OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY (SALTERS)

Chemistry of Natural Resources

2848

Wednesday **7 JUNE 2006** 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, Centre number and candidate number in the boxes above.
- Answer **all** the questions.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Write your answers, in blue or black ink, in the spaces provided on the question paper. Pencils may be used for diagrams and graphs **only**.
- Do not write in the bar code. Do not write in the grey area between the pages.
- **DO NOT** WRITE IN THE AREA **OUTSIDE** THE BOX BORDERING EACH PAGE. ANY WRITING IN THIS AREA WILL NOT BE MARKED.

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 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	15	
2	16	
3	33	
4	26	
TOTAL	90	

This question paper consists of 12 printed pages.

SP (MML 10521 2/05/CG) S98804/5

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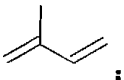
[Turn over

Answer **all** the questions.

1 It has been found that oak trees emit a hydrocarbon called 'isoprene'. This is the second most abundant naturally-produced hydrocarbon in our atmosphere, after methane. The skeletal formula of isoprene is shown below.



isoprene

(a) **(i)** Name the functional group that is present in isoprene.

..... [1]

(ii) Draw the **full structural** formula of isoprene.

[2]

(iii) Give the systematic name for isoprene.

..... [2]

(b) A student suggested testing for isoprene in the air near oak trees by sucking the air through bromine water.

(i) What effect would isoprene have on the colour of bromine water?

.....

..... [1]

(ii) Explain why methane would not have this effect.

.....

..... [1]

(iii) Suggest the **skeletal** formula of a product that will be formed when isoprene reacts with bromine.

[2]

(iv) Underline the **two** words that describe the reaction of isoprene with bromine water.

addition **electrophilic** **elimination** **nucleophilic** **substitution**

[2]

(c) Hydrocarbons such as isoprene contribute to the build-up of tropospheric ozone.

They interfere with the normal reactions for the formation and breakdown of ozone. The reaction for the breakdown of ozone involves naturally occurring NO_2 and NO.

$$NO_2 \xrightarrow{h\nu} NO + O \qquad \textbf{equation 1.1}$$

$$NO + O_3 \longrightarrow NO_2 + O_2 \qquad \textbf{equation 1.2}$$

$$O + O_2 \longrightarrow O_3 \qquad \textbf{equation 1.3}$$

(i) Combine **two** of these equations to show how ozone is broken down.

[1]

(ii) Hydrocarbons lead to reactions in which NO is converted into NO_2. Explain how this leads to a build-up of ozone.

.....

.....

..... [2]

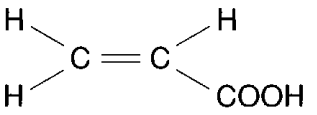
(iii) Suggest **one** disadvantage of a build-up of tropospheric ozone.

.....

..... [1]

[Total: 15]

2 Acrylic acid is used as a monomer in the polymers that make up non-drip paints.



acrylic acid

(a) **(i)** Draw the structure of the repeating unit of poly(acrylic acid).

[1]

(ii) Acrylic acid is often used in a copolymer with another monomer.

Give the essential feature of the structure of the other monomer and explain what is meant by the term *copolymer*.

.....

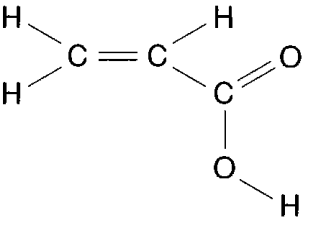
.....

.....

..... [2]

(b) Acrylic acid is used in non-drip paints. It causes polymers to be soluble in water because of hydrogen bonding between the acid groups and water.

(i) Complete the diagram to show **one** hydrogen bond between a molecule of acrylic acid and a molecule of water. Show lone pairs and partial charges.



[4]

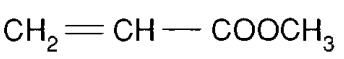
(ii) Suggest why paint that is based on polymers of acrylic acid, and that contains water as solvent, is likely to be *non-drip*.

.....

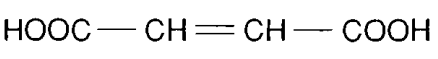
.....

..... [1]

(c) Two other monomers are sometimes used to make acrylic polymers for paint. Their structures are shown below.



compound A



compound B

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

A polymer derived from **compound A** is more flexible than one derived from **compound B**. Explain this in terms of the intermolecular forces involved.

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..... [4]

Quality of Written Communication [1]

(ii) **Compound B** can exist as two *geometric isomers*. Draw the structures of these two isomers and give the names that distinguish them.

[2]

(iii) Suggest whether the **polymer** formed from **compound B** would show geometric isomerism, giving a reason for your answer.

.....

.....

..... [1]

[Total: 16]

3 Forest fires produce small quantities of bromomethane, CH_3Br. Bromomethane breaks down in the stratosphere to produce bromine radicals.

(a) (i) Write an equation for the decomposition of bromomethane to produce bromine radicals.

[1]

(ii) Name the **type** of bond fission that is occurring here.

..... [1]

(b) (i) The bond enthalpy of the C–Br bond is +290 kJ mol^{-1}. Calculate the minimum energy (in **J**) needed to break a **single** C–Br bond.

Avogadro constant, $L = 6.02 \times 10^{23}\,mol^{-1}$

minimum energy = ... J [2]

(ii) Calculate the minimum frequency of radiation needed to break a C–Br bond.

Planck constant, $h = 6.63 \times 10^{-34}\,J\,Hz^{-1}$

minimum frequency = ... Hz [2]

(iii) How would the minimum frequency of radiation needed to break a C–C*l* bond compare with that needed to break a C–Br bond? Explain your answer.

.....

.....

..... [2]

(c) In the stratosphere, Br radicals act as catalysts to break down ozone.

(i) Explain how the presence of ozone in the stratosphere benefits us.

.....

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..... [3]

(ii) The first reaction by which this breakdown occurs is shown in **equation 3.1**.

Complete **equation 3.2** to show how Br atoms act as catalysts in breaking down ozone.

$Br + O_3 \rightarrow BrO + O_2$ **equation 3.1**

$BrO + O \rightarrow$ **equation 3.2**

[1]

(iii) Give the **overall** equation for the reaction in **equations 3.1** and **3.2**.

[1]

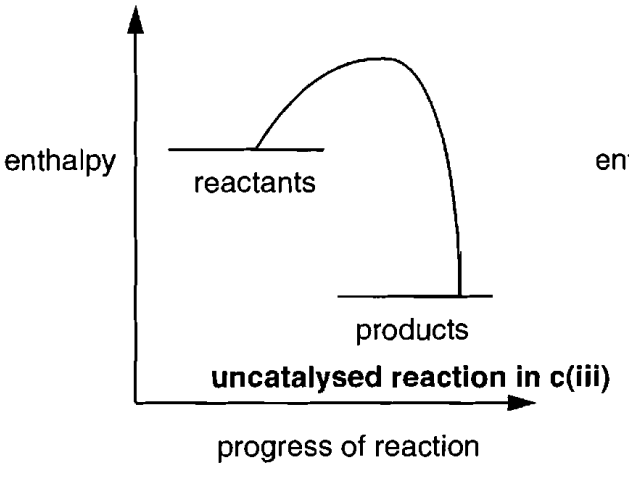
(iv) Why is the action of bromine described as *homogeneous* catalysis?

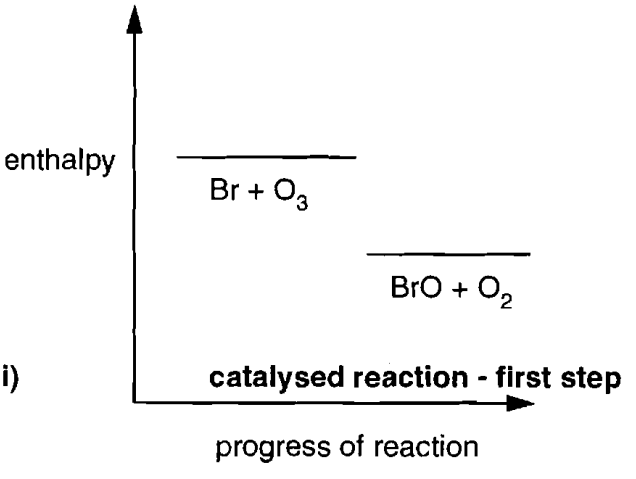
.....

..... [1]

(v) In order for Br radicals to act as catalysts in the breakdown of ozone, they must be regenerated. The *activation enthalpy* of the reaction in **equation 3.1** must also be lower than that for the uncatalysed reaction.

Complete the diagrams below to illustrate this, labelling the activation enthalpy in both cases.





[2]

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

The breakdown of ozone in the stratosphere is speeded up by the presence of a catalyst.

Give **two** other factors which will increase the rate of this reaction.

Explain the increase in reaction rate in each case in terms of the reacting particles.

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..... [5]

Quality of Written Communication [1]

(d) When bromomethane, CH_3Br, is bubbled through aqueous silver nitrate a precipitate of silver bromide forms slowly.

(i) The first reaction to occur is the hydrolysis of bromomethane by the water present. Write an equation for this reaction.

[2]

(ii) The bromomethane molecule has a polar bond. Explain the meaning of the term *polar* and how this is linked to the *electronegativities* of the atoms involved. Draw a diagram to illustrate the polar bond in bromomethane.

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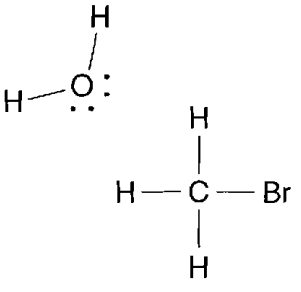
..... [3]

(iii) Complete the diagram to show the attack of a water molecule on bromomethane and the resulting electron pair movement within the molecule.



[2]

(iv) What word describes the action of water in this substitution reaction?

..... [1]

(v) Write an **ionic** equation that describes the precipitation of silver bromide, showing state symbols.

[2]

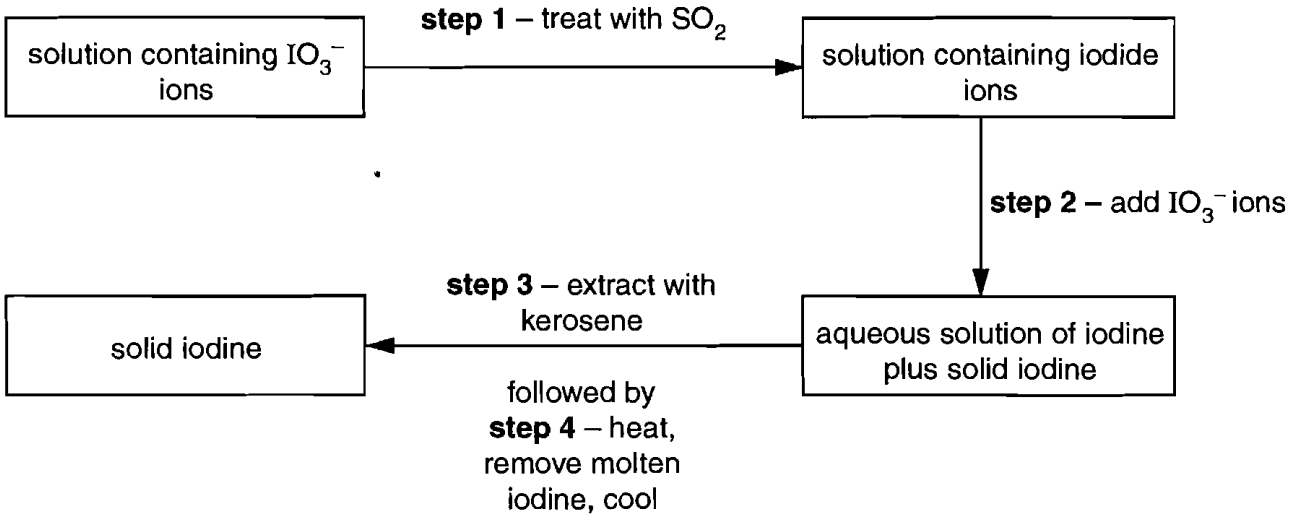
(vi) Give the colour of the precipitate of silver bromide formed.

..... [1]

[Total: 33]

[Turn over

4 Iodine is extracted from ores containing IO_3^- by the following process.



(a) Give the oxidation states of iodine in the following molecules or ions.

I_2 ..... I^- ..... IO_3^- ..... [3]

(b) The reaction in **step 1** is shown below.

$$IO_3^- + 3SO_2 + 3H_2O \longrightarrow I^- + 6H^+ + 3SO_4^{2-}$$

(i) Which element is oxidised in this reaction?

..... [1]

(ii) Calculate the mass of sulphur dioxide needed to produce 2500 g of iodide ions.

Give your answer to **two** significant figures.

A_r: S, 32; O, 16; I, 127

mass of sulphur dioxide = ... g [3]

(c) In **step 2**, iodide ions are oxidised to iodine molecules.

(i) Write a half-equation for this reaction.

[2]

(ii) Use the flow chart to suggest what is reduced at the same time.

..... [1]

(d) Explain why kerosene, a hydrocarbon solvent, is used in **step 3** to extract the iodine from an aqueous solution.

.....

.....

..... [2]

(e) A 100 cm^3 sample of $IO_3^-(aq)$ has a concentration of 0.023 mol dm^{-3}.

Calculate the maximum mass of iodine which could be obtained from this solution.

Assume all the I from the IO_3^- can be converted to I_2.

A_r: I, 127

mass = ... g [2]

(f) Iodine and bromine are both members of the halogen group and have similarities and differences in their properties.

(i) Complete the table to compare the appearance of iodine and bromine in various states.

element	colour in aqueous solution	state of element at room temperature	colour of element at room temperature
iodine	brown		
bromine	brown		

[3]

(ii) Show the similarities in electron configuration of bromine and iodine by writing the configuration of the **outermost subshell** for each.

(For example, the answer for sulphur would be $3p^4$.)

Br ..... I ..... [2]

(iii) Bromine is more easily reduced than iodine.

Write an ionic equation for the reaction between a halogen and halide ions (in aqueous solution) that shows this.

[2]

(iv) Iodine vapour is as dangerous as bromine vapour. How can the production of iodine vapour be minimised while iodine is being transported?

.....

..... [1]

(g) Solid sodium iodide has a cubic crystal lattice similar to that of sodium chloride.

Sketch and label some ions to illustrate the structure of the lattice of sodium iodide.

Show part of a layer of ions and indicate how the three-dimensional structure is built up.

[3]

(h) Sodium iodide dissolves in water because water molecules cluster round the sodium and iodide ions. What term is used to describe ions surrounded by water molecules?

..... [1]

[Total: 26]

END OF QUESTION PAPER