

Tuesday 4 June 2013 – Afternoon

AS GCE CHEMISTRY B (SALTERS)

F332/01/TEST Chemistry of Natural Resources

Candidates answer on the Question Paper.

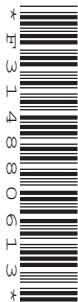
OCR supplied materials:

- *Data Sheet for Chemistry B (Salters)* (inserted)
- *Advance Notice: 'Atmospheric Nitrogen'* (inserted)

Other materials required:

- Scientific calculator

Duration: 1 hour 45 minutes




Candidate forename		Candidate surname	
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Centre number						Candidate number				
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INSTRUCTIONS TO CANDIDATES

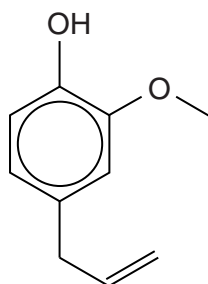
- The Inserts will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question 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.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

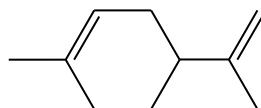
- The number of marks is given in brackets [] at the end of each question or part question.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.
This means for example you should:
 - ensure that text is legible and that spelling, punctuation and 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 '*Atmospheric nitrogen*' 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.

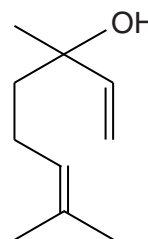
- 1 A car screen-wash product contains a mixture of eugenol, limonene and linalool.



eugenol



limonene



linalool

- (a) (i) Name a functional group that is present in all three of these compounds.

..... [1]

- (ii) Name a functional group that is present in eugenol but **not** in linalool (not the arene ring or the hydroxyl group).

..... [1]

- (b) Limonene reacts with bromine.

- (i) Draw the structure of the molecule that is produced from the reaction of a molecule of limonene with excess bromine.

[2]

- (ii) Underline two words that describe the mechanism of the reaction between limonene and bromine.

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

[2]

- (iii) The impure liquid organic product of the reaction of limonene with bromine is dried after it has been prepared.

Name a drying agent that could be used.

..... [1]

(iv) Name the process that would be used to purify the liquid product.

..... [1]

(c) Limonene reacts with hydrogen.

Give the reagents and conditions for the reaction of limonene with hydrogen.

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

(d) Linalool contains an alcohol group.

(i) Classify the alcohol group in linalool as primary, secondary or tertiary.

..... [1]

(ii) Explain your answer to (d)(i).

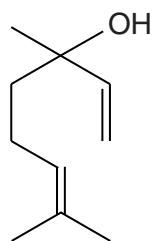
.....
..... [1]

(iii) Linalool is heated with acidified potassium dichromate solution.

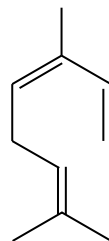
Describe and explain what you would **see**.

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

- (e) When linalool vapour is passed over heated aluminium oxide at 300°C, the linalool reacts to produce *Z*-ocimene.



linalool

*Z*-ocimene

- (i) Give the molecular formula of *Z*-ocimene.

..... [2]

- (ii) The reaction producing *Z*-ocimene from linalool has an inorganic product.

Identify this product.

..... [1]

- (iii) Underline the term below that describes the type of reaction that has occurred when *Z*-ocimene is produced from linalool.

addition **hydrolysis** **elimination** **substitution**

[1]

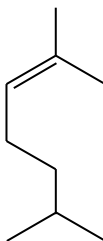
- (iv) During the reaction that forms *Z*-ocimene from linalool, *E*-ocimene is also produced.

Draw a skeletal formula for a molecule of *E*-ocimene.

[1]

5

- (f) *Z*-Ocimene reacts with hydrogen. One of the partially hydrogenated products of this reaction is shown below.

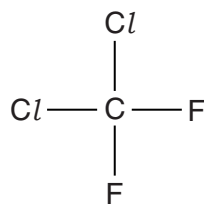


Give the systematic name of this compound.

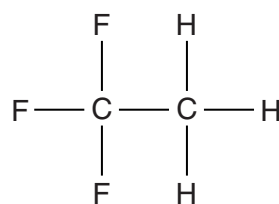
..... [2]

[Total: 21]

- 2 CFCs, such as CFC 12, were used as refrigerants. More recently, HFCs have taken over from CFCs because HFCs have much lower ozone depletion potentials. Examples of a CFC and an HFC are shown below.



CFC 12



HFC 143a

- (a) What does CFC stand for?

..... [1]

- (b) Give another large scale use for CFCs during the last century, other than as refrigerants.

..... [1]

- (c) CFC 12 was made from tetrachloromethane, CCl_4 , by reacting it with hydrogen fluoride.

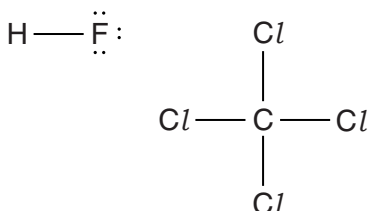
- (i) The reaction requires the use of a catalyst.

Explain how a catalyst increases the rate of a chemical reaction.

.....

 [2]

- (ii) Add relevant partial charges and 'curly arrows' to the diagram to show the attack of one hydrogen fluoride molecule on tetrachloromethane and the resulting electron pair movement in the tetrachloromethane molecule.



[3]

(d) CFCs cause ozone depletion because their C–Cl bonds break in the stratosphere when UV radiation is absorbed. The chlorine radicals that are produced catalyse the breakdown of ozone.

(i) Name the **type** of bond breaking process that occurs to form chlorine radicals from CFC molecules.

..... [1]

(ii) The bond enthalpy of the C–F bond is +467 kJ mol⁻¹.

Calculate the minimum energy (in Joules) needed to break a **single** C–F bond.

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

minimum energy = J [2]

(iii) Calculate the frequency of radiation that is needed to break a single C–F bond.

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

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

frequency = Hz [3]

(iv) Explain why C–F bonds are much less likely than C–Cl bonds to be broken in the stratosphere.

.....

 [2]

(v) In the 1980s, scientists researching the levels of ozone in the atmosphere discarded some of the data because they thought it was incorrect.

Explain why they thought the values were incorrect.

.....
 [1]

- 3 Chlorine is manufactured by the electrolysis of sodium chloride solution. There are several different types of cell that can be used, including diaphragm and membrane cells.

A membrane cell with oxygen-depolarised cathodes, ODC, is a new development that is being trialled. The ODC cell differs from the others in that it does not produce hydrogen at the cathode.

The table below compares the three different types of cell.

		Diaphragm	Membrane	Membrane with ODC
Operating voltage (V)		2.9–3.5	3.0–3.6	Approx. 2
Relative energy consumption per tonne Cl_2	Electrolysis	2.7	2.6	1.8*
	Evaporation	0.6	0.2	0.2
	Total	3.3	2.8	2.0*
CO ₂ emissions (tonnes per tonne Cl_2)		1.7	1.5	1.0

* estimated values

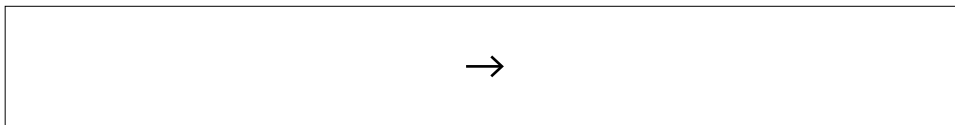
- (a) Suggest **two** reasons why the new ODC cell is being classed as green technology when compared to the other types of cell.

.....

 [2]

- (b) In all these cells, chlorine is produced at one electrode.

- (i) Write the half-equation for the production of chlorine at this electrode in any of these cells.



[2]

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

..... [1]

- (iii) Give **two** large scale uses for the chlorine that is formed.

.....

 [2]

- (iv) If an accident occurred causing a release of chlorine, people dealing with the incident would wear breathing apparatus.

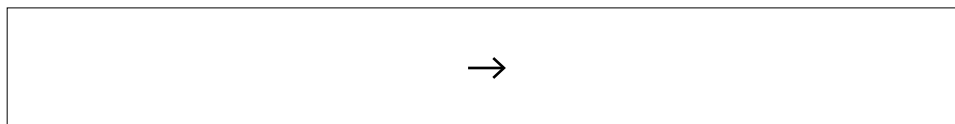
Explain why this would be necessary.

.....
 [2]

- (c) **Equations 3.1** and **3.2** show the processes that occur in an ODC cell at one electrode.

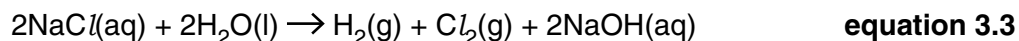


Write the overall half-equation for the reaction at this electrode.



[1]

- (d) **Equation 3.3** represents the overall reaction that occurs in the membrane electrolysis cell. All three products have uses in industry.



- (i) Calculate the volume of chlorine gas (in dm^3) that would be produced from 200 kg of dissolved sodium chloride.

Assume that 1 mole of gas occupies 24 dm^3 under the conditions of the experiment.

volume = dm^3 [3]

- (ii) Give the atom economy for the reaction shown in **equation 3.3**.

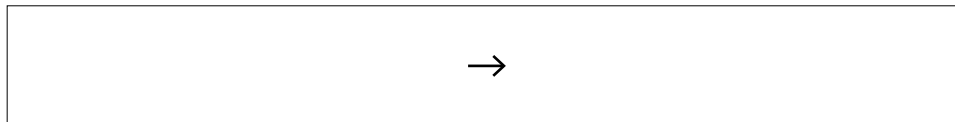
..... [1]

(e) Sodium chloride can be produced in the laboratory by burning sodium in chlorine.

(i) In the reaction between sodium and chlorine, each sodium atom forms a sodium ion.

Write an equation representing the first ionisation enthalpy of sodium.

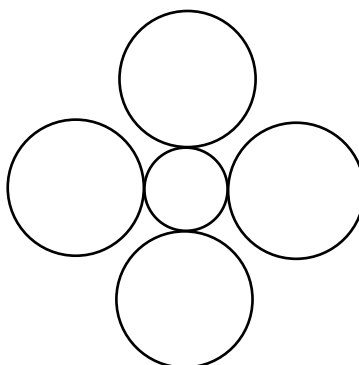
Include state symbols.



[2]

(ii) The diagram below shows part of a layer of the sodium chloride lattice.

Label each type of particle and complete the diagram by drawing in enough particles to show the structure of the **layer** clearly.



[3]

[Total: 19]

- 4 Large quantities of propene, $\text{CH}_3\text{CH}=\text{CH}_2$, are manufactured every year. Most of this propene is used to make poly(propene), which is used to cover electrical wires.

(a) Draw the structure of **one** repeat unit of poly(propene).

[1]

(b) Suggest a property of poly(propene) that makes it suitable for the covering of electrical wires.

.....

..... [1]

(c) Poly(propene) is an example of a thermoplastic polymer.

Explain what is meant by the term *thermoplastic*.

.....

..... [1]

(d) Propene reacts with water, forming propan-1-ol as one of the products.

Propan-1-ol has a higher boiling point than propene.

Explain this difference in boiling points in terms of intermolecular bonding.



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

.....

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.....

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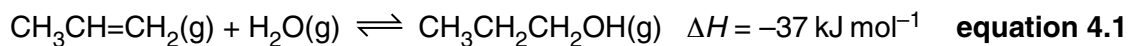
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.....

.....

..... [5]

- (e) A chemical company decided to make propan-1-ol from propene. The equation for the reaction is shown below.



Describe and explain the effect, if any, on the equilibrium **yield** of propan-1-ol in each of these cases:

- (i) increasing the temperature,



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

.....

.....

.....

..... [2]

- (ii) increasing the pressure.

.....

.....

..... [2]

- (f) (i) The temperature of the reaction mixture is increased.

Explain why the rate of the forward reaction in **equation 4.1** increases.

.....

.....

.....

..... [3]

- (ii) What happens to the rate of the reverse reaction in **equation 4.1** when the temperature is increased?

.....

..... [1]

[Total: 16]

5 This question is based on the Advance Notice article '*Atmospheric Nitrogen: Out of Thin Air*' that is provided as an insert to this paper.

(a) Explain what is meant by the term *radical*. Give an example of a radical from the article, other than the hydroxyl radical.

explanation:

.....

example:

..... [2]

(b) One nitrogen-containing compound found in the atmosphere is N_2O , see Fig. 2 in the article.

(i) Draw a '*dot-and-cross*' diagram to represent the bonding in a molecule of N_2O .

Show outer electrons only.

[2]

(ii) Using your answer in (i), describe and explain the shape of an N_2O molecule.

.....

.....

.....

..... [3]

(c) Nitrogen is also present in the atmosphere in NH_4^+ and NO_2^- .

(i) The conversion of NH_4^+ to NO_2^- is classified as oxidation.

Calculate the oxidation states for the nitrogen in NH_4^+ and NO_2^- . Use these oxidation states to explain why this conversion is classified as oxidation.

oxidation state of N in NH_4^+

oxidation state of N in NO_2^-

explanation:

.....

..... [3]

(ii) Give the systematic name for NO_2^- .

..... [1]

(d) Some of the ammonia in the atmosphere comes from the decomposition of urea.

(i) Write an equation for the decomposition of urea, in the presence of water, to form ammonia and carbon dioxide.

→

[1]

(ii) The concentration of ammonia in a sample of air is found to be 0.0010 ppm.

The concentration of nitrogen in the same sample is 78%.

How much more abundant is nitrogen than ammonia in this sample of air?

answer = times more abundant [2]

Question 5 continues on page 16

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

A large area of lined paper for writing. It consists of a vertical solid line on the left side, creating a margin. The rest of the page is filled with horizontal dotted lines, providing space for writing answers.

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