GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2014

GCE CHEMISTRY – CH4

SUMMER 2014 MARK SCHEME

SECTION A

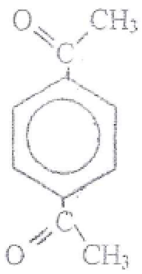
Q.1 (a) (i) $CH_3CH_2CH_2CH_2CH_3 + Cl_2 \rightarrow CH_3CH_2CH_2CH_2CH_2Cl + HCl$ [1]

(ii) $CH_3CH_2CH_2\dot{C}HCH_3$ [1]

(b) (Anhydrous) aluminium chloride / iron(III) chloride allow $AlCl_3$ / $FeCl_3$ [1]

(c) (i) orange / red precipitate [1]

(ii)



(1) —$COCH_3$ groups in any positions

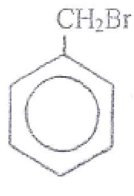
It must contain a C=O group but it is not an aldehyde as it does not react with Tollens' reagent (1) [2]

(d) (i) (Alkaline) potassium manganate(VII) (solution) allow $KMnO_4$ / MnO_4^- [1]

(ii) Dilute acid allow HCl / H^+ [1]

(iii) Lithium tetrahydridoaluminate(III) / lithium aluminium hydride allow $LiAlH_4$ [1]

(iv)

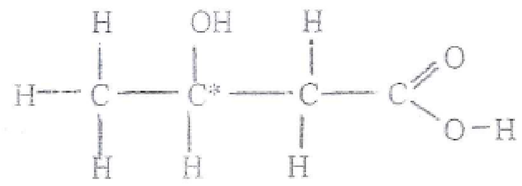


[1]

(e) Only the infrared spectrum of benzoic acid would have a peak at 1650–1750 cm^{-1} (1)
This is due to the carbonyl group present in the benzoic acid (1) [2]

Total [12]

Q.2 (a)



[1]

(b) (i) Acidified potassium dichromate allow H^+, $Cr_2O_7^{2-}$ [1]

(ii) I An equimolar mixture of two enantiomers / optical isomers
do not accept 'equal mixture' [1]

II It has no (apparent) effect on the plane of polarised light [1]

(c) (i) But-2-enoic acid; this is because each of the carbon atoms of the double bond has two different groups / atoms
allow reason based on the other isomer [1]

(ii) Any TWO from the following for (1) each
reagent used / temperature / quantities / time of reaction / catalyst / solvent [2]

(d) Reagent(s) KOH / I_2 or NaOCl / KI (1) allow names
Observation Yellow precipitate (1) [2]

(e) The NMR spectrum will consist of two peaks, as there are two discrete 'areas' of protons; these will be seen at between 2.0 to 2.5 (CH_3) and between 2.5 to 3.0 (CH_2) (1)
The peak area ratio will be 3:2 for the CH_3 and CH_2 protons respectively (1)
There will be no splitting of either signal as the protons causing these signals are not bonded directly to other carbon atoms that also have protons (1)

1 max if only one peak described correctly [3]

QWC *Legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning.* [1]

Total [13]

Q.3 (a) (i) 2 mol of ethanol gives 1 mol of ethoxyethane (1)

Moles of ethanol $= \frac{69}{46} = 1.5$

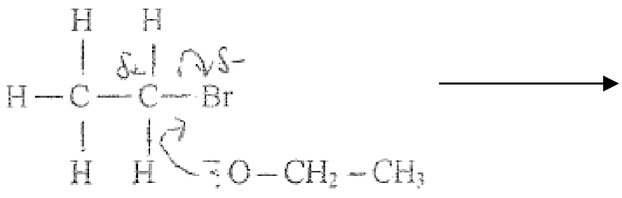
$\therefore$ Moles of ethoxyethane if theoretical yield $= 0.75$
$\therefore$ Moles of ethoxyethane if 45% yield $= 0.75 \times 0.45 = 0.34$ (1)

Mass of ethoxyethane $= 0.34 \times 74 = 25$g (1) allow error carried forward

[3]

(ii) Ethene / C_2H_4 [1]

(iii)

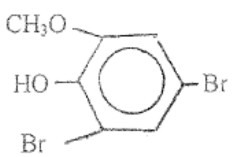


products

(1) for correct curly arrows (1) for correct δ^+ and δ^- [2]

(iv) They need to have an N–H / O–H / F–H bond / a highly electronegative atom bonded to hydrogen [1]

(b) (i) For example



[1]

Accept any polybrominated species
Do not accept a monobrominated species

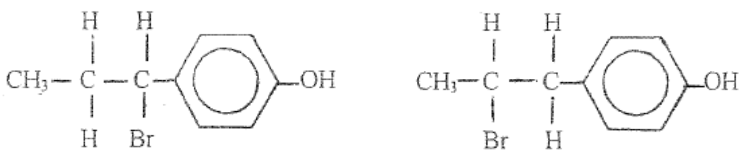
(ii) Bromine decolorised / orange to colourless / white solid [1]

(c) Reagent Iron(III) chloride solution / $FeCl_3$ (1)

Observation Purple coloration / solution (1) [2]

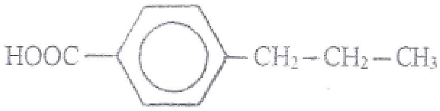
(d) (i) $C_{10}H_{12}O_1$ [1]

(ii)



[1]

(e) Displayed formula, for example



(1)

Functional group carboxylic acid (1) [2]

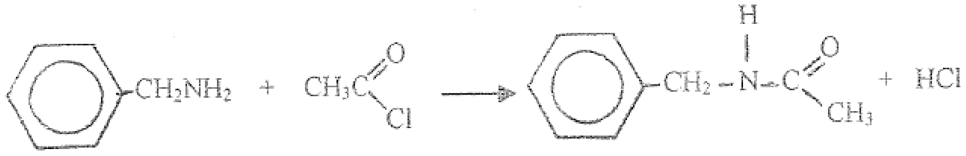
Total [15]

SECTION B

Q.4 (a) (i) (Fractional) distillation / (preparative) gas chromatography / HPLC / TLC column chromatography / solvent extraction [1]

(ii) the fragmentation pattern would be different / valid examples given [1]

(iii) I



[1]

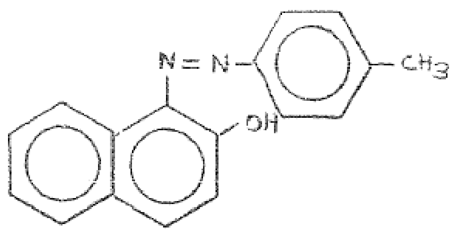
II Heated electrically / by a naked flame with a water bath (1)
Add compound **G** to the ethanol until the hot ethanol will (just) not dissolve any more solute (1)
Filter hot (1)
Allow to cool (1)
Filter (1)
Dry in air / window sill / < 60 ^{o}C in an oven (1) [5]

Maximum 4 out of 5 total if second marking point not given
Note 5 marks maximum here

QWC Information organised clearly and coherently, using specialist vocabulary where appropriate [1]

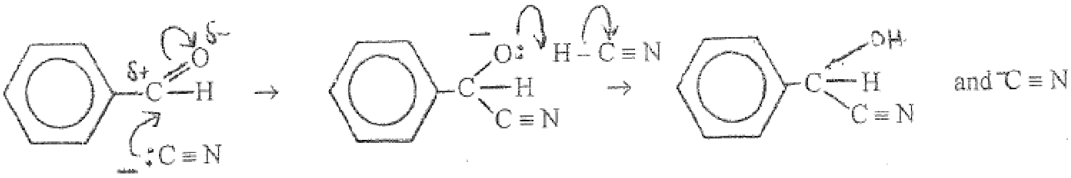
(iv) I The amine is reacted with sodium nitrite / HCl(aq) or nitrous acid (1)
at a temperature of < 10 ^{o}C (1) [2]

II



[1]

(b) (i) Nucleophilic addition (1)

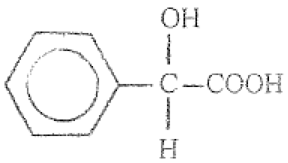


Accept a mechanism that shows HCN polarisation and nucleophilic addition as a concerted process

polarisation / charges shown (1) curly arrows on first structure (1)
regeneration of $^{-}C{\equiv}N$ or capture of H^+ and curly arrow (1) [4]

(ii) Chromophores (1)
The colour will be black (1) as the compound absorbs blue / other colours (1) [3]

(iii)



[1]

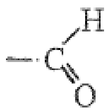
Total [20]

Q.5 (a)

	C 71.3	H 9.6	∴ O 19.1 (1)
÷ by A_r	$\frac{71.3}{12} = 5.94$	$\frac{9.6}{1.0} = 9.6$	$\frac{19.1}{16} = 1.193$
÷ smallest	$\frac{5.94}{1.193} = 5$	$\frac{9.6}{1.193} = 8$	$\frac{1.193}{1.193} = 1$ (1)

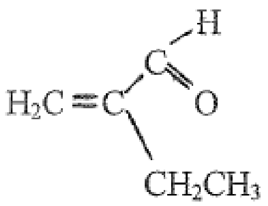
Only one oxygen atom per molecule

∴ Molecular formula is C_5H_8O (1)

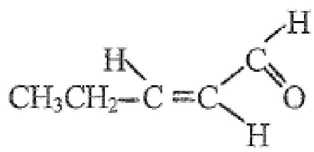
Silver mirror produced ∴  present (1)

Ion m/z 29 suggests ethyl group present / CH_3CH_2 (1)

Structure must be



or



(1)

[6]

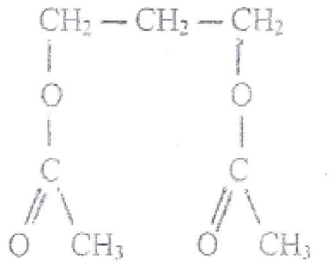
(b) (i) $C_{11}H_{24} \longrightarrow C_6H_{14} + C_2H_4 + C_3H_6$ [1]

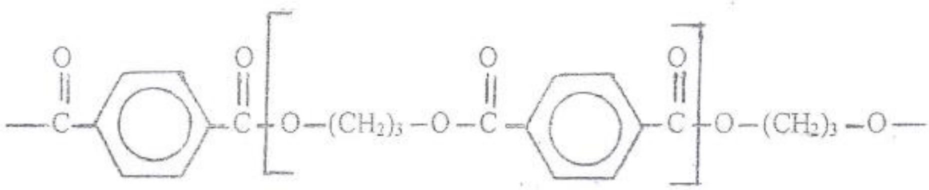
(ii) Total peak areas 26 + 13 + 46 = 85

% propene = $\frac{13 \times 100}{85}$ = 15.(3) [1]

(iii) Any THREE points for (1) each [3]

e.g. can it run at a lower temperature (reducing energy costs)
is the yield comparable / better than the yield from the propene process
is the time taken comparable / better than used in the propene process
is there a continued availability of starting materials
can the product be easily / better separated from the reaction mixture
is relatively more expensive equipment needed
is it a batch or continuous process

(iv)  [1]

(c) (i)  [1]

(ii) The production of PTT is an example of condensation polymerisation (1)
The production of poly(propene) is an example of addition polymerisation (1)
Condensation polymerisation needs bifunctional compounds / COOH,OH etc (1)

Addition polymerisation needs a $>C=C<$ present in the monomer (1)

Addition polymerisation has an atom economy of 100% (1)
Condensation polymerisation has an atom economy of < 100%
(as a co-product is formed) (1) [6]

QWC Selection of a form and style of writing appropriate to purpose and to complexity of subject matter [1]

Total [20]