Surname		Other Names	
Centre Number			Candidate Number					
Candidate Signature								

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General Certificate of Education
June 2004
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY CHM3/W
Unit 3(a) Introduction to Organic Chemistry

Thursday 10 June 2004 Morning Session

In addition to this paper you will require:
a calculator.

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 $R = 8.31$ J K^{-1} 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**.

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

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	0
1.0 **H** Hydrogen 1																	4.0 **He** Helium 2
6.9 **Li** Lithium 3	9.0 **Be** Beryllium 4											10.8 **B** Boron 5	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
23.0 **Na** Sodium 11	24.3 **Mg** Magnesium 12											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
39.1 **K** Potassium 19	40.1 **Ca** Calcium 20	45.0 **Sc** Scandium 21	47.9 **Ti** Titanium 22	50.9 **V** Vanadium 23	52.0 **Cr** Chromium 24	54.9 **Mn** Manganese 25	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
85.5 **Rb** Rubidium 37	87.6 **Sr** Strontium 38	88.9 **Y** Yttrium 39	91.2 **Zr** Zirconium 40	92.9 **Nb** Niobium 41	95.9 **Mo** Molybdenum 42	98.9 **Tc** Technetium 43	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	118.7 **Sn** Tin 50	121.8 **Sb** Antimony 51	127.6 **Te** Tellurium 52	126.9 **I** Iodine 53	131.3 **Xe** Xenon 54
132.9 **Cs** Caesium 55	137.3 **Ba** Barium 56	138.9 **La** Lanthanum 57 *	178.5 **Hf** Hafnium 72	180.9 **Ta** Tantalum 73	183.9 **W** Tungsten 74	186.2 **Re** Rhenium 75	190.2 **Os** Osmium 76	192.2 **Ir** Iridium 77	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
223.0 **Fr** Francium 87	226.0 **Ra** Radium 88	227 **Ac** Actinium 89 †															

Key

relative atomic mass — 6.9 **Li** Lithium

atomic number — 3

140.1 **Ce** Cerium 58	140.9 **Pr** Praseodymium 59	144.2 **Nd** Neodymium 60	144.9 **Pm** Promethium 61	150.4 **Sm** Samarium 62	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
232.0 **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	247.1 **Bk** Berkelium 97	252.1 **Cf** Californium 98	(252) **Es** Einsteinium 99	(257) **Fm** Fermium 100	(258) **Md** Mendelevium 101	(259) **No** Nobelium 102	(260) **Lr** Lawrencium 103

* **58 – 71** Lanthanides

† **90 – 103** Actinides

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

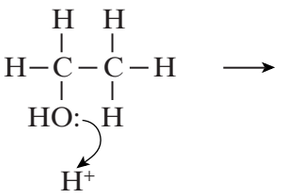
Table 2
Infra-red absorption data

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

(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 .....

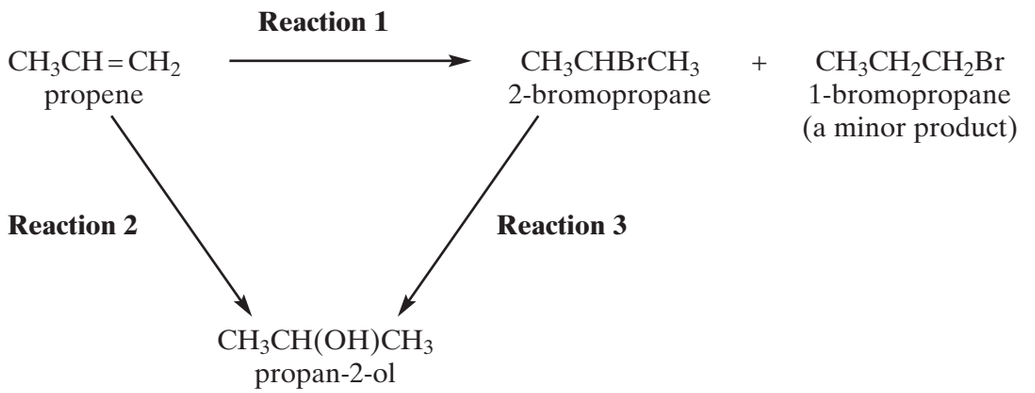
Equation

.....

(3 marks)

13

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.

Stage 1 $CH_3CH{=}CH_2 + H_2SO_4 \longrightarrow CH_3CH(OSO_2OH)CH_3$

Stage 2 $CH_3CH(OSO_2OH)CH_3 + H_2O \longrightarrow CH_3CH(OH)CH_3 + H_2SO_4$

(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

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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)

9

TURN OVER FOR THE NEXT QUESTION

4 (a) Bromomethane, CH_3Br, 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.

$$CH_3Br + 2NH_3 \longrightarrow CH_3NH_2 + NH_4Br$$

(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)

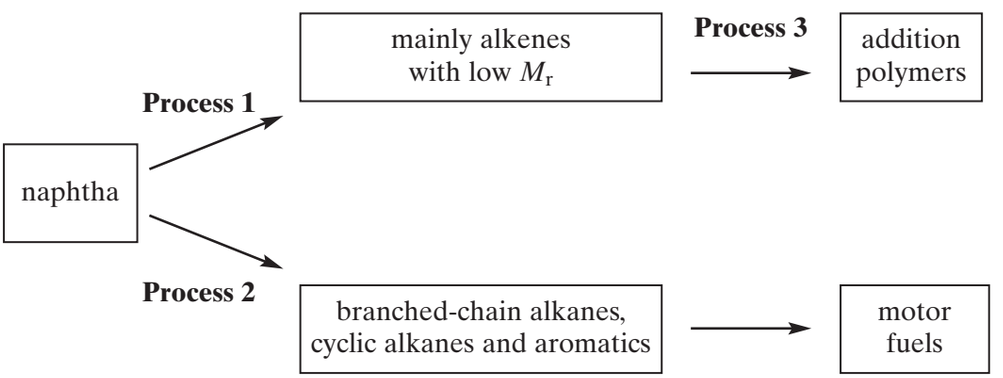
11

TURN OVER FOR THE NEXT QUESTION

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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