OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY (SALTERS) 2848

CHEMISTRY OF NATURAL RESOURCES

Tuesday **12 JUNE 2001** Morning 1 1/2 hours

Additional materials:
Scientific calculator
Data Sheet for Chemistry (Salters)
Candidates answer on the question paper.

Candidate Name	Centre Number	Candidate Number

TIME 1 1/2 hours

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

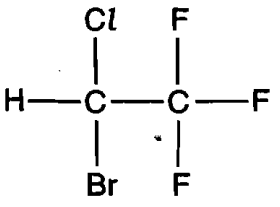
- The number of marks is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.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

FOR EXAMINER'S USE		
Qu	Max.	Mark
1	20	
2	18	
3	20	
4	22	
5	15	
6	15	
TOTAL	110	

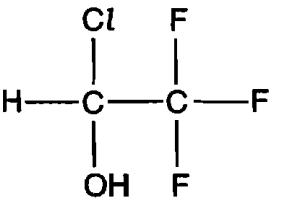
This question paper consists of 19 printed pages and 1 blank page.

Registered Charity Number:1066969
[Turn over

1 Halothane was widely used for many years as an anaesthetic in hospitals. The structure of halothane is shown below.



halothane



compound B

(a) Halothane can be hydrolysed by heating in water to form **compound B**.

(i) The mechanism for the reaction is described as nucleophilic substitution. What is the nucleophile in the reaction?

..... [1]

(ii) When aqueous silver nitrate is added to the solution containing hydrolysed halothane a precipitate of silver bromide forms. Write an ionic equation, giving state symbols, for the formation of silver bromide from silver ions and bromide ions.

..... [2]

(iii) Explain why the bromine atom in halothane is the first to be substituted.

.....

.....

..... [2]

(b) Chloroethane, C_2H_2Cl, has been used as a local anaesthetic. This can be hydrolysed with water or with aqueous sodium hydroxide.

(i) Name, and give the molecular formula of, the organic product of the hydrolysis of **chloroethane.**

name .....

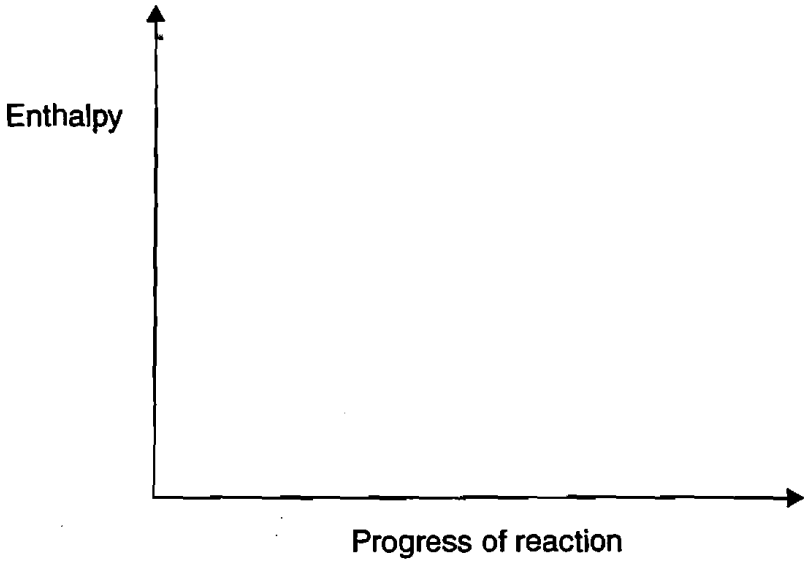
molecular formula ..... [2]

(ii) Explain why the hydrolysis reaction is much faster in sodium hydroxide solution than in water.

.....

..... [3]

(iii) The hydrolysis of chloroethane is an exothermic reaction and takes place in a single step. On the diagram below draw an energy profile for this reaction. Label clearly the activation enthalpy for the reaction.



[3]

(iv) Suggest a way in which the activation enthalpy for the reaction could be lowered.

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..... [1]

(v) The hydrolysis of chloroethane takes place about 250 times faster in boiling water than in water at room temperature. Explain in terms of collision theory and the kinetic energy of particles why there is an increase in reaction rate with temperature.

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..... [3]

(c) Chloroethane can be manufactured by reacting chlorine with ethane.

(i) What condition is essential for the reaction to occur at room temperature?

..... [1]

(ii) In practice chloroethane is only one of the products of the reaction. Further substitution of chlorine into the molecule leads to a mixture of products. What technique would be used to separate a mixture of volatile compounds, such as this?

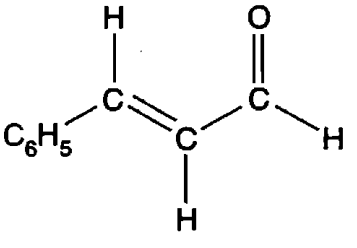
..... [1]

(iii) Give the structural formula of one other possible product of the reaction.

[1]

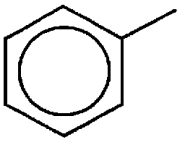
[Total: 20]

2 Cinnamon oil is obtained from the spicy bark of a tree found in Sri Lanka. The pleasant aroma of this oil is mainly caused by the compound shown below. This compound is commonly called cinnamaldehyde.



cinnamaldehyde

where C_6H_5 represents the benzene ring



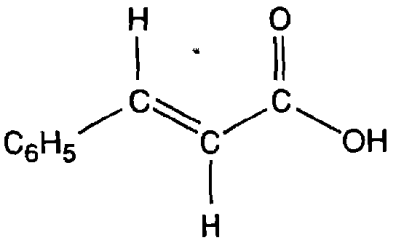
(a) Draw a ring around the aldehyde group in the structure of cinnamaldehyde. [1]

(b) Cinnamaldehyde exhibits geometric (*cis-trans*) isomerism.

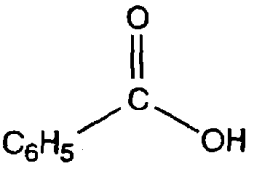
(i) Draw the structural formula of the geometric isomer of cinnamaldehyde.

[2]

(c) Oxidation of cinnamaldehyde by mild oxidising agents forms cinnamic acid. Strong oxidising agents lead to the formation of benzoic acid. The structures of these two acids are shown below.



cinnamic acid



benzoic acid

(i) One way of distinguishing between the two acids is to shake a sample with bromine water. State what you would **see.**

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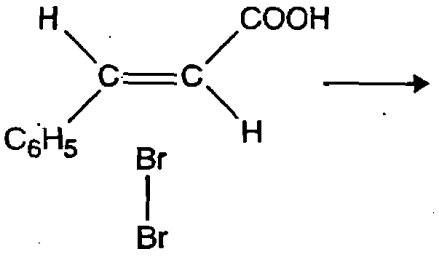
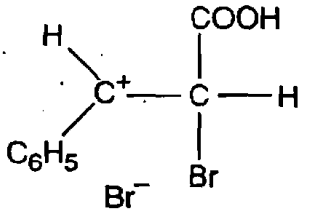
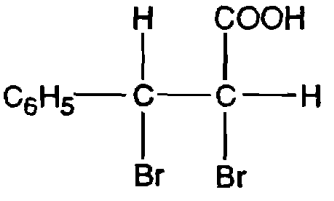
..... [2]

(ii) Use the reaction sequence below to describe the mechanism for the addition of bromine to cinnamic acid.





Intermediate B



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..... [4]

(iii) What **general** name is given to intermediates such as **intermediate B** in the diagram?

..... [1]

(d) Hydrogen bromide (HBr) also undergoes an addition reaction with cinnamic acid.

(i) Draw two possible structures for the product.

[2]

(ii) This reaction takes place by a similar mechanism to that shown in (c)(ii) in which initial attack is by H^+. Suggest which of your two structures is more likely to be formed. Give a reason for your answer.

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..... [1]

(f) At room temperature cinnamic acid is a solid, whereas cinnamaldehyde is an oil. Explain in terms of intermolecular forces why the boiling point of cinnamic acid is higher than that of cinnamaldehyde. (*In this question 1 mark is available for the quality of written communication.*)

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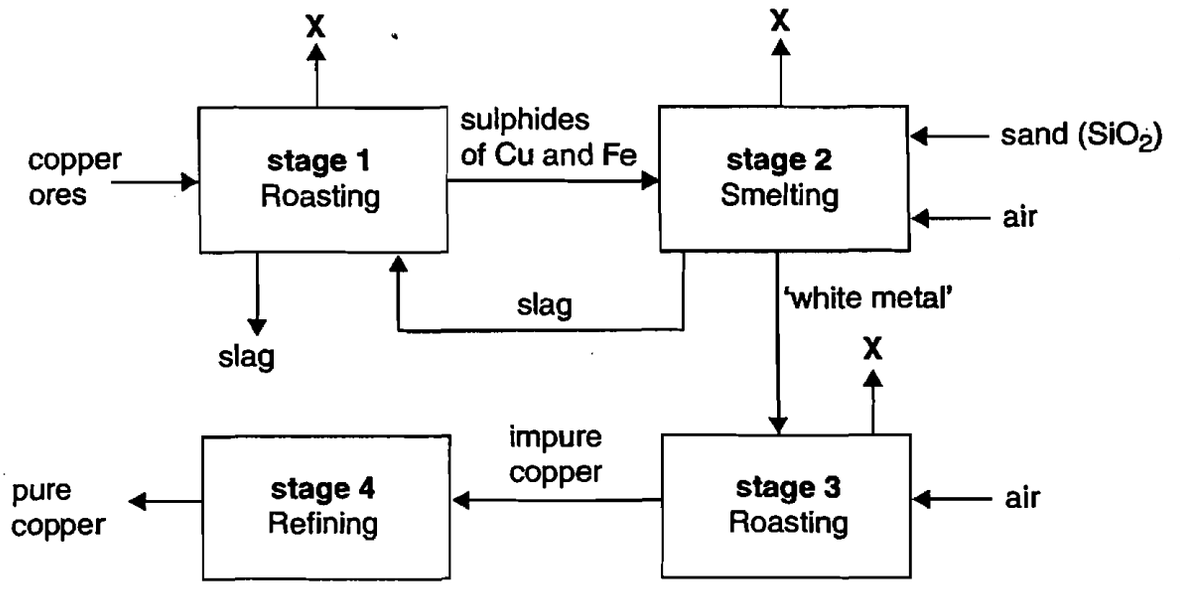
..... [5]

[Total: 18]

3 At Ecton Hill in Staffordshire, copper mining was carried out for 3 centuries. The output from the mines reached a peak in about 1770, resulting in a self-contained smelter being constructed nearby. The essential stages of the extraction process used are given in the flow diagram below.



(a) The copper ores from the Ecton mines contain several metal sulphides, including $CuFeS_2$.

If the oxidation state of iron in $CuFeS_2$ is +2, give the oxidation states of copper and sulphur in this mineral.

Copper .....

Sulphur ..... [3]

(b) **(i)** In **stage 1**, the ore was roasted to remove excess sulphur. Name the gas **X** which was formed from this sulphur. **X** was also given off in **stages 2** and **3**.

..... [1]

(ii) A chemical company today would not be allowed to release **X** into the environment. Explain how **X** is a pollutant.

.....

.....

..... [2]

(c) In **stage 2**, the iron sulphide was converted into iron(III) oxide. The iron(III) oxide then combined with sand (SiO_2) forming a silicate slag $Fe_2(SiO_3)_3$.

(i) Write a balanced equation for the formation of the slag.

..... [3]

(ii) A compound of copper, referred to as 'white metal', is left in the furnace after the slag is tapped off. 'White metal' contains 79.8% of copper and 20.2% of sulphur by mass. Calculate the empirical (simplest) formula of 'white metal'.
[A_r: S, 32.1; Cu, 63.5]

Answer ..... [3]

(d) Some 'white metal' dissolved in the slag in the smelter. Suggest why the slag was returned to the initial roasting furnace.

.....

..... [1]

(e) The last part of the process was the refining stage. Today this would be done by the electrolysis of a solution containing copper(II) ions. The anode (positive electrode) is a lump of impure copper and the cathode (negative electrode) is a sheet of pure copper metal.

(i) The half-equations for the processes taking place at the electrodes are,

at the cathode $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

at the anode $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

At which electrode does reduction take place? Give a reason for your answer.

.....

..... [1]

(ii) Suggest why the mass of the anode decreases whilst at the same time the concentration of the copper(II) ions in solution remains constant.

.....

..... [2]

(f) **(i)** The atomic (proton) number of iron is 26. Complete the boxes below showing the electronic configuration of an iron atom.

1s 2s 2p 3s 3p 3d 4s

[2]

(ii) Explain why iron is described as a d-block element.

.....

.....

..... [2]

[Total: 20]

4 The amount of copper in a sample of ore can be determined experimentally. A dry and finely ground sample of the ore is weighed accurately and heated under reflux with a concentrated solution of perchloric acid ($HClO_4$). A solution containing copper(II) and iron(III) ions is produced.

(a) (i) Draw a labelled diagram to show how you would heat the ore and acid mixture under reflux.

[3]

(ii) Explain why the ore used is finely ground.

.....

..... [2]

(b) Dilute aqueous ammonia is now added to the mixture after heating under reflux. Firstly this neutralises the acid. Secondly excess ammonia precipitates out the iron(III) ions. This precipitate can be removed from the mixture.

(i) Ammonia reacts with water as shown below.

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

This reaction is reversible.

1. Give the formulae of two bases in this equilibrium reaction.

..... [2]

2. Use Le Chatelier's Principle to predict and explain how the position of equilibrium changes when aqueous acid is added to the equilibrium mixture.

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..... [3]

(ii) Iron(III) ions react with the hydroxide ions in aqueous ammonia to give a precipitate. Name and give the formula of this precipitate.

Name ..... Formula ..... [2]

(c) When excess aqueous KI is added to the remaining solution of aqueous copper(II) ions, iodine is formed (see **Equation 4.1**).

$2Cu^{2+}(aq) + 4I^{-}(aq) \rightarrow I_2(aq) + 2CuI(s)$ **Equation 4.1**

(i) A white precipitatre of CuI forms. What colour change would you see in the **solution** as this reaction takes place?

From ..... to ..... [2]

(ii) What **type** of reaction leads to the formation of iodine from iodide ions?

..... [1]

(d) The mixture is now titrated with a solution of sodium thiosulphate of known concentration. This reacts with the iodine. The titration results enable a value for the copper present in the ore sample to be calculated.

Name the apparatus used to add the sodium thiosulphate solution to the iodine solution.

..... [1]

(e) When 0.600 g of copper ore were analysed using this method they produced enough iodine to react with exactly 25.0 cm^3 of 0.300 mol dm^{-3} sodium thiosulphate solution.

(i) Calculate the amount in moles of sodium thiosulphate in 25.0 cm^3 of 0.300 mol dm^{-3} sodium thiosulphate solution.

Answer ..... [2]

(ii) This titration shows that 7.5×10^{-3} moles of copper were present in the ore sample. Calculate the percentage by mass of copper in the ore sample.
[A_r: Cu, 63.5]

Answer ..... [2]

(iii) A damp sample of ore was used for the analysis. Suggest what the effect would be on the calculated percentage of copper. Give a reason for your answer.

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..... [2]

[Total: 22]

5 Each spring the ozone layer in the stratosphere thins over the poles. During the dark winter, there is a build-up of Cl_2 and HOCl molecules. As daylight returns in the spring, chlorine atoms are released from these molecules.

(a) (i) Explain how chlorine atoms are formed from chlorine molecules in the **spring.**

.....

..... [2]

(ii) Write an equation to show the formation of a chlorine atom from a HOCl molecule.

..... [1]

(b) These chlorine atoms then react according to **Equations 5.1 – 5.4.**

$2Cl + 2O_3 \rightarrow 2ClO + 2O_2$ **Equation 5.1**

$2ClO \rightarrow ClO{-}OCl$ **Equation 5.2**

$ClO{-}OCl \xrightarrow{h\nu} ClOO + Cl$ **Equation 5.3**

$ClOO \xrightarrow{h\nu} O_2 + Cl$ **Equation 5.4**

(i) What does the symbol *hν* indicate is happening in **Equations 5.3** and **5.4**?

.....

..... [2]

(ii) What name is given to particles such as ClO and Cl in **Equation 5.1**?

..... [1]

(iii) Use **Equations 5.1 – 5.4** to explain why chlorine atoms are able to destroy rapidly a large amount of ozone.

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..... [3]

(c) CFCs have been blamed for the presence of chlorine in the stratosphere. Chemists have now devised alternative halogen compounds to replace CFCs. What are these compounds and why don't they pose such a problem to the ozone layer as CFCs? State any **disadvantages** that these alternative compounds have. (*In this question 1 mark is available for the quality of written communication.*)

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..... [6]

[Total: 15]

6 Poly(chloroethene), PVC, is the most versatile thermoplastic and, after poly(ethene), the most widely used polymer.

(a) Explain the meaning of the term *thermoplastic.*

.....

..... [2]

(b) PVC is made from the monomer CH_2=CHC*l*. Draw the **full structural** formula of the repeating unit for PVC.

[2]

(c) Poly(ethene) is more flexible than PVC. Explain this in terms of intermolecular forces.

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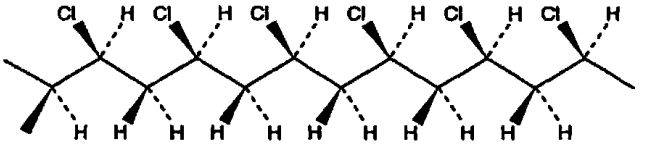
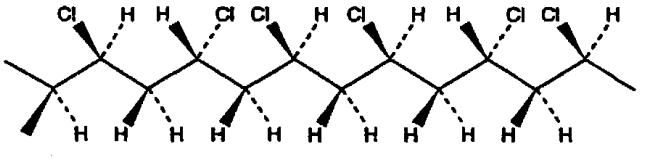
..... [3]

(d) Two forms of PVC are shown below. **A** is more crystalline than **B**.

Explain this in terms of the two structures.



A



B

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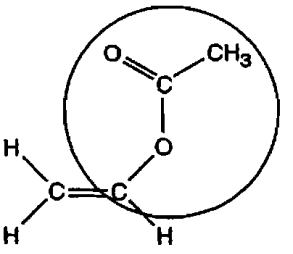
..... [2]

(e) A group of thermoplastic polymers can be produced from **compound C**. The structure of **C** is shown below.

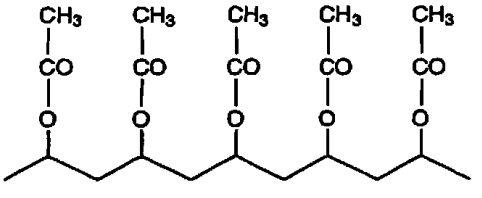


compound C

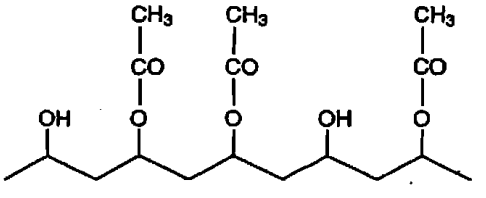
Name the functional group circled in **compound C**

..... [1]

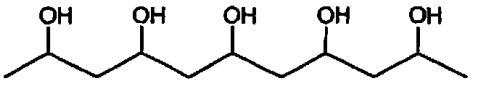
(f) Compound **C** can converted into **three** different polymers **D**, **E** and **F**. These are shown below.



D



E



F

(i) Complete the table below to show if hydrogen bonding can occur between polymer chains.

Polymer	Soluble in water	Hydrogen bonding yes/no
D	insoluble	
E	soluble	
F	insoluble	

[1]

(ii) The solubility in water of the three polymers is given in the table above. Suggest and explain why the solubility varies.

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..... [4]

[Total: 15]