Mark schemes

Q1.

(a) **M1** + 3 C_2H_6

M2 Zeolite/Aluminosilicate/Aluminium oxide

2

(b) Option B

1

(c) Alkenes

1

(d) **M1** Initial volume O_2 = 0.21 × 1350 = 283.5 (cm^3)

Alternative route:
M1 Vol Air decreases by 6.5 × 20 = 130 cm^3

M2 Volume of O_2 remaining = M1 - (6.5 × 20) = 153.5 cm^3

M2 = 1220 cm^3

M3 Volume of CO_2 formed = 20 × 4 = 80 cm^3

M3 Vol CO_2 produced = 4 × 20 = 80 cm^3

M4 Total volume of gas left = M2 + M3 + (0.79 × 1350) = 1300 cm^3

M4 Total Vol Air + CO_2 = 1220 + 80 = 1300 cm^3

4

(e) **M1** Acid rain

M1 Allow damages (limestone) buildings or statues/death of aquatic organisms/air pollution

M2 CaO or $CaCO_3$

2

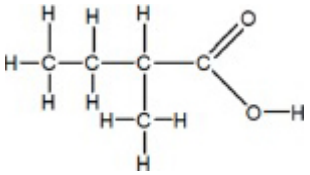
[10]

Q2.

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

1

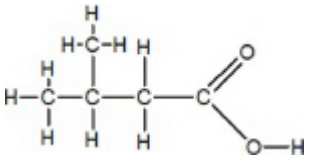
(b)



$CH_3CH_2CH(CH_3)COOH$

1

(c) **M1**



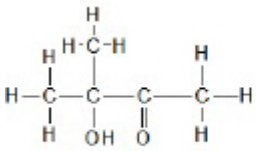
M1 $(CH_3)_2CHCH_2COOH$

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

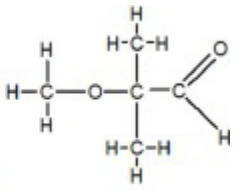
M2 Allow ECF for a 5 carbon carboxylic acid

2

(d) **M1**



Or



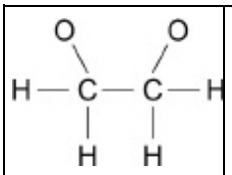
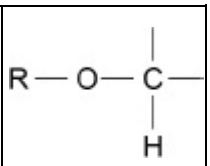
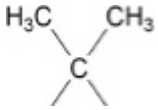
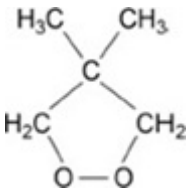
M2

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

[12]

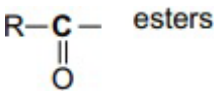
Q3.

(a) C=O

1

(b) Tick in the box for 7 ONLY

1

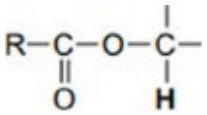
(c)  esters

Ignore acids

1

(d) M1 (Quartet) because neighbouring C has 3H

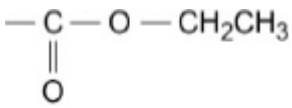
M2 (At δ = 4.1 ppm) because connected to single bonded O of ester or



M3 (Triplet) because neighbouring C has 2H

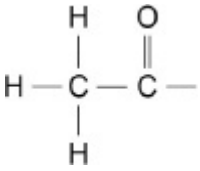
M4 (At δ = 1.26 ppm) because R_2CH_2 or RCH_3

M5



Ignore use of integration

5

(e) 

1

(f) Cannot deduce splitting patterns of peaks (at about δ = 2.60)

Or

No integration values

Allow

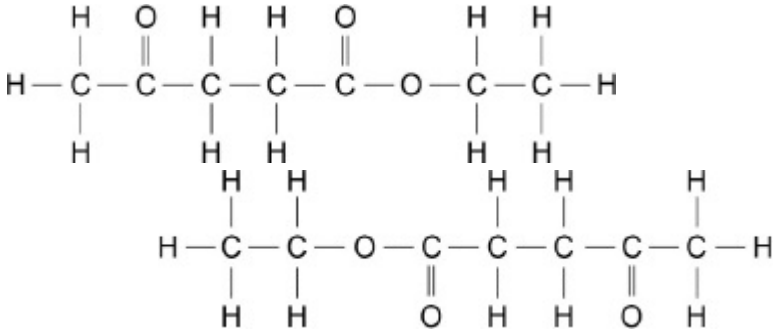
Peaks at δ = 2.60 and δ = 2.56 ppm overlap

OR

spectrum at δ = 2.60 is second order

1

(g)



1

[11]

Q4.

This question is marked using Levels of Response. Refer to the Mark Scheme Instructions for Examiners for guidance.

Level 3 **5-6 marks**	All stages are covered and each stage is generally correct and virtually complete. Answer is communicated coherently and shows a logical progression from Stage 1 to Stages 2 and 3 Covers at least 1 point for stage 1, 3 for stage 2 and 3 for stage 3.
Level 2 **3-4 marks**	All stages are covered but stage(s) may be incomplete or may contain inaccuracies Covers at least 1 point for stage 1 stage 2 and stage 3. OR two stages are covered and are generally correct and virtually complete. Covers at least 1 point for stage 1, and 3 for stage 2 or stage 3 OR 3 for stage 2 and 3 for stage 3 Answer is communicated mainly coherently and shows a logical progression from Stage 1 to Stages 2 and 3.
Level 1 **1-2 marks**	Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR only one stage is covered but is generally correct and virtually complete. Answer includes isolated statements but these are not presented in a logical order.
0 marks	Insufficient correct chemistry to gain a mark.

Indicative Chemistry content

Stage 1: infrared
1a) (broad peak) at 3400 cm^{-1} (any value from 3230-3550) indicates OH in alcohols
1b) peak at 1720 cm^{-1} (any value from 1680-1750) indicates C=O

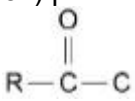
Stage 2: ^1H nmr
2a) peak at 3.9 ppm integration 1 so 1 **H**-C-O AND quartet so adjacent to CH_3 (stated or shown)
2b) peak at 3.7 ppm integration 1 so **H**O-C-(stated or shown)
2c) peak at 2.1 ppm integration 3 so $\mathbf{H_3}$C-C=O AND singlet so no adjacent H (stated or shown)
2d) peak at 1.2 ppm integration 3 so $\mathbf{H_3}$C- AND doublet so adjacent to CH (stated or shown)
2e) sum of integration values = 8 Hence $C_4H_8O_2$

Stage 3: ^{13}C nmr

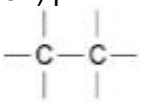
3a) peak at 210 ppm C=O aldehydes or ketones

3b) peak at 75 ppm C−O (alcohols, ethers or esters)

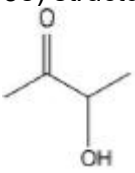
3c) peak at 25 ppm



3d) peak at 20 ppm



3e) structure



[6]