

Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Education
June 2008
Advanced Subsidiary Examination



CHEMISTRY
Unit 3(a) Introduction to Organic Chemistry

CHM3/W

Wednesday 4 June 2008 9.00 am to 10.00 am

For this paper you must have

- a calculator.

Time allowed: 1 hour

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or blank pages will not be marked.
- Your answers to the parts of **Section B** should be on the pages indicated.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- The Periodic Table/Data Sheet is provided as an insert.

Information

- The maximum mark for this paper is 60.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- Write your answer to the question in **Section B** 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 45 minutes on **Section A** and about 15 minutes on **Section B**.

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



J U N 0 8 C H M 3 W 0 1

APW/Jun08/CHM3/W

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SECTION A

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

- 1 Three atmospheric pollutants which can be formed when fossil fuels are burned are shown below.

CO
carbon monoxide

NO
nitrogen monoxide

SO₂
sulphur dioxide

- 1 (a) The combustion of hydrocarbons in a petrol-engined car can lead to the formation of CO and NO

- 1 (a) (i) State what is meant by the term *hydrocarbon*.

.....

(1 mark)

- 1 (a) (ii) Write an equation for the incomplete combustion of the hydrocarbon nonane (C₉H₂₀) to give CO and H₂O as the only products.

.....

(1 mark)

- 1 (a) (iii) State **one** essential condition for the formation of NO from air in a petrol-engined car. Write an equation for the reaction in which NO is formed.

Essential condition

Equation

.....

(2 marks)



1 (b) Most petrol-engined cars are fitted with a catalytic converter.

1 (b) (i) Identify **one** of the metals used as a catalyst in a catalytic converter.

.....
.....

(1 mark)

1 (b) (ii) Balance the following equation.



(1 mark)

1 (c) Natural gas is mainly methane and is burned as a fuel. State what is meant by the term *fuel*.

.....
.....
.....

(1 mark)

1 (d) Natural gas contains a small amount of hydrogen sulphide, H_2S
Write an equation for the combustion of H_2S in air to give SO_2 and H_2O as the only products.

.....
.....

(1 mark)

Turn over for the next question



2 The table below gives some of the names and structures of three isomers.

Name	Structure
	$\begin{array}{c} \text{H}_3\text{C} - \text{C} - \text{CH}_3 \\ \parallel \\ \text{O} \end{array}$
propanal	
prop-2-en-1-ol	$\text{H}_2\text{C}=\text{CHCH}_2\text{OH}$

2 (a) Complete the table.

(2 marks)

2 (b) Name the type of structural isomerism shown by these isomers.

.....

(1 mark)

2 (c) State what is meant by the term *molecular formula*.

.....

(1 mark)

2 (d) Give the molecular formula for these isomers.

.....

(1 mark)



2 (e) Propanal reacts with acidified potassium dichromate(VI) to form a carboxylic acid.

2 (e) (i) State the type of reaction.

.....
.....
(1 mark)

2 (e) (ii) Draw the structure of the carboxylic acid formed from propanal in this reaction.

(1 mark)

2 (e) (iii) Tollens' reagent or Fehling's solution can be used to show whether any propanal is present as an impurity in the carboxylic acid. Choose one of these reagents and state what will be observed if propanal is present.

Chosen reagent

Observation if propanal is present
(1 mark)

2 (f) Prop-2-en-1-ol is an unsaturated alcohol.

2 (f) (i) State what is meant by the term *unsaturated*.

.....
.....
.....
(1 mark)

2 (f) (ii) Identify the class of alcohol to which prop-2-en-1-ol belongs.

.....
(1 mark)

2 (f) (iii) Draw the structure of the product formed when prop-2-en-1-ol reacts with bromine.

(1 mark)

11

Turn over ►



3 (a) Tetrachloromethane, CCl_4 , can be made by the reaction of chlorine with trichloromethane, CHCl_3
This reaction occurs in sunlight.

3 (a) (i) Name the type of mechanism for this reaction.

.....
(1 mark)

3 (a) (ii) Outline the following steps in the mechanism for the reaction of chlorine with CHCl_3 to form CCl_4

Initiation step

.....

First propagation step

.....

Second propagation step

.....

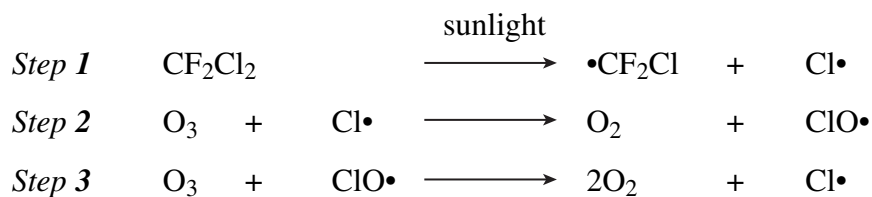
A termination step

.....

(4 marks)



- 3 (b) The following reaction mechanism is suggested to show how the chlorofluorocarbon CF_2Cl_2 may damage the ozone layer (O_3) in the upper atmosphere.



- 3 (b) (i) Give the name of CF_2Cl_2

.....
(1 mark)

- 3 (b) (ii) Name the type of reactive intermediate shown in each of these three steps.

.....
(1 mark)

- 3 (b) (iii) Name the type of mechanistic step illustrated by Step 3 of this mechanism.

.....
(1 mark)

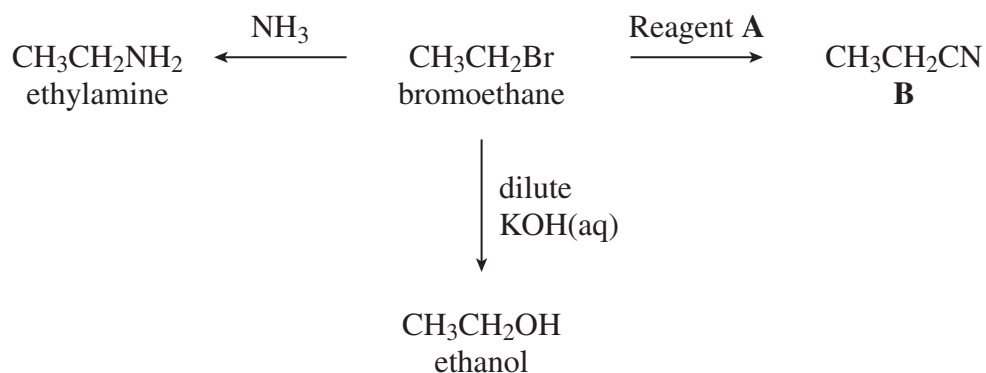
8

Turn over for the next question

Turn over ►



4 Consider the following reactions of bromoethane.



4 (a) Bromoethane reacts with ammonia to produce ethylamine.

4 (a) (i) What feature of the bromoethane molecule makes it susceptible to attack by an ammonia molecule?

.....
(1 mark)

4 (a) (ii) Outline a mechanism for this reaction.

(4 marks)



- 4 (b) Bromoethane is converted into compound **B** by reaction with reagent **A**. Identify reagent **A** and give the name of compound **B**.

Identity of reagent A

Name of compound B

(2 marks)

- 4 (c) The conversion of bromoethane into ethanol is a substitution reaction in which a nucleophile attacks the organic compound.

- 4 (c) (i) State what is meant by the term *nucleophile*.

.....

(1 mark)

- 4 (c) (ii) Identify the nucleophile in the reaction of potassium hydroxide with bromoethane.

.....

(1 mark)

Turn over for the next question

9

Turn over ►



5 Consider the following conversion of compound **P** into compound **Q**.



5 (a) Give the name of compound **Q**.

.....

(1 mark)

5 (b) Name and outline a mechanism for the conversion of **P** into **Q**.

Name of mechanism

Mechanism

(4 marks)



5 (c) Hydrogen bromide reacts with **Q** to form compound **R**, which is a position isomer of **P**.

5 (c) (i) Identify compound **R**.

.....
(1 mark)

5 (c) (ii) Name the type of mechanism for the conversion of **Q** into **R**.

.....
.....
(1 mark)

5 (d) Draw the structure of an alkene which is an isomer of **Q** and which shows stereoisomerism. State the type of stereoisomerism shown by this isomer.

Structure of isomer

Type of stereoisomerism
(2 marks)

9

Turn over for the next question

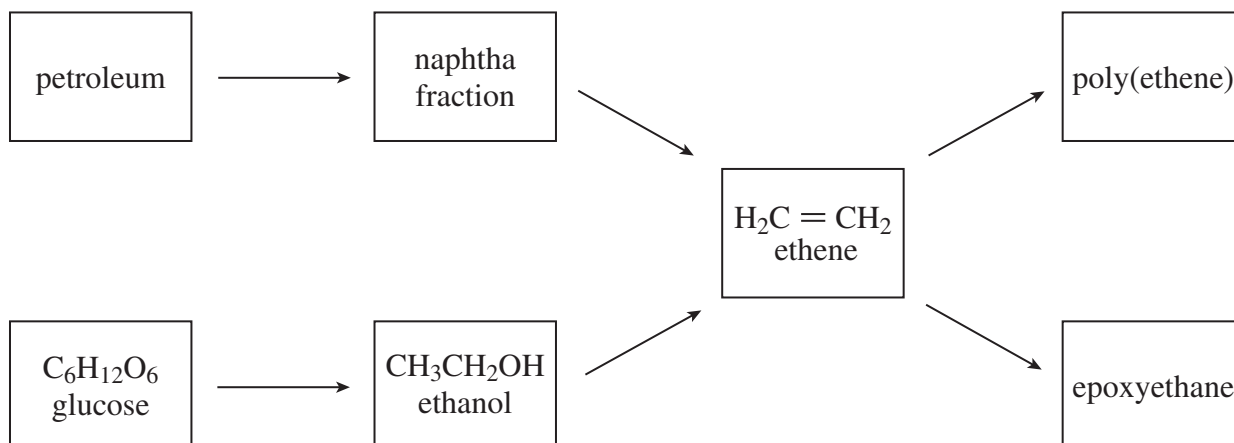
Turn over ►



SECTION B

Answer the question below in the space provided on pages 13 to 17 of this booklet.
You should answer each part of the question on the separate page indicated.
Each part of the question is reprinted at the top of the page.

- 6 Ethene can be produced either from petroleum or from glucose. These processes and the formation of some useful products from ethene are illustrated in the following scheme.



- 6 (a) The naphtha fraction is separated from petroleum by the process of fractional distillation. State the essential features of this process and explain how separation is achieved. (4 marks)
- 6 (b) Give the name of the process by which ethene is produced from the naphtha fraction. Give **one** essential condition for this process and name the type of reactive intermediate involved. (3 marks)
- 6 (c) State what must be added to an aqueous solution of glucose to convert it into ethanol. Name the process and write an equation for this reaction. (3 marks)
- 6 (d) The reaction of aqueous glucose to form ethanol produces a dilute aqueous solution. Name the process used to separate ethanol from this dilute aqueous solution. Identify a catalyst for the conversion of ethanol into ethene and state the type of reaction. (3 marks)
- 6 (e) Draw the structure of the repeating unit of poly(ethene) and the structure of epoxyethane. (2 marks)

END OF QUESTIONS



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CHEMISTRY
Unit 3(a) Introduction to Organic Chemistry

CHM3/W

Gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

Table 1
Proton n.m.r chemical shift data

Type of proton	δ/ppm
RCH_3	0.7–1.2
R_2CH_2	1.2–1.4
R_3CH	1.4–1.6
RCOCH_3	2.1–2.6
ROCH_3	3.1–3.9
RCOOCH_3	3.7–4.1
ROH	0.5–5.0

Table 2
Infra-red absorption data

Bond	Wavenumber/ cm^{-1}
C—H	2850–3300
C—C	750–1100
C=C	1620–1680
C=O	1680–1750
C—O	1000–1300
O—H (alcohols)	3230–3550
O—H (acids)	2500–3000

The Periodic Table of the Elements

- The atomic numbers and approximate relative atomic masses shown in the table are for use in the examination unless stated otherwise in an individual question.

I		II		III		IV		V		VI		VII		0																		
1.0 H Hydrogen 1	9.0 Li Lithium 3	6.9 Be Beryllium 4	24.3 Na Sodium 11	40.1 K Potassium 19	39.1 Ca Calcium 20	45.0 Sc Scandium 21	88.9 Y Yttrium 39	138.9 Ba Barium 56	137.3 Cs Caesium 55	223.0 Fr Francium 87	226.0 Ra Radium 88	227 Ac Actinium 89 †	47.9 Ti Titanium 22	91.2 Zr Zirconium 40	178.5 Hf Hafnium 72	180.9 Ta Tantalum 73	189 W Tungsten 74	186.2 Re Rhenium 75	195.1 Pt Platinum 78	197.0 Au Gold 79	200.6 Hg Mercury 80	204.4 Tl Thallium 81	207.2 Pb Lead 82	209.0 Bi Bismuth 83	210.0 Po Polonium 84	210.0 At Astatine 85	222.0 Rn Radon 86					
55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36	101.1 Ru Ruthenium 44	102.9 Rh Rhodium 45	106.4 Pd Palladium 46	107.9 Ag Silver 47	112.4 Cd Cadmium 48	114.8 In Indium 49	121.8 Sb Antimony 51	126.9 I Iodine 53	131.3 Xe Xenon 54	144.9 Pm Promethium 61	147.9 Sm Samarium 62	150.4 Pu Plutonium 94	151.9 Np Neptunium 93	152.0 Eu Europium 63	157.3 Gd Gadolinium 64	158.9 Tb Terbium 65	162.5 Dy Dysprosium 66	164.9 Ho Holmium 67	167.3 Er Erbium 68	168.9 Tm Thulium 69	173.0 Yb Ytterbium 70	175.0 Lu Lutetium 71
10.8 B Boron 5	27.0 Al Aluminium 13	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10	27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulphur 16	35.5 Cl Chlorine 17	39.9 Ar Argon 18	124.0 U Uranium 92	123.0 Th Thorium 90	231.0 Pa Protactinium 91	238.0 U Uranium 92	237.0 Np Neptunium 93	239.1 Pu Plutonium 94	243.1 Am Americium 95	247.1 Cm Curium 96	252.1 Cf Californium 98	252.1 Bk Berkelium 97	257 Fm Fermium 100	(258) Md Mendelevium 101	(259) No Nobelium 102	(260) Lr Lawrencium 103						

Key

relative atomic mass	6.9	Li	Lithium
atomic number	3		

* 58 – 71 Lanthanides

† 90 – 103 Actinides