

Mark schemes

1

(a) M1 NaOH

Only score M2 if M1 gained, but mark on from hydroxide. Mention of acid loses M1 & M2

1

M2 Aqueous/(warm)

Ignore alcoholic / conc / dil.

1

M3 (Fractional) distillation or described

Not just evaporation; not reflux

Allow chromatography

1

(b) M1 S is $\text{CH}_3\text{CH}(\text{CN})\text{CH}_2\text{CH}_3$
Allow without brackets 1

Step 3

M2 KCN (mark on from CN^-)
Not HCN, not KCN with acid 1

M3 Alcoholic / (aqueous)
Allow ethanolic
Can only score M3 if M2 gained 1

Step 4

M4 H_2

 LiAlH_4

Na
Can only score M5 if M4 gained 1

M5 Ni or Pt or Pd

Ethoxyethane or ether

 LiAlH_4 with acid loses both M4 and M5

Ignore 'followed by acid'

Na

Ethanol
NOT NaBH_4 OR Sn/HCl
Penalise other extras as list
Ignore pressure or temperature 1

[8]

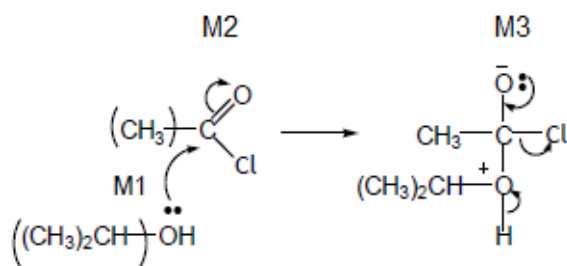
2

(a) (i) $(\text{CH}_3)_2\text{CHOH} + (\text{CH}_3\text{CO})_2\text{O} \rightarrow \text{CH}_3\text{COOCH}(\text{CH}_3)_2 + \text{CH}_3\text{COOH}$
Allow $\text{CH}_3\text{CO}_2\text{CH}(\text{CH}_3)_2$ and $\text{CH}_3\text{CO}_2\text{H}$
Ignore $(\text{CH}_3)_2 - \text{C}$ in equation 1

(1)-methylethyl ethanoate OR

Propan-2-yl ethanoate
Ignore extra or missing spaces, commas or hyphens 1

(ii)



M4 for 3 arrows and lp

NO Mark for name of mechanism

M1 for lone pair on O and arrow to C or to mid-point of space between O and C

M2 for arrow from C=O bond to O

- M2 not allowed independent of M1, but allow M1 for correct attack on C+
- + rather than $\delta+$ on C=O loses M2
- If Cl lost with C=O breaking, max1 for M1

M3 for correct structure with charges (penalise wrong alcohol here) but lone pair on O is part of M4

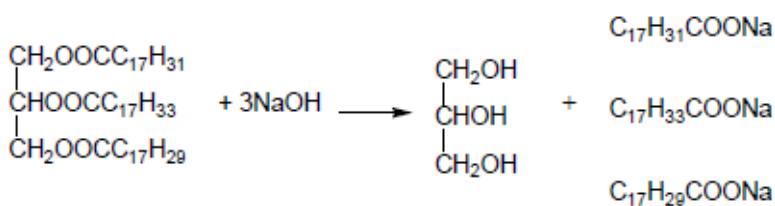
Penalise $(CH_3)_2 - C$ in M3

M4 for lone pair on O and three arrows

- Only allow M4 after correct / very close M3
- M4 can be gained over more than one structure
- Ignore Cl^- removing H^+

4

(b) (i)



Penalise covalent Na e.g. -O-Na

LHS 1
RHS 1

(ii) $C_{17}H_{33}COOCH_3$
Allow $C_{19}H_{36}O_2$

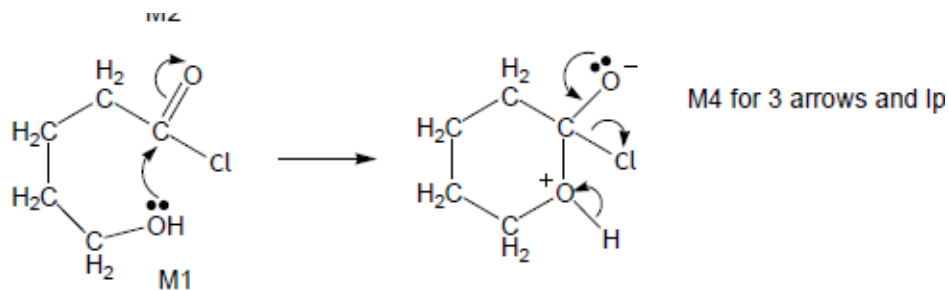
1

[9]

3

(a) (i) (nucleophilic) addition-elimination
Not electrophilic addition-elimination
Ignore esterification

1



M3 for structure

- If wrong nucleophile used or O–H broken in first step, can only score M2.
- M2 not allowed independent of M1, but allow M1 for correct attack on C+
- + rather than $\delta+$ on C=O loses M2.
- If Cl lost with C=O breaking lose M2.
- M3 for correct structure with charges but lone pair on O is part of M4.
- Only allow M4 after correct / very close M3.
- Ignore HCl shown as a product.

4

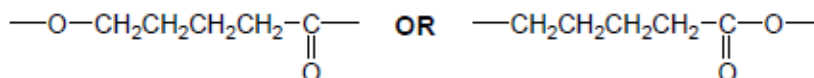
a 20-50 (ppm) or single value or range entirely within this range
If values not specified as a or b then assume first is a.

1

b 50-90 (ppm) or single value or range entirely within this range

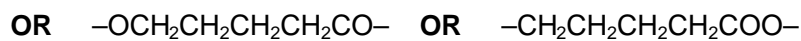
1

(ii)

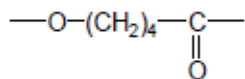


Must have trailing bonds, but ignore n.

1



Allow



but not $\text{—C}_4\text{H}_8\text{—}$

one unit only

Condensation

1

(b)

	Tollens'	Fehling's / Benedicts	Acidified potassium dichromate
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Penalise wrong formula for Tollens or missing acid with potassium dichromate but mark on.

1

J	No reaction / no (visible) change / no silver mirror	No reaction / no (visible) change / stays blue / no red ppt	No reaction / no (visible) change / stays orange / does not turn green
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Ignore 'clear', 'nothing'.

Penalise wrong starting colour for dichromate.

1

K	Silver <u>mirror</u> / grey <u>ppt</u>	Red <u>ppt</u> (allow brick red or red-orange)	(orange) turns green
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1

J Two (peaks)

Allow trough, peak, spike.

1

K Four (peaks)

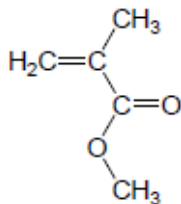
Ignore details of splitting.

If values not specified as J or K then assume first is J.

1

- (c) If all the structures are unlabelled, assume that the first drawn ester is L, the second ester is M; the first drawn acid is N, the second P. The cyclic compound should be obvious.

L
ester



OR $\text{H}_2\text{C}=\text{C}(\text{CH}_3)\text{COOCH}_3$

All $\text{C}_5\text{H}_8\text{O}_2$ L to P must have $\text{C}=\text{C}$.

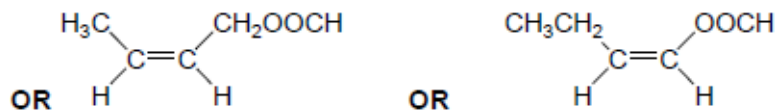
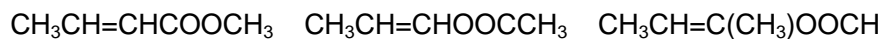
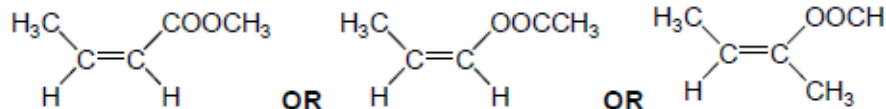
Allow CH_3^- .

Allow $-\text{CO}_2\text{CH}_3$ etc.

Allow $\text{CH}_2\text{C}(\text{CH}_3)\text{COOCH}_3$.

1

M
ester



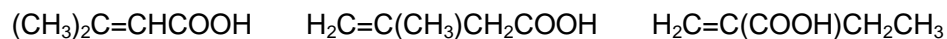
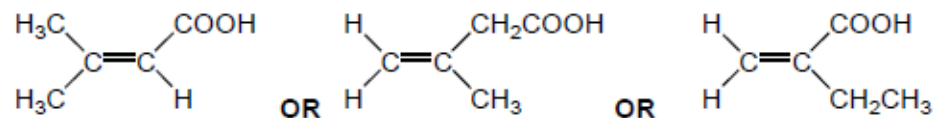
Allow either *E-Z* isomer.

Allow CH_3 - or C_2H_5 - but not CH_2CH_3 -.

Allow $\text{CH}_3\text{CHCHCOOCH}_3$ etc.

1

N
acid

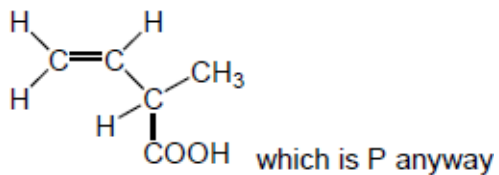


Allow CH_3 - or C_2H_5 - but not CH_2CH_3 -.

Allow $-\text{CO}_2\text{H}$.

Not cyclic isomers.

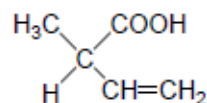
Not the optically active isomer.



Allow $(\text{CH}_3)_2\text{CCHCOOH}$ etc.

1

P
acid



Allow $-\text{CO}_2\text{H}$.

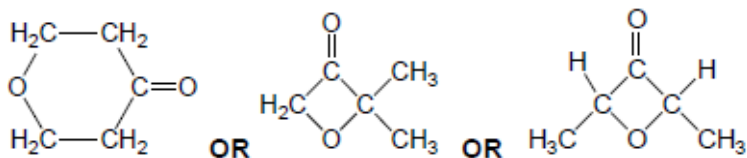


Allow $\text{CH}_3\text{CH}(\text{CO}_2\text{H})\text{CHCH}_2$ or

$\text{CH}_3\text{CH}(\text{CO}_2\text{H})\text{C}_2\text{H}_5$.

1

Q



Not cyclic esters.

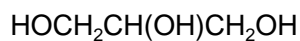
1
[19]

4

(a) (i) $3\text{CH}_3\text{OH}$

Not molecular formula

1

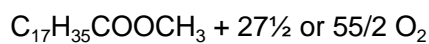


1

(ii) $\rightarrow 19\text{CO}_2 + 19\text{H}_2\text{O}$

Or doubled

1



Consequential on correct right-hand side

1

(b) (i) A 0.7

1

Ethanol 6.4

1

Water 3.6

1

(ii) No effect

If wrong, $CE=0$

1

Equal moles on each side of equation **OR** V cancels

Ignore moles of gas

1

(iii) M1 $K_c = \frac{[\text{DEM}][\text{H}_2\text{O}]^2}{[\text{A}][\text{C}_2\text{H}_5\text{OH}]^2}$

Must have all brackets but allow ()

1

(iv) M2 $\frac{2.1 \times (3.4)^2}{0.85 \times (7.2)^2}$

If K_c wrong can only score M4 for units consequential to their K_c working in (b)(iv)

1

M3 0.55 (min 2dp)

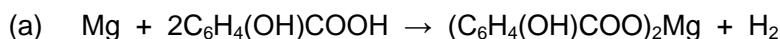
1

M4 No units

1

[13]

5



Accept multiples, including fractions.

1

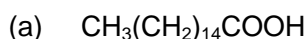
(b) Gas syringe / inverted burette over water / measuring cylinder over water

Collection apparatus must show graduations or be clearly labelled (eg syringe, burette, measuring cylinder).

1

[2]

6



Allow molecular formulae.

1



Allow one mark only if formulae are swapped in position.

1

(b) Keeping the foodstuff dry

Allow an answer which refers to removal of water from the environment.

Do not allow dehydration / removal of water from the fat.

1

(c) They (antioxidants) react with free radicals

1

And they are used up in the reaction / do not remain behind after reaction

Lose one mark for any reference to 'catalysts can't slow down a reaction'.

1

(d) Mol of fat = $(2.78 / 806 =) 3.45 \times 10^{-3}$

Mol of NaOH = 3.68×10^{-3} = mol of fatty acid

1

Mol of NaOH = 3.68×10^{-3}

Mol of fat hydrolysed = 1.23×10^{-3}

1

$$\text{Mol of fat hydrolysed} = (3.68 \times 10^{-3} / 3) = 1.23 \times 10^{-3}$$

$$\text{Mass of fat hydrolysed} = 0.987 \text{ g}$$

1

$$\text{Percentage hydrolysed} = 35.5 - 35.7$$

$$\text{Percentage hydrolysed} = 35.5 - 35.7$$

Do not penalise precision at any point.

Since there are a variety of approaches to this calculation, award four marks for a correct answer but it must be clear that there is some relevant working.

The answer alone gets M4 only.

Any incorrect use of the 3:1 ratio is CE – lose M3 and M4.

1

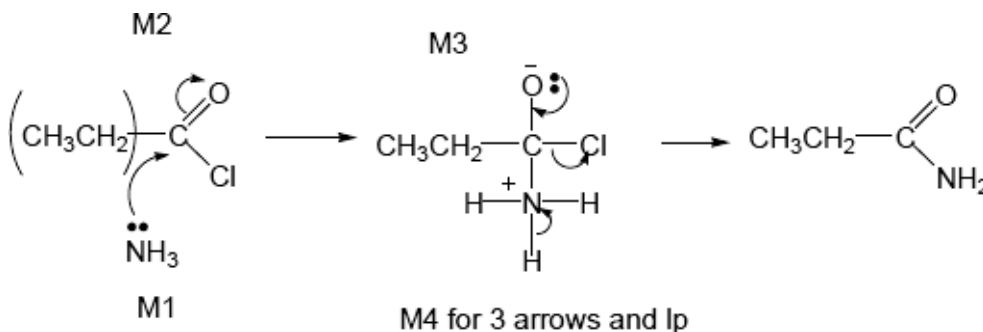
[9]

7

(a) (Nucleophilic) addition-elimination

- Minus sign on NH_3 loses M1 (but not M4 also)
- M2 not allowed independent of M1, but

1



- allow M1 for correct attack on C+
- + rather than $\delta+$ on C=O loses M2
- **If Cl lost with C=O breaking, max1 for M1**
- **M3** for correct structure with charges but lp on O is part of **M4**
- only allow **M4** after correct/very close **M3**
- For **M4**, ignore NH_3 removing H^+ but lose **M4** for Cl^- removing H^+ in mechanism,
- but ignore HCl shown as a product

4

propanamide (Ignore -1-)

penalise other numbers

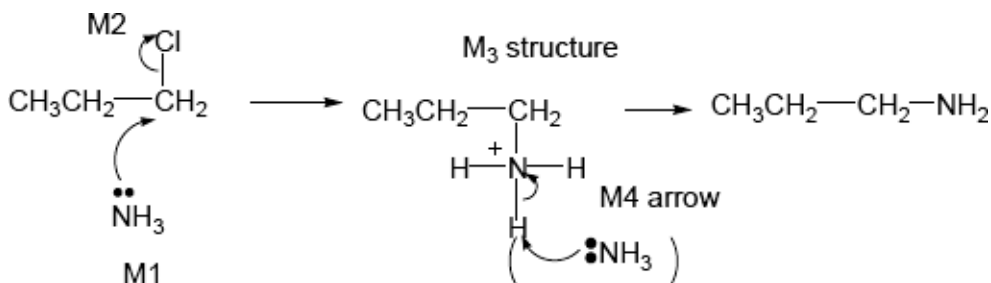
penalise propaneamide and N-propanamide

1

(b) Nucleophilic substitution

- Minus sign on NH_3 loses M1 (not M4 also)
- + rather than $\delta+$ on C=O loses M2

1



- ALLOW SN1 so allow M2 for loss of Cl⁻ before attack of NH₃ on C⁺ for M1
- only allow M4 after correct/very close M3
- For M4, ignore NH₃ removing H⁺ but lose M4 for Cl⁻ removing H⁺ in mechanism,

Propylamine (ignore number 1)

- but ignore HCl shown as a product

4

or propan-1-amine or 1-aminopropane (number 1 needed)

penalise other numbers

allow 1-propanamine

1

(c) electron rich ring or benzene or pi cloud repels nucleophile/ammonia

Allow

- C–Cl bond is short/stronger than in haloalkane
- C–Cl is less polar than in haloalkane
- resonance stabilisation between ring and Cl

1

[13]

8

(a) (i) Green

Ignore shades of green.

1

(ii) Excess acidified potassium dichromate(VI)

1

Reflux (for some time)

1

In the diagram credit should be given for

- a vertical condenser
Lose M3 and M4 for a distillation apparatus.

1

- an apparatus which would clearly work
Do not allow this mark for a flask drawn on its own.
Penalise diagrams where the apparatus is sealed.

1

(iii)	Distillation	1
	Immediately (the reagents are mixed)	1
(b)	Keep away from naked flames <i>Allow heat with water-bath or heating mantle. If a list is given ignore eye protection, otherwise lose this mark.</i>	1
(c)	(i) Tollens' or Fehling's reagents <i>Incorrect reagent(s) loses both marks. Accept mis-spellings if meaning is clear.</i>	1
	Silver mirror / red ppt. formed <i>Accept 'blue to red' but not 'red' alone.</i>	1
	(ii) Sodium carbonate (solution) / Group II metal <i>Allow indicator solutions with appropriate colours. Accept any named carbonate or hydrogen carbonate.</i>	1
	Effervescence / evolves a gas <i>Accept 'fizzes'.</i>	1
(d)	Propanoic acid <i>If this mark is lost allow one mark if there is reference to stronger intermolecular forces in the named compound. Lose M1 and M3.</i>	1
	Contains hydrogen bonding	1
	Some comparison with other compounds explaining that the intermolecular forces are stronger in propanoic acid	1

[15]