

**ADVANCED SUBSIDIARY GCE  
 CHEMISTRY (SALTERS)**

Chemistry of Natural Resources

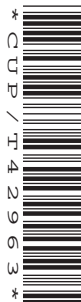
**THURSDAY 10 JANUARY 2008**

**2848/01**

Morning

Time: 1 hour 30 minutes

**Additional materials:** Scientific calculator  
*Data Sheet for Chemistry (Salters)* (Inserted)



Candidate  
Forename

Candidate  
Surname

Centre  
Number

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Candidate  
Number

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**INSTRUCTIONS TO CANDIDATES**

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Do **not** write outside the box bordering each page.
- Write your answer to each question in the space provided.

**INFORMATION FOR CANDIDATES**

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **90**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry (Salters)* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.

**FOR EXAMINER'S USE**

Qu.	Max.	Mark
1	17	
2	17	
3	15	
4	17	
5	24	
<b>TOTAL</b>	<b>90</b>	

This document consists of **16** printed pages and a *Data Sheet for Chemistry (Salters)*.

Answer **all** the questions.

1 In 2005, a report was published summarising methods for the capture and storage of carbon dioxide from industrial processes.

(a) Large quantities of carbon dioxide are produced each year by some industrial processes, such as cement manufacture.

(i) Cement is made by heating limestone,  $\text{CaCO}_3$ , with clay, which contains silicon dioxide,  $\text{SiO}_2$ .

The limestone decomposes to produce calcium oxide and carbon dioxide. Write the equation for this decomposition of limestone.

→

[1]

(ii) At room temperature carbon dioxide is a gas but silicon dioxide is a solid.

Explain this difference in terms of bonding and structure.

.....

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.....

.....

.....

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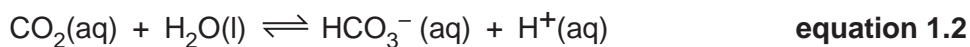
..... [3]

(b) In an air sample that was analysed, carbon dioxide was found to be present at a value of 395 parts per million.

Calculate the percentage of carbon dioxide in the sample.

answer = ..... [1]

- (c) One of the methods being considered for storing carbon dioxide is to pump it onto the ocean floor. Some of the carbon dioxide will dissolve in the surrounding sea water. The following equations show the reactions that take place.



- (i) Increased levels of carbon dioxide gas have an effect on the  $\text{H}^+$  concentration, and hence on the acidity, of the sea water.

Use Le Chatelier's Principle and **equations 1.1** and **1.2** to explain this effect.

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

- (ii) Suggest a possible environmental impact of a change in acidity of the sea water.

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

- (d) In this question, one mark is available for the quality of spelling, punctuation and grammar.

Carbon dioxide is described as a 'greenhouse gas'.

Explain the link between increased concentrations of carbon dioxide in the troposphere and global warming.

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

Quality of Written Communication [1]

(e) Most carbon dioxide from industrial processes is allowed to escape into the atmosphere.

(i) Suggest **two** methods, other than capture and storage, that could help to reduce carbon dioxide levels in the atmosphere.

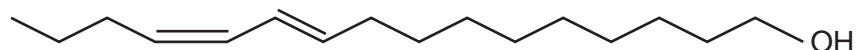
.....  
..... [2]

(ii) Suggest why capture and storage of carbon dioxide is more expensive than your suggested methods.

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

[Total: 17]

- 2 The female silkworm moth produces a chemical, commonly known as bombykol, to attract potential mates.



**bombykol**

- (a) (i) Bombykol contains **two** different types of functional group.

Name **both** of these functional groups.

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

- (ii) Give the molecular formula of bombykol.

..... [1]

- (b) Other compounds exist that are geometric isomers of bombykol.

- (i) How many **other** compounds are geometric isomers of bombykol?

..... [1]

- (ii) Draw the skeletal formula of **one** of the geometric isomers of bombykol.

[2]

- (c) Bombykol can react to form an aldehyde.

- (i) Complete the diagram below to show the **full structural formula** of the aldehyde group that forms.



[1]

- (ii) Give the reagents and conditions required for the conversion of bombykol to an aldehyde.

reagents .....

conditions ..... [3]

- (iii) Underline the word that describes the type of reaction occurring when bombykol is converted into an aldehyde.

**addition                  oxidation                  reduction                  substitution**

[1]

- (d) Bombykol will react with bromine. The reaction mechanism is described as electrophilic addition.

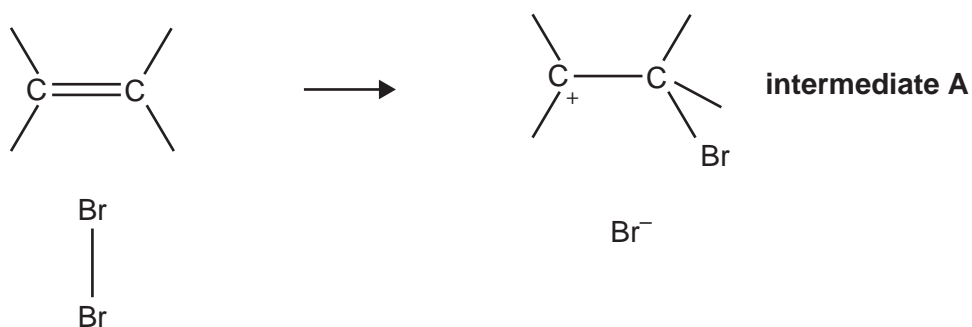
- (i) Explain what is meant by the term *electrophile*.

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

- (ii) The diagrams below show part of the first step in the mechanism for the reaction of a C=C bond with bromine.

Complete this step in the reaction mechanism below, by

- including relevant partial charges and
- adding 'curly arrows' to show the electron movements.



[3]

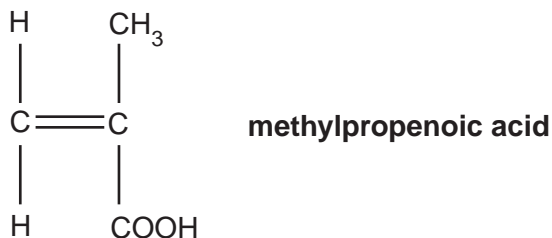
- (iii) What name is given to the **type** of organic intermediate, such as **intermediate A**, formed in this step?

..... [1]

[Total: 17]

3 Early golf balls were often made from a naturally occurring rubber. Modern golf balls are covered with a synthetic polymer that has much better resistance to cuts than natural rubber.

(a) One synthetic polymer used for golf balls is produced from a combination of ethene and methylpropenoic acid.



(i) Draw out a section of the polymer formed from ethene and methylpropenoic acid. Include **two** units of ethene and **one** unit of methylpropenoic acid.

[2]

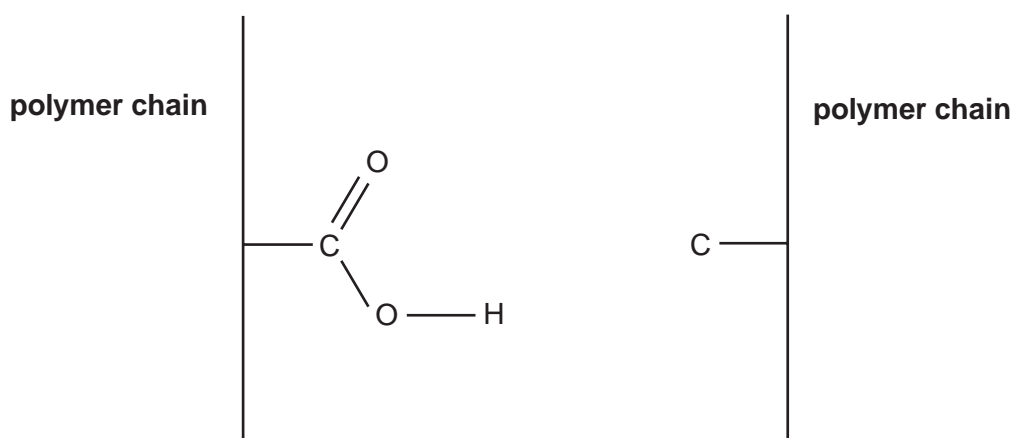
(ii) What term is used to describe a polymer formed from two different types of monomer?

..... [1]

(b) Chains of this synthetic polymer can be held together by the formation of hydrogen bonds between the acid groups.

Complete the diagram to show how **one** hydrogen bond forms between acid groups from two different polymer chains.

Show relevant lone pairs and partial charges.



[3]

- (c) Explain how the presence of hydrogen bonds between chains produces a polymer that is **not** very flexible.

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

- (d) The properties of this polymer can be changed by neutralising some of the carboxylic acid groups with a solution of an appropriate base, as shown in **equation 3.1**.

R-COOH represents the polymer molecule.



Name a compound that could provide OH<sup>-</sup> ions for this reaction.

..... [1]

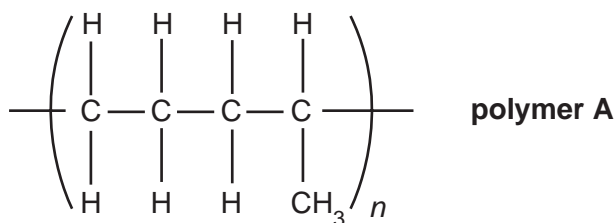
- (e) The polymer formed from ethene and methylpropenoic acid is a thermoplastic.

Explain the meaning of the term *thermoplastic*.

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



- (f) Ethene forms a range of polymers with other monomers. One example is **polymer A**.



- (i) Name the monomer that reacted with ethene to produce **polymer A**.

..... [1]

- (ii) The average  $M_r$  of **polymer A** is 28 000.

Calculate the average value of  $n$  in the formula of **polymer A** given above.

$A_r$ : C, 12; H, 1.0

average value of  $n =$  ..... [2]

- (iii) What is the strongest type of intermolecular force that would form between chains of **polymer A**?

..... [1]

- (iv) Suggest **one** physical property you would expect **polymer A** to have.

..... [1]

[Total: 15]

- 4 A mining company carried out the analysis of an ore sample to find out how much copper the ore sample contained. The laboratory analysis used the following stages starting with copper(II) sulphide, CuS.

**Stage 1** Roasting the ore  $2\text{CuS} + 3\text{O}_2 \rightarrow 2\text{CuO} + 2\text{SO}_2$  **equation 4.1**

**Stage 2** Leaching out the copper  $\text{CuO} + 2\text{NH}_4^+ \rightarrow \text{Cu}^{2+} + 2\text{NH}_3 + \text{H}_2\text{O}$  **equation 4.2**

$\text{Cu}^{2+} + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_4]^{2+}$  **equation 4.3**

**Stage 3** Filtering

**Stage 4** Acidifying the filtrate

**Stage 5** Displacing the copper using zinc

- (a) (i) From **equations 4.1 to 4.3** choose an equation that represents a redox reaction. State which element has been oxidised.

equation .....

element being oxidised ..... [2]

- (ii) From **equations 4.1 to 4.3** choose an equation that represents an acid-base reaction.

Identify the acid in your chosen equation.

Explain why this is classified as an acid.

equation .....

acid .....

explanation .....

..... [3]

- (b) **Stage 1** is often carried out on an industrial scale.

- (i) Suggest **one** environmental problem that the sulphur dioxide produced in **stage 1** could cause. Explain your answer.

.....

..... [2]

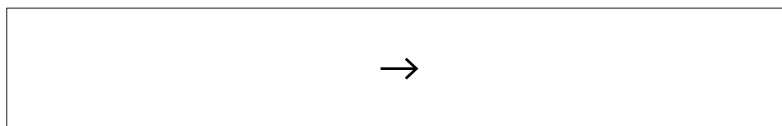
- (ii) Suggest **one** method that could be used to remove the sulphur dioxide produced from **stage 1**.

.....

..... [1]

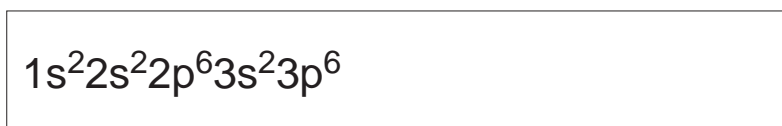
(c) In **stage 5**, the copper(II) ions in the filtrate are reacted with powdered zinc to give solid copper as the product.

(i) Write the **ionic** equation for this reaction.



[2]

(ii) Complete the electronic configuration for a copper **atom**.



[2]

(d) A sample of the copper produced by this process was reacted with an acid. The resulting solution, containing copper ions, was analysed by a titration.

(i) The copper ion concentration was found to be  $0.050 \text{ mol dm}^{-3}$ .

Calculate the number of moles in  $200 \text{ cm}^3$  of this solution.

moles of copper ions = ..... [2]

(ii) The amount of copper in **d(i)** was produced from a sample of the ore that weighed 0.80 g.

Calculate the percentage by mass of copper in the ore.

Give your answer to **two** significant figures.

$A_r$ : Cu, 63.5

percentage copper = ..... % [3]

[Total: 17]

- 5 Until recently, large amounts of bromomethane,  $\text{CH}_3\text{Br}$ , were being sprayed onto agricultural land to kill pests, weeds and micro-organisms that affected crop growth. An international agreement has now been reached to stop production of bromomethane, because it was realised that its contribution to ozone depletion is more significant than was previously thought.

(a) Name the homologous series that bromomethane belongs to.

..... [1]

Bromomethane is produced by reacting hydrogen bromide with methanol. The hydrogen bromide for this process is made industrially by reacting hydrogen and bromine.

(b) Suggest a source for the hydrogen used in this process.

..... [1]

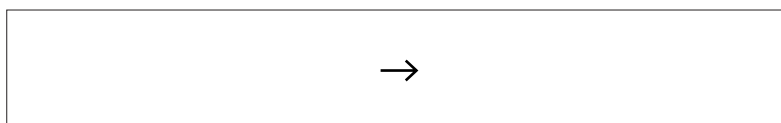
(c) The bromine can be obtained from sea water by the steps outlined in the table below.

step	process carried out
1	Sea water containing $0.07 \text{ g dm}^{-3}$ of $\text{Br}^-(\text{aq})$ is used. Excess chlorine is added to the sea water to produce $\text{Br}_2$ .
2	$\text{Br}_2$ is removed from the water by blowing a strong air current through it. This produces $\text{Br}_2(\text{g})$ at low concentration.
3	$\text{SO}_2(\text{g})$ and water are added to reduce $\text{Br}_2$ to $\text{HBr}$ . This gives $\text{HBr}(\text{aq})$ at approximately $0.81 \text{ mol dm}^{-3}$ .
4	$\text{Cl}_2(\text{g})$ is added to regenerate $\text{Br}_2$ as liquid bromine.

Use information from the table above to answer these questions.

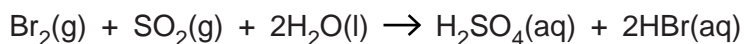
(i) In **step 1**, chlorine,  $\text{Cl}_2$ , is added to convert the bromide ions to bromine molecules.

Write the ionic equation for this reaction.



[2]

- (ii) In **step 3** the reaction below takes place.



Give the oxidation state of the sulphur before and after the reaction. Explain how you can tell that the sulphur has been oxidised.

before the reaction .....

after the reaction .....

explanation ..... [3]

- (iii) Calculate the concentration of bromide ions in the sea water at the start of **step 1**, giving your answer in  $\text{mol dm}^{-3}$ .

$A_r$ : Br, 80

concentration = .....  $\text{mol dm}^{-3}$  [2]

- (iv) From your answer to **c(iii)**, work out how many times more concentrated the  $\text{Br}^-$  ion is in the solution at **step 3** than in the original sea water sample.

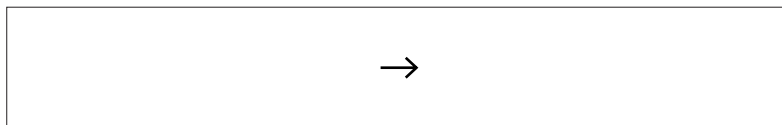
answer = ..... [1]

- (v) Give the colour of the bromine after **step 4** of the process.

..... [1]

(d) Bromomethane is produced by reacting hydrogen bromide with methanol,  $\text{CH}_3\text{OH}$ .

(i) Write the equation for this reaction.



[2]

(ii) Underline the **two** words that describe the mechanism of the reaction between methanol and hydrogen bromide.

**addition****electrophilic****elimination****nucleophilic****radical****substitution**

[2]

(e) The hydrogen bromide for this process is made industrially by passing a mixture of hydrogen and bromine vapour over a heated catalyst.

Explain how the use of a catalyst makes the reaction occur more quickly.

Use the ideas of activation enthalpy and collision theory to help you.

.....

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.....

.....

..... [3]



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