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General Certificate of Education  
January 2002  
Advanced Subsidiary Examination



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

**CHM3/W**

Friday 18 January 2002 Morning Session

<p><b>In addition to this paper you will require:</b> a Periodic Table; a calculator.</p>
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For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
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**

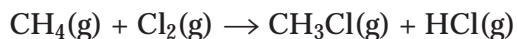
- You are advised to spend about 50 minutes on **Section A** and about 25 minutes on **Section B**.

**NO QUESTIONS APPEAR ON THIS PAGE**

**SECTION A**

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

- 1 The equation below represents a reaction between methane and chlorine.



- (a) State an essential condition required for this reaction to occur. Explain why this condition is essential.

*Condition* .....

*Explanation* .....

.....  
(2 marks)

- (b) (i) State the type of mechanism involved in the above reaction.

.....

- (ii) Name the three types of step involved in this mechanism.

*Step 1* .....

*Step 2* .....

*Step 3* .....

(4 marks)

- (c) In addition to  $\text{CH}_3\text{Cl}$ , compounds such as  $\text{CH}_2\text{Cl}_2$  and  $\text{CH}_3\text{CH}_2\text{Cl}$  may also be formed when chlorine reacts with methane.

- (i) Write equations for the two steps in the mechanism by which  $\text{CH}_2\text{Cl}_2$  is formed from  $\text{CH}_3\text{Cl}$

*Equation 1* .....

*Equation 2* .....

- (ii) Write an equation to represent a step in the mechanism in which  $\text{CH}_3\text{CH}_2\text{Cl}$  is formed.

.....

(3 marks)

Turn over 

2 (a) In the manufacture of margarine, unsaturated vegetable oils such as sunflower oil are hardened.

(i) State the reagent and conditions used in this process.

*Reagent* .....

*Conditions* .....

.....

(ii) Soft and hard margarines are obtained from the same vegetable oil. How does the structure and the melting point of a soft margarine differ from that of a hard one?

*Difference in structure* .....

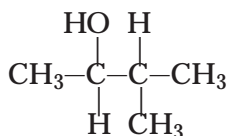
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*Difference in melting point* .....

.....

(5 marks)

(b) In the presence of reagent **X**, the alcohol shown below undergoes a reaction to form two isomeric alkenes.



(i) Name this alcohol.

.....

(ii) Give the name of the type of reaction involved in the formation of the two alkenes.

.....

(iii) Suggest the identity of reagent **X**.

.....

(iv) Give the structural formulae of the two isomeric alkenes.

*Alkene 1*

*Alkene 2*

(5 marks)

3 Propene reacts with bromine by a mechanism known as electrophilic addition.

(a) Explain what is meant by the term *electrophile* and by the term *addition*.

*Electrophile* .....

.....

*Addition* .....

.....

(2 marks)

(b) Explain why bromine, a non-polar molecule, is able to react with propene.

.....

.....

.....

(2 marks)

(c) Outline the mechanism for the electrophilic addition of bromine to propene. Give the name of the product formed.

*Mechanism*

*Name of product* .....

(5 marks)

(d) The polymerisation of propene to form poly(propene) is an important industrial process. Name the type of polymerisation involved.

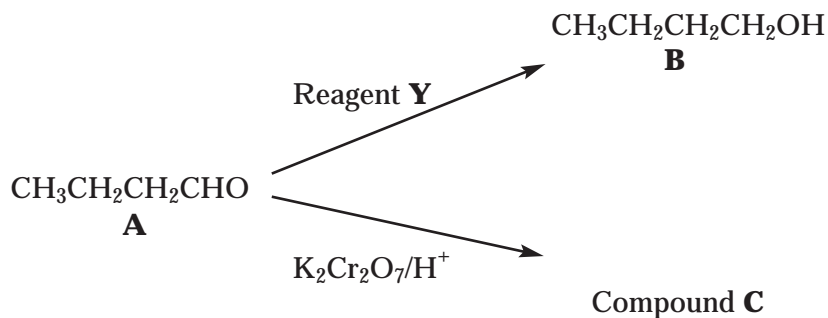
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(1 mark)

Turn over ►

10

4 Two reactions of compound **A** are shown in the reaction scheme below.



- (a) (i) State the type of reaction occurring in the conversion of compound **A** into compound **B**. Identify a suitable reagent **Y**.

Type of reaction .....

Reagent **Y** .....

- (ii) Write an equation for the conversion of compound **A** into compound **C**.  
Use [O] to represent  $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$

.....  
(3 marks)

(b) Functional group isomerism is one type of structural isomerism.

- (i) Explain what is meant by the term *functional group isomerism*.

.....  
.....

- (ii) Give the name or structural formula of a functional group isomer of compound **A** which contains only one functional group.

.....  
(3 marks)

- (c) (i) State what is meant by the terms *empirical formula* and *molecular formula*.

*Empirical formula* .....

.....

*Molecular formula* .....

.....

- (ii) Deduce the empirical formula and the molecular formula of compound **D** ( $M_r = 116$ ) which contains 62.07% carbon, 10.34% hydrogen and 27.59% oxygen by mass.

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(5 marks)

11

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

- 5 (a) The equation below shows the reaction of 2-bromopropane with an excess of ammonia.



Name and outline the mechanism involved.

*Name of mechanism* .....

*Mechanism*

(5 marks)

- (b) When 2-bromopropane is heated with ethanolic potassium hydroxide, an elimination reaction occurs. State the role of potassium hydroxide and outline a mechanism for this reaction.

*Role of potassium hydroxide* .....

*Mechanism*

(5 marks)

10



**SECTION B**

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

- 6** (a) Gas oil (diesel), kerosine (paraffin), mineral oil (lubricating oil) and petrol (gasoline) are four of the five fractions obtained by the fractional distillation of crude oil within the temperature range 40–400 °C.

Identify the missing fraction and state the order in which the five fractions are removed as the fractionating column is ascended. Give **two** reasons why the fractions collect at different levels in the fractionating column. *(4 marks)*

- (b) Thermal cracking of large hydrocarbon molecules is used to produce alkenes. State the type of mechanism involved in this process. Write an equation for the thermal cracking of  $C_{21}H_{44}$  in which ethene and propene are produced in a 3:2 molar ratio together with one other product. *(3 marks)*

- (c) Write equations, where appropriate, to illustrate your answers to the questions below.

- (i) Explain why it is desirable that none of the sulphur-containing impurities naturally found in crude oil are present in petroleum fractions.
- (ii) The pollutant gas NO is found in the exhaust gases from petrol engines. Explain why NO is formed in petrol engines but is not readily formed when petrol burns in the open air.
- (iii) The pollutant gas CO is also found in the exhaust gases from petrol engines. Explain how CO and NO are removed from the exhaust gases and why the removal of each of them is desirable. *(10 marks)*

- 7** Ethanol is produced commercially by fermentation of aqueous glucose,  $C_6H_{12}O_6$ . State **two** conditions, other than temperature, which are necessary for fermentation. Explain why neither a low temperature nor a high temperature is suitable for this reaction. Give **two** advantages of this method of production over that by the direct hydration of ethene. Write an equation for the production of ethanol by fermentation and an equation for the complete combustion of ethanol. *(8 marks)*

**END OF QUESTIONS**

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Turn over 





