

**ADVANCED SUBSIDIARY GCE**  
**CHEMISTRY B (SALTERS)**  
Chemistry of Natural Resources

**F332/TEST**

Candidates answer on the question paper

**OCR Supplied Materials:**

- *Data Sheet for Chemistry B (Salters)* (inserted)
- *Advance Notice: 'Origin of the Earth's Atmosphere'* (inserted)

**Other Materials Required:**

- Graph paper
- Scientific calculator

**Wednesday 3 June 2009**  
**Morning**

**Duration:** 1 hour 45 minutes




Candidate Forename		Candidate Surname	
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Centre Number						Candidate Number				
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**INSTRUCTIONS TO CANDIDATES**

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

**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 '*Origin of the Earth's Atmosphere*' 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 **16** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	23	
2	26	
3	12	
4	19	
5	20	
<b>TOTAL</b>	<b>100</b>	

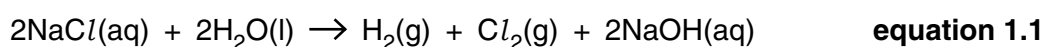
Answer **all** the questions.

**1** Chlorine can be manufactured from sodium chloride solution using electrolysis. The process also produces hydrogen and sodium hydroxide, which themselves have uses.

**(a)** If an accident occurred during chlorine manufacture, people dealing with the incident would wear breathing apparatus. Explain why this would be necessary.

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

**(b)** **Equation 1.1** represents the overall reaction that occurs in the electrolysis cell.



**(i)** Calculate the volume of chlorine gas that would be produced from 100 kg of dissolved sodium chloride.

Assume that 1 mol of gas occupies 24 dm<sup>3</sup> under the conditions of the experiment.

volume = ..... dm<sup>3</sup> [3]

**(ii)** Explain, using ideas of atom economy, why this electrolysis is a particularly useful industrial process.

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

- (c) The table below gives information about three types of electrolysis cell that are used for chlorine production. In some cases, the NaOH(aq) must be slowly evaporated, by heating with steam, to produce the concentration required for further use.

Table 1.1

	mercury cell	diaphragm cell	membrane cell
amount of electricity used	most <span style="display: inline-block; width: 100%; border-bottom: 1px solid black; position: relative; top: -5px;"> <span style="position: absolute; right: -10px; top: -5px;">→</span> </span> least		
mass of steam used [tonnes steam/tonne NaOH (aq)]	none	3	1
purity of products	extremely pure	$Cl_2$ contains $O_2$ and must be purified before use	$Cl_2$ contains some $O_2$ and may need purifying before use
environmental concerns unique to this method	mercury loss causes environmental damage	none	none

- (i) Suggest **one** advantage and **one** disadvantage of the diaphragm cell over the mercury cell.

advantage of diaphragm cell: .....

.....

disadvantage of diaphragm cell: .....

..... [2]

- (ii) Suggest why a company might build a new chlorine manufacturing plant near to an existing plant.

.....

..... [1]

- (iii) All of the methods shown in **Table 1.1** involve the conversion of chloride ions to chlorine molecules. Write a half-equation for this reaction.

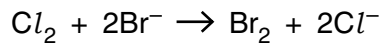
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[2]

- (iv) Write the electronic configuration, in terms of s and p sub-shells, for a chlorine atom.

..... [1]

- (d) Chlorine can be used to produce bromine. The chlorine is passed through a solution, obtained from seawater, which contains bromide ions.



**equation 1.2**

- (i) Give the oxidation states of chlorine in  $\text{Cl}_2$  and  $\text{Cl}^-$ .

$\text{Cl}_2$  .....  $\text{Cl}^-$  ..... [2]

- (ii) Give the name of the process in which  $\text{Cl}_2$  is converted to  $\text{Cl}^-$  giving an explanation for your choice.

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

- (iii) Explain why the reaction represented by **equation 1.2** happens, by reference to the oxidising ability of chlorine and bromine.

..... [1]

- (iv) Give a use for the bromine that is produced in **equation 1.2**.

..... [1]

- (e) Explain, in terms of intermolecular bonds, why chlorine is a gas at room temperature and pressure but bromine is a liquid under the same conditions. As part of your answer, you should explain how the intermolecular bonds arise.



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

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..... [5]

**[Total: 23]**

2 Chlorine is present in seawater as chloride ions.

(a) Seawater can be tested, to show it contains chloride ions, by mixing it with a solution containing silver ions.

(i) Give the colour of the silver chloride precipitate that would form.

..... [1]

(ii) Write the ionic equation that describes the precipitation of silver chloride, showing state symbols.

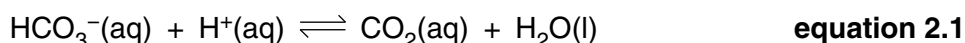
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[2]

(iii) The seawater also contains sulfate ions. These react with the silver ions, forming silver sulfate. Give the formula of silver sulfate.

..... [1]

(b) Seawater is slightly alkaline. This is due to the presence of  $\text{HCO}_3^-$  ions in the water.



(i) Use **equation 2.1** and Le Chatelier's principle to explain what would happen to the concentration of  $\text{HCO}_3^-$  ions in the seawater if more carbon dioxide were to dissolve in the water.

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

(ii) The reaction represented by **equation 2.1** can reach a position of dynamic equilibrium.

Explain what is meant by the term *dynamic equilibrium*.

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

(c) Some microorganisms in seawater can convert chloride ions into chlorine-containing molecules, such as chloromethane,  $\text{CH}_3\text{Cl}$ . Chloromethane is then released into the atmosphere.

(i) Explain, in terms of intermolecular bonds, why chloromethane has a lower boiling point than water.

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

(ii) Draw a diagram showing how two molecules of chloromethane,  $\text{CH}_3\text{Cl}$ , would form one intermolecular bond. Include relevant partial charges.

[2]

(iii) Chloromethane is slightly soluble in water. Give the strongest type of intermolecular bond that could form between molecules of chloromethane and water.

..... [1]

(iv) In the atmosphere,  $\text{C-Cl}$  bonds in chloromethane molecules can be broken when the molecules absorb energy.

The bond enthalpy of the  $\text{C-Cl}$  bond is  $+346 \text{ kJ mol}^{-1}$ .

Calculate the minimum energy (in Joules) needed to break a **single**  $\text{C-Cl}$  bond.

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

minimum energy = ..... J [2]

(v) Calculate the frequency of radiation that is needed to break one  $\text{C-Cl}$  bond.

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

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

frequency = ..... Hz [3]

(d) A student decides to make the halogenoalkane 1-chlorobutane,  $C_4H_9Cl$ , by reacting butan-1-ol,  $C_4H_9OH$ , with hydrogen chloride.

(i) Write a balanced chemical equation for the reaction.

→

[1]

(ii) Underline the **two** words that describe the reaction mechanism of butan-1-ol with hydrogen chloride.

**addition    electrophilic    elimination    nucleophilic    radical    substitution**

[2]

(iii) The organic product forms as an impure liquid. Describe how the student could remove the acidic impurities from the liquid.

.....

.....

..... [1]

(iv) The student needs to dry the liquid 1-chlorobutane. Name a drying agent she could use.

..... [1]

(v) In the experiment, the student uses 10g of butan-1-ol,  $C_4H_9OH$ , and produces 2.0g of 1-chlorobutane,  $C_4H_9Cl$ .

Calculate the percentage yield of the conversion of butan-1-ol to 1-chlorobutane.

yield = ..... % [4]

[Total: 26]

3 In the 1980s, two incidents occurred in Africa as a result of rock slides that disturbed the water in the bottom of a lake. In both cases, large volumes of carbon dioxide gas, originally released by volcanic activity on the lake floor, erupted from the water and suffocated people.

(a) Some gases, including carbon dioxide, enter the Earth's atmosphere as a result of human activities, such as the combustion of fuel in vehicle engines.

(i) Give another industrial activity that acts as a source of atmospheric carbon dioxide.

..... [1]

(ii) Name another gas, that is present in vehicle exhaust fumes, which is a pollutant.

Explain why it is considered to have a polluting effect.

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

(b) Carbon dioxide is described as a 'Greenhouse gas'. Explain how increased concentrations of carbon dioxide in the troposphere could be linked to global warming, saying where the energy comes from originally.



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

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..... [6]



(c) One of the methods being considered for reducing the amount of atmospheric carbon dioxide is to capture it. Carbon dioxide can then be stored by pumping it, under pressure, onto the ocean floor.

(i) Suggest why is it unlikely that carbon dioxide stored under the ocean would escape in the way that occurred in the African lakes.

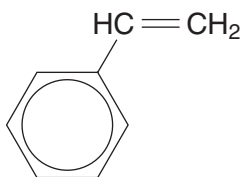
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..... [1]

(ii) Name **two** ways of reducing the amount of carbon dioxide in the atmosphere, other than storing it under the ocean.

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

[Total: 12]

- 4 Poly(phenylethene), commonly known as polystyrene, is used to make packaging. The monomer from which it is produced, phenylethene, is a product of the petrochemical industry.



**phenylethene**

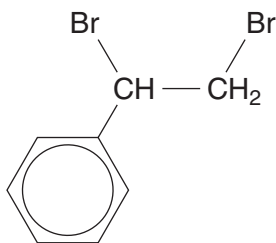
- (a) Name the **type** of polymerisation that occurs when polystyrene is made from phenylethene.

..... [1]

- (b) Draw the structure of the repeating unit that forms.

[1]

- (c) When this reaction is done in the laboratory, any unreacted phenylethene can be detected by adding a solution of bromine to the reaction mixture. The reaction produces **compound A**.

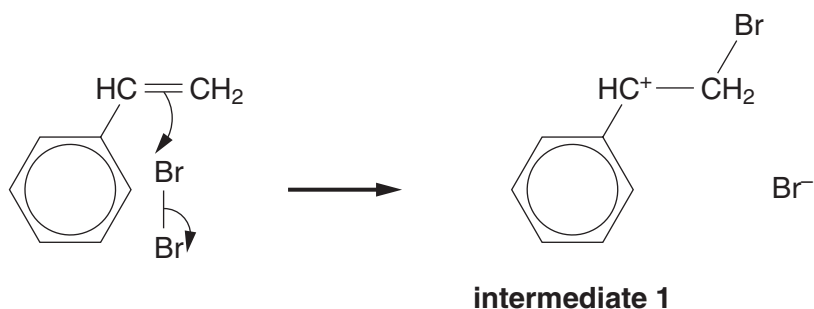


**compound A**

- (i) What colour change would you see when the phenylethene reacts with bromine?

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

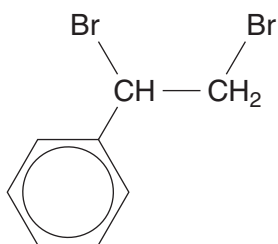
- (ii) The first step in the mechanism for this reaction is shown below.



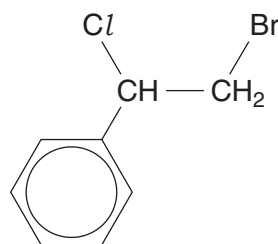
What name is given to the **type** of organic intermediate, such as **intermediate 1**, formed in the reaction?

..... [1]

- (iii) If an aqueous mixture of bromine and potassium chloride is added to phenylethene, some **compound B** is produced, as well as **compound A**.



**compound A**



**compound B**

Use the mechanism shown in (ii) to explain why both these compounds are formed.

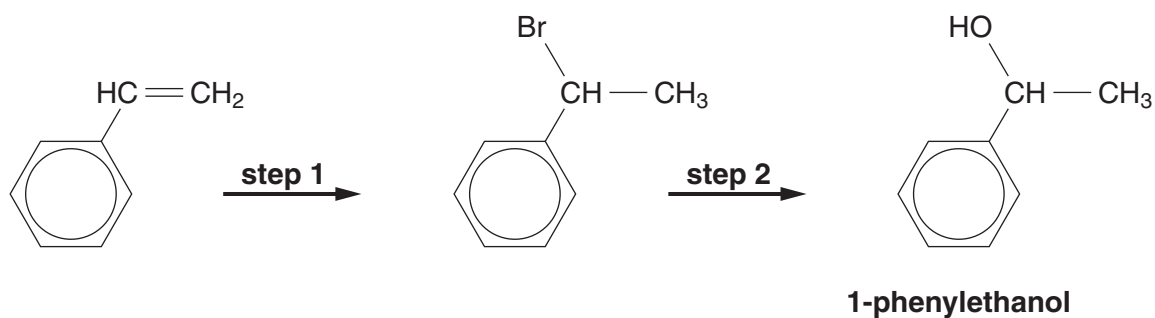
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..... [3]

- (d) 1-Phenylethanol, a compound that is used for making perfumes, can be prepared in the laboratory from phenylethene in two steps.



- (i) Give the reagent that you would use for **step 1**.

..... [1]

- (ii) The reaction occurring in **step 1** involves attack by an electrophile.

Explain what is meant by the term *electrophile* and how the electrophile attacks the alkene.

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

- (iii) On an industrial scale, phenylethene is more likely to be converted to 1-phenylethanol using a one step process.

Suggest the reagents and conditions that could be used to achieve this.

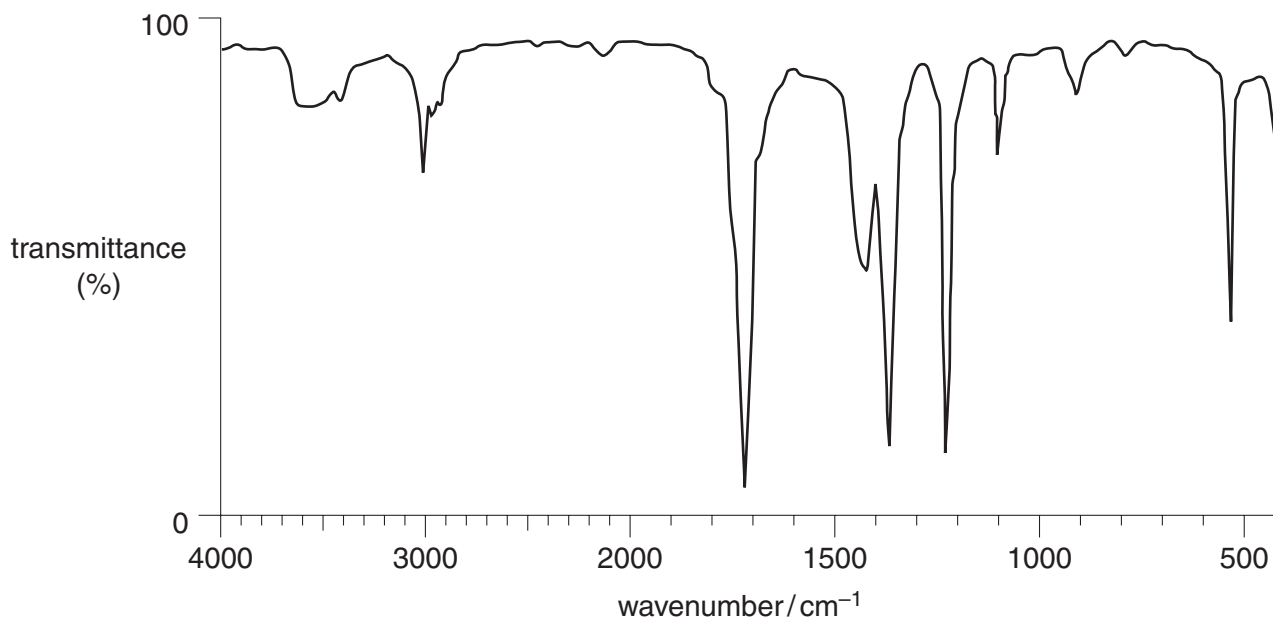
.....  
 .....  
 ..... [3]

(e) 1-Phenylethanol is an example of a secondary alcohol.

(i) Explain why the alcohol group is classified as secondary.

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

(ii) Another secondary alcohol, propan-2-ol,  $(\text{CH}_3)_2\text{CHOH}$ , can be oxidised by heating with acidified potassium dichromate solution. The infrared spectrum below is that of the product obtained from the oxidation of propan-2-ol.



Explain how this spectrum shows that the oxidation was successful.

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

[Total: 19]

5 This question is based on the Advance Notice article '*Origin of the Earth's atmosphere*' which is provided as an insert to this paper.

(a) Explain what is meant by the term *photochemical dissociation*. Give an example from the Advance Notice article in your answer.

meaning: .....

.....

.....

example: .....

.....

..... [3]

(b) Explain, using equations, how ozone formed in the Earth's atmosphere. Describe how it shields '...the Earth's surface from UV...'.



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

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..... [6]

(c) Use data from **Table 1** in the Advance Notice article to answer this question.

Calculate how many molecules of oxygen there are per molecule of methane in dry tropospheric air, under the same conditions of temperature and pressure.

molecules of oxygen per molecule of methane = ..... [2]

(d) Suggest why FeS<sub>2</sub> is **not** found on the Earth's surface today. Include an equation in your answer.

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

(e) Describe and explain the way in which the temperature of the atmosphere changes on going from the surface of the Earth to the top of the stratosphere.

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

(f) Explain why reactions between atoms may occur more quickly at the top of the troposphere than in the middle of the stratosphere, even though the temperature at these points is the same.

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

[Total: 20]

END OF QUESTION PAPER

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