OCR
RECOGNISING ACHIEVEMENT

Wednesday 23 May 2012 – Afternoon

AS GCE CHEMISTRY B (SALTERS)

F332/TEST Chemistry of Natural Resources

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry B (Salters)* (inserted)
- *Advance Notice: 'Plastic Fantastic'* (inserted)

Other materials required:
- Scientific Calculator

Duration: 1 hour 45 minutes

* F 3 3 2 T E S T *

* F 3 1 4 8 8 0 6 1 2 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

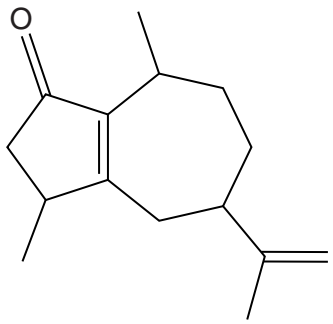
- The inserts will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Answer **all** the questions.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- The insert *'Plastic Fantastic'* is provided for use with question 5.
- A copy of the *Data Sheet for Chemistry B (Salters)* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **100**.
- This document consists of **20** pages. Any blank pages are indicated.

Answer **all** the questions.

1 The substance 'rotundone' has been found to give a peppery flavour to some spices and wines.



rotundone

(a) Name **two** functional groups that are present in a molecule of rotundone.

.....

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

(b) Give the molecular formula of rotundone.

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

(c) Rotundone reacts with bromine at room temperature and pressure.

(i) Describe the colour change when rotundone reacts with bromine.

from ..... to ..... **[2]**

(ii) Write the equation for the reaction of rotundone with excess bromine.

Represent rotundone by your molecular formula from part **(b)**.

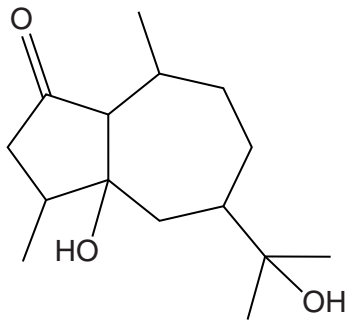
[2]

(iii) Underline the **two** words that describe the mechanism of the reaction between rotundone and bromine.

addition **electrophilic** **nucleophilic** **radical** **substitution**

[2]

(d) Rotundone reacts with water to form compound **A** as one of the products.



compound A

(i) Give the reagents and conditions for the reaction of rotundone with water to form compound **A**.

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.....

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

(ii) Name the strongest type of intermolecular bond between molecules of compound **A**.

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

(iii) Classify the alcohol groups in compound **A** as primary, secondary or tertiary.

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

(iv) Explain your answer to **(iii)**.

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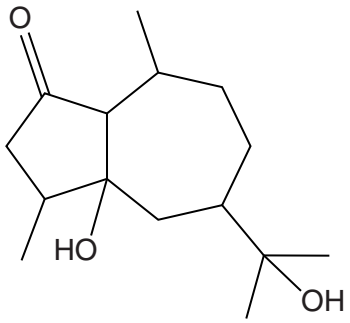
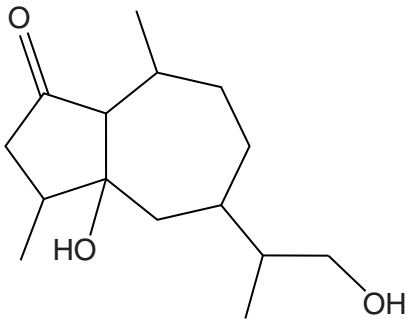
..... **[1]**

(e) Compound **B** is another product of the reaction of rotundone with water.



compound A



compound B

Compounds **A** and **B** are each heated under reflux in separate containers with acidified potassium dichromate(VI) solution.

Describe the colour change, if any, in each case **and** explain your answer in terms of the alcohol groups in compounds **A** and **B**.

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..... **[5]**

[Total: 20]

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PLEASE TURN OVER FOR QUESTION 2

2 The manufacture of chlorofluorocarbons (CFCs) has been banned because they cause ozone depletion in the stratosphere. CFCs have been replaced by a range of compounds, including hydrocarbons and hydrochlorofluorocarbons (HCFCs).

The following table gives information about a CFC, an alkane and a HCFC.

compound	formula	boiling point/K	flammable	ODP*	price
C	$CFCl_3$	297	no	1.0	medium
D	$CH_3CH_2CH_3$	231	yes	0.0	low
E	CF_3CCl_2H	301	no	0.02	high

* ODP is the ozone depletion potential.

(a) Give the systematic name for compound **E**.

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

(b) Suggest why compound **D** is much cheaper than compounds **C** and **E**.

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

(c) Suggest why compound **D** cannot be used as a cleaning solvent.

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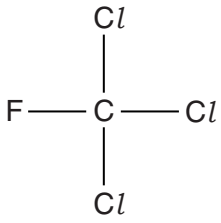
..... **[1]**

(d) Compound **C**, $CFCl_3$, contains polar bonds.

(i) Mark **all** the partial charges on the atoms in the diagram of the $CFCl_3$ molecule shown below.



[1]

(ii) Explain why the molecule $CFCl_3$ has the partial charges you have shown in **(i)**.

In your answer, you should use appropriate technical terms, spelled correctly.

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

(iii) Draw a diagram to represent the **shape** of a molecule of $CFCl_3$.

[1]

(iv) Use your answers to **(i)** and **(iii)** to explain whether or not there is an overall permanent dipole for the $CFCl_3$ molecule.

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

(e) Explain why CFCs like compound **C**, $CFCl_3$, are not broken down in the troposphere and how CFCs contribute to the breakdown of ozone in the stratosphere.

In your answer, you should make it clear how the steps you describe are linked to one another.

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..... **[5]**

(f) Explain why the presence of ozone in the stratosphere is important for humans.

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

(g) Compound **E**, CF_3CCl_2H, is broken down in the troposphere. The first step in the breakdown of compound **E** involves a reaction with OH radicals.

$$CF_3CCl_2H + OH \rightarrow CF_3CCl_2 + H_2O \qquad \textbf{equation 2.1}$$

Draw a '*dot-and-cross*' diagram for an OH radical.

Show outer shell electrons only.

[1]

(h) OH radicals are formed from water molecules in the stratosphere.

(i) The bond enthalpy of the O–H bond in water is $+463\,kJ\,mol^{-1}$.

Calculate the minimum energy, **in J**, required to break a single O–H bond.

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

energy = ... J **[2]**

(ii) Calculate the minimum frequency of radiation needed to break the O–H bond.

Give the appropriate units.

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

frequency = ... units ..... **[3]**

(iii) What **type** of bond breaking occurs when OH radicals are produced from water molecules?

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

(iv) Suggest why OH radicals are not produced in the **troposphere** by the action of sunlight on water molecules.

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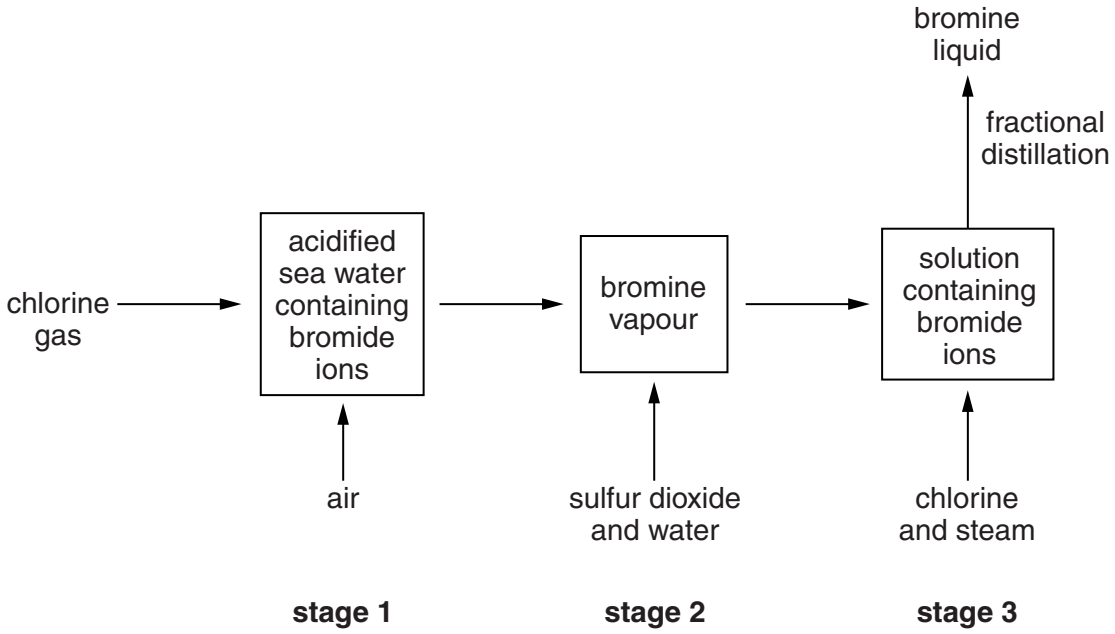
..... **[1]**

[Total: 26]

3 Bromine can be extracted from sea water. One method of making bromine is shown in the flow chart below.



(a) In **stage 1**, chlorine reacts with bromide ions in the sea water.

Write an **ionic** equation for the reaction of chlorine gas with bromide ions to produce bromine vapour.

Include state symbols.

→

[2]

(b) In **stage 2**, bromine vapour is treated with sulfur dioxide and water to produce an aqueous solution containing bromide ions.

$$Br_2 + SO_2 + 2H_2O \rightarrow 2Br^- + SO_4^{2-} + 4H^+ \qquad \textbf{equation 3.1}$$

(i) Complete the table below to show the oxidation states for bromine and sulfur in **equation 3.1**.

element	initial oxidation state	final oxidation state
Br		
S		

[3]

(ii) Give the formula of the reducing agent in the reaction shown in **equation 3.1** and explain your answer.

reducing agent: .....

explanation: .....

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

(c) A student is given a solution of bromide ions. The concentration of bromide ions in the solution is the same as that found in a sample of sea water. The student adds acidified silver nitrate to the solution of bromide ions.

$$Ag^+ + Br^- \longrightarrow AgBr \qquad \textbf{equation 3.2}$$

Describe what the student **sees** when the reaction shown in **equation 3.2** occurs.

.....

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

(d) The student titrates a 25.0 cm^3 sample of the solution of bromide ions, Br^-, with 0.0200 mol dm^{-3} silver nitrate solution, $AgNO_3$. The reaction requires 32.60 cm^3 of silver nitrate solution to reach the end-point.

(i) Calculate the number of moles of $AgNO_3$ the student uses in the titration.

answer = ... mol **[1]**

(ii) Use your answer to **(i)** and **equation 3.2** to give the number of moles of Br^- ions that react.

answer = ... mol **[1]**

(iii) Calculate the concentration of Br^- ions in the sample.

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

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

[Total: 14]

4 Carbon monoxide and hydrogen are produced industrially by reacting methane with steam in the presence of a powdered solid catalyst. Chemists are now investigating the use of *nanoparticles* of the catalyst coated onto an inert wire mesh. Nanoparticles are particles the size of a few thousand atoms.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H = +206\,kJ\,mol^{-1} \qquad \textbf{equation 4.1}$$

(a) The reaction shown in **equation 4.1** is in a state of dynamic equilibrium.

Explain what is meant by *dynamic equilibrium*.

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

(b) Explain why the use of nanoparticles of catalyst, rather than the powdered solid, could further increase the rate of the reaction.

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

(c) Using a catalyst has an effect on the activation enthalpy for the reaction.

Explain what is meant by the term *activation enthalpy.*

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

(d) In addition to looking at different catalysts, chemists have also studied how changing pressure and temperature affect the rate and equilibrium yield of the reaction shown in **equation 4.1**.

(i) Describe and explain the effect, if any, of an increase in **pressure** on the **rate** of reaction.

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

(ii) Describe and explain the effect, if any, of an increase in **pressure** on the equilibrium **yield** of the reaction.

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

(iii) Describe and explain the effect, if any, of an increase in **temperature** on the equilibrium **yield** of the reaction.

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

(e) Methane contributes to the greenhouse effect. There is a low concentration of methane in our atmosphere.

(i) Give an agricultural activity that acts as a source of methane.

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

(ii) Methane acts as a greenhouse gas because it can absorb infrared radiation.

Explain how increased concentrations of methane in the troposphere could be linked to global warming.

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

(iii) A sample of air is analysed and found to contain 1.8 ppm of methane and 21% oxygen by volume.

How much more abundant is oxygen than methane in this sample of air?

answer = ... times more abundant **[2]**

[Total: 20]

5 This question is based on the Advance Notice article '**Plastic Fantastic**' which is provided as an insert to this paper.

(a) Explain what is meant by the term *addition polymer*. Give an example of an addition polymer **from the article**, other than poly(ethene).

Explanation: .....

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Example: ..... **[3]**

(b) Classify the **type** of reaction shown in the forward reaction in **Figure 1** in the article.

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

(c) Gibson and Fawcett used infrared spectroscopy to show that the product of the reaction contained only carbon and hydrogen.

(i) Explain how infrared spectroscopy produces a spectrum for a compound and how the spectrum would confirm the presence of only carbon and hydrogen in the product.

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

(ii) Describe a feature of the infrared spectrum that Gibson and Fawcett would have expected from the product if the reaction shown in **Figure 1** of the article had occurred. Give an appropriate wavenumber range.

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

(d) The article describes the involvement of oxygen in the polymerisation of ethene, which starts with an initiation reaction.

(i) What is an **initiation** reaction?

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

(ii) Suggest a meaning for a 'half curly arrow' as shown in the equation on page 3 of the article.

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

(iii) Write an equation, which is shown in the article, representing a **termination** reaction.

[1]

(e) Both HDPE and LDPE have instantaneous dipole–induced dipole bonds as the only type of intermolecular bond.

Explain why a heavier weight can be hung on a thread of HDPE, compared to a similar thread of LDPE.

In your answer you should include an explanation of:

- how instantaneous dipole–induced dipole bonds form;
- how the structures of the two polymers affect the strength of their instantaneous dipole–induced dipole bonds.

In your answer, you should make it clear how the points you describe are linked to one another.

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..... **[7]**

[Total: 20]

END OF QUESTION PAPER

ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

ADDITIONAL PAGE

ADDITIONAL PAGE