CAMBRIDGE INTERNATIONAL EXAMINATIONS

General Certificate of Education Advanced Level

CHEMISTRY 9701/6

PAPER 6 – OPTIONS

MAY/JUNE 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.

Write your answers on the separate answer paper provided.

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

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.

FOR EXAMINER'S USE

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

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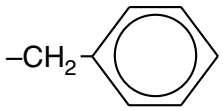
BIOCHEMISTRY

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

1 **(a)** Explain what is meant by the *tertiary structure* of a globular protein. [2]

(b) There are four types of R group interactions which hold the tertiary structure in its necessary shape.

Two of these R group interactions are shown.



hydrophobic, van der Waals' forces

$-CH_2-S-S-CH_2-$ disulphide linkages

State the other **two** R group interactions and give an example of each. [2]

(c) Explain in chemical terms how R group interactions are broken (destroyed) by each of the following examples of denaturing. Identify which type of R group interaction is broken in each example.

(i) by metal ions such as Cu^{2+}, Ag^{+}, Hg^{2+}

(ii) by heat

(iii) by extreme pH changes

[6]

2 **(a)** Describe with the aid of a diagram the structure of DNA, deoxyribonucleic acid. [4]

(b) **(i)** What is the function of DNA?

(ii) In brief outline, describe its role in the synthesis of proteins. [6]

ENVIRONMENTAL CHEMISTRY

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

3 **(a)** It might be expected that sulphur dioxide would make a significant contribution to the greenhouse effect.

Explain, in terms of its ir spectrum, why sulphur dioxide might be expected to contribute to the greenhouse effect. [4]

(b) It has recently been reported that sulphate-rich mists above urban areas, produced from sulphur dioxide, reflect sunlight back into space more effectively than they absorb it. This suggests that emissions of sulphur dioxide may actually be contributing to a reduction in global warming. The aerosols which reflect sunlight are sulphate-rich.

Explain how sulphur dioxide in the troposphere is converted into sulphate ions. [2]

(c) Considerable efforts are however made to limit sulphur dioxide emissions.
One reason is that sulphur dioxide contributes to acid rain.

Using appropriate equations, explain how acid rain is produced. [1]

(d) One method used by industry to remove sulphur from coal employs limestone-based fluidised beds. Supporting your answer with equations, explain this method. [3]

4 Although the calcium ion is not required in large amounts for plant growth, it is an ion that is widely distributed on the Earth's surface and it is involved in many processes essential to the maintenance of healthy soil and water conditions.

(a) Explain the weathering process which leads to the chemical removal of calcium ions from limestone rocks and the subsequent precipitation of calcium carbonate in soils.

Give equations for the reactions that occur. [4]

(b) Agricultural land often becomes acidic over a period of time and may then need liming with calcium carbonate to raise the pH.

(i) Why do growing plants tend to make the soil acidic?

(ii) Liming neutralises the immediate acidity of the soil solution but also has a longer term effect. Explain how liming is able to resist a reduction in pH over a longer period of time.

(iii) Suggest **three** reasons why it is important to raise the pH of soil to maintain effective growing conditions.

[6]

PHASE EQUILIBRIA

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

5 The solubility of potassium chloride, KC*l*, in water at various temperatures is given in the table.

temperature / °C	0	20	40	60	80	100
solubility / g KC*l* per 100 g water	29	32	36	41	47.5	54

(a) **(i)** Use graph paper to plot the solubility curve of potassium chloride in water.

(ii) Use the graph to estimate the solubility of potassium chloride at 25 °C and at 75 °C [3]

(b) **(i)** What would be observed when a saturated solution of potassium chloride at 75 °C is cooled to 25 °C?

(ii) What quantitative prediction about **(b)(i)** can be made from your answer to **(a)(ii)**? [2]

(c) Calculate the mole fraction of saturated potassium chloride in water at 25 °C. [2]

(d) Aqueous potassium chloride has a minimum temperature in the liquid phase of –18 °C at a mole fraction of 0.055.

Sketch the phase diagram of the system water/potassium chloride, including this minimum, the freezing point of pure water and the answer to **(c).**

Label the areas of the sketch. [3]

6 **(a)** Draw and label a diagram of the apparatus used to separate the two components of a mixture of propan-1-ol (bp 97 °C) and pentan-1-ol (bp 139 °C). [2]

(b) Draw a sketch of the boiling point/composition curve for propan-1-ol and pentan-1-ol mixtures. Use this sketch, and the concept of theoretical plates, to explain the theory of how these components are separated. [5]

(c) Propan-1-ol is completely miscible with water, but pentan-1-ol has a solubility of 2.7 g per 100 g of water.

Explain the differences in these two solubilities. [3]

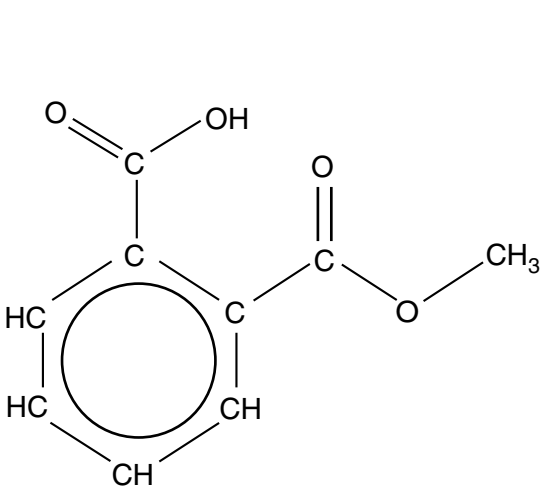
SPECTROSCOPY

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

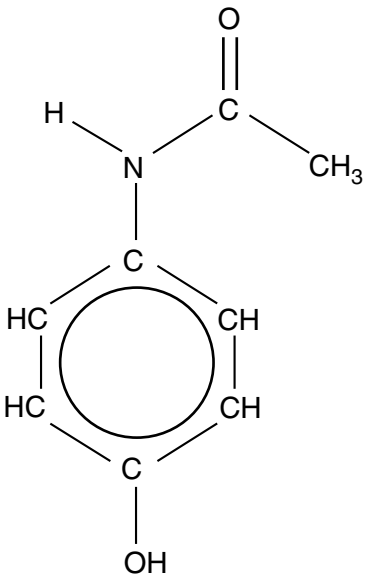
7 A person might accidentally or deliberately take a large number of tablets of a common drug all at the same time. In order to ensure the correct medical treatment, it is important to identify such tablets as rapidly as possible.

(a) Outline **two** ways in which such tablets might be prepared for infra-red analysis. [4]

(b) Two common drugs found in tablet form are shown below.



aspirin



paracetamol

(i) For each drug, state the functional groups which would produce infra-red absorptions.

(ii) Suggest, with a reason, in which range of wavenumbers in the infra-red spectrum you would look to try to distinguish these two drugs.

[3]

(c) Explain how nmr spectroscopy could be used to distinguish between these two drugs**.** [3]

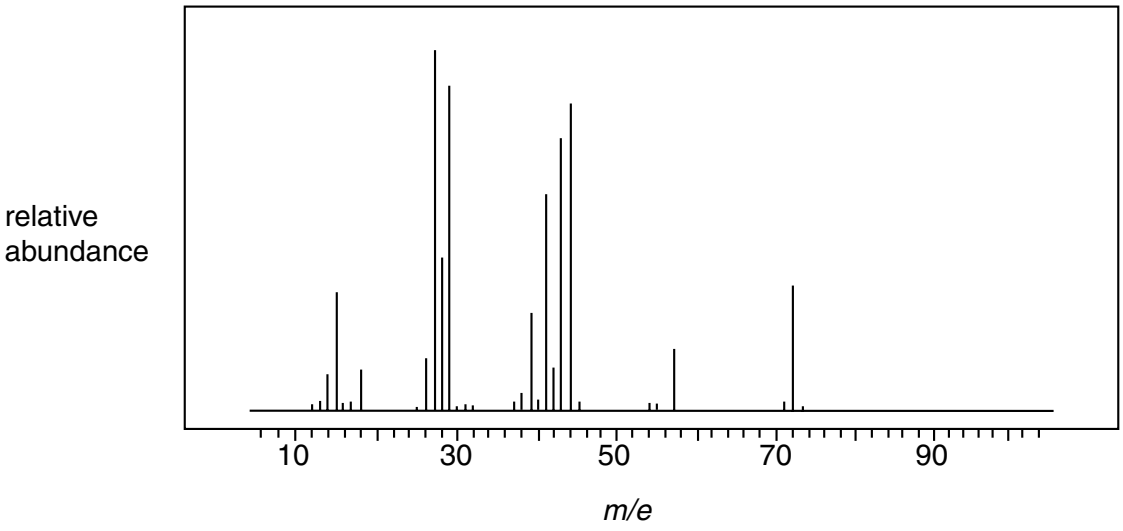
8 **(a)** Explain how the following peaks may arise in the mass spectrum of an organic compound.

(i) M + 1

(ii) M + 2

[3]

(b) The mass spectrum shown below was produced by a compound **F**, $C_nH_{2n}O$.



The (M+1) peak has a relative abundance which is 4.4% of that of the peak due to the molecular ion. What is the value of *n* in the formula of **F**? [3]

(c) **F** contains the -CHO functional group. Suggest the identities of the ions produced which give peaks at *m/e* 57 and 29 respectively. [2]

(d) The base peak is at *m/e* 44. When the ion responsible for this peak is formed, an alkene molecule is also produced. Suggest the identity of each of these species. [2]

[Turn over

TRANSITION ELEMENTS

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

9 **(a)** Explain why the 3d orbitals around a transition metal ion split into two groups when the ion is combined with six ligands in an octahedral complex. [2]

(b) **(i)** State the electronic configuration of the Co^{2+} ion.

(ii) State, with a reason, whether you would expect this ion to be paramagnetic. [2]

(c) When air is bubbled through an aqueous solution containing $CoCl_2$, NH_4Cl and NH_3, and the resulting solution evaporated, crystals of a salt **X** can be isolated. **X**, which contains an octahedral ion, has the following composition by mass:

Co, 25.2%; N, 24.0%; H, 5.1%; Cl, 45.6%.

On adding an excess of $AgNO_3$(aq) to an aqueous solution containing 0.01 mol of **X**, 1.43 g of AgCl(s) is precipitated.

(i) Calculate the empirical formula of **X**, and suggest what the six ligands are around the cobalt atom.

(ii) Calculate the oxidation number of the cobalt atom in **X**.

(iii) Draw relevant diagrams to show the type of isomerism that is possible in the cation of **X**. [6]

10 (a) (i) Describe the rusting of iron in terms of the redox processes that occur.

(ii) Blocks of magnesium are often bolted to the iron hulls of ships. Explain how this protects the hull from rusting.

[6]

(b) $Fe^{3+}(aq)$ ions catalyse the reaction between $I^{-}(aq)$ and $S_2O_8^{2-}(aq)$.

(i) Use relevant half-equations from the *Data Booklet* to construct an overall equation for the reaction.

(ii) By considering relevant $E^{\ominus}$ values, describe and explain the role of the Fe^{3+} ions in this reaction, writing equations where appropriate.

[4]

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