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General Certificate of Education  
June 2002  
Advanced Subsidiary Examination



**CHEMISTRY**  
**Unit 3(a) Introduction to Organic Chemistry**

**CHM3/W**

Monday 10 June 2002 Afternoon Session

**In addition to this paper you will require:**  
the AQA Periodic Table (Reference CHEM/PT/EX);  
a calculator.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
Total (Column 1)	→		
Total (Column 2)	→		
TOTAL			
Examiner's Initials			

Time allowed: 1 hour 15 minutes

**Instructions**

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in **Section A** and **Section B** in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

**Information**

- The maximum mark for this paper is 75.
- Mark allocations are shown in brackets.
- This paper carries 25 per cent of the total marks for AS. For Advanced Level this paper carries 12½ per cent of the total marks.
- You are expected to use a calculator where appropriate.
- The following data may be required.  
Gas constant  $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$
- Your answers to questions in Section B should be written in continuous prose, where appropriate. You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.

**Advice**

- You are advised to spend about 50 minutes on **Section A** and about 25 minutes on **Section B**.

**SECTION A**

Answer **all** questions in the spaces provided.

- 1 (a) Crude oil is separated into fractions by fractional distillation. Outline how different fractions are obtained by this process.

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(3 marks)

- (b) The table below gives details of the supply of, and demand for, some crude oil fractions.

Fractions	Approximate %	
	Typical supply from crude oil	Global demand
Gases	2	4
Petrol and naphtha	16	27
Kerosine	13	8
Gas oil	19	23
Fuel oil and bitumen	50	38

- (i) Use the data given above to explain why catalytic cracking of crude oil fractions is commercially important.

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.....

.....

- (ii) Give the two main types of product obtained by catalytic cracking.

Type 1 .....

Type 2 .....

(4 marks)

- (c) Name a catalyst used in catalytic cracking. State the type of mechanism involved and outline the industrial conditions used in the process.

*Catalyst* .....

*Type of mechanism* .....

*Conditions* .....

.....

(4 marks)



2 (a) In the presence of ultraviolet light, methane and chlorine react to form a number of chlorine-containing products, including  $\text{CH}_2\text{Cl}_2$  and  $\text{CHCl}_3$

(i) Write an equation for the initiation step in the mechanism for this reaction.

.....

(ii) Write the overall equation for the formation of  $\text{CHCl}_3$  from  $\text{CH}_2\text{Cl}_2$  and  $\text{Cl}_2$

.....

(iii) Write equations for the two propagation steps by which  $\text{CH}_2\text{Cl}_2$  is converted into  $\text{CHCl}_3$

*Equation 1* .....

*Equation 2* .....

(iv) Suggest what effect increasing the intensity of the ultraviolet light would have on the rate of the reaction between methane and chlorine. Explain your answer.

*Effect on rate* .....

*Explanation* .....

.....

(6 marks)

(b) Many hydrocarbon compounds burn readily in air.

(i) Write an equation to show the complete combustion of  $\text{C}_{15}\text{H}_{32}$

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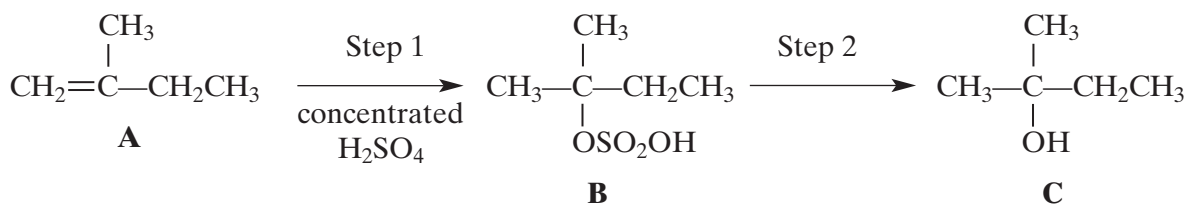
(ii) One of the gaseous products of the incomplete combustion of methane in gas fires is known to be poisonous. Identify this product and write an equation for the reaction in which it is formed from methane.

*Identity of product* .....

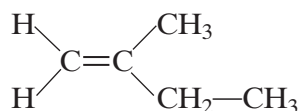
*Equation* .....

(4 marks)

- 3 The reaction scheme below shows the conversion of compound **A**, 2-methylbut-1-ene, into compound **B** and then into compound **C**.



- (a) The structure of **A** is shown below. Circle those carbon atoms which must lie in the same plane.



(1 mark)

- (b) Outline a mechanism for the reaction in Step 1.

(4 marks)

- (c) State the reagent and condition used in Step 2. Name compound **C**.

Reagent .....

Condition .....

Name of compound **C** .....

(3 marks)

- (d) When compound **A** is converted into compound **C**, a second alcohol, **D**, is also formed. Alcohol **D** is isomeric with **C** but is formed as a minor product. Identify alcohol **D** and explain why it is formed as the minor product.

Identity of alcohol **D** .....

Explanation .....

.....

.....

(3 marks)

- 4 (a) An alcohol containing carbon, hydrogen and oxygen only has 64.9% carbon and 13.5% hydrogen by mass. Using these data, show that the empirical formula of the alcohol is  $C_4H_{10}O$

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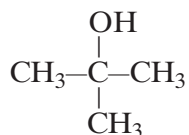
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(3 marks)

- (b) The structural formulae of two of the four possible alcohols of molecular formula  $C_4H_{10}O$  are shown below.



*Isomer 1*



*Isomer 2*

- (i) What type of alcohol is Isomer 1? Suggest a reason why this type of alcohol is not easily oxidised.

*Type of alcohol* .....

*Reason* .....

.....

- (ii) Draw the structural formulae of the two remaining alcohols of molecular formula  $C_4H_{10}O$

*Isomer 3*

*Isomer 4*

(4 marks)

(c) Isomer 2 was oxidised by adding it dropwise to acidified potassium dichromate(VI) solution and immediately distilling off the product. When this product was treated with Fehling's solution, a red precipitate was formed.

(i) State the type of product distilled off during the oxidation by acidified potassium dichromate(VI) solution.

.....

(ii) Write an equation for the oxidation by potassium dichromate(VI), showing clearly the structure of the organic product. Use [O] to represent the oxidising agent.

.....

(iii) Name and draw a structure for the organic product formed by the reaction with Fehling's solution.

Name .....

Structure .....

(5 marks)

(d) State **one** advantage and **one** disadvantage of the production of ethanol by the hydration of ethene compared to the fermentation of glucose.

Advantage .....

Disadvantage .....

(2 marks)

(e) Outline a mechanism for the dehydration of ethanol to form ethene in the presence of an acid catalyst.

(4 marks)

**SECTION B**

Answer **both** the questions below in the space provided on pages 9 to 12 of this booklet.

- 5 Epoxyethane is produced commercially by the oxidation of ethene.

State the reagent and the catalyst required for this process and identify two different types of hazard associated with the production of epoxyethane. Write an equation for the reaction of epoxyethane with water in a 1 : 1 mole ratio and give a use for the product obtained. Write an equation for the reaction of an excess of epoxyethane with ethanol and give a use for the product obtained. (8 marks)

- 6 Reaction of 2-bromobutane with potassium hydroxide can produce two types of product depending on the solvent used. In aqueous solution, the formation of an alcohol, **E**, is more likely but in ethanolic solution the formation of alkenes is more likely.

(a) For each type of product, name the type of reaction occurring and state the role of the potassium hydroxide. (4 marks)

(b) Name alcohol **E** and draw its structural formula. By reference to the structure of the halogenoalkane, explain why the initial step in the mechanism of the reaction producing the alcohol occurs. (5 marks)

(c) When 2-bromobutane reacts with ethanolic potassium hydroxide, two structurally isomeric alkenes are produced, one of which shows stereoisomerism.

Outline the mechanism for the formation of one of the structurally isomeric alkenes. Explain why two structurally isomeric alkenes are formed and draw the structure of the second structural isomer. Draw the structural formulae of the two stereoisomers.

(8 marks)

**END OF QUESTIONS**



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Handwriting practice area with 25 horizontal dotted lines.

