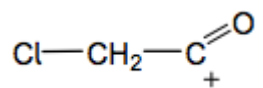


Mark schemes

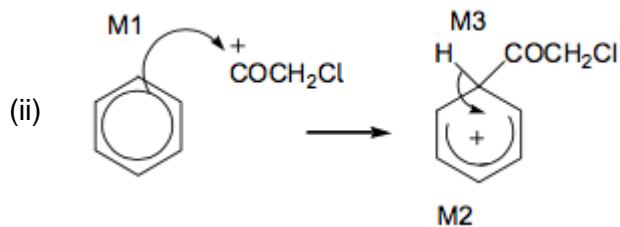
1

(a) (i)



Allow $[\text{ClCH}_2\text{CO}]^+$

1



M1 for arrow from inside hexagon to C or + on C on correct electrophile

M2 for structure of intermediate

- Horseshoe centred on C1;
- + in intermediate not too close to C1 (allow on or "below" a line from C2 to C6)

M3 for Arrow from bond to H into ring

- Allow M3 arrow independent of M2 structure
- + on H in intermediate loses M2 not M3
- Ignore Cl- removing H^+

1
1
1

(b) Reagent

Water

(Aqueous) silver nitrate

NaOH followed by acidified silver nitrate

(Water +) named indicator

Named alcohol

Na₂CO₃ or NaHCO₃

Ammonia

1

P

No reaction

No reaction (or slow formation of ppt)

No reaction (or slow formation of ppt)

No colour change

NVC

NVC

No reaction

Do NOT award

No observation

1

Q

Steamy /misty/ white fumes

White precipitate (immediately formed)

White precipitate (immediately formed)

Indicator turns to correct acid colour

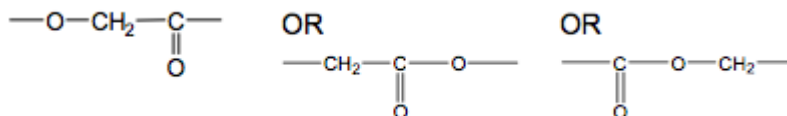
Fruity or sweet smell or misty fumes

Fizzing or effervescence (not just gas produced)

White smoke

1

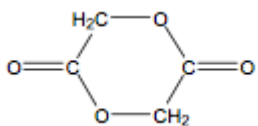
(c) (i)



One unit only
Must have trailing bonds
Ignore n and brackets
allow $\text{---O---CH}_2\text{---CO---}$

1

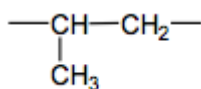
(i)



Allow CO for C=O

1

(d) (i)



One unit only
Must have trailing bonds
Ignore n and brackets

1

(ii) PGA sutures react/dissolve/break down/are biodegradable/
are hydrolysed / attacked by water or nucleophiles /no need to
remove

OR Polypropene not biodegradeable/ not hydrolysed / not attacked
by water/nucleophiles

1

(Ester links have) polar bonds

polypropene contains non-polar bonds

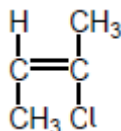
ignore intermolecular forces

1

[12]

2

(a)

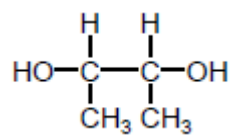


1

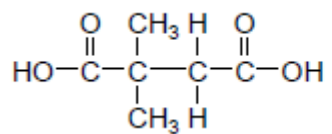
Addition

1

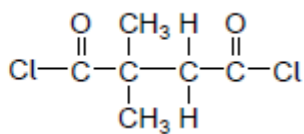
(b)



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]

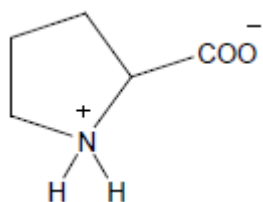
3

D

[1]

4

(a) (i)



Allow CO₂⁻ and NH₂⁺

1

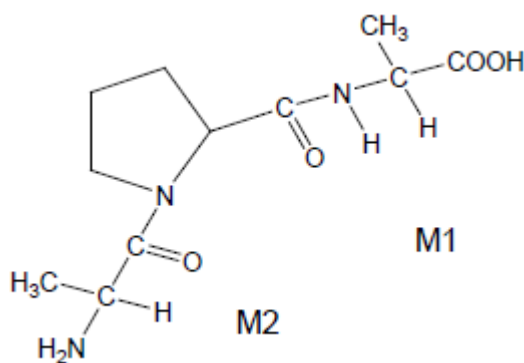
(ii) NOTE – **Two** marks for this clip

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

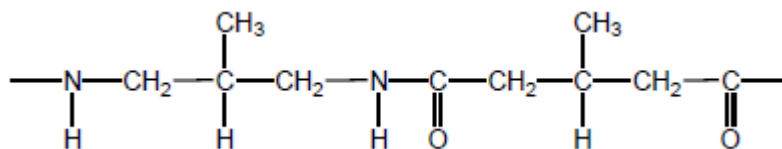
1

(ii) 4-amino-3-methylbutanoic acid

Ignore commas, spaces or missing hyphens

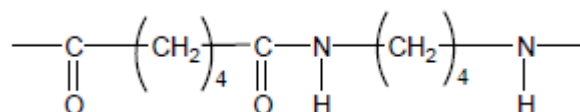
1

(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]

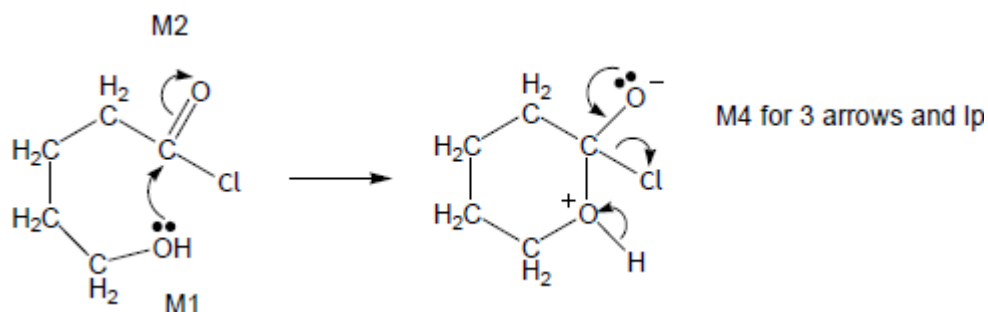
5

- (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

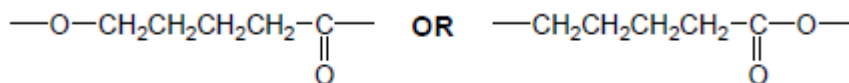
- a 20-50 (ppm) or single value or range entirely within this range
If values not specified as a or b then assume first is a.

1

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

1

- (ii)

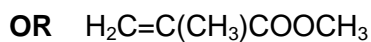
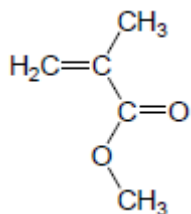


Must have trailing bonds, but ignore n.

1

- (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



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

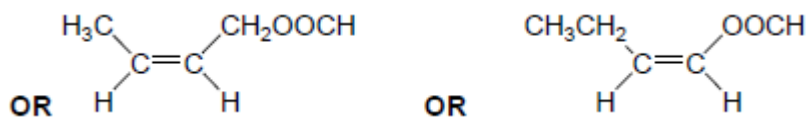
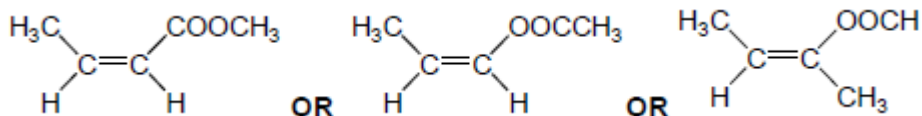
Allow CH_3^- .

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

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

1

M
ester



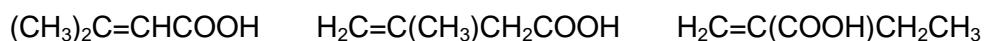
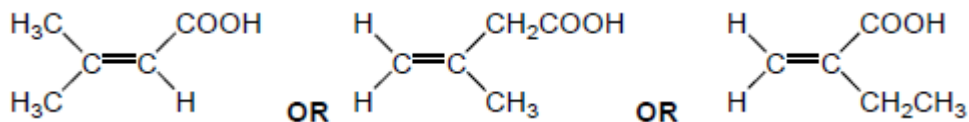
Allow either *E-Z* isomer.

Allow CH_3^- or C_2H_5^- but not CH_2CH_3^- .

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

1

N
acid

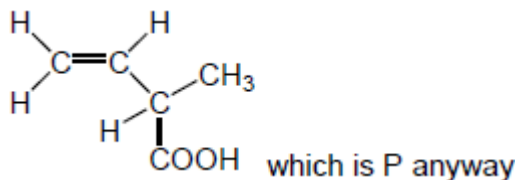


Allow CH_3 - or C_2H_5 - but not CH_2CH_3 -.

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

Not cyclic isomers.

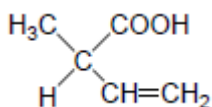
Not the optically active isomer.



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

1

P
acid



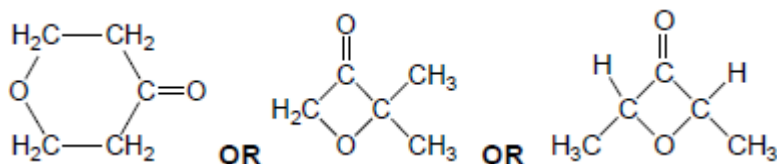
Allow $-\text{CO}_2\text{H}$.



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]

6

(a) (i) 2-hydroxypropanoic acid

OR

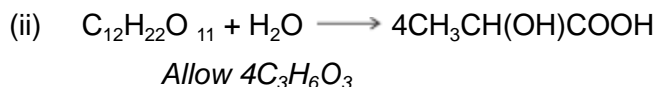
2-hydroxypropan(-1-)oic acid

Do not penalise different or missing punctuation or extra spaces.

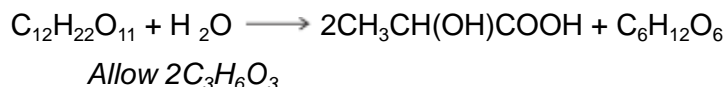
Spelling must be exact and order of letters and numbers as here.

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

1



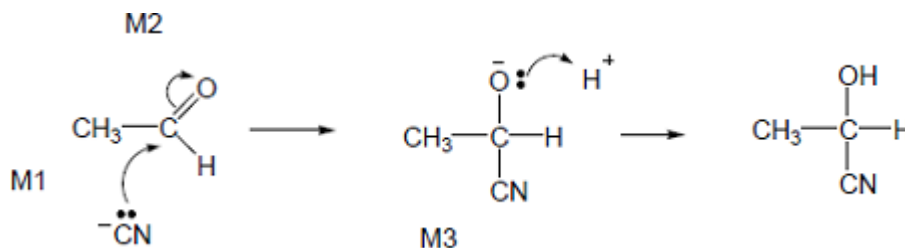
OR



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

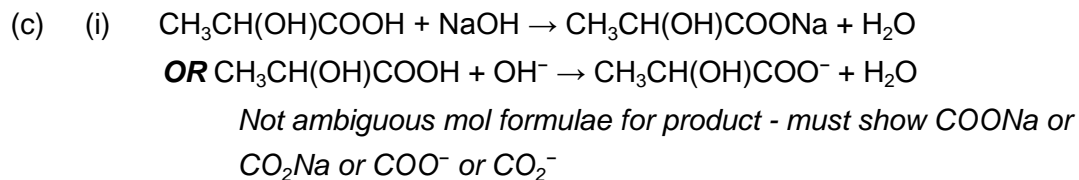
(iii) (Plane) polarized light

If missing no further mark.

1

(Polarised light) rotated by single enantiomer but unaffected by racemate
Both needed; not allow bend, twist etc.

1



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^-

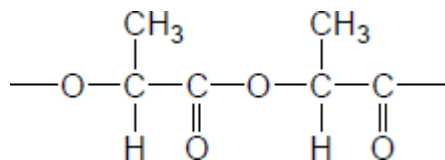
Ignore reference to equilibrium unless it is shown.

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 $-COO-$

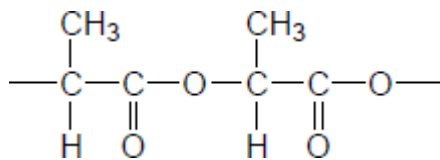
NB Correct answer scores 2

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

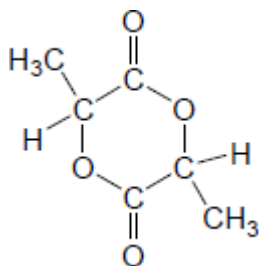
(ii) (Poly)ester ie allow ester

Not terylene.

Ignore spaces and brackets in answer.

1

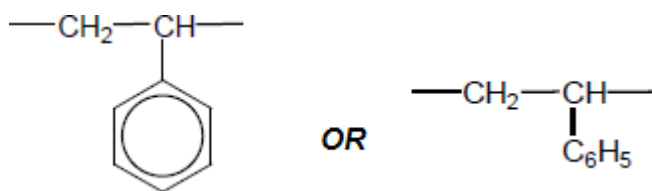
(iii)



Allow any 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]