CONWY

SCIENCE TUITION

WJEC A LEVEL

ALIPHATIC OXYGEN CONTAINING COMPOUNDS QUESTIONS I WITH ANSWERS

(a) Ethanol, usually referred to as 'alcohol', is the legal drug most commonly used by adults. However, it is a depressant and addiction to ethanol is the greatest medical problem resulting from the use of drugs.

It consists of a hydroxyl group, –OH, attached to an alkyl group.

(i) State a large scale use of ethanol other than in beers, wines and spirits. [1]

(ii) Phenol also contains a hydroxyl group but it is attached to a benzene ring.

State how and explain why the hydroxyl group in phenol behaves differently from that in ethanol. [2]

(iii) Give a chemical test to distinguish between ethanol and phenol, stating reagent(s) and observation(s). [2]

(b) Describe how you could prepare ethanal from ethanol. Your answer should include any reagents and essential experimental conditions. [3]

(c) (i) State what you would expect to observe when **each** of ethanal and propanone are added separately to the following: [4]

I. Tollens' reagent;
II. iodine in the presence of aqueous sodium hydroxide;
III. 2,4-dinitrophenylhydrazine.

(ii) Explain how the product of the reaction in *(c)*(i)III may be used to identify ethanal or propanone.

(d) When methane and chlorine are combined in sunlight, a reaction occurs with chloromethane as the main organic product. Write the mechanism for this reaction. [4]

(e) Starting with bromoethane, outline how you could prepare a sample of propylamine. Your answer should include any reagents and conditions needed for this conversion. [4]

Total [20]

Section B Total [40]

8.1 *(a)* (i) e.g. solvents / fuel / anti-bacterial uses [1]

(ii) Phenol is more acidic (1)
since phenoxide ion is stabilised by charge delocalisation (1)
[2]

(iii) Add $FeCl_3$ solution (1)
phenol changes colour to violet, ethanol no change (1)
(accept bromine water / acidified potassium dichromate)
[2]

(b) Warm with acidified (1)
sodium dichromate (1)
distil from the reaction mixture as it forms (1)
[3]

(c) (i) Ethanal silver mirror, propanone no change (1)
(ii) Both form pale yellow crystals (1)
(iii) Both form yellow-orange precipitate (1)
(iv) By determining the characteristic melting point of the 2,4-dintrophenylhydrazone (1)
[4]

(d) $Cl_2 \longrightarrow 2Cl\cdot$ (1)
$CH_4 + Cl\cdot \longrightarrow CH_3\cdot + HCl$ (1)
$CH_3\cdot + Cl_2 \longrightarrow CH_3Cl + Cl\cdot$ (1)
$CH_3\cdot + CH_3\cdot \longrightarrow C_2H_6$ (1)

(accept any termination equation) [4]

Reflux with potassium cyanide in ethanol (to form propanenitrile) (2)
React with $LiAlH_4$ in ether to form propylamine. (2)
[4]

Total [20]

Section B Total [40]

SECTION B

Answer **both** *questions in the separate answer book provided.*

4 *(a)* Two organic compounds **P** and **Q** are to be identified.

(i) **P** produced effervescence when added to saturated sodium hydrogencarbonate solution.
Q gave an orange precipitate with 2,4-dinitrophenylhydrazine and a pale yellow precipitate with iodine in alkaline solution.
Identify the groups in **P** and **Q** whose presence is confirmed by these tests. [2]

(ii) The two compounds produced the following *m/z* peaks in a mass spectrometer:

1st spectrum 60, 45, 15 2nd spectrum 58, 43, 28, 15.

State the relative molecular masses of the two compounds. [1]

(iii) Using all the information in (i) and (ii), identify the two compounds **P** and **Q**, giving full reasons for your choice. Your answer should state which mass spectrum corresponds to **P** and which to **Q** and include the identity of the ion responsible for each peak in the two mass spectra. [6]

(b) Propanoic acid has the formula CH_3CH_2COOH.

(i) List the peaks which would be found in the NMR spectrum of propanoic acid. For each peak give the approximate chemical shift (ppm) and the splitting of the peak. [3]

(ii) Explain why propanoic acid is completely soluble in water but butanoic acid, $CH_3CH_2CH_2COOH$, is less soluble. [2]

(iii) State the reagent(s) and conditions necessary to convert propanoic acid into

I. ethane, [2]
II. propan-1-ol, [2]
III. propanoyl chloride. [2]

Total [20]

Section B

2 (a) (i) $NaHCO_3$ shows **P** is carboxylic acid / -COOH (1)
2,4-DNPH shows carbonyl (½)
Iodine in alkali shows **Q** is methyl carbonyl / CH3CO- (½)
((1) for CH3CO- with no explanation) [2]

(ii) 1st spectrum 60 2nd spectrum 58
2 × (½) [1]

(iii) Carboxylic acid group $COOH^+$ m/e 45 (1)
Methylcarbonyl group CH_3CO^+ m/e 43 (1)

Probable that 1st spectrum is acid (**P**), 2nd spectrum is methylcarbonyl (**Q**) (1)

60 – 45 = 15 must be CH_3^+ as other group in acid (½)
or
58 - 43 = 15 must be CH_3^+ in methyl carbonyl

43 – 15 = 28 must be CO^+ (½)

Compounds are ethanoic acid (**P**) and propanone (**Q**) 2 x (1)
(Lose one (½) if no mention at all of positive charges on peak(s))
[6]

(b) (i) 3 ×(½) for splitting + (½) for shift) [3]

COOH	no splitting	11 ppm
CH_3 -	triplet	0.2 to 2.0 ppm
- CH_2 – CO-	quadruplet	2 to 3 ppm

(ii) Hydrogen bonding to (corresponding OH) dipoles on water. (1)
Longer (alkyl) chain length in butanoic acid decreases effectiveness of hydrogen bonding. (1) [2]

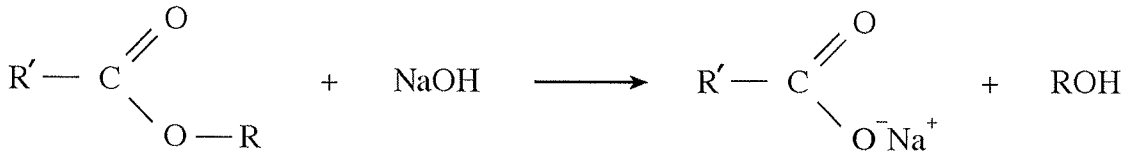
(iii) State the reagent(s) and conditions necessary to convert propanoic acid into
I. Heat (1) (not reflux) with sodalime (1) [2]

II. $LiAlH_4$ (1) in dry ether (½) at room temperature (½) [2]

III. PCl_5 / $SOCl_2$ (1) dry conditions (½)
at room temperature (½) [2]

Total [20]

3. *(a)* Esters are hydrolysed by aqueous sodium hydroxide.



One way to identify an ester is to hydrolyse it with an excess of aqueous sodium hydroxide and then to titrate the excess sodium hydroxide with an acid.

3·52 g of an ester **N** was added to an aqueous solution of sodium hydroxide containing a total of 0·0800 mole of sodium hydroxide.

The excess sodium hydroxide was exactly neutralised by 25·0 cm^3 of hydrochloric acid of concentration 1·60 mol dm^{-3}, according to the following equation.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

(i) I. Calculate the number of moles of hydrochloric acid used in the reaction with the excess of sodium hydroxide.

.....

.....

II. State the number of moles of sodium hydroxide in excess.

.....

III. Calculate the number of moles of sodium hydroxide that have reacted with the ester.

.....

.....

IV. State the number of moles of ester present.

.....

[2]

(ii) Calculate the relative molecular mass of the ester. [1]

.....

.....

(iii) Give a graphic formula for the ester. [1]

(b) Complete the table below by giving the products formed when **butanone** reacts with the reagents listed and the reagent(s) needed to give the product shown. [3]

Reagent(s)	*Organic product (if any)*
$NaBH_4$	
acidified $K_2Cr_2O_7$	
	yellow antiseptic smelling solid

(c) A molecule of nonane, C_9H_{20}, is cracked to produce two molecules of ethene and one molecule of a third product, compound **T**.

(i) Find the molecular formula of compound **T**. [1]

.....

(ii) Compound **T** is a branched chain isomer. Give a graphic formula for compound **T** and name your chosen compound. [2]

.....

Total [10]

Section A Total [35]

3. (a) (i) I Number of moles of hydrochloric acid used $= \frac{1.60 \times 25.0}{1000} = 0.0400$ (½)

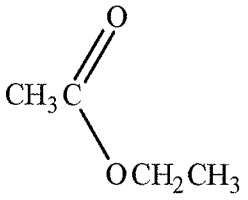
II (Mole ratio NaOH : ester is 1 : 1)
∴ number of moles of the ester = 0.0400 (½)

III Number of moles of sodium hydroxide that have reacted with the ester = 0.0800 – 0.0400 = 0.0400 (½)

IV (Mole ratio NaOH : ester is 1 : 1)
∴ number of moles of the ester = 0.0400 (½) [2]

(ii) M_r of the ester $= \frac{\text{mass}}{\text{moles}} = \frac{3.52}{0.0400} = 88$ [1]

(iii) Ester could be any of these [1]



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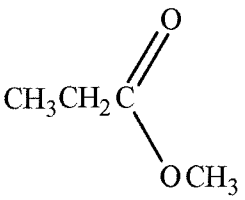

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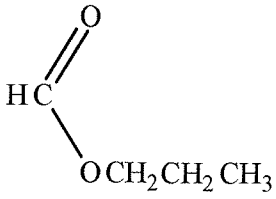

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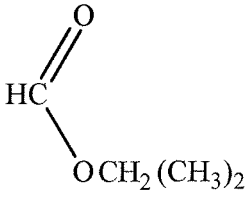


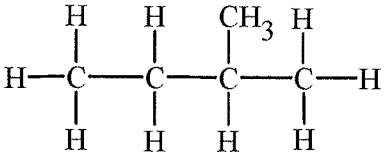
(b)

Reagent(s)	*Organic product (if any)*
$NaBH_4$	butan-2-ol (1)
acidified $K_2Cr_2O_7$	no reaction (1)
I_2/NaOH or NaOCl/KI (1)	yellow antiseptic smelling solid

[3]

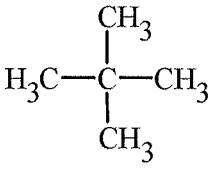
(c) (i) C_5H_{12} [1]

(ii)



2-methylbutane

or



(2,2)-dimethylpropane (1)

(1)

[2]

Total [10]
Total Section A [35]