OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **2848/01**

CHEMISTRY (SALTERS)

Chemistry of Natural Resources

WEDNESDAY 6 JUNE 2007 Morning

Time: 1 hour 30 minutes

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

Candidate Name

Centre Number

Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

- The number of marks for each question 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.
- 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	14	
2	15	
3	30	
4	31	
TOTAL	90	

This document consists of **14** printed pages, **2** blank pages and a *Data Sheet for Chemistry (Salters)*.

[Turn over

Answer **all** the questions.

1 Large quantities of copper are mined around the world. Chalcocite is one of the copper-containing ores. One important use of copper is in making electrical wires.

(a) The copper wire for electrical applications is covered with a layer of a polymer, such as PVC. Explain why this is done.

.....

..... [1]

(b) To extract copper from its ore, the ore is first crushed and made into a slurry by mixing with water. The slurry is mixed with a detergent containing 'collector' molecules. Air is then blown through the mixture. This separates the copper mineral grains from the rest of the mixture.

(i) Name this separation technique.

..... [1]

(ii) Explain how this separation technique works.

.....

.....

..... [2]

(c) The ore chalcocite contains copper(I) sulphide. Some of this ore is converted into copper and sulphur dioxide during smelting.

(i) Give the formula of copper(I) sulphide.

..... [1]

(ii) Write a balanced equation for the smelting of copper(I) sulphide.

$\rightarrow$

[2]

(iii) The sulphur dioxide formed in the smelting process is not allowed to escape into the atmosphere because it causes acid rain. Suggest a useful product that could be obtained from the sulphur dioxide.

.....

..... [1]

(d) Some of the copper remains as copper(II) sulphide after the smelting process. Laboratory analysis is used to assess how much copper remains in the solid after smelting. The copper can be removed from the solid by reacting it with sulphuric acid. The copper goes into solution as copper(II) sulphate.

(i) The solid and the copper(II) sulphate solution are separated using vacuum filtration. Explain how this process works and why it is efficient.

.....

.....

..... [2]

(ii) The reaction for the formation of the copper(II) sulphate is shown below.

$$CuS + H_2SO_4 \rightarrow CuSO_4 + H_2S$$ **equation 1.1**

This is an acid-base reaction. Give the formula of the ion that is acting as the base.

..... [1]

(iii) Copper can be formed from the copper(II) sulphate solution by reacting with excess zinc, as shown below.

$$CuSO_4(aq) + Zn(s) \rightarrow Cu(s) + ZnSO_4(aq)$$ **equation 1.2**

Use **equation 1.2** to calculate the mass of copper that would be produced from 100 g of $CuSO_4$ that has been dissolved in water. Give your answer to **two** significant figures.

A_r: Cu, 63.5; S, 32; O, 16.

mass = ... g [3]

[Total: 14]

2 Sulphur dioxide is often added to wine as a preservative, but it is important to get the final concentration correct. If too much is added the wine tastes of sulphur dioxide, too little and the wine goes bad. The concentration of sulphur dioxide in wine can be calculated by titrating the wine with an aqueous solution of iodine.

(a) The equation for the reaction between sulphur dioxide and iodine is shown below.

$$SO_2(aq) + I_2(aq) + 2H_2O(l) \longrightarrow SO_4^{2-}(aq) + 2I^-(aq) + 4H^+(aq) \qquad \textbf{equation 2.1}$$

(i) Give the oxidation states of the iodine and sulphur before and after the reaction, by completing the following table.

oxidation state of sulphur in:	oxidation state of iodine in:
SO_2 = ...	I_2 = ...
SO_4^{2-} = ...	I^- = ...

[4]

(ii) State, with a reason, whether sulphur is oxidised or reduced in the conversion of SO_2 into SO_4^{2-}.

.....

..... [1]

(b) A sample of white wine was analysed for its sulphur dioxide content by titrating it with an aqueous solution of iodine.

(i) State the colour change of the iodine as it reacts with the sulphur dioxide solution.

from ..... to ..... [2]

(ii) 16.20 cm^3 of 0.0100 mol dm^{-3} aqueous I_2 solution was needed to react with 50.00 cm^3 of the wine. Calculate the number of moles of iodine, I_2, used in the titration.

number of moles = ... [2]

(iii) Use **equation 2.1** to write down the number of moles of sulphur dioxide in the 50.00 cm^3 of wine.

moles of sulphur dioxide = ... [1]

(iv) What is the concentration of sulphur dioxide in the wine in mol dm^{-3}?

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

(v) The concentration of sulphur dioxide in wine is usually quoted in $g\,dm^{-3}$. What is the concentration of the sulphur dioxide in this wine in $g\,dm^{-3}$?

A_r: S, 32; O, 16.

concentration = ... $g\,dm^{-3}$ [2]

(vi) The generally accepted maximum concentration of sulphur dioxide in wine is $0.25\,g\,dm^{-3}$. A concentration of less than $0.01\,g\,dm^{-3}$ is insufficient to preserve the wine. Comment on the effectiveness of the sulphur dioxide in the wine analysed in **(v)**.

.....

..... [1]

[Total: 15]

3 Large quantities of chloromethane, CH_3Cl, and bromomethane, CH_3Br, are released into the Earth's troposphere (lower atmosphere) each year from marine life in the oceans.

(a) Name the homologous series of compounds to which both chloromethane and bromomethane belong.

..... [1]

(b) Chloromethane and bromomethane are both gases at room temperature whilst water is a liquid.

(i) Water molecules are held together by hydrogen bonds. Draw a diagram to show how **two** water molecules can be linked by a hydrogen bond. Include relevant lone pairs and partial charges in your diagram.

[4]

(ii) Describe **two** features of a water molecule that enable it to form hydrogen bonds.

.....

.....

.....

..... [2]

(iii) Name the strongest type of intermolecular force that can form between molecules of chloromethane.

..... [1]

(iv)

	boiling point/K
bromomethane	277
chloromethane	249
water	373

Use ideas about intermolecular forces to explain:

- why chloromethane has a lower boiling point than water;

.....

.....

.....

- why bromomethane has a higher boiling point than chloromethane.

.....

.....

..... [3]

(c) Most of the chloromethane and bromomethane molecules that enter the troposphere are removed by reaction with hydroxyl radicals. Hydroxyl radicals form from water molecules in the troposphere.

(i) Draw a dot-cross diagram for the hydroxyl, OH, radical.

[2]

(ii) Ozone in the troposphere breaks down to form an oxygen atom and an oxygen molecule. Name the **type** of bond breaking that occurs in this reaction.

..... [1]

(iii) This bond breaking process requires energy. Name the **type** of radiation that is needed for this process and give the **source** of this energy.

type .....

source ..... [2]

(iv) An oxygen atom reacts with a water molecule in the troposphere to produce hydroxyl radicals. Write the balanced chemical equation for this reaction.

→

[1]

(v) Two of the steps in the chain reaction between hydroxyl radicals and chloromethane are shown below.

$$CH_3Cl + OH \rightarrow CH_2Cl + H_2O \qquad \textbf{equation 3.1}$$

$$CH_2Cl + OH \rightarrow CH_2ClOH \qquad \textbf{equation 3.2}$$

Classify the steps shown in **equations 3.1** and **3.2** as being **initiation**, **propagation** or **termination**, as appropriate.

equation 3.1 .....

equation 3.2 ..... [2]

(d) The chloromethane and bromomethane that dissolve in the oceans are hydrolysed by the water, releasing HCl or HBr.

(i) Write the equation for the hydrolysis reaction for chloromethane.

→

[2]

(ii) Name the organic compound that forms in this reaction.

..... [1]

(iii) Underline two of the following words to describe the hydrolysis reaction in **(i)** above.

addition elimination electrophilic nucleophilic radical substitution

[2]

(e) The ease with which the chloromethane and bromomethane are hydrolysed depends on one of the factors shown:

- the strength of the carbon–halogen bond;
- the polarity of this bond.

(i) State which bond, C–Cl or C–Br, is the more polar and explain why.

.....

..... [1]

(ii) State which bond, C–C*l* or C–Br, is stronger and explain why.

.....

..... [1]

(iii) Under the same reaction conditions, the hydrolysis of bromomethane occurs more rapidly than the hydrolysis of chloromethane. Which factor is more important in determining the rate at which hydrolysis occurs; bond strength or bond polarity? Explain your answer.

.....

.....

..... [1]

(f) Some of the chloromethane in the Earth's atmosphere could be formed from reactions involving atmospheric methane. Most of the methane released into the Earth's atmosphere is oxidised in the troposphere, but some reaches the stratosphere (upper atmosphere) where it reacts with chlorine radicals.

(i) Write a balanced equation for the oxidation of methane in the troposphere to produce carbon dioxide and water.

$\rightarrow$

[2]

(ii) A possible route for the formation of chloromethane from methane in the stratosphere is shown in **equations 3.3** and **3.4** below.

$$CH_4 + Cl \longrightarrow CH_3 + HCl \qquad \textbf{equation 3.3}$$

$$CH_3 + Cl \longrightarrow CH_3Cl \qquad \textbf{equation 3.4}$$

Suggest why the activation enthalpy for the reaction shown in **equation 3.4** is lower than that for the reaction shown in **equation 3.3**.

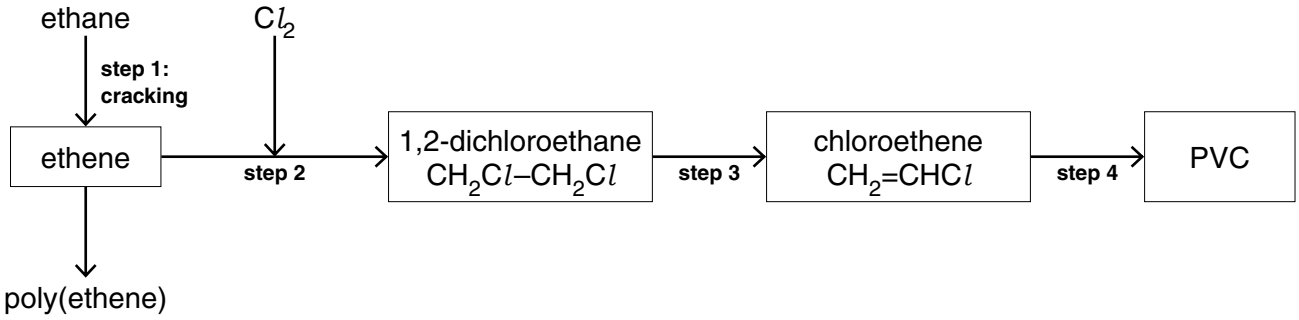
.....

.....

..... [1]

[Total: 30]

4 'Polyvinylchloride', PVC, is a polymer made by a series of processes that start with crude oil and sodium chloride. Ethane is obtained from crude oil, and chlorine is obtained from sodium chloride. The flow chart shown below summarises the remaining processes that are involved in producing PVC.



(a) The ethane for **step 1** is obtained from crude oil. Name the process that is used to separate ethane from crude oil.

..... [1]

(b) In this question, one mark is available for the quality of the use and organisation of scientific terms.

The cracking reaction in **step 1** converts ethane into ethene and hydrogen. The reaction equation is shown below.

$$C_2H_6(g) \rightleftharpoons C_2H_4(g) + H_2(g) \qquad \Delta H = +138\ kJ\,mol^{-1} \qquad \textbf{equation 4.1}$$

Altering the temperature and pressure conditions for the process given in **equation 4.1** can increase the **rate** of this reaction.

Explain how the **temperature** and **pressure** could be changed in order to make the reaction **faster**. Use the ideas of activation enthalpy and collision theory to help you explain why your changes make the reaction faster.

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..... [6]

Quality of Written Communication [1]

(c) Changing the temperature and pressure conditions for the reaction shown in **equation 4.1** can have an effect on the **yield** of ethene.

$$C_2H_6(g) \rightleftharpoons C_2H_4(g) + H_2(g) \qquad \Delta H = +138\,kJ\,mol^{-1} \qquad \textbf{equation 4.1}$$

(i) Use Le Chatelier's principle to explain how the yield of ethene will change if the **temperature** is increased.

.....

.....

.....

..... [3]

(ii) Explain how the yield of ethene will change if the **pressure** is increased.

.....

.....

..... [2]

(d) Some of the ethene that forms is used in a polymerisation reaction to make poly(ethene).

(i) Poly(ethene) is an example of a polymer that was discovered accidentally. Give another example of a polymer that was discovered by accident.

..... [1]

(ii) What **type** of polymerisation is the polymerisation of ethene?

..... [1]

(iii) Give **one** use for the poly(ethene) that is produced. Explain the property of poly(ethene) that makes it suitable for your given use.

.....

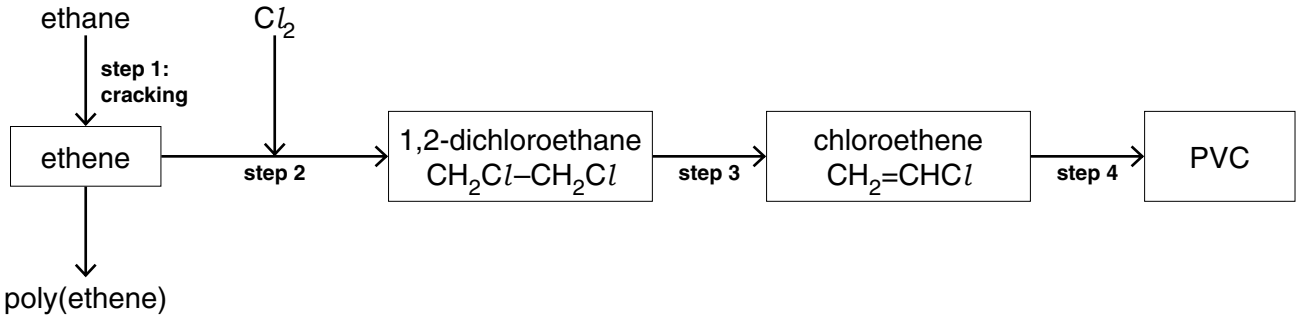
.....

..... [2]

(iv) Poly(ethene) is a thermoplastic polymer. Explain what is meant by the term *thermoplastic*.

..... [1]

(e) Ethene is converted, in **step 2**, into 1,2-dichloroethane by reaction with chlorine. The chlorine is produced by electrolysis of sodium chloride solution.



(i) Give the half-equation for the production of chlorine in electrolysis.

→

[2]

(ii) The chlorine is used to convert ethene into 1,2-dichloroethane in an electrophilic addition reaction. Explain what is meant by the terms *electrophilic* and *addition*.

.....

.....

.....

.....

..... [3]

(f) In **step 3**, 1,2-dichloroethane is decomposed into chloroethene by heating it to a temperature of between 450 °C and 650 °C.

(i) Name the other product of the decomposition reaction of 1,2-dichloroethane.

..... [1]

(ii) The reaction produces just one organic product because chloroethene does not exist as geometric (*cis-trans*) isomers. What is meant by *cis-trans* isomerism?

.....

.....

..... [1]

(g) (i) Draw the repeating unit for PVC.

[1]

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

PVC can be produced so that it has a high proportion of crystalline regions. This causes the PVC to be very rigid. Explain why the high proportion of crystalline regions causes this rigidity.

In your answer you should consider the points below:

- What the term *crystalline* means in this context.
- Why, in terms of intermolecular forces, a more crystalline structure is less flexible than one with fewer crystalline regions.

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..... [4]

Quality of Written Communication [1]

[Total: 31]

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