

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**

**Advanced Subsidiary GCE**

**CHEMISTRY (SALTERS)**

**2851**

Minerals to Medicines

Wednesday **4 JUNE 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										
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**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 provided 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**

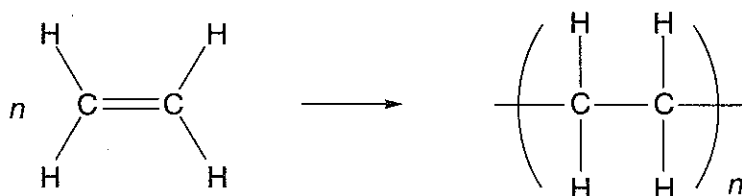
- The number of marks is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry (Salters)*.
- You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

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	14	
2	27	
3	21	
4	28	
<b>TOTAL</b>	<b>90</b>	

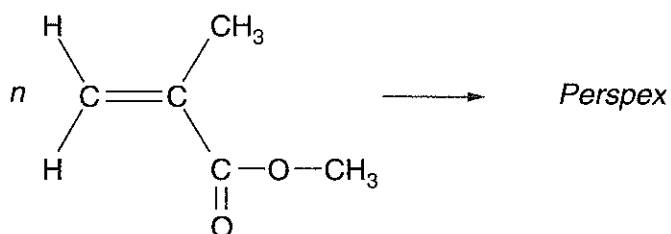
**This question paper consists of 14 printed pages and 2 blank pages.**

Answer **all** the questions.

- 1 Poly(ethene) is made from ethene by an addition polymerisation reaction. The equation for this reaction is given below.

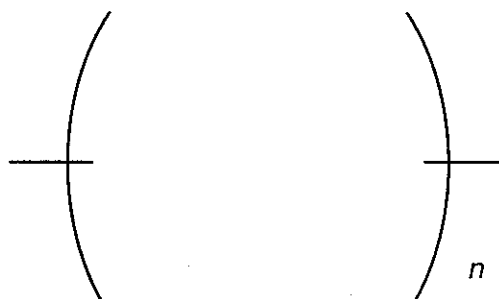


- (a) The polymer *Perspex* is made from methyl 2-methylpropenoate in an addition polymerisation reaction similar to that shown above for the formation of poly(ethene).



**methyl 2-methylpropenoate**

- (i) Which functional group in the molecule enables methyl 2-methylpropenoate to undergo an addition reaction?  
.....[1]
- (ii) Name another functional group present in methyl 2-methylpropenoate.  
.....[1]
- (iii) In the brackets below, draw the repeating unit for *Perspex*.



[1]

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

*Perspex* is less flexible than poly(ethene). Explain, in terms of the structure of the polymer chains and the intermolecular forces between the polymer chains, why this is so.

.....

.....

.....

.....

.....

.....

.....

[4]

Quality of Written Communication [1]

(c) (i) Draw the full structural formula of the product formed when bromine reacts with **ethene**.

[2]

(ii) In this reaction, bromine acts as an electrophile. What do you understand by the term *electrophile*?

.....

.....

.....

[2]

(iii) Explain how bromine acts as an electrophile when it reacts with ethene.

.....

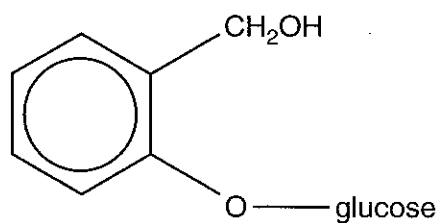
.....

.....

[2]

[Total: 14]

- 2 In the early years of the nineteenth century, chemists isolated *salicin* from willow bark.



- (a) (i) Circle in the list below the **type** of alcohol group present in salicin.

primary

secondary

tertiary

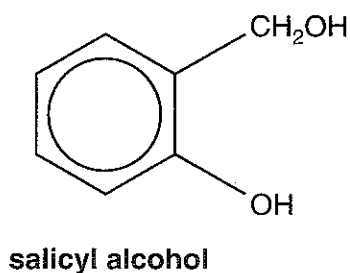
[1]

- (ii) Explain your choice.

.....

.....[1]

- (b) Hydrolysis of salicin leads to the formation of two products. One is glucose. The other is shown below and is called salicyl alcohol.



- (i) Thin layer chromatography can be used to show that the hydrolysis mixture contains **two** products, one of which is salicyl alcohol. With the aid of labelled diagrams, describe how you would carry this out.

[5]

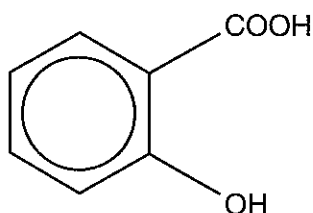
- (ii) Give the reagent used in a chemical test to show that salicyl alcohol contains a phenol group. What would you expect to see?

reagent added .....

observation .....

[2]

- (c) Salicyl alcohol is easily oxidised to salicylic acid.



salicylic acid

Salicylic acid contains a carboxylic acid group. Draw the **full structural formula** of a carboxylic acid group.

[1]

- (d) (i) The relative molecular mass of salicylic acid is 138. What would you look for in a mass spectrum of salicylic acid to confirm this is true?

.....[1]

- (ii) The mass spectrum of salicylic acid,  $C_7H_6O_3$ , contains a peak at a mass of 120. What fragment is lost from the molecular ion to produce this peak?

.....[1]

- (iii) What is the molecular formula of the ion responsible for the peak at a mass of 120?

.....[1]

- (e) Salicylic acid is soluble in warm water. The concentration of a solution can be determined by titration with aqueous sodium hydroxide.

- (i) What name is given to the **type** of reaction which occurs in this titration?

.....[1]

- (ii) What piece of apparatus should a student use to measure out  $25.0\text{ cm}^3$  of aqueous salicylic acid?

.....[1]

- (iii) 33.3 cm<sup>3</sup> of 0.015 mol dm<sup>-3</sup> sodium hydroxide solution reacted with the 25.0 cm<sup>3</sup> of salicylic acid solution.

Calculate the number of moles of sodium hydroxide added to the salicylic acid.

answer ..... mol [2]

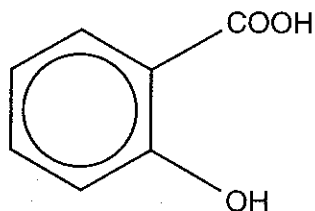
- (iv) **Two** moles of sodium hydroxide react with **one** mole salicylic acid. Use your answer from (iii) to calculate the number of moles of salicylic acid in 25.0 cm<sup>3</sup> of salicylic acid solution.

answer ..... mol [1]

- (v) Calculate the concentration of the salicylic acid solution.

answer ..... mol dm<sup>-3</sup> [2]

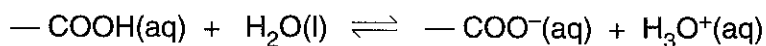
- (f) List **all of the types** of intermolecular force present between salicylic acid molecules.



salicylic acid

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

- (g) The carboxylic acid group,  $\text{—COOH}$ , in salicylic acid reacts with water reversibly to produce an acidic solution according to the equation below.



- (i) Explain why water is acting as a base in this reaction.

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

- (ii) A solution containing  $\text{—COO}^{\text{—}}$  ions is added to the acidic solution. Use the equation above and Le Chatelier's principle to explain what would happen to the concentration of the  $\text{H}_3\text{O}^{\text{+}}$  ions.

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

[Total: 27]

- 3 Most plants can take up small amounts of metals such as nickel from the soil. Recently, some plants have been discovered which take up large amounts of metals. These plants are so effective that they can be used commercially to extract the metals from the ground. This process is called phytomining.

(a) Suggest **one** advantage of phytomining over conventional mining.

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

(b) At present nickel is obtained mainly from sulphide ores. One nickel ore contains 2% by mass of nickel sulphide, NiS.

[A<sub>r</sub>: Ni, 59; S, 32]

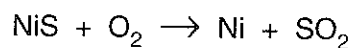
(i) Calculate the number of moles of nickel sulphide present in 1000 kg of ore.

answer ..... mol [2]

(ii) How many moles of nickel are present in this amount of ore?

answer ..... mol [1]

(c) In extracting nickel from the ore containing NiS, the ore is roasted in air. The equation for this reaction is given below.



(i) In the table below, write down the oxidation state of each element in the equation. One of them has been done for you.

element	oxidation state	
	reactants	products
S	-2	
Ni		
O		

[4]

(ii) Using information from the table, state an element which has been **oxidised**, giving the reason for your choice.

element .....

reason .....

[2]

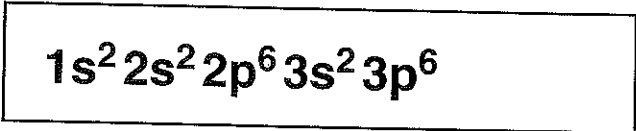


(d) A number of elements can be extracted by phytomining. They include cadmium, cobalt, copper, manganese, nickel, selenium, uranium and zinc.

(i) Name **one** of these elements that is **not** a d-block element.

.....[1]

(ii) Use your Periodic Table to help you complete the electron structure for nickel atoms:



[2]

(e) (i) In phytomining, the dried plant material is burned to produce an ash which contains nickel. In this process, large quantities of carbon dioxide are released into the atmosphere. Explain why increasing the concentration of carbon dioxide in the atmosphere is an environmental hazard.

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

(ii) In the **long term**, phytomining does not change the concentration of carbon dioxide in the atmosphere. Explain why.

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

(f) Infrared spectroscopy can be used to measure the concentration of carbon dioxide in the atmosphere. CO<sub>2</sub> molecules absorb infrared radiation strongly at 2360 cm<sup>-1</sup>.

(i) What effect does this infrared radiation have on CO<sub>2</sub> molecules?

.....[2]

(ii) Why do molecules absorb infrared radiation at **specific** frequencies?

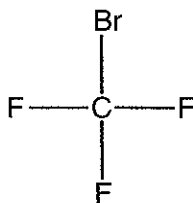
.....[1]

(iii) How would measuring the absorption at 2360 cm<sup>-1</sup> indicate **changes** in CO<sub>2</sub> concentration?

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

[Total: 21]

- 4 Halons are compounds related to CFCs, where one or more chlorine atoms are replaced by bromine. Freon 13B1 is a commercially produced halon once widely used in fire extinguishers.

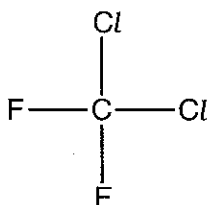


Freon 13B1

- (a) Give the systematic chemical name for Freon 13B1.

.....[1]

- (b) (i) Freon 13B1 breaks down in the upper atmosphere more easily than the CFC shown below. Suggest an explanation for this.



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

- (ii) Draw the structures of the products formed when the C—Br bond in Freon 13B1 is broken homolytically.

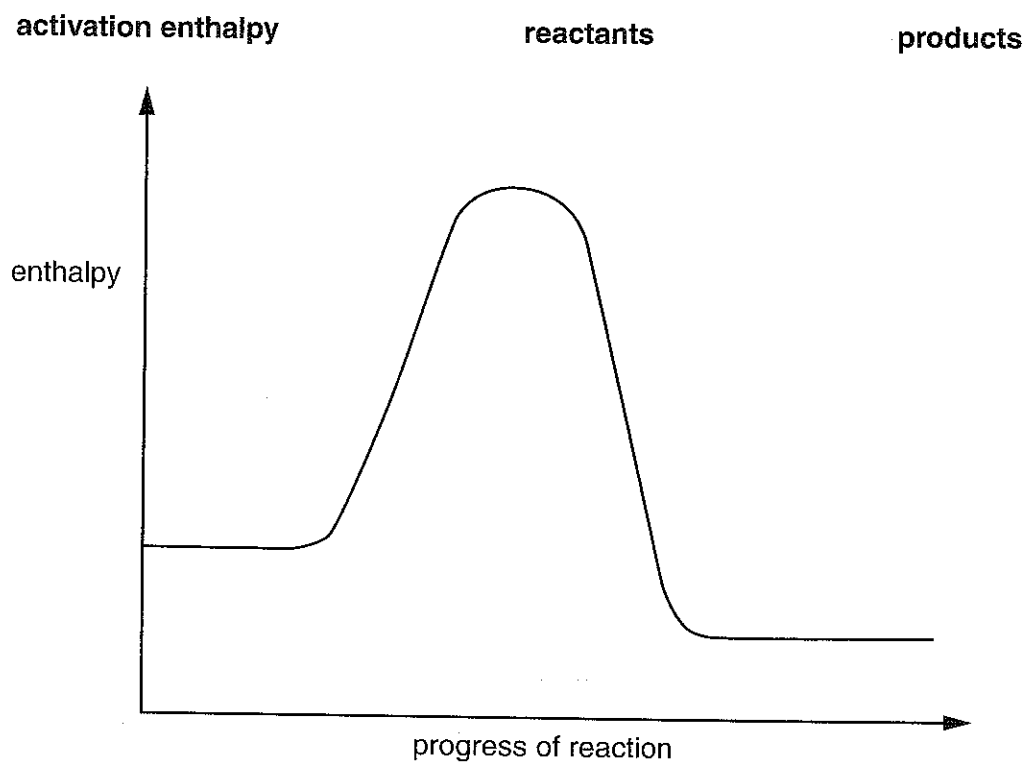
[2]

- (iii) What do you call the type of particles formed by homolytic fission?

.....[1]



- (e) (i) The enthalpy profile diagram below is for the reaction between  $\text{CH}_3\text{Br}$  and water. Insert the following labels in their correct places.



[3]

- (ii) How does the enthalpy profile diagram show that the overall reaction is exothermic?

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

- (iii) How would you show **practically** that the reaction is exothermic?

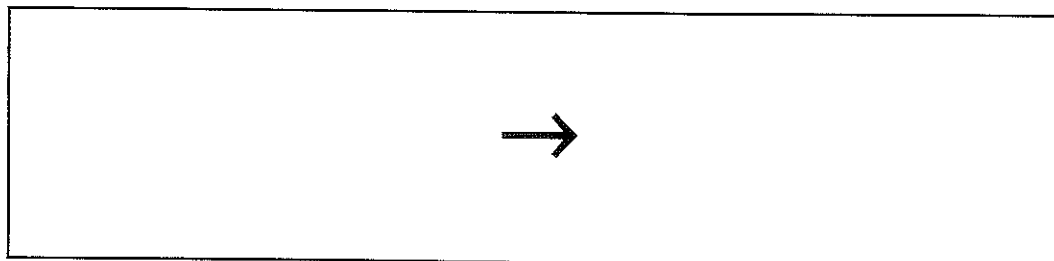
.....  
 ..... [1]

- (f) (i) The hydrolysis of  $\text{CH}_3\text{Br}$  is faster in warm water than in cold. Explain why the rates of most reactions increase as the temperature rises.

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

- (ii) Aqueous bromide ions are formed in this hydrolysis reaction. These ions can be detected by aqueous silver nitrate. A precipitate of silver bromide is formed.

Write an ionic equation for formation of silver bromide. Include state symbols in the equation.



[3]

[Total: 28]