Question - 01

Compounds **V**, **W**, **X** and **Y** are isomers with the molecular formula $C_5H_{10}O_2$

Isomers **V** and **W** are carboxylic acids with formulas that can be written as C_4H_9COOH

(a) Give an equation for the reaction of C_4H_9COOH with sodium hydrogencarbonate.

_____

(1)

(b) Isomer **V** has an asymmetric carbon atom.

Deduce the structure of **V**.

(1)

(c) Isomer **W** has four peaks in its ^1H NMR spectrum.

Deduce the structure of **W**.

Deduce the integration ratio for the four peaks in the ^1H NMR spectrum of **W**.

Structure

Integration ratio _____

(2)

(d) Isomer **X** has three singlets with integration ratio 1:3:6 in its ^1H NMR spectrum.

Deduce the structure of **X**.

Explain why the peaks in the ^1H NMR spectrum are singlets.

Structure

Explanation _____

_____

_____

(2)

(e) The table below shows information about the peaks in the ^{1}H NMR spectrum of isomer **Y**.

Chemical shift δ / ppm	Integration ratio	Splitting pattern
3.65	2	singlet
1.19	3	singlet

Draw the parts of the structure of **Y** that can be deduced from each of these peaks.

Deduce the structure of **Y**.

State how many peaks are in the ^{13}C NMR spectrum of **Y**.

Part of structure from peak at δ = 3.65 ppm

Part of structure from peak at δ = 1.19 ppm

Structure of **Y**

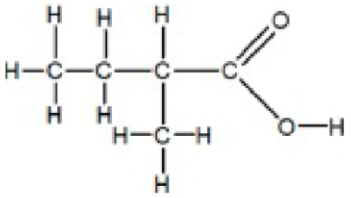
Number of peaks in ^{13}C NMR spectrum of **Y** _____

(6)

(a) $C_4H_9COOH + NaHCO_3 \rightarrow C_4H_9COONa + CO_2 + H_2O$

1

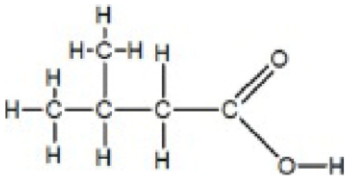
(b)



$CH_3CH_2CH(CH_3)COOH$

1

(c) **M1**



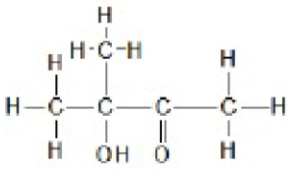
M1 $(CH_3)_2CHCH_2COOH$

M2 6:1:2:1 (Any order)

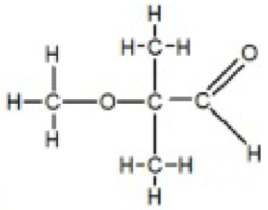
M2 Allow ECF for a 5 carbon carboxylic acid

2

(d) **M1**



Or



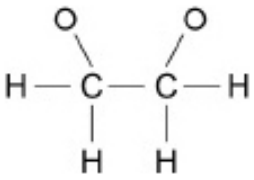
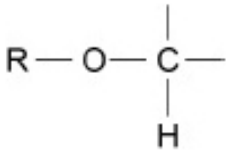
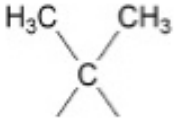
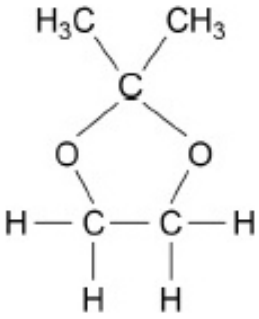
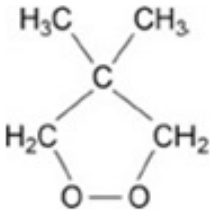
M2

Adjacent C has no (non-equivalent) H attached (so no splitting/spin-spin coupling takes place)

M1 $(CH_3)_2C(OH)COCH_3$ *or* $CH_3OC(CH_3)_2CHO$

2

(e)

	Scores M1 and M2	Allow M1 for	
	Scores M3 and M4	Allow M3 for	RCH_3
	Scores M5		This structure also scores M5 
^{13}C peaks	= 3	M6	Allow ECF from their M5 of $C_5H_{10}O_2$

6

Question - 02

This question is about isomers with the molecular formula $C_5H_{10}O$

(a) Draw the skeletal formula of a branched chain aldehyde with molecular formula $C_5H_{10}O$ that is optically active.

(1)

(b) Describe how you distinguish between separate samples of the two enantiomers of the branched chain aldehyde $C_5H_{10}O$

_____

_____

_____

_____

_____

_____

(2)

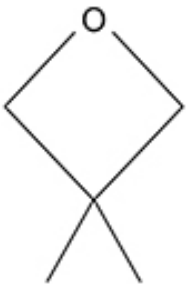
(c) Draw the *E* and *Z* forms of a structural isomer of $C_5H_{10}O$ that shows **both** optical and geometric isomerism.

E isomer	*Z* isomer

(2)

(d) Isomer J is cyclic and has an ether functional group (C–O–C)
Isomer J has only three peaks in its ^{13}C NMR spectrum.

Isomer J



Draw **two** other cyclic isomers of $C_5H_{10}O$ that have an ether functional group and only three peaks in their ^{13}C NMR spectra.

(2)

(a)

1

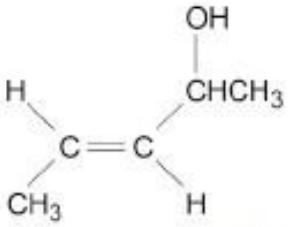
(b) Use Plane polarised light

M1

rotates (the plane of) in opposite directions

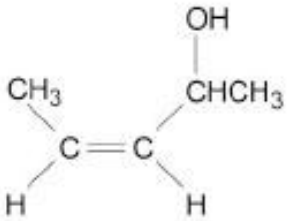
M2

(c)



Must be E isomer

M1



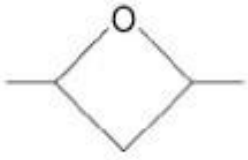
Must be Z isomer

Allow 1 mark out of 2 for 2 correct structures but shown in the wrong boxes

M2

(d)

M1



M2