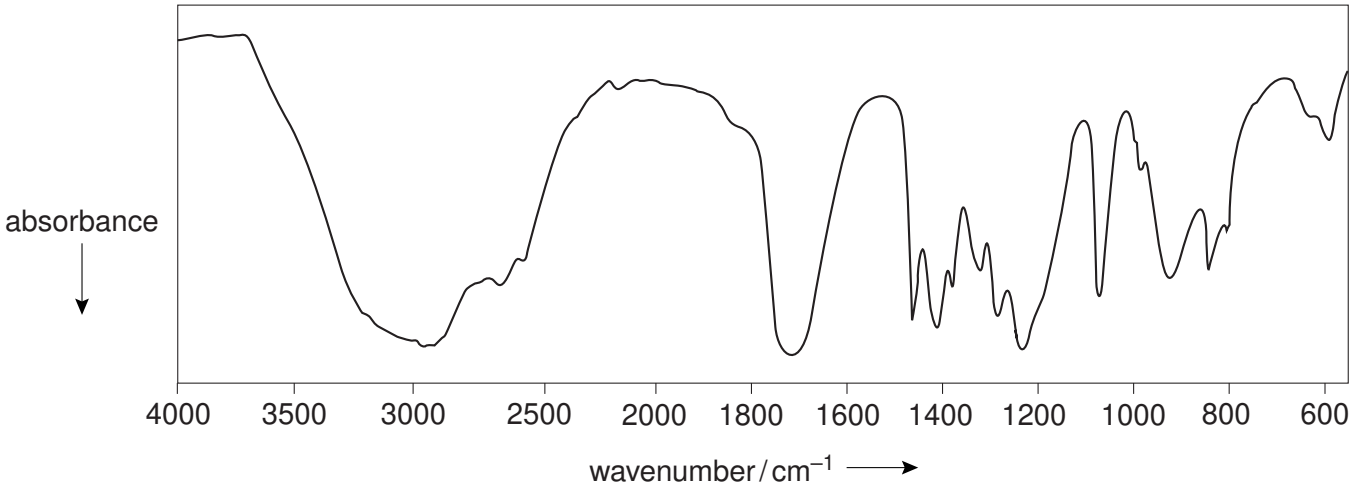
(d) The infra-red spectrum shown was produced from a compound **F** with the formula $C_3H_6O_2$.

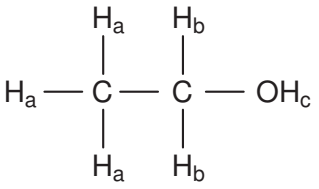
Identify the characteristic absorptions for the compound, giving their wavenumbers, and hence suggest a structure for the compound.



[3]

8 **(a)** Nmr spectroscopy can give information about groups adjacent to a particular proton, as well as about the proton itself. The process which gives us information about adjacent protons is called 'spin-spin' splitting.

Using ethanol as an example, explain the splitting pattern associated with each group of protons in the molecule.



[5]

(b) Give **two** advantages of nmr spectroscopy as a valuable diagnostic tool in medicine. [2]

(c) Many transition metal compounds, such as copper(II) sulphate pentahydrate, are coloured, yet not all copper compounds are coloured.

(i) Explain why Cu^{2+} compounds are generally coloured whereas Cu^{+} compounds are not.

(ii) Suggest why copper(II) sulphate pentahydrate is coloured, but the anhydrous salt is not.

[3]

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[Turn over

TRANSITION ELEMENTS

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

9 **(a)** By using the ligands NH_3, $NH_2CH_2CH_2NH_2$ and Cl^-, and the ion Co^{2+}, illustrate **two** types of stereoisomerism that can occur in 6-coordinated complex ions. Draw clear diagrams of the complexes you describe. [3]

(b) Explain the following observations, writing balanced equations for all reactions.

(i) Warming a pink aqueous solution of cobalt(II) chloride causes its colour to change to blue. On cooling the solution returns to its pink colour.

(ii) When concentrated HCl is added to this pink aqueous solution of cobalt(II) chloride, the solution turns blue. Diluting the solution with water causes its colour to return to pink.

(iii) When NaOH(aq) is added to aqueous solution of cobalt(II) chloride, a pink precipitate is formed. On adding an excess of NaOH(aq), the precipitate dissolves to form a blue solution.

[7]

10 **(a)** **(i)** Describe the redox processes that occur during the rusting of iron and steel.

(ii) Describe and explain **one** way in which rusting can be prevented.

[5]

(b) When a solution of NaOCl is added to a strongly alkaline suspension of Fe_2O_3, a purple solution results. When $BaCl_2$(aq) is added, a red solid is precipitated with the composition Ba, 53.4%; Fe, 21.7%; O, 24.9% by mass.

(i) Calculate the empirical formula of the red solid, and hence determine the oxidation number of iron contained within it.

(ii) Construct a balanced (ionic) equation for the reaction between Fe_2O_3, OCl^- and OH^-.

[5]

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