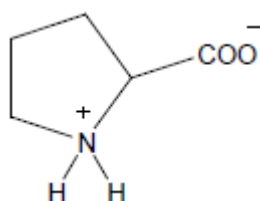


M1.(a) (i)

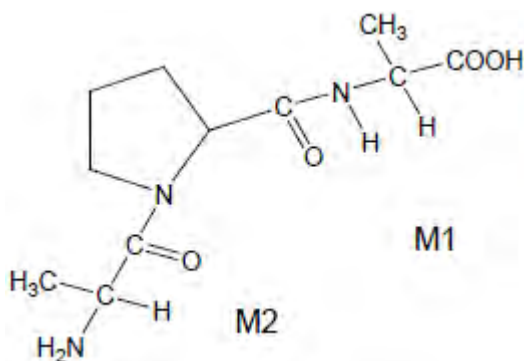


Allow CO₂⁻ and NH₂⁺

1

- (ii) NOTE – **Two** marks for this clip
M1 for alanine section bonded through N
M2 for alanine section bonded through C
But penalise error in proline ring

1



Allow MAX 1 for correct tripeptide in polymer structure

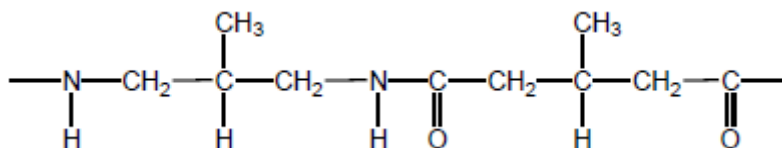
1

- (b) (i) 3-methylpent-2-ene
Ignore E-Z, commas, spaces or missing hyphens
- (ii) 4-amino-3-methylbutanoic acid
Ignore commas, spaces or missing hyphens

1

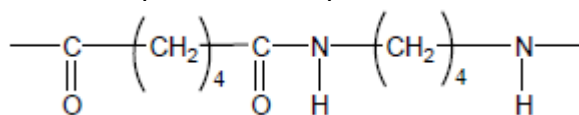
1

(iii)



or any polyamide section containing

8 carbons plus two C=O plus two N-H, such as



Trailing bonds are required

1

- (iv) Non polar OR no polar groups / bonds (for attack by water / acids / alkalis / nucleophiles or for hydrolysis)

C-C bonds are strong

1

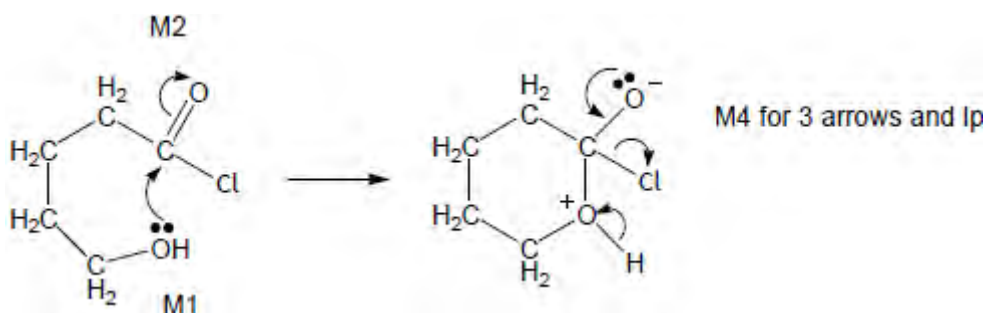
[7]

M2.(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.

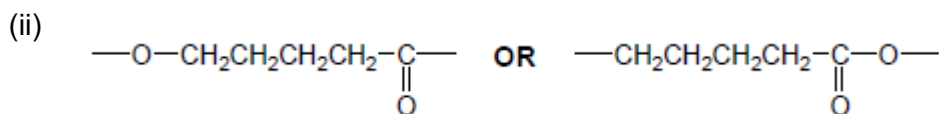
4

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

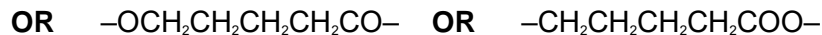
b 50-90 (ppm) or single value or range entirely within this range

1

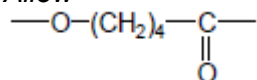


Must have trailing bonds, but ignore n.

1



Allow



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

one unit only

Condensation

1

(b)

	Tollens'	Fehling's / Benedict's	Acidified potassium dichromate
--	----------	------------------------	--------------------------------

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
----------	--	---	--

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
----------	---	--	----------------------

1

J Two (peaks)
Allow trough, peak, spike.

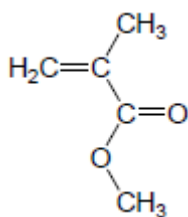
1

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.

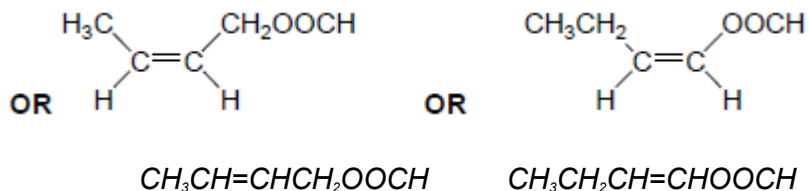
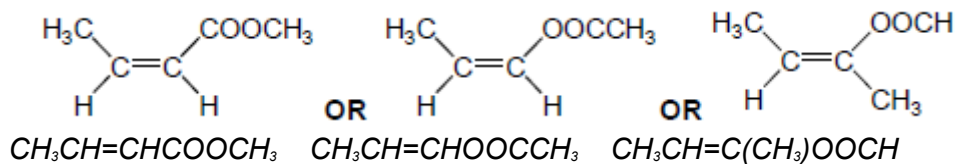
L
ester



OR $H_2C=C(CH_3)COOCH_3$
All $C_5H_8O_2$ L to P must have $C=C$.
Allow CH_3- .
Allow $-CO_2CH_3$ etc.
Allow $CH_2C(CH_3)COOCH_3$.

1

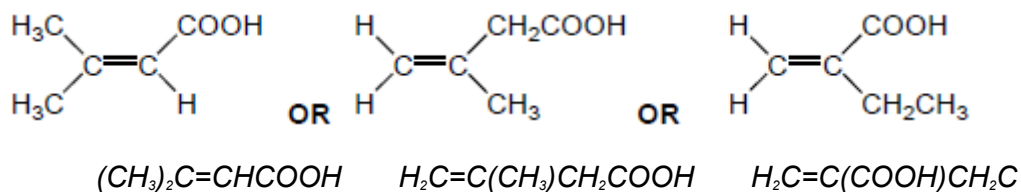
M
ester



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.

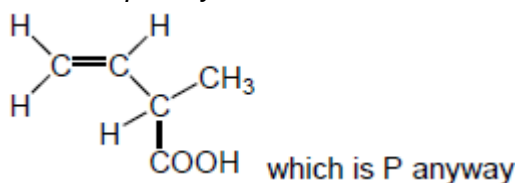
1

N
acid



H_3

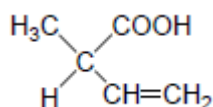
Allow CH_3 - or C_2H_5 - but not CH_2CH_3 -.
 Allow $-\text{CO}_2\text{H}$.
 Not cyclic isomers.
 Not the optically active isomer.



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

1

P
acid

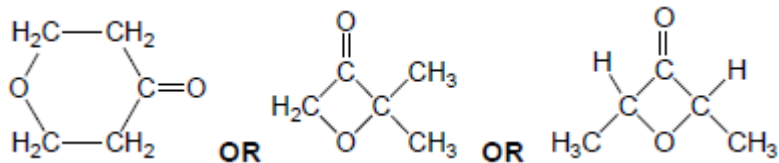


Allow $-\text{CO}_2\text{H}$.

$\text{CH}_3\text{CH}(\text{COOH})\text{CH}=\text{CH}_2$
 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]

M3.(a) (i) 2-hydroxypropanoic acid

OR

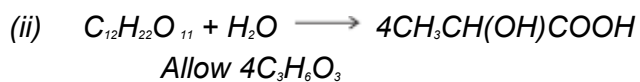
2-hydroxypropan(-1-)oic acid

Do not penalise different or missing punctuation or extra spaces.

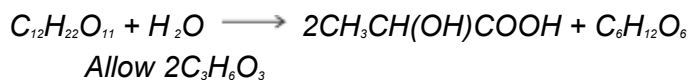
Spelling must be exact and order of letters and numbers as here.

Can ignore -1- before -oic, but penalise any other numbers here.

1



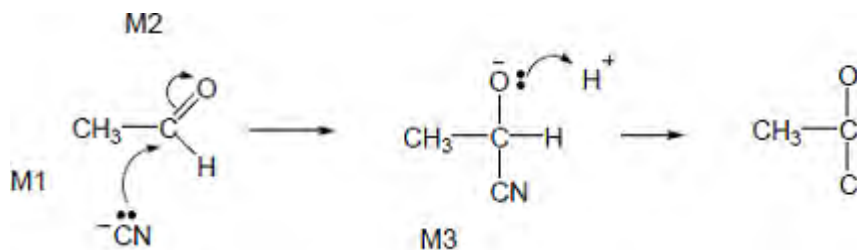
OR



1

(b) (i) Nucleophilic addition

M4 for lp, arrow and H+



- M1 lp and minus must be on C
- M1 and M4 include lone pair and curly arrow.
- M2 not allowed independent of M1, but allow following some attempt at attack on carbonyl C
- allow M1 for correct attack on C+
- + rather than $\delta+$ on C=O loses M2
- M3 is for correct structure including minus sign but lone pair is part of M4
- Allow arrow in M4 to H of H-CN with arrow forming cyanide ion.

5

(ii) Equal mixture of enantiomers / (optical) isomers

1

(iii) (Plane) polarized light
If missing no further mark.

1

(Polarised light) rotated by single enantiomer but unaffected by racemate

Both needed; not allow bend, twist etc.

1

(c) (i) $\text{CH}_3\text{CH}(\text{OH})\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}(\text{OH})\text{COONa} + \text{H}_2\text{O}$
OR $\text{CH}_3\text{CH}(\text{OH})\text{COOH} + \text{OH}^- \rightarrow \text{CH}_3\text{CH}(\text{OH})\text{COO}^- + \text{H}_2\text{O}$
 Not ambiguous mol formulae for product - must show COONa or CO_2Na or COO^- or CO_2^-

1

(ii) $[\text{H}^+] = K_a$ **OR** $\text{pH} = \text{p}K_a$

1

pH = 3.86

Allow more than 2 decimal places but not fewer.

1

(iii) M1 buffer

Ignore acidic but penalise alkaline or basic.

1

Any two out of the three marks M2 , M3 & M4

M2 Large lactate concentration in buffer

OR sodium lactate completely ionised

M3 added acid reacts with / is removed by lactate ion or A^- or sodium lactate or salt

OR equation $H^+ + A^- \rightarrow HA$

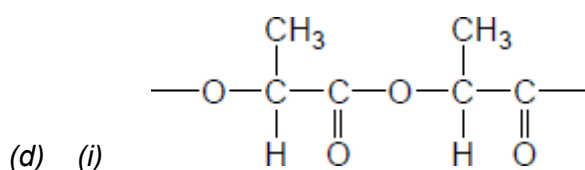
Ignore reaction of H^+ with OH^-

Ignore reference to equilibrium unless it is shown.

M4 ratio $[HA] / [A^-]$ stays almost constant

Ignore H^+ or pH remains constant.

Max 2



No marks if ester link missing

Correct ester link

allow $-COO-$

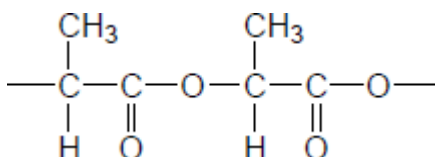
NB Correct answer scores 2

Ignore n here (compare with (d)(iv)).

Ignore brackets

1

OR



All rest correct with trailing bonds

If OH or COOH on either or both ends, lose one, ie dimer scores 1

If more than two repeating units, lose 1

1

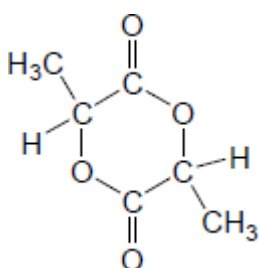
(ii) (Poly)ester ie allow ester

Not terylene.

Ignore spaces and brackets in answer.

1

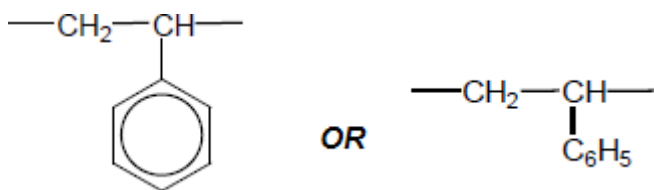
(iii)



Allow any cyclic C₆H₈O₄

1

(iv)



Penalise n here (compare with (d)(i))

Ignore brackets.

Not allow Ph for phenyl.

1

(v) In landfill, no air or UV, to assist decay

OR not enough water or moisture (to hydrolyse polyester)

Allow landfill has / contains:

no or few bacteria / micro-organisms / enzymes compared with compost heap

OR less oxygen

OR lower temperature.

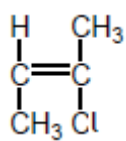
1

[22]

M4.D

[1]

M5.(a)

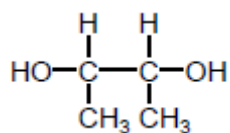


1

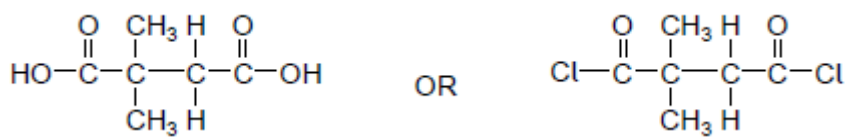
Addition

1

(b)



1



1

(c) Q is biodegradable

1

Polar C=O group or δ^+ C in Q (but not in P)

1

Therefore, can be attacked by nucleophiles (leading to breakdown)

1

[7]