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

CHEMISTRY **9701/06**

Paper 6 Options

October/November 2005

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 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.

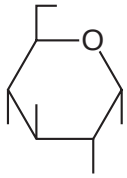
This document consists of **9** printed pages and **3** blank pages.

BIOCHEMISTRY

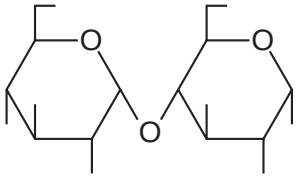
Answer **both** questions on the paper provided.

1 Diagrams **A**, **B**, **C** and **D** represent carbohydrates.

A



B



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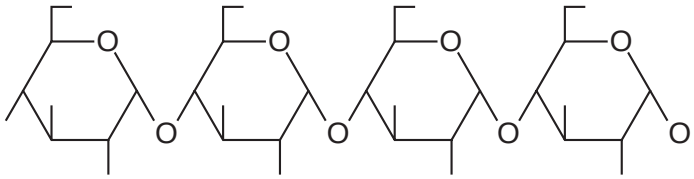
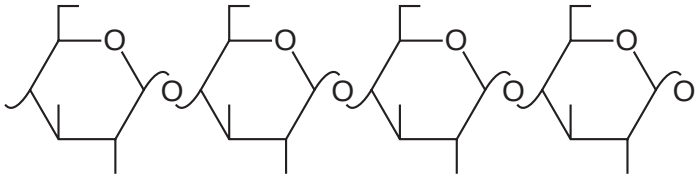


D



(a) Name and draw a displayed formula for the molecule drawn as **A**. [1]

(b) **B** can be converted into **A**.

(i) Write an equation using molecular formulae for the conversion of **B** into **A**, and state what type of reaction it is.

(ii) Two different methods can be used for this conversion. For **each**, state the reagents used and the conditions necessary. [5]

(c) Explain the structural differences between **C** and **D** and the consequent roles that **each** has in nature. [4]

2 The principal ester in olive oil has the common name glyceryl trioleate. Hydrolysis of olive oil yields 3 moles of oleic acid per mole of this ester. The systematic name for oleic acid is *cis*-octadec-9-enoic acid and its structural formula is $CH_3(CH_2)_7CH{=}CH(CH_2)_7CO_2H$.

(a) (i) Name **two** functional groups in oleic acid.

(ii) Draw the structural formula of the ester, glyceryl trioleate. In your diagram, use R to represent $CH_3(CH_2)_7CH{=}CH(CH_2)_7$.

[3]

(b) (i) Complete hydrolysis of 1.00 g of glyceryl trioleate liberated 3.50×10^{-3} moles of oleic acid. Use these data to calculate the relative molecular mass of glyceryl trioleate.

(ii) State **one** function of triglyceryl esters in the human diet.

[3]

(c) (i) State **two** fat-soluble vitamins which may be found in a margarine made from olive oil.

(ii) For **one** of the vitamins:

- name a common source of the vitamin (other than from olive oil or its derivatives),
- state the effect on the human body caused by a deficiency of this vitamin.

[4]

ENVIRONMENTAL CHEMISTRY

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

3 **(a)** Clays are composed of layers containing silicon/oxygen and aluminium/oxygen sheets.

(i) What is the difference in geometry between the silicon/oxygen and aluminium/oxygen units?

(ii) Sketch the structure of a 2:1 clay.

(iii) Explain why soils containing 2:1 clays crack rather than crumbling when they dry out. [5]

(b) Explain how ion retention occurs on the surface of silicate clays, and why this is important for plant growth. [3]

(c) In 1986 the Chernobyl power station accident released large amounts of radioactive caesium compounds into the environment. The isotope ^{137}Cs was found to contaminate soils in a wide region for a considerable period.

Explain how clays could have been involved in the retention of $^{137}Cs^{+}$ ions in the soil. [2]

4 There has been a great deal of research in recent years on problems associated with the 'greenhouse effect', and its potential effects on the climate of the Earth.

(a) Outline why gases such as methane and carbon dioxide are considered to be greenhouse gases, whereas oxygen and nitrogen are not. [2]

(b) The combustion of fossil fuels is a major source of carbon dioxide in the atmosphere. State another important source and give a balanced equation for the reaction that produces carbon dioxide. [2]

(c) **(i)** Explain why the oceans are important in helping to control the amount of carbon dioxide in the atmosphere.

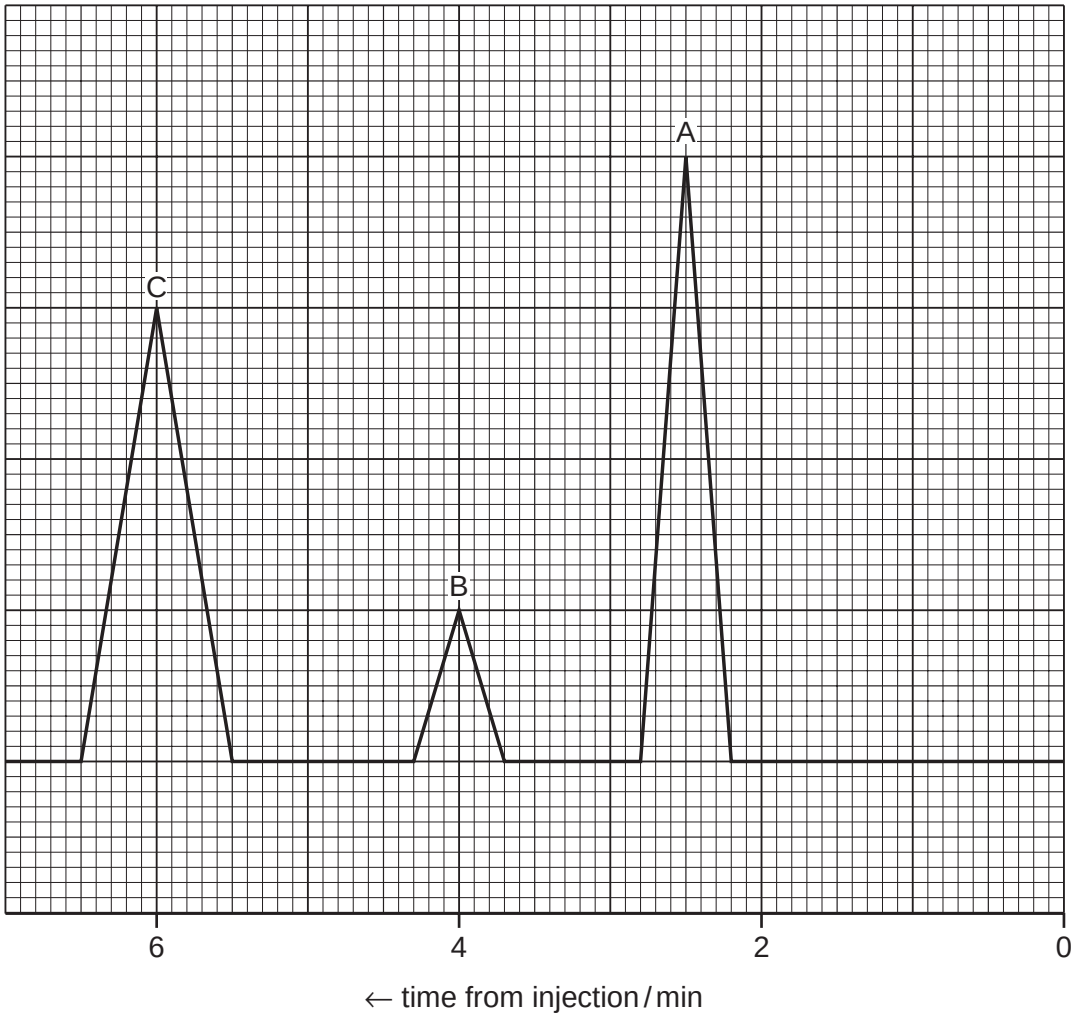
(ii) Suggest what other functions the oceans play in regulating the climate on Earth. [6]

PHASE EQUILIBRIA

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

5 **(a)** Outline the important parts of the apparatus used for high performance liquid chromatography, HPLC. [3]

(b) Researchers have discovered a new plant in the rainforest. The esters it produces have potential to form the basis of a new perfume. A sample of the perfume is dissolved in ethanol and analysed using gas/liquid chromatography, GLC. The trace obtained is shown below.



(i) Why does the *x*-axis run in the reverse direction to a conventional plot?

(ii) What causes the different components to be separated in the column?

(iii) Calculate the different proportions of the three components in the mixture, showing your working.

(iv) How would you expect the speed of elution to change if one of the esters was replaced with an alcohol of similar M_r? Explain your answer.

[7]

6 **(a)** Sketch the shape of the eutectic diagram for tin and lead. Points of interest and the areas of your diagram should be labelled.

[Actual values of any points on your diagram are **not** expected]. [4]

(b) Most metals are not used in their pure states, but as alloys. Discuss the advantages of using an alloy, rather than one of its pure metal components, with reference to each of the following:

(i) the use of tin and lead in solders,

(ii) the use of nickel and copper in coinage metals.

[6]

SPECTROSCOPY

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

7 **(a)** Explain the significance of the following peaks in the spectrum of the compound $C_2H_4Br_2$.

(i) M + 1

(ii) M + 2

(iii) M + 4

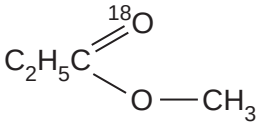
[3]

(b) State and explain what you would expect the ratio of the heights of the M + 2 and M + 4 peaks to be. [2]

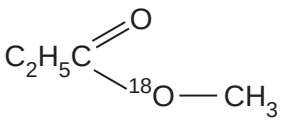
(c) You are provided with a sample of an ester of formula $C_4H_8O_2$, in which one of the oxygen atoms has been labelled with ^{18}O. Suggest how you could use mass spectrometry to

(i) identify the ester;

(ii) decide whether the ^{18}O was present as **K** or **L**.



K

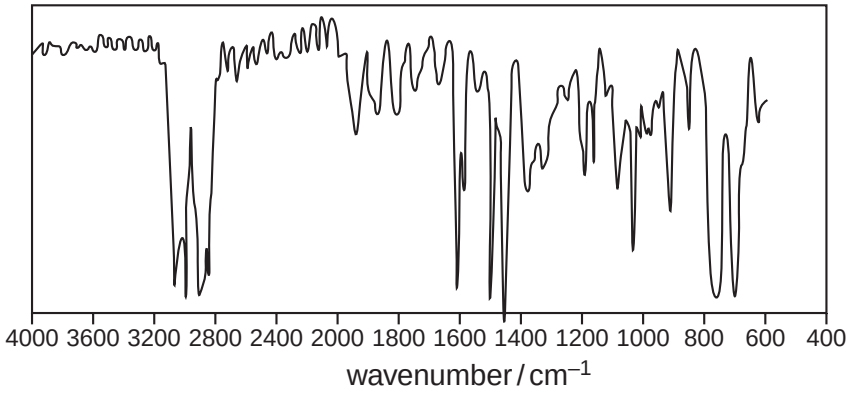


L

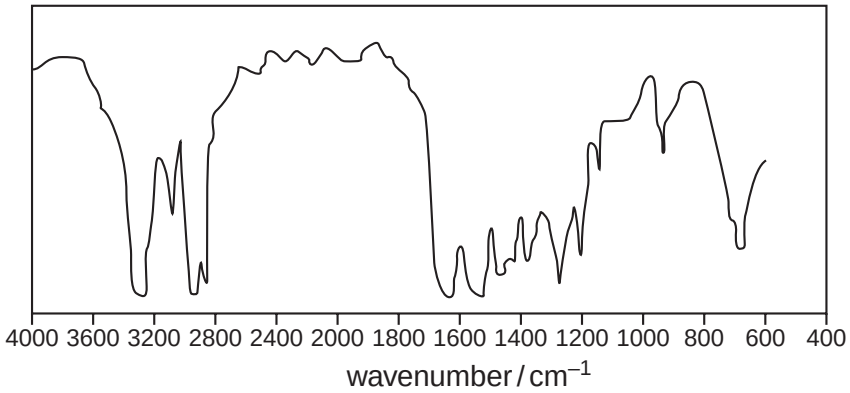
[5]

8 The recycling of plastics could become cheaper and more efficient if the sorting of different types of plastic waste could be automated. One way of distinguishing between different plastics is by using infra-red radiation. The plastics absorb radiation in different parts of the spectrum. The spectra shown were produced by three common types of waste plastic **P**, **Q** and **R**.

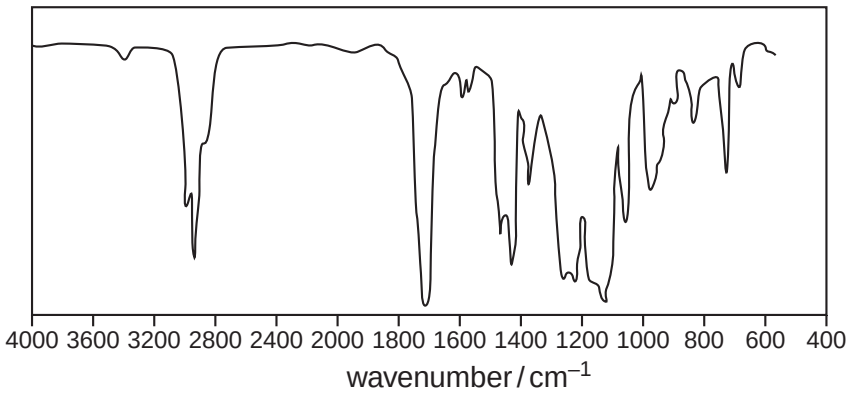
P



Q



R



(a) Explain why plastics absorb radiation in the infra-red region of the electromagnetic spectrum. [2]

(b) Explain why the different plastics absorb in different regions of the infra-red spectrum. [2]

(c) For each of the plastics **P**, **Q** and **R**, suggest:

(i) an absorption which could be used to distinguish it;

(ii) its identify.

[6]

TRANSITION ELEMENTS

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

9 **(a)** **(i)** Outline the use of carbon monoxide in the purification of nickel in the Mond process.

(ii) An alternative method of purifying nickel is by electrolysis. The main impurity is copper. In this process, the impure nickel is the anode of the electrolysis cell, with $NiSO_4(aq)$ as the electrolyte. The pure nickel is deposited on the cathode.

Use the *Data Booklet* to describe the electrode reactions that take place, and suggest how the copper impurity is removed.

[7]

(b) Nickel forms a variety of 4- and 6-coordinated complexes. The purple-blue $[Ni(H_2O)_2(NH_3)_4]^{2+}$ ion can exist in two stereoisomeric forms, whereas the complex $[Ni(CN)_2(R_3P)_2]$, which is also blue, exists in only one form. [The R group is an organic group such as methyl, $–CH_3$].

Suggest the shapes of these two complexes, and draw structures to explain the observations on their isomerism. [3]

10 **(a)** The complex ions $[Fe(H_2O)_6]^{3+}$ and $[Fe(H_2O)_6]^{2+}$ differ in their paramagnetism. Explain the origin of paramagnetism in these complexes, and predict which ion will be the more paramagnetic. [3]

(b) Describe tests you could use to determine whether a nearly-colourless aqueous solution contained Fe^{2+} ions, Fe^{3+} ions or both. [4]

(c) The reaction between $I^-(aq)$ and $S_2O_8^{2-}(aq)$ is catalysed both by Fe^{2+} and by Fe^{3+} ions.

(i) Write an equation for the overall reaction.

(ii) Use relevant $E^{\ominus}$ data from the *Data Booklet* to explain why both iron ions catalyse this reaction. [3]

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