

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY

2815/03

Environmental Chemistry

Tuesday

25 JUNE 2002

Morning

50 minutes

Candidates answer on the question paper.

Additional materials:

Data sheet for Chemistry

Scientific calculator

Candidate Name	Centre Number	Candidate Number												
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TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry*.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Question Number	Max.	Mark
1	13	
2	8	
3	8	
4	16	
TOTAL	45	

This question paper consists of 8 printed pages.

- 1 The oxygen-only reactions involved in the formation of ozone in the stratosphere may be summarised as follows.



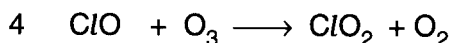
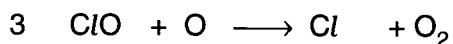
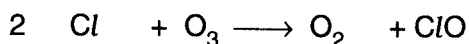
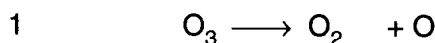
- (a) (i) Explain why the standard conditions, implied by ΔH^\ominus , do not really describe the reaction conditions in the stratosphere.

.....
[2]

- (ii) How many electrons are there in an O radical?

.....[1]

- (b) The presence of CFCs in the stratosphere can lead to ozone depletion through a sequence of reactions such as that given below.



- (i) Where does the energy come from for **step 1** of the sequence?

.....[1]

- (ii) One chlorine atom can destroy about 5000 molecules of ozone by a chain reaction. Which **two** steps in the above sequence propagate this chain reaction? Explain your answer.

.....

[2]

- (iii) Complete a *dot-and-cross* diagram for the radical ClO_2 . Show outer electron shells only.



[1]

(c) (i) What role does ozone have in the stratosphere which is beneficial to people?

.....
..... [1]

(ii) State **one** damaging result of ozone pollution in the *troposphere*.

.....
..... [1]

(iii) Emissions of CFCs have been significantly reduced in recent years. Suggest why this has not yet resulted in restoration of the ozone layer.

.....
.....
..... [2]

(iv) Explain why hydrofluoroalkanes, such as CH_2FCF_3 , may be used as environmentally safer alternatives to CFCs.

.....
.....
..... [2]

[Total : 13]

2 Organic waste in landfill sites is decomposed by aerobic and anaerobic bacteria.

(a) What does *anaerobic* mean?

.....[1]

(b) Two products of anaerobic decomposition are hydrogen sulphide and methane. State what problems may arise from their production in landfill.

hydrogen sulphide

.....

methane

.....

[2]

(c) Discuss the advantages **and** disadvantages of incinerating waste containing paper and plastic.

(1 mark is available for the quality of written communication.)

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.....

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.....

.....

.....[5]

[Total : 8]

- 3 The Dolomite mountains in Italy consist of rocks containing magnesium and calcium carbonates, both of which dissolve in rainwater.

(a) Write an equation, with state symbols, for the reaction which occurs when magnesium carbonate dissolves in rainwater.

[2]

(b) The composition of a typical mineral water is shown in the table.

Ion	Concentration in mg dm^{-3}	Ion	Concentration in mg dm^{-3}
calcium	35.0	sulphate	6.0
magnesium	15.0	nitrate	1.5
sodium	12.0	chloride	10.0
potassium	1.3	hydrogencarbonate	179.0

(i) Calculate the concentration of hydrogencarbonate ions, HCO_3^- , in mol dm^{-3} .

concentration mol dm^{-3} [2]

(ii) When 1 dm^3 of the mineral water is evaporated to dryness by heating, the solid residue has a mass of 186 mg. Suggest why the solid residue has a smaller mass than the total for all the ions present.

.....

[2]

(c) Why are the following used in the process of making potable water?

(i) Chlorine

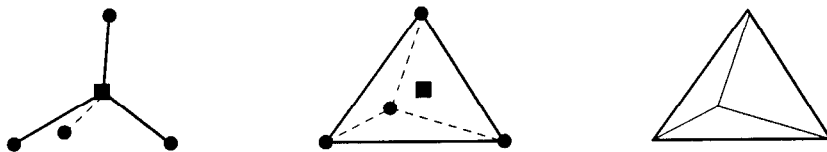
.....[1]

(ii) Aluminium sulphate

.....[1]

[Total : 8]

- 4 The diagrams below show the structure of the tetrahedral silicate 'SiO₄' unit found in silicates and clays.



- (a) (i) Label the silicon atom in the **left hand** diagram. [1]
- (ii) Draw a chain of three silicate tetrahedra, using the **right hand** version of the structure above.

[1]

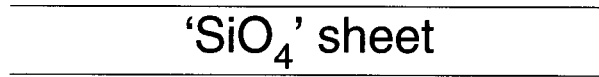
- (iii) Name and draw the shape of the 'AlO₆' unit found in clays.

Name

Shape

[2]

- (b) (i) Complete the diagram to show the structure of the **unit layer** of a typical 2:1 clay mineral, composed of 'AlO₆' sheets and 'SiO₄' sheets.



[1]

- (ii) Explain why soils containing some 2:1 clays crack when they dry, whilst soils containing other clays crumble.

.....
.....
.....
.....
.....[4]

- (c) Describe what happens to ions in rocks when the rocks are dissolved in water by weathering.

.....
.....
.....[2]

- (d) After the Chernobyl power station accident in 1986 radioactive caesium compounds, containing ¹³⁷Cs⁺ ions, were found in soils in parts of the UK.

- (i) State the composition of the nucleus of ¹³⁷Cs.

..... [2]

- (ii) Explain how clays could have been involved in the retention of radioactive caesium ions in the soil.

.....
.....
.....
.....[3]

[Total : 16]