Surname		Other	Names			
Centre Number			Candida	ate Number		
Candidate Signature						

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General Certificate of Education June 2005 Advanced Subsidiary Examination



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

Wednesday 8 June 2005 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 12½ per cent of the total marks.
- You are expected to use a calculator where appropriate.
- The following data may be required. Gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
- Your answers to the 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

APW/0205/CHM3/W

• You are advised to spend about 45 minutes on **Section A** and about 15 minutes on **Section B**.

	For Exam	iner's Use	
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
Total (Column	1)	→	
Total (Column	2)	\rightarrow	
TOTAL			
Examine	r's Initials		

SECTION A

Answer all questions in the spaces provided.

1	The	petrol	is separated into fractions by fractional distillation. fraction (C_4 to C_{12}) is burned in internal combustion engines and the naphtha C_7 to C_{14}) is cracked.
	(a)		oleum is separated into fractions when it is heated and the vapour mixture is passed a fractionating column.
		(i)	Explain what is meant by the term <i>fraction</i> as applied to fractional distillation.
		(ii)	State a property of the molecules in petroleum which allows the mixture to be separated into fractions.
		(iii)	Describe the temperature gradient in the column.
			(3 marks)
	(b)	The	fractions from petroleum contain alkane hydrocarbons.
		(i)	Write an equation for the incomplete combustion of the alkane C_8H_{18} to produce carbon monoxide and water only.
		(ii)	One isomer of C_8H_{18} is 2,2,3-trimethylpentane. Draw the structure of this isomer.

(2 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.

-	=											=	≥	>	5	=	0	
1.0 T Hydrogen			Key														4.0 He Helium 2	
6.9 L	9.0 Be		relative a	relative atomic mass		6.9 Li						10.8 B	12.0 C	14.0 Z	0.9	19.0 F	20.2 Ne	
Lithium 3	Beryllium 4		atomic number	mber —		Lithium 3						Boron 5	Carbon 6	Carbon Nitrogen 6 7	Oxygen 8	Fluorine	Neon 10	
23.0 Na	24.3 Mg	1										27.0 Al	28.1 Si	31.0 P	32.1 S	ت ₂ 2	39.9 Ar	
Sodium 11	Magnesium 12											Aluminium 13	Silicon 14	Phosphorus 15	Sulphur 16	Chlorine 7	Argon 18	
39.1 7	40.1 Ca	45.0 Sc	47.9 Ti	50.9 V	52.0 Ç	54.9 Mn	55.8 Fe	8.0 6.0				69.7 Ga	72.6 Ge	74.9 As	79.0 Se	9.9 Br	83.8 Kr	3
Potassium 19	Calcium 20	Scandium 21	Titanium 22	Vanadium 23		Manganese 25	lron 2.	Cobalt 7	Nickel 28		Zinc 30	Gallium 31	Germanium 32	Germanium Arsenic Selenium I 32 34 38	Selenium 34	3romine 5	Krypton 36	
85.5 Rb	87.6 Sr	88.9 \	91.2 Zr	92.9 Nb	95.9 Mo	98.9 Tc	101.1 Ru	02.9 Rh		107.9 Ag	112.4 Cd	114.8 In	118.7 Sn	121.8 Sb	127.6 Te	56.9 -	131.3 Xe	
Rubidium 37	_	Yttrium 39	_	Niobium 41	Molybdenum 42		Ruthenium 44	Rhodium 5	Palladium 46		Cadmium 48	Indium 49	Tin 50	Antimony 51	Tellurium 52	lodine 3	Xenon 54	
132.9 Cs	137.3 Ba	138.9 La	178.5 Hf	180.9 Ta	183.9 W	186.2 Re	190.2 Os	92.2 Ir	195.1 Pt	197.0 Au	200.6 Hg	204.4 TI	207.2 Pb	209.0 Bi	.10.0 8	210.0 At	222.0 Rn	
Caesium 55	_	Lanthanum 57 *	Hafnium 72	Tantalum 73	Tungsten 74	_	Osmium 76	Iridium 7			Mercury 80			Bismuth 83	Polonium 34	Astatine 85	Radon 86	
223.0 Fr	226.0 Ra	227 Ac																
Francium 87	Radium 88	ĕ 68										_						

140.1 Ce	40.1 140.9 144.2 Ce Pr Nd	144.2 Nd	و. ع	150.4 Sm	150.4 152.0 Sm Eu	157.3 Gd		162.5 Dy	164.9 Ho	167.3 Er	168.9 Tm	173.0 Yb	175.0 Lu
Cerium 58	Praseodymium Neodymium Pron 59 60 61	Neodymium 60	Promethium 61	Samarium 62	Europium 63	Gadolinium Terbium 64 65		Dysprosium 66	Holmium 37	Erbium 68	Thulium 69	Ytterbium 70	Lutetium 71
232.0	231.0	238.0	232.0 231.0 238.0 237.0 239.1 243.1 24	239.1	243.1	47.1	247.1 2	:52.1	(252)	257)	(258)	(259)	(260)
Th	Pa	U	Th Pa U Np Pu Am	Pu	Am	Cm	BK	Cf	Es	Fm	Md	No	Lr
Thorium	Protactinium 91	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Lawrencium
90		92	93	94	95	3	97	98	99	00	101	102	103

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_3 CH	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

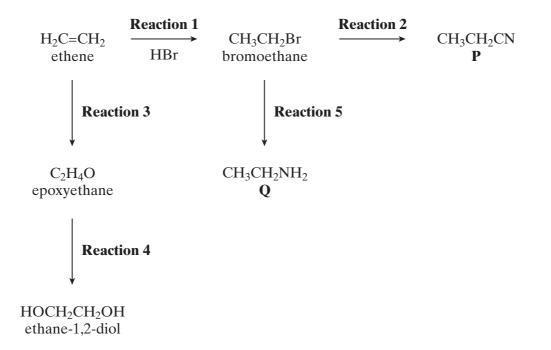
Bond	Wavenumber/cm ⁻¹
С—Н	2850-3300
С—С	750–1100
C=C	1620–1680
C=O	1680–1750
С—О	1000-1300
O—H (alcohols)	3230–3550
O—H (acids)	2500–3000

	(1 mark)
(i)	Give the type of reactive intermediate formed during catalytic cracking.
(ii)	Identify a catalyst used in catalytic cracking.
	(2 marks)
(i)	Give the type of reactive intermediate formed during thermal cracking. State how this reactive intermediate is formed.
	Reactive intermediate
	How intermediate is formed
(ii)	Identify the different type of hydrocarbon produced in a high percentage by the thermal cracking of alkanes.
(ii)	Identify the different type of hydrocarbon produced in a high percentage by



TURN OVER FOR THE NEXT QUESTION

2 Consider the following scheme of reactions.



(a) In **Reaction 1**, ethene undergoes electrophilic addition with hydrogen bromide.

(i)	State what is meant by the term <i>electrophile</i> .

(ii) Outline a mechanism for this reaction.

(5 marks)

(b)	Epox	xyethane is formed from ethene in Reaction 3 .
	(i)	Identify a reagent and a catalyst for this reaction.
		Reagent
		Catalyst
	(ii)	Draw the structure of epoxyethane.
	(iii)	Identify a reagent which will react with epoxyethane to form ethane-1,2-diol in Reaction 4 .
		(4 marks)
(c)	In R	eactions 2 and 5, bromoethane undergoes nucleophilic substitution.
	(i)	Identify a reagent for Reaction 2 . Name the organic product, P .
		Reagent for Reaction 2
		Name of product P
	(ii)	Identify a reagent for Reaction 5 . Name the organic product, Q .
		Reagent for Reaction 5
		Name of product $oldsymbol{Q}$
	(iii)	Outline a mechanism for Reaction 5 .

(8 marks)



NO QUESTIONS APPEAR ON THIS PAGE

3 Consider the following reaction in which an alkene is formed from a haloalkane.

 $CH_3CHBrCH_2CH_3 + KOH \xrightarrow{heat} CH_3CH=CHCH_3 + KBr + H_2O$ ethanol solvent but-2-ene

(a) Name the haloalkane used in this reaction.

		(1 mark)

(b) Name and outline a mechanism for this reaction.

Name of mechanism	
-------------------	--

Mechanism

(4 marks)

(c) Another alkene, which is a structural isomer of but-2-ene, is also formed during this reaction.

(1)	State what is meant by the term structural isomers.

(ii) Draw the structure of this other alkene.

(2 marks)

- 4 Many naturally-occurring organic compounds can be converted into other useful products.
 - (a) Glucose, $C_6H_{12}O_6$, can be fermented to make ethanol, which can then be dehydrated to make the unsaturated compound, ethene.

(1)	write an equation for the fermentation of glucose to form ethanol.
(ii)	Identify a catalyst for the dehydration of ethanol to form ethene. Write an equation for this reaction.
	Catalyst
	Equation(3 marks)
_	table oils, which contain unsaturated compounds, are used to make margarine ify a catalyst and a reagent for converting a vegetable oil into margarine.
Catal	yst
Regar	ont

(b)

(2 marks)

(c) Oleic acid can be obtained from vegetable oils. Oleic acid is an example of an unsaturated compound.

CH₃(CH₂)₇CH=CH(CH₂)₇COOH oleic acid

(i)	Deduce the molecular formula and the empirical formula of oleic acid.
	Molecular formula
	Empirical formula
(ii)	State what is meant by the term <i>unsaturated</i> .
(iii)	Identify a reagent for a simple chemical test to show that oleic acid is unsaturated. State what you would observe when oleic acid reacts with this reagent. **Reagent**
	Observation with oleic acid
	(5 marks)

 $\left(\frac{10}{10}\right)$

TURN OVER FOR THE NEXT QUESTION

SECTION B

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

5 Chlorination of ethane follows a free-radical substitution mechanism. This mechanism is similar to that which occurs when methane is chlorinated. The overall equation for the reaction of ethane to form chloroethane is given below.

$$C_2H_6 + Cl_2 \longrightarrow C_2H_5Cl + HCl$$

State the conditions and outline a mechanism for this reaction. Show how butane can be formed in this reaction. (5 marks)

6 Some alcohols can be oxidised to form aldehydes, which can then be oxidised further to form carboxylic acids.

Some alcohols can be oxidised to form ketones, which resist further oxidation. Other alcohols are resistant to oxidation.

- (a) Draw the structures of the **two** straight-chain isomeric alcohols with molecular formula, $C_4H_{10}O$ (2 marks)
- (b) Draw the structures of the oxidation products obtained when the two alcohols from part (a) are oxidised separately by acidified potassium dichromate(VI).

 Write equations for any reactions which occur, using [O] to represent the oxidising agent.

 (6 marks)
- (c) Draw the structure and give the name of the alcohol with molecular formula $C_4H_{10}O$ which is resistant to oxidation by acidified potassium dichromate(VI). (2 marks)

END OF QUESTIONS

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1	2
1	1

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