ERRATUM NOTICE

General Certificate of Education
June 2007

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

Wednesday 6 June 2007 9.00 am to 10.00 am

Instructions to Invigilators

Before the start of the examination please ask candidates to amend their question papers as follows. (Please read out this message twice to ensure understanding.)

Turn to page 6, question 3 (a)(i)

The word 'occurring' has been misspelt as 'occuring'.
Insert the letter 'r' after the first letter 'r' so
that the word reads 'occurring'.

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Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Education
June 2007
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Wednesday 6 June 2007 9.00 am to 10.00 am

For this paper you must have
- 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.
- Answer the questions in **Section A** and **Section B** in the spaces provided.
- 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			
2			
3			
4			
5			
6			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

There are no questions printed on this page

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SECTION A

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

1 (a) Petroleum contains a mixture of hydrocarbons. The mixture can be separated into fractions by fractional distillation.

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

.....

.....

(ii) State the two physical changes which occur during fractional distillation.

Change 1 .....

Change 2 .....

(3 marks)

(b) The cracking of fractions obtained from petroleum can lead to high yields of ethene. Ethene can be polymerised to form poly(ethene). Ethene can also be oxidised to form the very reactive compound epoxyethane.

(i) Draw the structure of the repeating unit of poly(ethene).

(ii) State why epoxyethane is a very reactive compound.

.....

.....

(iii) Name the product formed when epoxyethane reacts with water.

.....

(3 marks)

6

Turn over ►

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2 The cracking of alkanes gives useful products such as motor fuels and alkenes.

(a) (i) Name the type of reactive intermediate formed during the catalytic cracking of alkanes.

.....

(ii) Identify a catalyst used in catalytic cracking.

.....

(2 marks)

(b) (i) Name the type of reactive intermediate formed during the thermal cracking of alkanes.

.....

(ii) Write an equation for the thermal cracking of one molecule of the alkane $C_{10}H_{22}$ to produce a different alkane and propene only.

.....

(2 marks)

(c) Motor fuels contain cyclohexane, C_6H_{12}

(i) State which of the two types of cracking is more likely to produce cyclohexane as one of the products.

.....

(ii) State the conditions necessary for cyclohexane to undergo complete combustion.

.....

(iii) Draw the structure of cyclohexane.

(iv) Write an equation for the incomplete combustion of C_6H_{12} to form carbon and water only.

.....

(4 marks)

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(d) The burning of fuels in a petrol engine produces some carbon monoxide and some nitrogen monoxide.
These two gases are atmospheric pollutants which can be removed by the use of a catalytic converter.

(i) Write an equation for the reaction in which nitrogen monoxide is formed in a petrol engine. State **one** essential condition for this reaction to occur.

Equation .....

Condition .....

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

.....

(iii) Write an equation to show how carbon monoxide and nitrogen monoxide react together in a catalytic converter.

.....

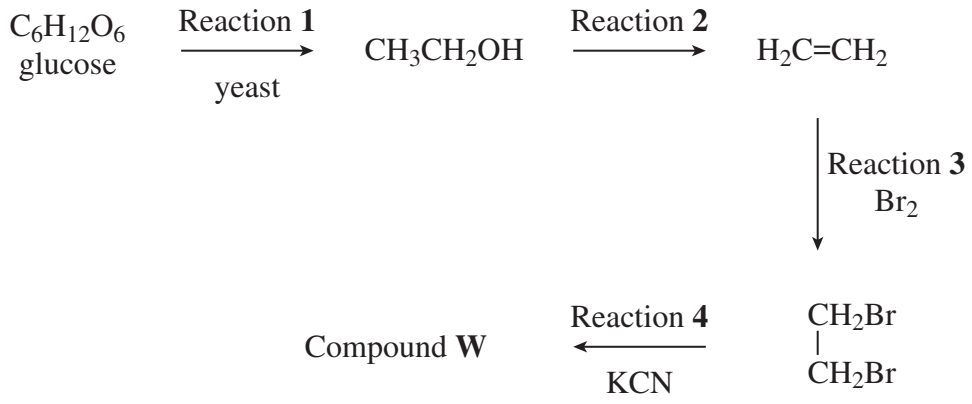
(4 marks)

12

Turn over for the next question

LEAVE MARGIN BLANK

3 Consider the following sequence of reactions.



(a) (i) Name the process occuring in Reaction **1**.

.....

(ii) Write an equation for Reaction **1** and state a suitable temperature for this process to occur.

Equation

Suitable temperature .....

(3 marks)

(b) Name the type of mechanism in Reaction **2**.

.....

(1 mark)

(c) Outline a mechanism for Reaction **3**.

(4 marks)

LEAVE MARGIN BLANK

(d) Compound **W** is formed in Reaction **4**.

(i) Name the type of mechanism in Reaction **4**.

.....

(ii) Draw the structural formula of compound **W** (M_r = 80.0), showing all of the bonds in the molecule.

.....

(2 marks)

10

Turn over for the next question

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4 Isomers are compounds with the same molecular formula.

(a) Compound **X** is the alcohol $CH_3CH(OH)CH_3$

(i) Name compound **X**.

.....

(ii) Draw the structure of the position isomer of compound **X**.

(2 marks)

(b) Compound **Y** is the alkene $(CH_3)_2C{=}C(CH_3)_2$

(i) Name compound **Y**.

.....

(ii) Draw the structure of a straight-chain isomer of compound **Y**.

(2 marks)

(c) Compound **Z** is the ketone $CH_3CH_2COCH_2CH_3$

(i) Name compound **Z**.

.....

(ii) Draw the structure of a functional group isomer of compound **Z** which contains a C=O group.

(2 marks)

LEAVE MARGIN BLANK

(d) (i) Name the type of stereoisomerism shown by 1,2-dibromoethene.

.....

(ii) Draw and name the two stereoisomers of 1,2-dibromoethene.

*Stereoisomer **1***

*Stereoisomer **2***

Name ..... *Name* .....

(3 marks)

(e) What feature of the double bond in 1,2-dibromoethene prevents Stereoisomer **1** from changing into Stereoisomer **2**?

.....

(1 mark)

10

Turn over for the next question

LEAVE MARGIN BLANK

5 The following table shows some carboxylic acids which occur in nature.

Name	Structure
Stearic acid	$CH_3(CH_2)_{16}COOH$
Linoleic acid	$CH_3(CH_2)_4CH{=}CHCH_2CH{=}CH(CH_2)_7COOH$
Ricinoleic acid	$CH_3(CH_2)_4CH_2CH(OH)CH_2CH{=}CH(CH_2)_7COOH$

(a) Give the molecular formula of stearic acid.

.....

(1 mark)

(b) (i) Give the empirical formula of linoleic acid.

.....

(ii) Identify the reagent and catalyst needed to convert linoleic acid into stearic acid.

Reagent .....

Catalyst .....

(3 marks)

(c) Linoleic acid can be converted into ricinoleic acid.

(i) Name the type of reaction involved.

.....

(ii) Suggest why this reaction leads to the formation of more than one organic product.

.....

.....

(2 marks)

(d) Ricinoleic acid has an alcohol functional group. Identify the class of alcohols to which ricinoleic acid belongs.

.....

(1 mark)

7

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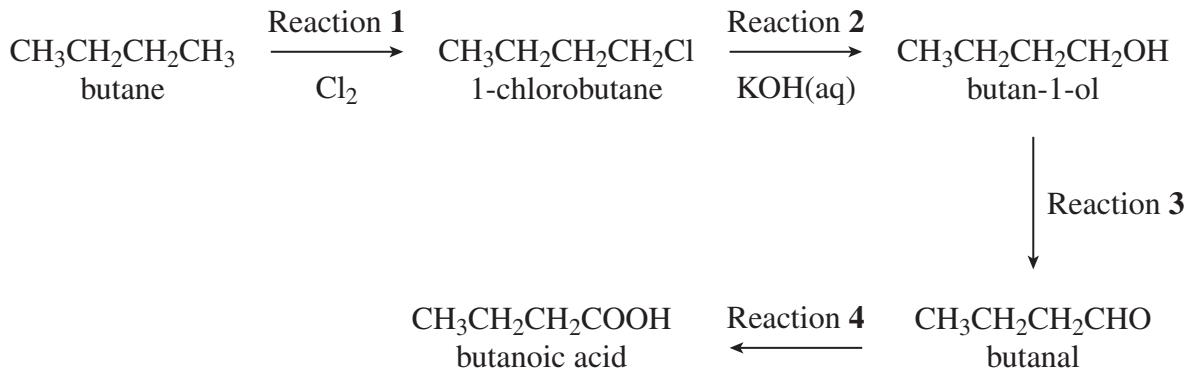
SECTION B

Answer the question below in the space provided on pages 12 to 14 of this booklet.
You should answer part (a) on page 12, part (b) on page 13 and part (c) on page 14.

6 Consider the following sequence of reactions.



(a) The type of mechanism for Reaction **1** is the same as that for the chlorination of methane. Identify the type of reactive intermediate and state the conditions for this reaction.
Give the name of each step in this type of mechanism.
Write an overall equation for the reaction that occurs when C_4H_{10} reacts with a large excess of chlorine to form C_4Cl_{10}

(6 marks)

(b) In Reaction **2**, a nucleophile reacts with 1-chlorobutane to form butan-1-ol as the main organic product. State what is meant by the term *nucleophile*.
Identify the nucleophile in Reaction **2** and the feature of the 1-chlorobutane molecule which makes it susceptible to nucleophilic attack.
Give **one** change to the reaction conditions for Reaction **2** so that the main organic product is but-1-ene rather than butan-1-ol.

(4 marks)

(c) Reactions **3** and **4** are of the same type. For these two reactions, state the type of reaction involved, identify a suitable reagent or combination of reagents and state how a high yield of butanoic acid can be obtained.
Outline a simple chemical test to detect the presence of any unreacted butanal in the final reaction mixture.

(5 marks)

END OF QUESTIONS

LEAVE MARGIN BLANK

Write your answer to Question 6(a) on this page.

LEAVE MARGIN BLANK

Write your answer to Question 6(b) on this page.

LEAVE MARGIN BLANK

Write your answer to Question 6(c) on this page.

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June 2007
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CHEMISTRY **CHM3/W**
Unit 3(a) Introduction to Organic Chemistry

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.

Key

relative atomic mass

atomic number

6.9 **Li** Lithium 3

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 †															

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