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 | |

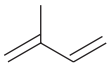
**This question paper consists of 12 printed pages.**



**[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]

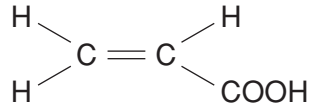
**(iii)** Suggest **one** disadvantage of a build-up of tropospheric ozone.

.....

..... [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*.

.....

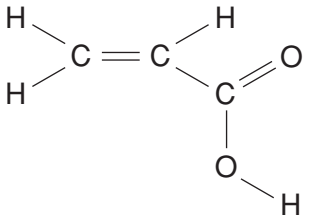
.....

.....

..... [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*.

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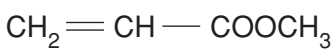
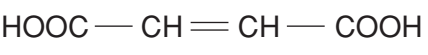
.....

..... [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.

.....

.....

..... [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.

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

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

[1]

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

[1]

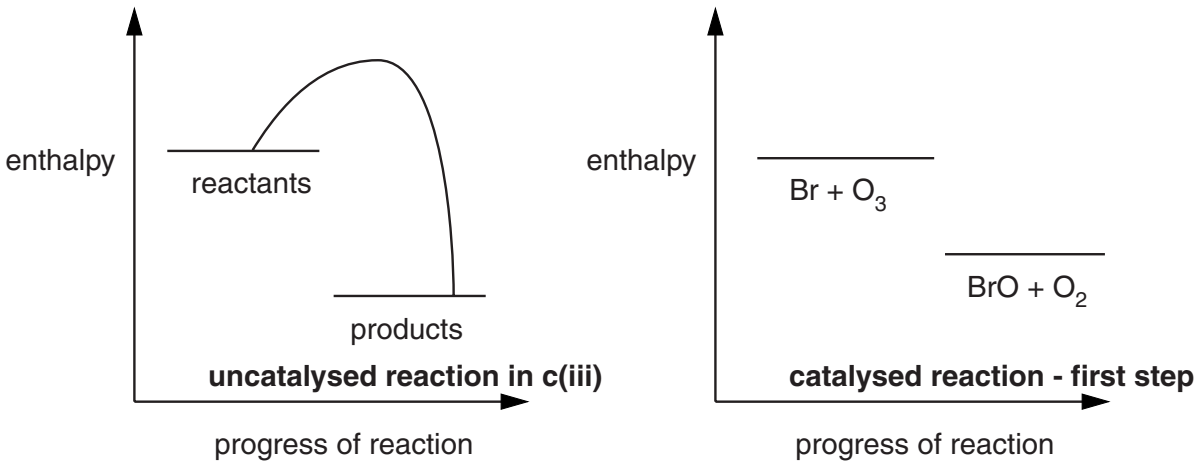
**(iv)** Why is the action of bromine described as *homogeneous* catalysis?

.....

..... [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]

**[Turn over**

**(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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.....

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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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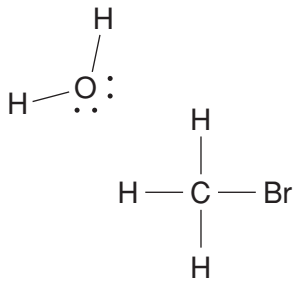
..... [3]

**(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.

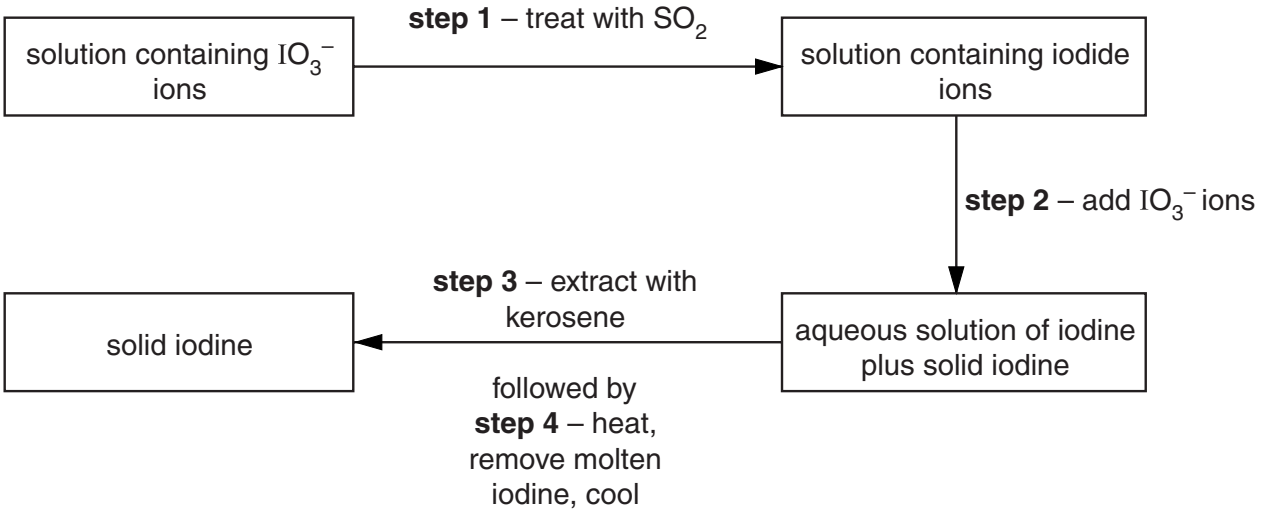
[2]

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

..... [1]

[Total: 33]

**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