

**ADVANCED SUBSIDIARY GCE
CHEMISTRY**

Chains and Rings

THURSDAY 11 JANUARY 2007

2812/01

Morning

Time: 1 hour

Additional materials: Scientific calculator
Data Sheet for Chemistry (Inserted)



Candidate
Name

Centre
Number

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Candidate
Number

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INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.

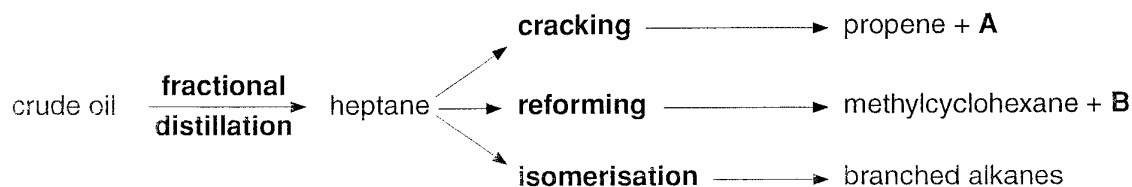
FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	12	
2	14	
3	12	
4	12	
5	10	
TOTAL	60	

This document consists of **14** printed pages, **2** blank pages and a *Data Sheet for Chemistry*.

Answer **all** the questions.

- 1 Crude oil is first separated by fractional distillation. The fractions can then be refined further by cracking, reforming and isomerisation.

The reaction sequence below shows the production of heptane, C_7H_{16} , from fractional distillation of crude oil, followed by cracking, reforming and isomerisation.



- (a) What is meant by the term *fractional distillation*?

.....
 [1]

- (b) The cracking of heptane produces propene and **A**.

Write a balanced equation for this cracking of heptane.

..... [1]

- (c) The reforming of heptane produces methylcyclohexane and **B**.

- (i) Show the structural formula of methylcyclohexane.

[1]

- (ii) Write a balanced equation for this reforming.

[1]

- (iii) Predict which of 2-methylhexane, 2,3-dimethylpentane and 2,2,3-trimethylbutane has the lowest boiling point.

.....[1]

- (iv) Explain why 2-methylhexane, 2,3-dimethylpentane and 2,2,3-trimethylbutane have different boiling points.

.....

.....

.....[2]

- (e) Crude oil and its fractions are described as non-renewable fossil fuels. To reduce the demand for fossil fuels, ethanol can be mixed with petrol. Ethanol is an example of a renewable biofuel.

- (i) What is meant by a *biofuel*?

.....

.....[1]

- (ii) Why are fossil fuels *non-renewable* but ethanol *renewable*?

.....

.....

.....[1]

[Total: 12]

2 This question is about two alcohols, ethanol and propan-2-ol, $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$.

(a) Ethanol can be formed by fermentation of glucose, $\text{C}_6\text{H}_{12}\text{O}_6$.

(i) Write a balanced equation, including state symbols, for the formation of ethanol by fermentation.

.....[2]

(ii) Fermentation only occurs in the presence of yeast. State **two** other essential conditions.

.....
[2]

(iii) How would you know when fermentation of glucose is complete?

.....
[1]

(b) Propan-2-ol can be formed by the hydration of an alkene in the presence of a catalyst.

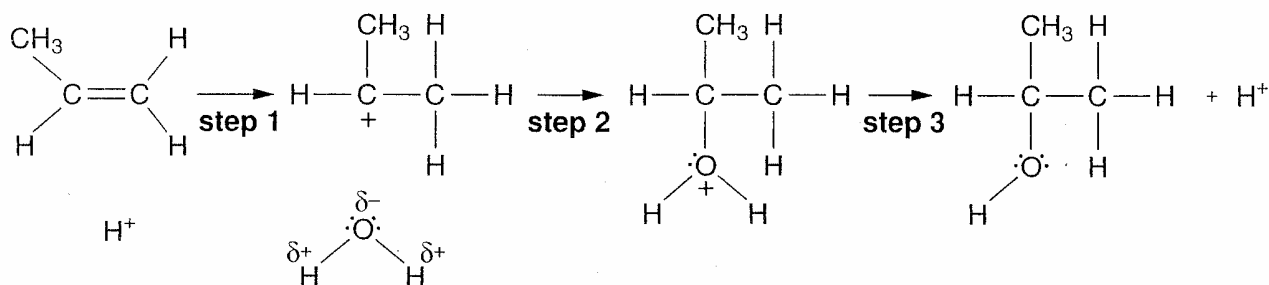
(i) Suggest a suitable catalyst for this reaction.

.....[1]

(ii) This is an electrophilic addition reaction. What is meant by the term *electrophile*?

.....[1]

(c) A mechanism for the reaction in (b) is shown below.



(i) Add 'curly arrows' to the mechanism to show the movement of electron pairs in steps 1, 2 and 3. [3]

(ii) Suggest, with a reason, the role of the H^+ .

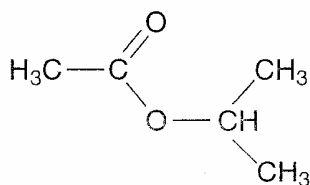
.....[1]

- (d) Propan-2-ol is flammable and readily burns.

Write a balanced equation for the complete combustion of propan-2-ol.

.....[2]

- (e) Compound **D**, shown below, can be used as a solvent for plastics and fats and is also used in perfumery.



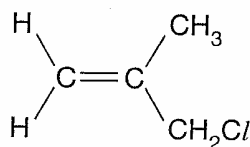
compound **D**

Compound **D** can be prepared from propan-2-ol and another organic compound. Identify this other compound.

[1]

[Total: 14]

- 3 Methyl allyl chloride, MAC, is an important industrial chemical. It is used as an intermediate in the production of synthetic fibres, pharmaceuticals and epoxy resins. The structural formula of MAC is shown below.



MAC

- (a) Give the **systematic** chemical name of MAC.

.....[1]

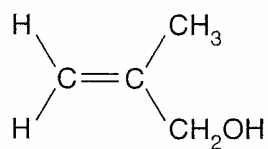
- (b) MAC contains the alkene group and can undergo polymerisation. Draw a section of the polymer, poly(MAC), showing **two** repeat units.

[2]

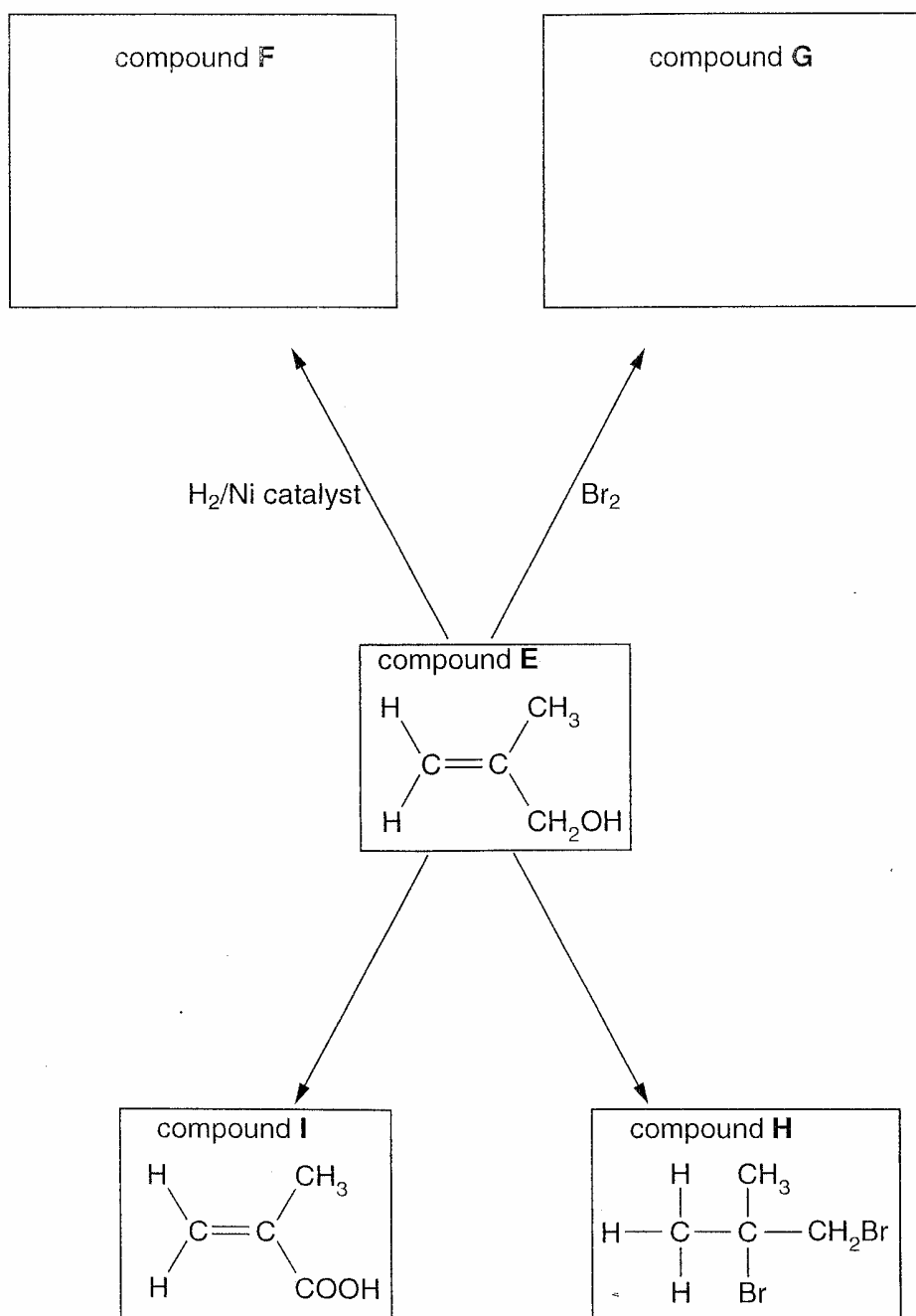
Part (c) continues on the next page

(c) MAC reacts with NaOH to produce compound E.

compound E

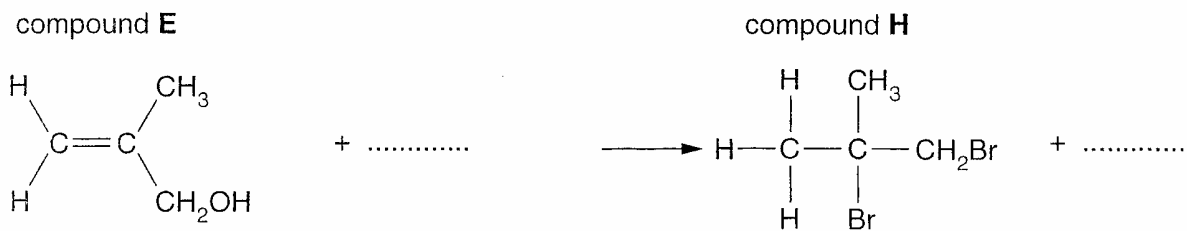


The reaction scheme below shows how compound E can be converted into a variety of other chemicals.



(i) Draw the structures of compounds **F** and **G** in the boxes. [2]

(ii) Complete the balanced equation for the formation of compound **H**.



[2]

(iii) State the reagents and conditions for the formation of compound **I**.

.....
 [2]

(iv) Suggest a possible organic intermediate that could be formed in the formation of compound **I**.

[1]

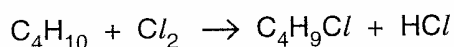
(d) Explain how infra-red spectroscopy could be used to distinguish between compound **E** and compound **I**.

.....

 [2]

[Total: 12]

- 4 Butane, C_4H_{10} , under certain conditions, reacts with Cl_2 to form a mixture of chlorinated products. One possible product is C_4H_9Cl .



- (a) (i) State the conditions.

.....[1]

- (ii) Write equations to show the mechanism of this reaction.

initiation

propagation

.....[3]

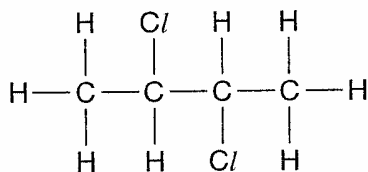
- (iii) Write **one** equation for a reaction that would terminate this mechanism.

.....[1]

- (iv) State the type of bond fission involved in the initiation step.[1]

- (b) One other possible product of the reaction between butane and chlorine is compound **J**, $C_4H_8Cl_2$, shown below.

compound **J**



- (i) Name compound **J**.

.....[1]

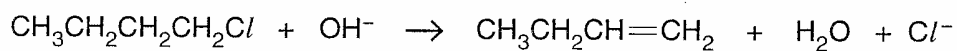
- (ii) Draw the skeletal formula of compound **J**.

[1]

- (iii) In addition to compound **J**, suggest **one** other possible structural isomer of $C_4H_8Cl_2$ that could have been formed in this reaction.

[1]

- (c) 1-Chlorobutane can react with a solution of sodium hydroxide to produce but-1-ene, as shown in the equation below.



- (i) State the solvent in which the sodium hydroxide is dissolved.

.....[1]

- (ii) State the type of reaction.

.....[1]

- (iii) Compound **J** also reacts with sodium hydroxide to produce a mixture of **structural** isomers, each with the formula C_4H_6 .

Draw **one** of the structural isomers formed.

[1]

[Total: 12]

