OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY (SALTERS) 2848

CHEMISTRY OF NATURAL RESOURCES

Friday **17 JANUARY 2003** Morning 1 hour 30 minutes

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

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 30 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

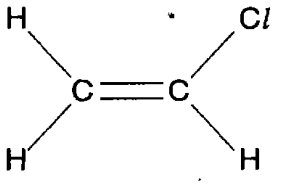
- The number of marks is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry (Salters).*
- You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

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	16	
2	28	
3	22	
5	9	
TOTAL	75	

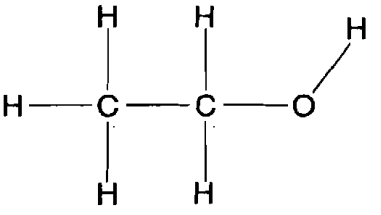
Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 Ethene is used in manufacturing a wide range of chemicals. The structural formulae of two such compounds are given below.



compound **A**



ethanol

(a) (i) Give the systematic name of compound **A**.

.....[1]

(ii) Compound **A** is used to manufacture a thermoplastic polymer by addition polymerisation.

Explain the term *thermoplastic*.

.....

.....[2]

(iii) Draw the repeating unit of the polymer formed by addition polymerisation of compound **A**.

[1]

(b) Ethanol is used as a polar solvent. Polar molecules contain at least one polar bond.

Use the data given below to identify the most polar bond in ethanol.

Draw this bond and label its partial charges.

[Electronegativity values: H, 2.2; C, 2.6; O, 3.4]

[2]

(c) Ethanol can be readily converted into ethanoic acid.

(i) What reagents are used in the laboratory to convert ethanol into ethanoic acid?

.....

.....[2]

(ii) The reagents and ethanol are heated together under reflux.

Explain what is meant by the term *heating under reflux.*

.....

.....[2]

(iii) Ethanol and ethanoic acid can be distinguished by using infrared spectroscopy. Ethanoic acid has a **strong** absorption peak in its spectrum which is not present in the spectrum of ethanol.

Using the *Data Sheet* provided, give the wavenumber range for this peak and the bond that causes it.

wavenumber ..... cm^{-1}

bond ..... [2]

(d) In some countries, ethene is manufactured from ethanol. The equation for the reaction is given below.

$$C_2H_5OH \longrightarrow C_2H_4 + H_2O$$

What **type** of reaction is this? Circle the correct answer in the list below.

addition **condensation** **elimination** **substitution**

[1]

(e) The molecule ethene contains a C=C double bond that reacts with bromine.

(i) Explain why bromine is attracted to the C=C double bond.

.....

.....

.....[2]

(ii) Draw the structure of the carbocation that forms when a bromine molecule reacts with an ethene molecule.

[1]

[Total: 16]

For Examiner's Use

2 Carbon dioxide gas, both in the atmosphere and in industrial waste gases, causes much concern for chemists. They have to design methods to remove the gas from industrial waste gases. The devices they produce are called 'scrubbers'. Despite this, the atmospheric concentration of carbon dioxide continues to rise.

(a) In this question, one mark is available for the quality of written communication.

Chemists have linked the worldwide increase in the atmospheric carbon dioxide concentration with global warming.

Explain how an increase in the concentration of carbon dioxide leads to an increase in the temperature of the atmosphere.

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.....

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.....

.....

.....

.....

.....[5]

Quality of Written Communication [1]

(b) The oceans help to reduce the concentration of carbon dioxide in the atmosphere. **Equations 2.1** and **2.2** describe two of the reactions involved. Hydrogencarbonate ions are constantly being removed by natural processes.

$$CO_2\,(g) \rightleftharpoons CO_2\,(aq) \qquad \textbf{Equation 2.1}$$

$$H_2O(l) + CO_2(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq) \qquad \textbf{Equation 2.2}$$

hydrogencarbonate ion

(i) In this question, one mark is available for the quality of written communication.

Use these equations and ideas of chemical equilibrium to explain how the oceans remove carbon dioxide from the atmosphere.

.....

.....

.....

.....

.....

.....

.....[4]

Quality of Written Communication [1]

(ii) By considering **Equation 2.2**, suggest a reason why you might expect the oceans to be slightly acidic.

.....

.....[1]

(c) Governments and environmental groups are exploring ways of reducing the concentration of carbon dioxide in the atmosphere. Describe and explain **one** method, apart from the use of scrubbers, for doing this.

.....

.....

.....[2]

(d) Carbon dioxide scrubbers are very important for maintaining a fresh supply of air in confined spaces where the air is recirculated.

Two principles are important for their efficient operation:

- the gas must come into contact with some absorbent material
- the gas must be near the absorbent material long enough for a chemical reaction to occur.

(i) Draw a labelled diagram of a simple apparatus that could be used to absorb carbon dioxide from a stream of air using a solid absorbent.

[3]

(ii) Solid calcium hydroxide, $Ca(OH)_2$, is often used to absorb carbon dioxide. Calcium carbonate is formed. Write a balanced chemical equation for the reaction which takes place. Give state symbols.

..... $\longrightarrow$ ..... [2]

(e) Calcium carbonate can be detected by the characteristic fizzing that occurs when an acid is added to it.

Give the formula of the ion that acts as an acid in this reaction and the ion that acts as a base.

acid ..... base ..... [2]

(f) Sodium peroxide can also be used as an absorbent for carbon dioxide. **Equation 2.3** shows the reaction that takes place.

$$2Na_2O_2\,(s) + 2CO_2(g) \longrightarrow 2Na_2CO_3\,(s) + O_2(g) \qquad \textbf{Equation 2.3}$$

....

(i) Write, under the formulae in **Equation 2.3**, the oxidation state of **oxygen** in each substance involved in the reaction. [4]

(ii) Disproportionation is a reaction in which an element is both oxidised and reduced. Explain why **Equation 2.3** is an example of disproportionation.

.....

.....

.....[2]

(iii) Suggest an advantage that using sodium peroxide as an absorbent has over using calcium hydroxide.

.....[1]

[Total: 28]

3 The element zirconium, Zr, and its compounds are becoming increasingly important as constituents in a wide range of high-tech materials. The main ore of the element is called 'zircon sand'.

(a) The atomic number of zirconium is 40. Which block in the Periodic Table is zirconium in?

.....[1]

(b) 'Zircon sand', $ZrSiO_4$, is used to make zirconium(IV) oxide.

(i) The equation for the first stage in this process is given below.

Balance this equation by writing numbers on the dotted lines.

$$\ldots\ldots NaOH + ZrSiO_4 \longrightarrow Na_2SiO_3 + Na_2ZrO_3 + \ldots\ldots H_2O$$ [2]

(ii) In the next stage of the process, water is added. The result is a precipitate of zirconium(IV) oxide in an aqueous solution. Suggest a method of separating the solid from the aqueous solution.

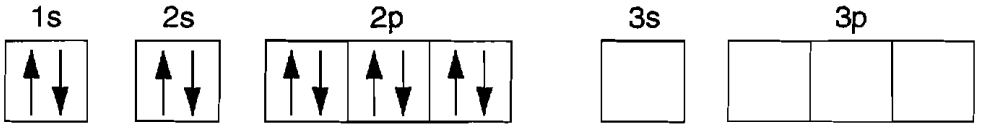
.....[1]

(iii) Calculate the maximum mass of zirconium(IV) oxide, ZrO_2, which is produced from 1000 kg of pure $ZrSiO_4$. Assume 1 mole of $ZrSiO_4$ gives 1 mole of ZrO_2.
[A_r: O,16; Si,28; Zr,91]

Answer.....kg [2]

(c) The aqueous solution from **(b) (ii)** contains sodium silicate, Na_2SiO_3. Silicon is in Group 4 of the Periodic Table and in some ways its chemistry resembles that of carbon.

(i) Silicon has a similar outer electron structure to carbon. In the boxes below, show the s and p electrons of silicon's electron structure. [2]



(ii) Both carbon and silicon form covalent dioxides, CO_2 and SiO_2. These have very different structures and properties. Describe **one** way in which CO_2 and SiO_2 differ in their **properties**.

.....

.....

.....[2]

(iii) How does the **structure** of SiO_2 differ from that of CO_2?

.....

.....

.....[2]

(iv) Use your answer to **(iii)** to help you **explain** why CO_2 and SiO_2 differ in their properties.

.....

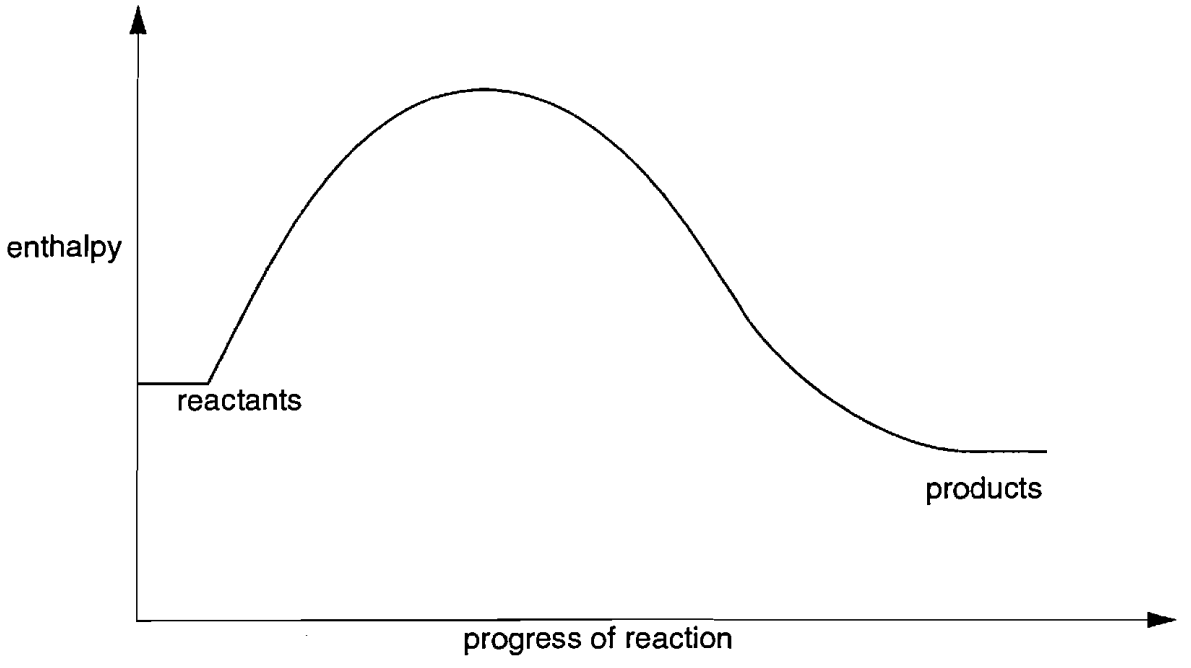
.....

.....[2]

(d) One of the most important uses of zirconium(IV) oxide is as a catalyst. It is used in catalytic converters for cars because it can withstand high temperatures.

(i) The diagram below shows an enthalpy profile for an uncatalysed reaction.

- draw the enthalpy profile for the same reaction in the presence of a catalyst
- mark clearly on the diagram the **activation enthalpy** of the **catalysed** reaction
- mark clearly on the diagram the **activation enthalpy** of the **uncatalysed** reaction



[5]

[Turn over

For Examiner's Use

(ii) Use the diagram and collision theory to explain why reactions go faster in the presence of a catalyst.

.....

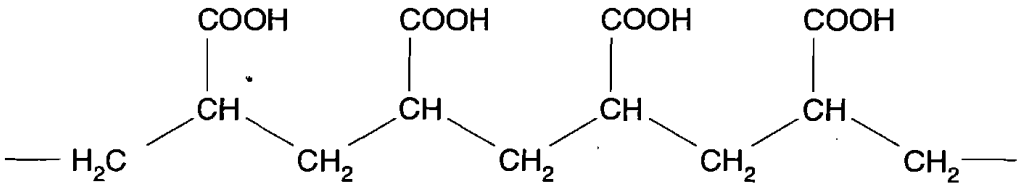
.....

.....

.....[3]

[Total: 22]

5 Superabsorbent polymers are used in a variety of medical and hygiene products.
The most widely used polymer is the sodium salt of poly(acrylic acid).
The structure of part of a poly(acrylic acid) chain is shown below.



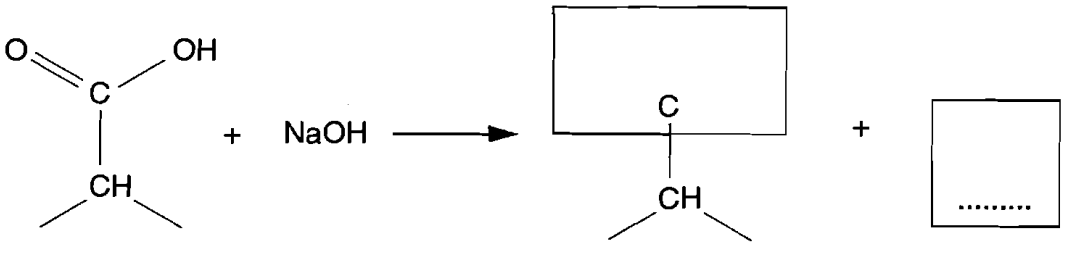
poly(acrylic acid)

(a) Draw the structural formula of acrylic acid.

[1]

(b) The carboxylic acid groups on the poly(acrylic acid) chain can be converted into their sodium salts by reaction with sodium hydroxide.

Fill in the boxes to complete the equation below for the reaction of poly(acrylic acid) with sodium hydroxide.



sodium salt

[3]

(c) A sample of poly(acrylic acid) reacted with 35.0 cm^3 aqueous sodium hydroxide of concentration 0.10 mol dm^{-3}.

Calculate the number of moles of acid groups present in the sample of the polymer.

answer ..... mol [2]

(d) Superabsorbent polymers are used widely in disposable nappies. The polymers are treated so that there is some cross-linking.

(i) Explain the meaning of the term *cross-linking*.

.....

.....[2]

(ii) Suggest why cross-linking polymers are used in making nappies.

.....

.....[1]

[Total: 9]