

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY (SALTERS)

Minerals to Medicines

2851

Friday

9 JANUARY 2004

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.

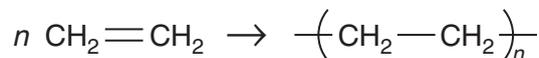
FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	16	
2	32	
3	20	
4	22	
TOTAL	90	

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

Answer **all** the questions.

1 The properties of poly(ethene) depend upon how it is made.

(a) Low density poly(ethene), ldpe, was the earliest form of the polymer. Polymerisation is carried out by heating ethene under pressure.



(i) What name is given to this **type** of polymerisation?

.....[1]

(ii) The polymer is formed by a radical chain reaction. Name the three stages in the mechanism of a radical chain reaction.

1st stage

2nd stage

3rd stage [3]

(b) Ziegler and Natta discovered catalysts that enabled ethene to be polymerised at around 60 °C and at a lower pressure than before. The polymer is known as high density poly(ethene), hdpe.

(i) In terms of the structures of hdpe and ldpe, explain why hdpe has a higher **density** than ldpe.

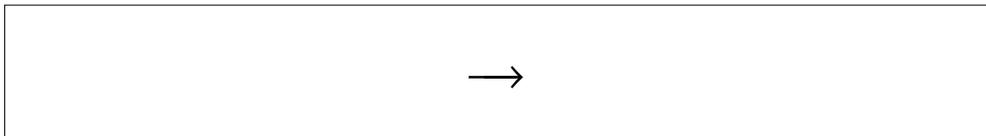
.....
.....
.....
.....[3]

(ii) Hdpe is much more crystalline than ldpe. Explain the meaning of the term *crystalline* as applied to polymers.

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

- (c) One of the components of a Ziegler-Natta catalyst is titanium(IV) chloride, TiCl_4 . This is a colourless liquid at room temperature. TiCl_4 is easily hydrolysed by water to form a white solid, TiO_2 , and a solution of hydrochloric acid.

- (i) Write a balanced equation for this reaction. State symbols are not required.



[2]

- (ii) Use the above information to suggest the type of bonding present in TiCl_4 . Give a reason for your choice.

type of bonding

reason[2]

- (d) (i) Which **block** in the Periodic Table contains Ti?

.....

[1]

- (ii) Use the Periodic table on the *Data Sheet* to deduce the number of d and s electrons in the outer orbitals of Ti.

d electrons s electrons [2]

[Total: 16]

2 The atmosphere is a complex mixture of chemical substances, some of which are pollutants.

(a) In the table below, give the names of the three most abundant gases in the troposphere (lower atmosphere).

Assume that the air is dry.

name of gas	concentration (by volume) %
	78
	21
	1

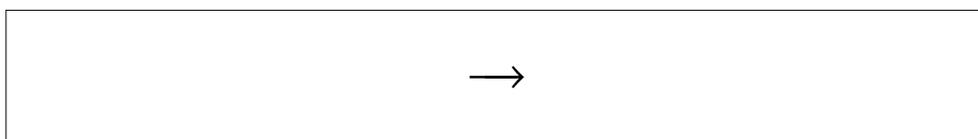
[3]

(b) In unpolluted air, oxides of nitrogen (NO and NO₂) are present in a concentration of about 0.003 parts per million by volume. Express 0.003 ppm as a percentage.

answer % [2]

(c) Pollutants are not all gases. One pollutant consists of droplets of sulphuric acid (H₂SO₄). The sulphuric acid is formed in the atmosphere when SO₂ reacts with oxygen and water.

(i) Write a balanced equation for this reaction. State symbols are not required.



[2]

- (ii) Ammonia gas, NH_3 , is produced in large amounts from animal wastes. Ammonia reacts with sulphuric acid to form solid particles of ammonium sulphate.

Give the formulae of the ammonium ion and of ammonium sulphate.

formula of ammonium ion

formula of ammonium sulphate

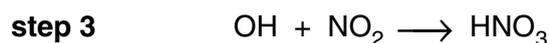
[2]

- (iii) Explain why ammonia is acting as a base when it reacts with H_2SO_4 .

.....

.....[2]

- (d) The gas NO_2 , like SO_2 , reacts in the atmosphere to form an acid. The mechanism for this is shown below.



- (i) What type of radiation is needed for **step 1** to occur?

.....[1]

- (ii) In **step 2**, hydroxyl radicals, OH , are formed. What does the term 'radical' tell you about the electron structure of OH ?

.....[1]

- (iii) Give the oxidation states of nitrogen in the following compounds in **step 3**.

NO_2 HNO_3 [2]

- (iv) Use your answers to (iii) to decide what **type** of reaction is taking place in **step 3**. Explain your choice.

type of reaction

explanation

.....[2]

- (ii) Write down the number of moles of hydrogen ions in 24.8 cm^3 of the rain water solution.

number of moles = [1]

- (iii) Calculate the concentration of hydrogen ions in the rain water sample. **Give your answer to two significant figures.**

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

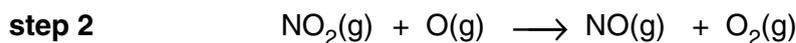
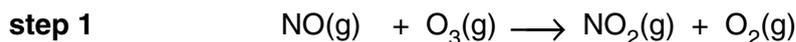
[Total: 32]

- 3 In the early 1970s, chemists were concerned that supersonic jet aircraft like Concorde flying in the stratosphere would damage the ozone layer.

(a) Why is damage to the ozone layer a major concern?

.....
[1]

(b) The cause of this concern was the production of nitrogen monoxide by jet engines. Chemists suggested the following mechanism for the destruction of ozone.



(i) In **step 2**, the reacting oxygen atoms come from molecular oxygen. Describe how an oxygen molecule is converted into oxygen atoms in the stratosphere.

.....
[2]

(ii) **Step 1** is much slower than **step 2**. Which step has the lower activation enthalpy? Explain your choice of answer.

.....
[1]

(c) In the mechanism above for the destruction of ozone, NO is acting as a homogeneous catalyst.

(i) Explain the term *homogeneous*.

.....[1]

(ii) How can you tell from the equations in (b) that NO is a catalyst?

.....[1]

- (iii) In the stratosphere **CFC-11**, CCl_3F , breaks down by **homolytic** bond fission to form two radicals, one of which catalyses the destruction of ozone. In the boxes below, give the formulae of the radicals.

[2]

- (iv) In the homolytic bond fission of **CFC-11**, what determines which bond is broken?

.....[1]

- (v) The stratosphere also contains CH_3Cl . In the laboratory, CH_3Cl can break down by **heterolytic** bond fission to form two ions. In the boxes below, give the formulae of the ions.

[2]

[Total: 20]

- 4 The most expensive perfumes contain oils from natural sources. Rose oil, for example, is expensive because 4 kg of rose petals are needed to produce 1 g of rose oil. Consequently, rose oil is only used in the finest fragrances.

Chemists have been able to produce fragrances synthetically in the laboratory from readily available starting materials.

- (a) Suggest **one** reason why synthetically produced fragrances are usually cheaper than natural ones.

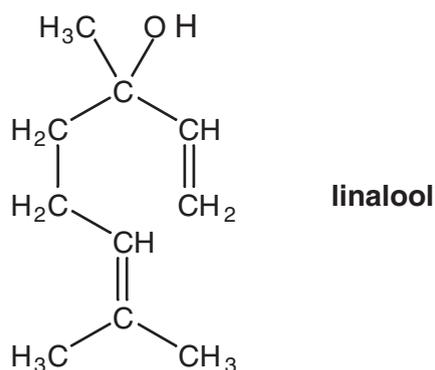
.....

.....[1]

- (b) Rose oil contains a mixture of compounds. Using labelled diagrams, describe how **thin layer** chromatography can be used to show this.

[5]

(c) Linalool is a component of rose oil.

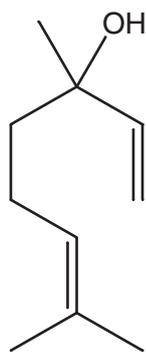


Give the **molecular** formula of linalool.

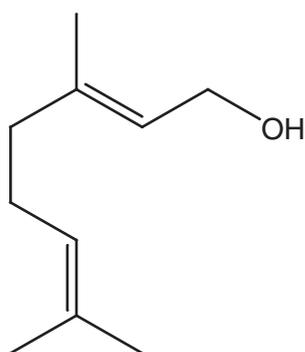
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[2]

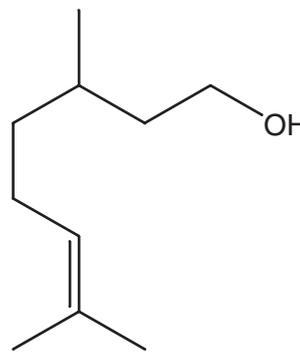
(d) The skeletal formulae of linalool and two other components of rose oil are shown below.



linalool



geraniol



citronellol

(i) Classify the —OH groups in linalool and citronellol by ticking the appropriate boxes in the table below. Give the reason for your choice in each case.

name	primary alcohol	secondary alcohol	tertiary alcohol	reason
linalool				
citronellol				

[4]

(ii) Which compound shows geometric (cis-trans) isomerism? Explain your choice.

.....

[2]

(e) Geraniol can be converted into citronellol. Give the reagent and conditions for this reaction.

reagent

conditions

.....[3]

(f) Chemists found that 1 mol of linalool reacts with 2 mol of bromine, Br₂.

(i) Give a formula of the product.

[2]

(ii) Classify the reaction of bromine with linalool by circling **two** words from the following list.

addition electrophilic nucleophilic radical substitution

[2]

(iii) In the mechanism for the reaction, the bromine molecule becomes polarised and then reacts with the linalool molecule. What causes the bromine molecule to become polarised?

.....[1]

[Total: 22]

END OF QUESTION PAPER

