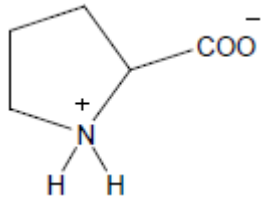
M1.(a) (i)



Allow CO_2^- and NH_2^+

1

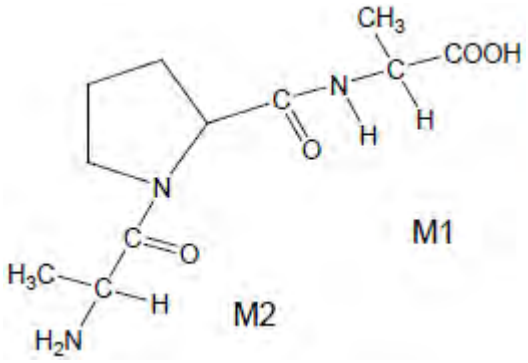
(ii) NOTE − **Two** marks for this clip

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

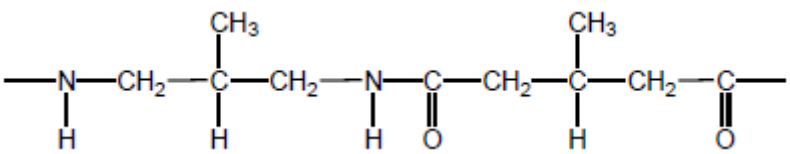
1

(ii) 4-amino-3-methylbutanoic acid

Ignore commas, spaces or missing hyphens

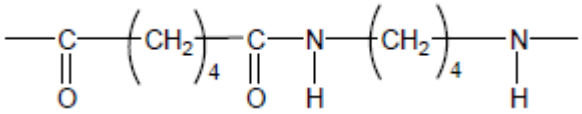
1

(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

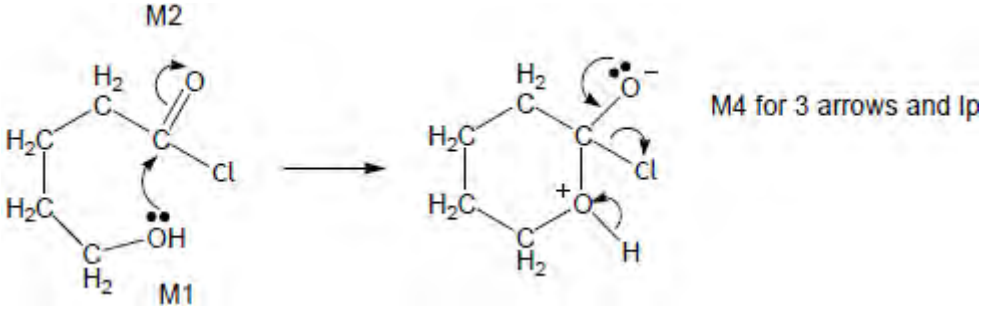
[7]

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 δ+ on C=O loses M2.*
- *If Cl lost with C=O breaking lose M2.*
- *M3 for correct structure <u>with charges</u> but lone pair on O is part of M4.*
- *Only allow M4 after correct / very close M3.*
- *Ignore HCl shown as a product.*

4

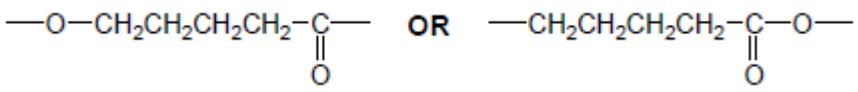
a 20-50 (ppm) or single value or range entirely within this range

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

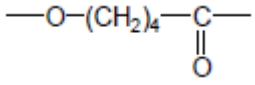
(ii)  **OR**

Must have trailing bonds, but ignore n.

1

OR –$OCH_2CH_2CH_2CH_2CO$– **OR** –$CH_2CH_2CH_2CH_2COO$–

Allow



but not - C_4H_8-

one unit only

Condensation

1

(b)

	Tollens'	*Fehling's / Benedicts*	*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)*

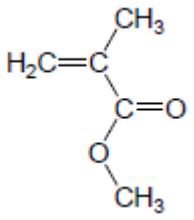
Ignore details of splitting.

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.

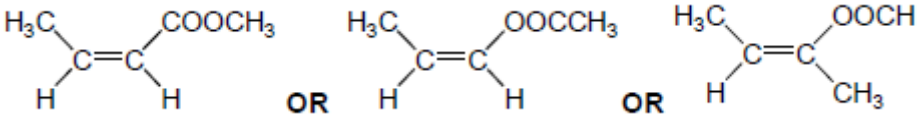
Allow CH_3–.

Allow $-CO_2CH_3$ etc.

Allow $CH_2C(CH_3)COOCH_3$.

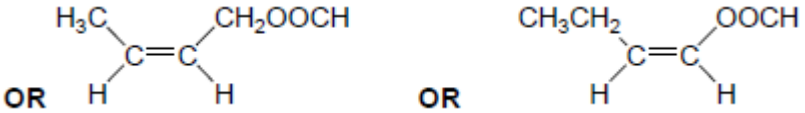
1

M
ester



OR OR

$CH_3CH=CHCOOCH_3$ *$CH_3CH=CHOOCCH_3$* *$CH_3CH=C(CH_3)OOCH$*



OR OR

$CH_3CH=CHCH_2OOCH$ *$CH_3CH_2CH=CHOOCH$*

Allow either E–Z isomer.

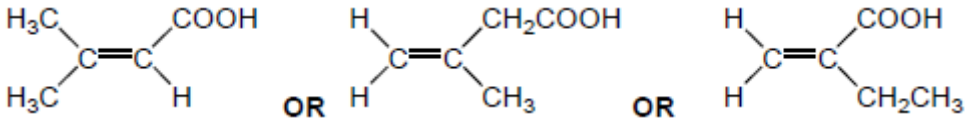
Allow CH_3– or C_2H_5– but not CH_2CH_3–.

Allow $CH_3CHCHCOOCH_3$ etc.

1

N

acid



OR OR

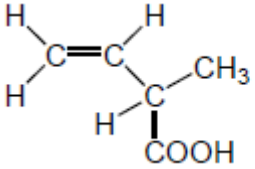
$(CH_3)_2C=CHCOOH$ *$H_2C=C(CH_3)CH_2COOH$* *$H_2C=C(COOH)CH_2CH_3$*

Allow CH_3– or C_2H_5– but not CH_2CH_3–.

Allow −CO_2H.

Not cyclic isomers.

Not the optically active isomer.



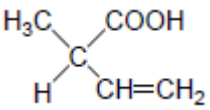
which is P anyway

Allow $(CH_3)_2CCHCOOH$ etc.

1

P

acid



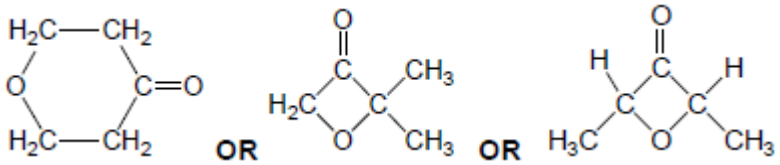
Allow −CO_2H.

$CH_3CH(COOH)CH=CH_2$

Allow $CH_3CH(CO_2H)CHCH_2$ or $CH_3CH(CO_2H)C_2H_3$.

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

(ii) $C_{12}H_{22}O_{11} + H_2O \longrightarrow 4CH_3CH(OH)COOH$

Allow $4C_3H_6O_3$

OR

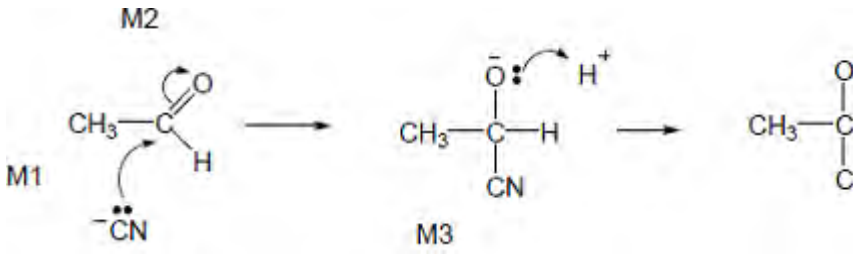
$C_{12}H_{22}O_{11} + H_2O \longrightarrow 2CH_3CH(OH)COOH + C_6H_{12}O_6$

Allow $2C_3H_6O_3$

1

(b) *(i)* *Nucleophilic addition*

M4 for lp, arrow and H+



- *M1 lp <u>and minus</u> 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 δ+ 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) *<u>Equal</u> mixture of enantiomers / (optical) isomers*

1

(iii) *(Plane) polarized light*

If missing no further mark.

1

(Polarised light) <u>rotated</u> by single enantiomer but unaffected by racemate

Both needed; not allow bend, twist etc.

1

(c) *(i)* $CH_3CH(OH)COOH + NaOH \rightarrow CH_3CH(OH)COONa + H_2O$
OR $CH_3CH(OH)COOH + OH^- \rightarrow CH_3CH(OH)COO^- + H_2O$

Not ambiguous mol formulae for product - must show COONa or CO_2Na or COO^- or CO_2^-

1

(ii) $[H^+] = K_a$ ***OR*** $pH = pK_a$

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

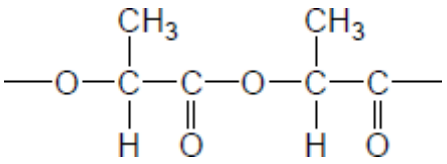
M2 Large lactate concentration in buffer
OR *sodium lactate completely ionised*

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

(d) (i)



No marks if ester link missing

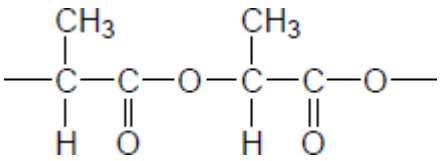
Correct ester link
allow –COO–

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

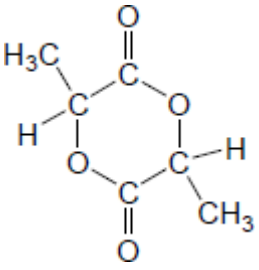
(ii) *(Poly)ester ie allow ester*

Not terylene.

Ignore spaces and brackets in answer.

1

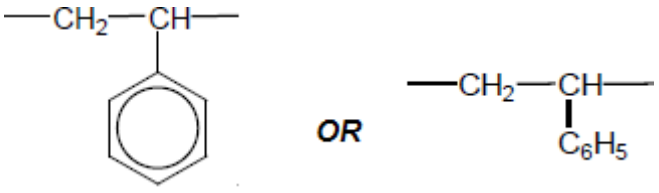
(iii)



Allow any <u>cyclic $C_6H_8O_4$</u>

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 *<u>lower</u> temperature.*

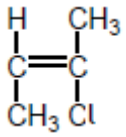
1

[22]

M4.*D*

[1]

M5.*(a)*

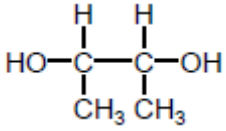


1

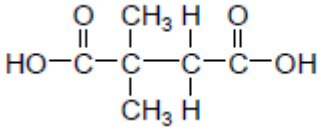
Addition

1

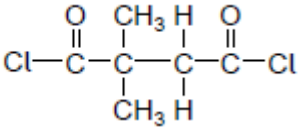
(b)



1



OR



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]