CAMBRIDGE INTERNATIONAL EXAMINATIONS

General Certificate of Education Advanced Level

CHEMISTRY 9701/6

PAPER 6 Options

OCTOBER/NOVEMBER SESSION 2002

1 hour

Additional materials:
Answer Paper
Data Booklet.

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number on the front of the answer paper/answer booklet.

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

Write your answers on the separate answer paper provided.

If you use more than one sheet of paper, fasten the sheets together.

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 and an Insert for Question 7.

This question paper consists of 11 printed pages, 1 blank page and an insert.

SPA (NH/CG) S40774/5
© CIE 2002

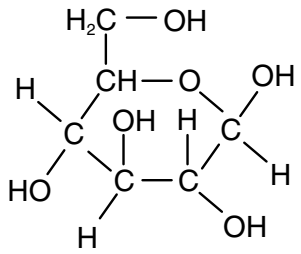
University of Cambridge
Local Examinations Syndicate

[Turn over

BIOCHEMISTRY

If you attempt this option, answer **both** questions on the paper provided.

1 **(a)** A ring formula of glucose is given below.



(i) Draw the structural formulae of the two disaccharides which can be formed by using glucose only.

(ii) Explain why there are two possible structures.

[3]

(b) Explain, with the aid of a diagram which shows the intermolecular bonding, why glucose is soluble in water. [2]

(c) The first step of glycolysis is the formation of glucose-6-phosphate.

(i) Write a word equation for this reaction and state what is required for the reaction to proceed.

(ii) Draw a displayed formula of glucose-6-phosphate.

(iii) Explain what controls the extent of this reaction when it takes place in cells.

[5]

2 **(a)** **(i)** Draw a large, labelled sketch to show how the rate of an enzyme-catalysed reaction varies as the substrate concentration increases with a fixed amount of enzyme.

(ii) Explain how the Michaelis constant, K_m, is obtained from the sketch. Illustrate your answer by using dotted lines on the sketch.

(iii) What does the magnitude of K_m indicate?

[6]

(b) On the same sketch draw additional lines which show how the kinetics change in the presence of

(i) a competitive inhibitor,

(ii) a cofactor or a coenzyme.

Label these two lines and explain why each of the above alters the kinetics. [4]

ENVIRONMENTAL CHEMISTRY

If you attempt this option, answer **both** questions on the paper provided.

3 The sea of the Kattegat off the East coast of rural Denmark consists of two identifiable layers. The deeper layer is the North Sea, which is the water adjacent to the coast, but this is over-laid by warmer water which has travelled from the Baltic Sea. The North Sea water is more saline (i.e. contains more dissolved salts) than the water from the Baltic.

In recent years a number of changes have been observed in the water of the Kattegat. Concentrations of dissolved oxygen in the North Sea water have dropped from around 6 or 7 mg dm^{-3} to concentrations in the polluted range of 4 mg dm^{-3}. Algae are found in what is known as the 'jump layer' that exists between the North Sea and Baltic water layers. White sulphur-digesting bacteria are observed on the ocean floor. Cod, which feed at greater depths, are in serious decline although herring – the prey of the cod – which live in surface waters are thriving. The potential loss of the cod industry is of serious concern as many people depend on it for their living.

(a) It has been suggested that the drop in oxygen concentration in the coastal waters is a result of increasingly intensive farming.

Explain why this might be so. [4]

(b) Give **two** reasons why the water from the Baltic floats above the water from the North Sea. [1]

(c) Why might the growth of algae be more noticeable in the 'jump layer' than on the ocean surface? [2]

(d) Explain why cod are in decline but herring are not. [2]

(e) Suggest why the presence of the sulphur-digesting bacteria indicates a particularly worrying problem. [1]

4 During the early 1970s nearly one million tonnes of CFCs were being manufactured annually. Uses included blowing agents for making foam, cleaning agents, propellants and as a component of air conditioning units.

(a) Give **three** physical or chemical properties relevant to their use in these applications. [2]

(b) Using appropriate equations, describe how $CFCl_3$ (CFC-11) can be involved in the destruction of the ozone layer. Explain why a single molecule of CFC may destroy many molecules of ozone. [4]

(c) CFCs may be classified according to both their global warming potential (GWP) relative to carbon dioxide and their ozone depletion potential (ODP) relative to $CFCl_3$. The global warming potential is usually quoted to cover a specified period of time.

The table below summarises this information for $CFCl_3$ and CF_2Cl_2 (CFC-12).

	ODP	**20 year GWP**	**100 year GWP**
$CFCl_3$	1	4500	3400
CF_2Cl_2	3.2	7100	7100

(i) Suggest why CF_2Cl_2 has a greater value for its ODP.

(ii) Suggest why there is a difference in the 20 year and 100 year GWP figures for $CFCl_3$ but not for CF_2Cl_2.

[3]

(d) The CFCs used in air conditioning units have now been almost entirely replaced by compounds such as CF_3CHCl_2 (HCFC-123).

Explain why this compound is considered to be preferable to $CFCl_3$. [1]

PHASE EQUILIBRIA

If you attempt this option, answer **both** questions on the paper provided.

5 **(a)** The table gives data about the hydrides of Group VI.

compound	bp / K	ΔH_{vap} / kJ mol^{-1}
H_2O	373	40.7
H_2S	213	18.7
H_2Se	243	19.3
H_2Te	268	23.2

Explain the changes in intermolecular forces when molecules go from the liquid to the vapour phase. [2]

(b) **(i)** Comment on the nature of the intermolecular forces in these molecules as indicated by their boiling points.

(ii) Calculate the ratios ΔH_{vap} / bp for the four hydrides.
Comment on any point of interest from these ratios.

[5]

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

(ii) Why should Raoult's law hold for mixtures of H_2S and H_2Se, but for mixtures of H_2O and H_2S shows a positive deviation?

[3]

6 (a) (i) What is meant by the *partition coefficient*?

(ii) If iodine is shaken with 100 cm^3 of water and 100 cm^3 of an organic solvent, the concentration of iodine in the water layer is 4.0×10^{-3} mol dm^{-3} and in the organic solvent is 1.0×10^{-2} mol dm^{-3}.
Calculate the partition coefficient for iodine between the organic solvent and water.

(iii) The aqueous layer is separated and shaken with 50 cm^3 of the pure organic solvent. What will be the concentration of iodine in the organic solvent at equilibrium in mol dm^{-3}?

[6]

(b) (i) State Henry's law.

The solubility of atmospheric nitrogen in water at 1 atm at 0 °C is 23.6 cm^3 dm^{-3}, and that of oxygen at 1 atm is 48.9 cm^3 dm^{-3}. Air contains 79% N_2 and 20% O_2 by volume.

(ii) Calculate the solubility of each gas in water at its individual partial pressure.
[Leave the result in cm^3 of gas per dm^3 of water.]

(iii) Calculate the percentage composition of dissolved air.

[4]

[Turn over

SPECTROSCOPY

If you attempt this option, answer **both** questions on the paper provided.

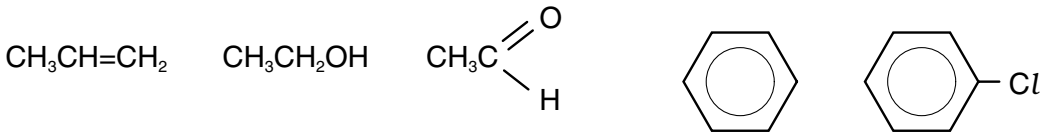
7 Organic molecules, such as propanone, $(CH_3)_2CO$, absorb energy in the uv/visible region of the spectrum as a result of electronic transitions.

(a) Copy the diagram below and draw arrows to show the electronic transitions which cause absorptions in propanone.



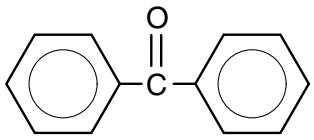
[3]

(b) Study each of the molecules drawn below, and draw those which show **more than one** absorption in the uv/visible region.



[2]

(c) Diphenylmethanone, shown below, also absorbs in the uv/visible region of the spectrum.



(i) Predict where, relative to the absorptions shown by propanone, diphenylmethanone will absorb energy.

(ii) Explain your answer to **(i)**. [3]

(d) The colour of blood is due to oxygen-carrying molecules which consist of organic groups surrounding a transition metal ion. In humans this transition metal is iron, and the blood is red. In horseshoe crabs, the metal is copper and the blood is blue and in sea squirts the metal is vanadium and the blood is green.

The spectrum provided on the insert shows the major absorption peak for human blood. On this spectrum draw and label the corresponding absorption peaks for the blood of horseshoe crabs and for the blood of sea squirts.

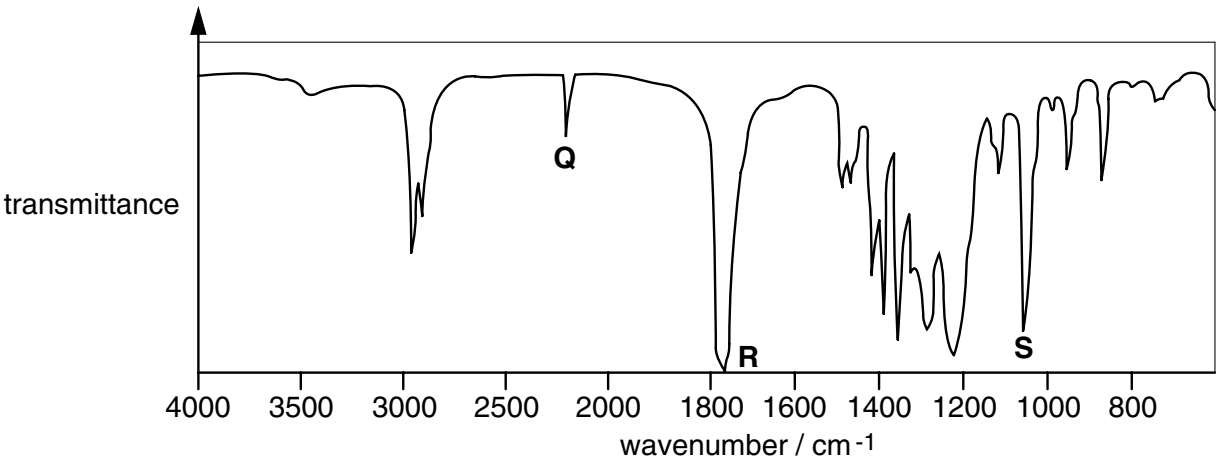
[2]

8 **(a)** **(i)** Explain what is meant by the term *mull* in infra-red spectroscopy.

(ii) Ethanol is a good solvent for many organic compounds. Explain why ethanol is not a suitable solvent for use in producing infra-red spectra of such compounds.

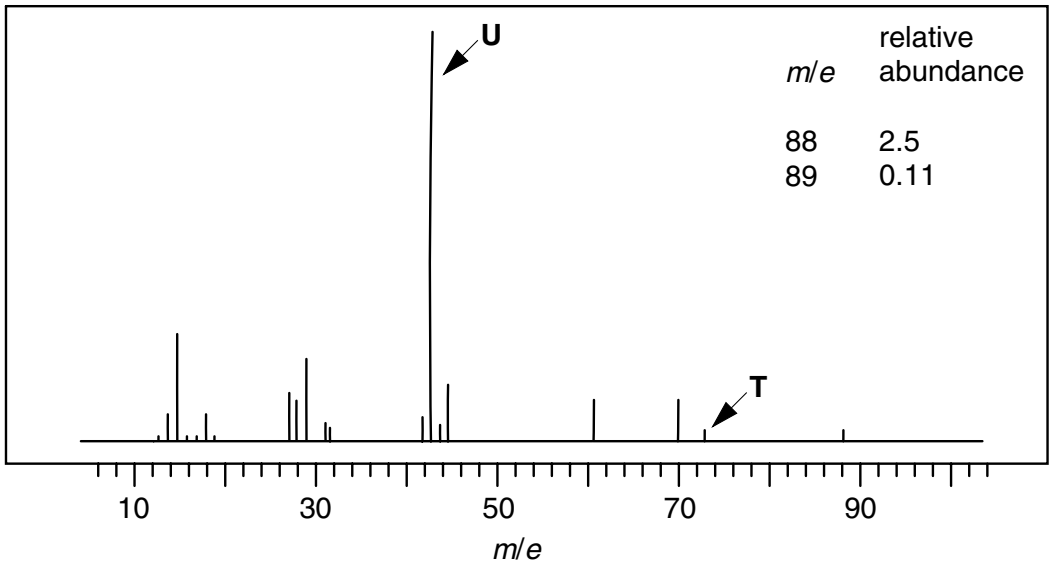
[3]

(b) The infra-red spectrum shown was obtained from a compound **J** of formula $C_5H_7O_2N$.



Identify the bonds responsible for the absorptions labelled **Q**, **R** and **S**, and hence suggest a structure for **J**. [3]

(c) The mass spectrum shown was obtained from a compound **K**.



(i) Deduce what fragment has been lost in forming the peak labelled **T**.

(ii) Deduce what fragment has been lost from **T** in forming peak **U**.

(iii) Suggest a formula for **K**. [4]

[Turn over

TRANSITION ELEMENTS

If you attempt this option, answer **both** questions on the paper provided.

9 **(a)** Outline how an impure sample of copper metal, containing zinc, nickel and silver impurities, can be purified by electrolysis. Explain what happens to each of the impurities during the process. [6]

(b) **(i)** Name an alloy that contains copper, and state the other metal(s) present.

(ii) Such alloys can be analysed by making use of the following reaction,

$$2Cu^{2+} + 4I^{-} \longrightarrow 2CuI + I_2$$

and titrating the resulting solution of iodine with thiosulphate ions.

$$2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^{-}$$

A 0.250 g sample of a copper-containing alloy was converted into an aqueous solution of Cu^{2+} ions, and an excess of I^{-}(aq) ions was added. The iodine liberated required 20.0 cm^3 of 0.100 mol dm^{-3} thiosulphate to react completely.

What is the percentage of copper in the alloy?

[4]

10 **(a)** State the electronic configuration of the Mn^{3+} ion. [1]

(b) State the colours of aqueous solutions containing manganese in each of the oxidation states +2, +3, +6 and +7. [3]

(c) Compounds containing manganese oxo-anions often disproportionate in aqueous solution.

(i) Use the following half-equation, and other data from the *Data Booklet*, to construct an overall equation for the disproportionation of MnO_4^{2-} in strongly acidic solution.
Calculate the $E^{\ominus}_{cell}$ for the process.

$$MnO_4^{2-} + 8H^+ + 4e^- \longrightarrow Mn^{2+} + 4H_2O \quad E^{\ominus} = +1.74\,V$$

(ii) When potassium manganate(VII) is reduced with aqueous sodium sulphite, the bright blue salt K_3MnO_4 is produced. The salt readily disproportionates in acidic solution, giving a brown precipitate of MnO_2(s) and a purple solution.

Calculate the oxidation number of manganese in the blue salt, and construct a balanced ionic equation for its disproportionation.

[6]

[Turn over

BLANK PAGE

Centre Number	Candidate Number

Candidate Name _____

CAMBRIDGE INTERNATIONAL EXAMINATIONS

General Certificate of Education Advanced Level

CHEMISTRY

9701/6

PAPER 6 Options

INSERT

INSTRUCTIONS TO CANDIDATES

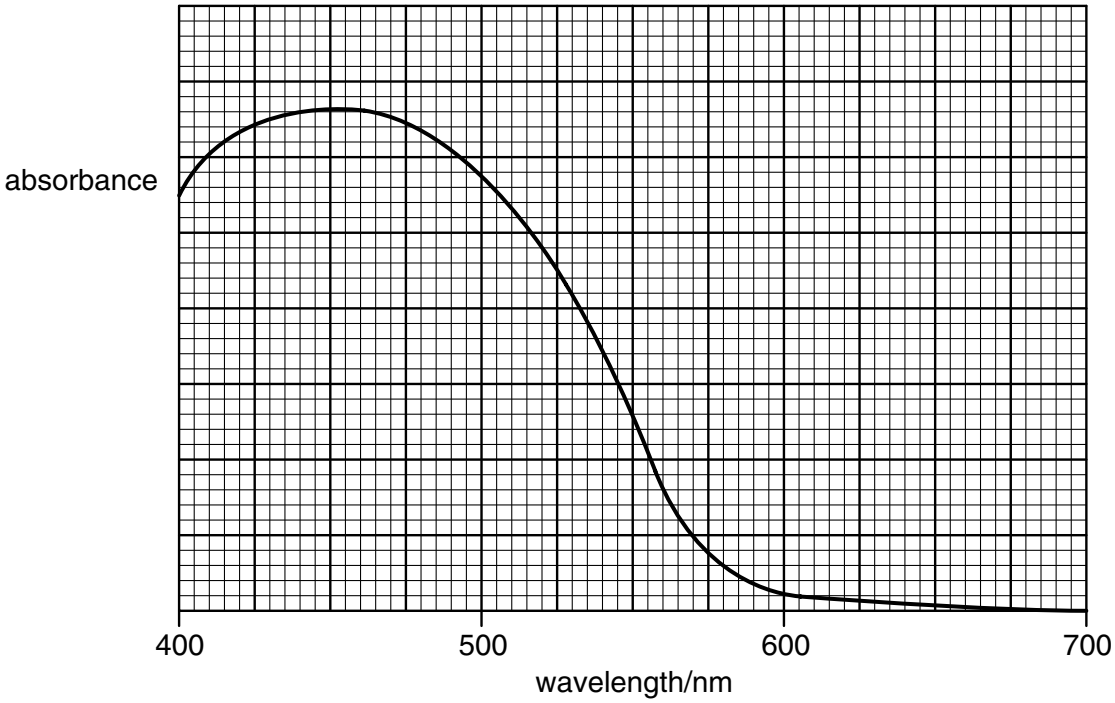
This insert is for use with Question **7 (d)** from the above question paper and should be attached to your answer for that question.

This insert consists of 2 printed pages.

© CIE 2002

University of Cambridge Local Examinations Syndicate

[Turn over


absorbance
400
500
600
700
wavelength/nm