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Centre Number						Candidate Number					
Candidate Signature											

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General Certificate of Education  
June 2004  
Advanced Subsidiary Examination



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

**CHM3/W**

Thursday 10 June 2004 Morning Session

<b>In addition to this paper you will require:</b> a calculator.
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For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
Total (Column 1)		→	
Total (Column 2)		→	
TOTAL			
Examiner's Initials			

Time allowed: 1 hour

**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.
- The Periodic Table/Data Sheet is provided on pages 3 and 4. Detach this perforated sheet at the start of the examination.

**Information**

- The maximum mark for this paper is 60.
- Mark allocations are shown in brackets.
- This paper carries 25 per cent of the total marks for AS. For Advanced Level this paper carries  $12\frac{1}{2}$  per cent of the total marks.
- You are expected to use a calculator where appropriate.
- The following data may be required.  
Gas constant  $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
- Your answers to the question 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 45 minutes on **Section A** and about 15 minutes on **Section B**.

**SECTION A**

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

1 (a) Ethanol,  $C_2H_5OH$ , can be made from glucose,  $C_6H_{12}O_6$

(i) Write an equation to represent this reaction.

.....

(ii) Give the name of this process for making ethanol.

.....

(2 marks)

(b) Ethanol can be used as a fuel in the internal combustion engine of a motor car.

(i) Write an equation for the complete combustion of ethanol.

.....

(ii) Identify a pollutant produced when ethanol is burned in a limited supply of air.

.....

(iii) Nitrogen monoxide,  $NO$ , is a pollutant gas produced by motor cars. Write an equation to represent a reaction occurring in the catalytic converter which decreases the amount of this pollutant.

.....

(3 marks)

## 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	VIII	IX	X	XI	XII
1.0	<b>H</b> Hydrogen 1											
6.9	<b>Li</b> Lithium 3	<b>Be</b> Beryllium 4										
23.0	<b>Na</b> Sodium 11	<b>Mg</b> Magnesium 12										
39.1	<b>K</b> Potassium 19	<b>Ca</b> Calcium 20	<b>Sc</b> Scandium 21	<b>Ti</b> Titanium 22	<b>V</b> Vanadium 23	<b>Cr</b> Chromium 24	<b>Mn</b> Manganese 25	<b>Fe</b> Iron 26	<b>Co</b> Cobalt 27	<b>Ni</b> Nickel 28	<b>Cu</b> Copper 29	<b>Zn</b> Zinc 30
85.5	<b>Rb</b> Rubidium 37	<b>Sr</b> Strontium 38	<b>Y</b> Yttrium 39	<b>Zr</b> Zirconium 40	<b>Nb</b> Niobium 41	<b>Mo</b> Molybdenum 42	<b>Tc</b> Technetium 43	<b>Ru</b> Ruthenium 44	<b>Rh</b> Rhodium 45	<b>Pd</b> Palladium 46	<b>Ag</b> Silver 47	<b>Cd</b> Cadmium 48
132.9	<b>Cs</b> Caesium 55	<b>Ba</b> Barium 56	<b>La</b> Lanthanum 57	<b>Hf</b> Hafnium 72	<b>Ta</b> Tantalum 73	<b>W</b> Tungsten 74	<b>Re</b> Rhenium 75	<b>Os</b> Osmium 76	<b>Ir</b> Iridium 77	<b>Pt</b> Platinum 78	<b>Au</b> Gold 79	<b>Hg</b> Mercury 80
223.0	<b>Fr</b> Francium 87	<b>Ra</b> Radium 88	<b>Ac</b> Actinium 89									
10.8	<b>B</b> Boron 5											
12.0	<b>C</b> Carbon 6											
14.0	<b>N</b> Nitrogen 7											
16.0	<b>O</b> Oxygen 8											
19.0	<b>F</b> Fluorine 9											
20.2	<b>Ne</b> Neon 10											
27.0	<b>Al</b> Aluminium 13											
28.1	<b>Si</b> Silicon 14											
31.0	<b>P</b> Phosphorus 15											
32.1	<b>S</b> Sulphur 16											
35.5	<b>Cl</b> Chlorine 17											
39.9	<b>Ar</b> Argon 18											
69.7	<b>Ga</b> Gallium 31											
72.6	<b>Ge</b> Germanium 32											
74.9	<b>As</b> Arsenic 33											
79.0	<b>Se</b> Selenium 34											
114.8	<b>In</b> Indium 49											
118.7	<b>Sn</b> Tin 50											
121.8	<b>Sb</b> Antimony 51											
126.9	<b>I</b> Iodine 53											
127.6	<b>Te</b> Tellurium 52											
204.4	<b>Tl</b> Thallium 81											
207.2	<b>Pb</b> Lead 82											
209.0	<b>Bi</b> Bismuth 83											
210.0	<b>Po</b> Polonium 84											
210.0	<b>At</b> Astatine 85											
222.0	<b>Rn</b> Radon 86											

**Key**

relative atomic mass	6.9	<b>Li</b>	Lithium
atomic number	3		

140.1	<b>Ce</b> Cerium 58	140.9	<b>Pr</b> Praseodymium 59	144.2	<b>Nd</b> Neodymium 60	144.9	<b>Pm</b> Promethium 61	150.4	<b>Sm</b> Samarium 62	152.0	<b>Eu</b> Europium 63	157.3	<b>Gd</b> Gadolinium 64	162.5	<b>Dy</b> Dysprosium 66	164.9	<b>Ho</b> Holmium 67	167.3	<b>Er</b> Erbium 68	168.9	<b>Tm</b> Thulium 69	173.0	<b>Yb</b> Ytterbium 70	175.0	<b>Lu</b> Lutetium 71
232.0	<b>Th</b> Thorium 90	231.0	<b>Pa</b> Protactinium 91	238.0	<b>U</b> Uranium 92	237.0	<b>Np</b> Neptunium 93	239.1	<b>Pu</b> Plutonium 94	243.1	<b>Am</b> Americium 95	247.1	<b>Cm</b> Curium 96	252.1	<b>Cf</b> Californium 98	(252)	<b>Es</b> Einsteinium 99	(257)	<b>Fm</b> Fermium 100	(258)	<b>Md</b> Mendelevium 101	(259)	<b>No</b> Nobelium 102	(260)	<b>Lr</b> Lawrencium 103

\* 58 – 71 Lanthanides

† 90 – 103 Actinides

**Table 1**  
Proton n.m.r chemical shift data

Type of proton	$\delta/\text{ppm}$
$\text{RCH}_3$	0.7–1.2
$\text{R}_2\text{CH}_2$	1.2–1.4
$\text{R}_3\text{CH}$	1.4–1.6
$\text{RCOCH}_3$	2.1–2.6
$\text{ROCH}_3$	3.1–3.9
$\text{RCOOCH}_3$	3.7–4.1
$\text{ROH}$	0.5–5.0

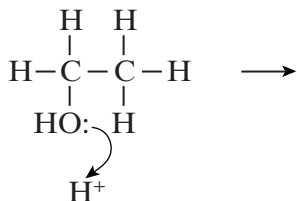
**Table 2**  
Infra-red absorption data

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

- (c) Ethene can be formed by the dehydration of ethanol using concentrated sulphuric acid. Name and complete a mechanism for this reaction.

Name of mechanism .....

Mechanism



(5 marks)

- (d) Epoxyethane is manufactured from ethene. Give a suitable catalyst for this manufacturing process. Write an equation for the reaction, clearly showing the structure of epoxyethane.

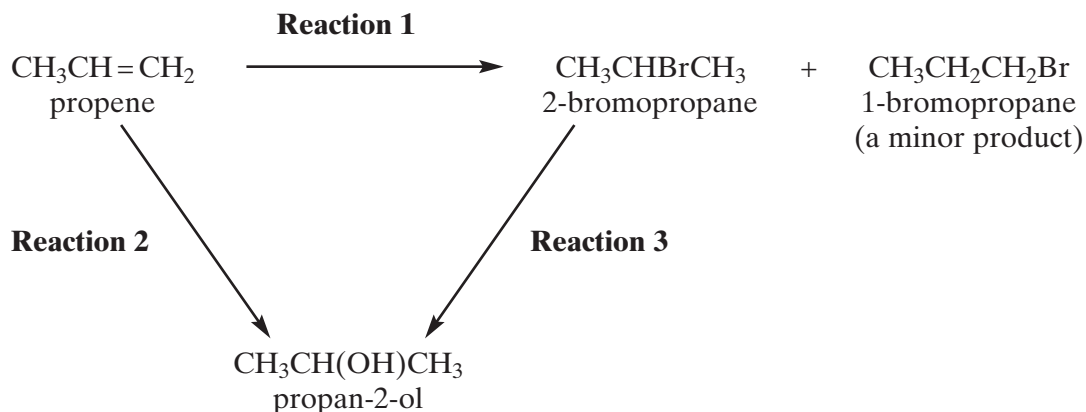
Catalyst .....

Equation

.....

(3 marks)

2 Consider the following reaction scheme.



(a) (i) Name the mechanism for **Reaction 1**.

.....

(ii) Explain why 1-bromopropane is only a minor product in **Reaction 1**.

.....

.....

.....

(3 marks)

(b) Give a suitable reagent and state the essential conditions required for **Reaction 3**.

Reagent .....

Conditions .....

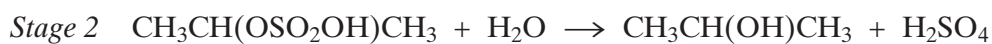
(2 marks)

(c) The reagent used for **Reaction 3** can also be used to convert 2-bromopropane into propene. State the different conditions needed for this reaction.

.....

(1 mark)

(d) **Reaction 2** proceeds in two stages.



(i) Name the class of alcohols to which propan-2-ol belongs.

.....

(ii) Outline a mechanism for Stage 1 of **Reaction 2**, using concentrated sulphuric acid.

(iii) State the overall role of the sulphuric acid in **Reaction 2**.

.....

(6 marks)

12

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

- 3 (a) (i) Give a suitable reagent and state the necessary conditions for the conversion of propan-2-ol into propanone. Name the type of reaction.

*Reagent* .....

*Conditions* .....

*Type of reaction* .....

- (ii) Propanone can be converted back into propan-2-ol. Give a suitable reagent and write an equation for this reaction.  
(Use [H] to represent the reagent in your equation.)

*Reagent* .....

*Equation*

.....  
(5 marks)

- (b) Propanal is an isomer of propanone.

- (i) Draw the structure of propanal.

- (ii) A chemical test can be used to distinguish between separate samples of propanone and propanal. Give a suitable reagent for the test and describe what you would observe with propanone and with propanal.

*Test reagent* .....

*Observation with propanone* .....

*Observation with propanal* .....

(4 marks)



**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

4 (a) Bromomethane,  $\text{CH}_3\text{Br}$ , can be formed by a reaction between bromine and methane. The mechanism for this reaction is similar to the mechanism for the chlorination of methane.

(i) Name the mechanism for this reaction.

.....

(ii) Give the name of, and state an essential condition for, the first step in the mechanism for this reaction.

Name .....

Essential condition .....

(iii) Write an equation for a termination step in the mechanism for this reaction which gives ethane as a product.

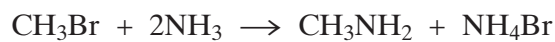
.....

(iv) Bromomethane can undergo further substitution. Write an overall equation for the reaction between bromomethane and bromine in which dibromomethane is formed.

.....

(5 marks)

- (b) Bromomethane reacts with the nucleophile ammonia according to the following equation.



- (i) Explain what is meant by the term *nucleophile*.

.....  
.....

- (ii) Name the organic product of this reaction.

.....

- (iii) Outline a mechanism for this reaction.

(6 marks)

11

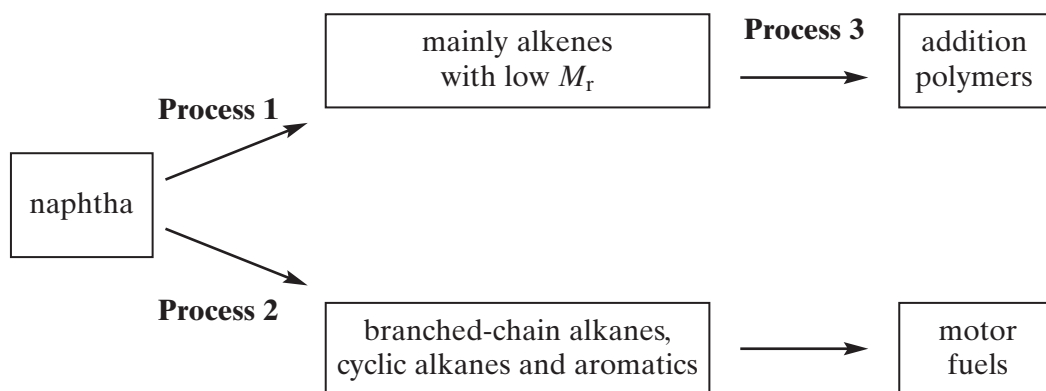
**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

## SECTION B

Answer the question below in the space provided on pages 12 to 16 of this booklet.

- 5 Naphtha is one of the fractions obtained from crude oil and is a source of useful products.



- (a) Naphtha is separated from crude oil by the process of fractional distillation. Outline the essential features of fractional distillation and explain why separation is achieved by this process. (4 marks)
- (b) Give a name for **Process 1**. State **one** essential condition and name the type of reactive intermediate involved in this process. Write an equation to show how one molecule of an alkane  $C_{13}H_{28}$  can be converted into two molecules of ethene, one molecule of propene and one molecule of an alkane. (5 marks)
- (c) **Process 2** produces branched-chain alkanes and cyclic alkanes from larger alkanes. Give a name for **Process 2** and name the type of reactive intermediate involved in this process. Draw **one** possible structure for each of the alkanes  $C_5H_{12}$  and  $C_6H_{12}$  which are produced in **Process 2**. Name the alkane  $C_5H_{12}$  which you have drawn. (5 marks)
- (d) Write an equation to illustrate the formation of an addition polymer from propene in **Process 3**. (1 mark)

END OF QUESTIONS

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.....

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.....

Dotted lines for writing.

**Turn over** ▶

Handwriting practice area consisting of 25 horizontal dotted lines.

Lined writing area with horizontal dashed lines.

**Turn over** ▶

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