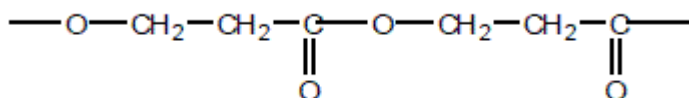


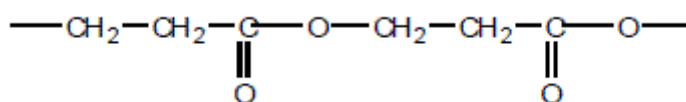
- M1. (a) 3-hydroxypropanoic acid
allow 3-hydroxypropionic acid
must be correct spelling

1

- (b) (i) must show trailing bonds



or can start at any point in the sequence, e.g.



not allow dimer

allow $\text{---O---CH}_2\text{CH}_2\text{COOCH}_2\text{CH}_2\text{CO---}$

or $\text{---CH}_2\text{CH}_2\text{COOCH}_2\text{CH}_2\text{COO---}$

ignore () or n

NB answer has a total of 6 carbons and 4 oxygens

1

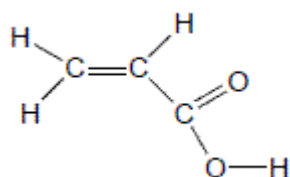
- (ii) condensation (polymerisation)
Allow close spelling

1

- (c) (i) C=C or carbon-carbon double bond

1

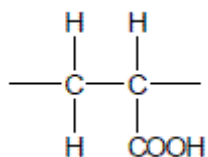
- (ii)



must show ALL bonds including O-H

1

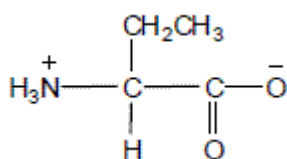
(iii) must show trailing bonds



allow polyalkene conseq on their c(ii)
ignore n

1

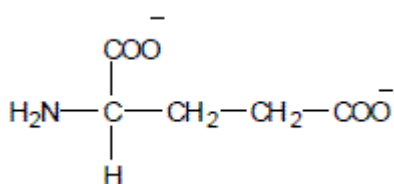
(d)



allow NH_3^+ —
allow COO^-

1

(e) (i)



In (e), do not penalise a slip in the number of carbons in the
-CH₂CH₂- chain, but all must be bonded correctly
NB two carboxylate groups
Allow COONa or COO⁻ Na⁺ but not covalent bond to Na
allow NH₂—

1

(ii)

OR

(amino acids have) different R_f values

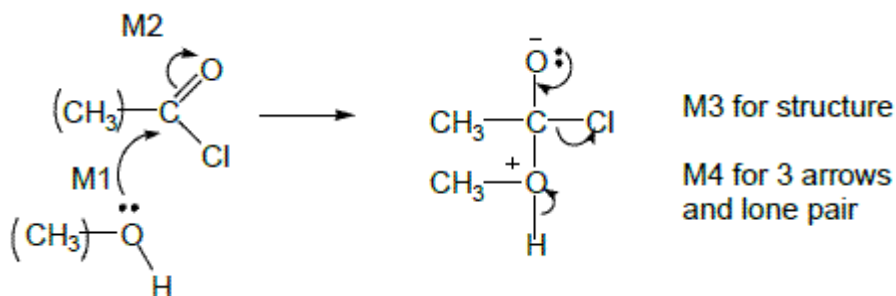
OR

(amino acids) travel at different speeds or take different times

1

[13]

- M2.** (a) **M1** $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
not $\text{C}_3\text{H}_7\text{COOH}$ 1
- M2** $\text{CH}_3\text{CH}_2\text{OH}$ or $\text{C}_2\text{H}_5\text{OH}$ 1
- M3** $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOCH}_2\text{CH}_3 + \text{H}_2\text{O}$
allow $\text{C}_3\text{H}_7\text{COOC}_2\text{H}_5$
penalise M3 for wrong products and unbalanced equation 1
- M4** H_2SO_4 or HCl or H_3PO_4 conc or dil or neither
not HNO_3 1
- (b) **M1** $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
not $\text{C}_4\text{H}_9\text{OH}$ 1
- M2** $(\text{CH}_3\text{CO})_2\text{O}$ 1
- M3** $\rightarrow \text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_2\text{CH}_3 + \text{CH}_3\text{COOH}$
allow $\text{CH}_3\text{COOC}_4\text{H}_9$
penalise M3 for wrong products and unbalanced equation 1
- (c) (nucleophilic) addition-elimination



not acylation alone

M2 not allowed indep of M1 but allow M1 for correct attack on C+

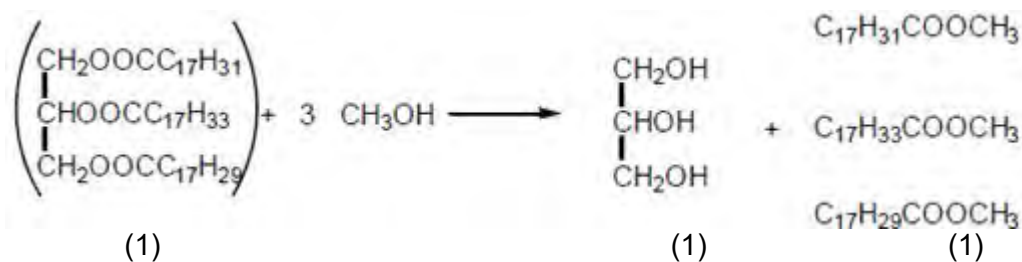
+C=O loses M2

only allow M4 after correct or v close M3

ignore Cl removing H⁺

5

(d)



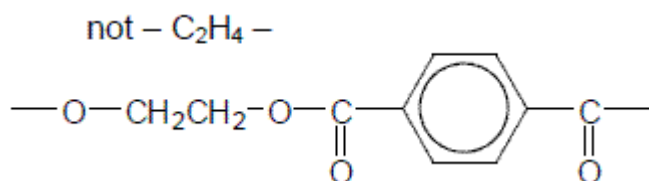
ignore errors in initial triester

First mark for 3CH₃OH

Third mark for all three esters

3

(e)



First mark for correct ester link second mark for the rest including trailing bonds

If ester link wrong, lose second mark also

2

Adv reduces landfill
saves raw materials
lower cost for recycling than making from scratch
reduces CO₂ emissions by not being incinerated
not allow cost without qualification

ignore energy uses

1

Disad difficulty/cost of collecting/sorting/processing
product not suitable for original purpose, easily contaminated
not allow cost without qualification
ignore energy uses

1

[19]

M3. (a) polyamide or nylon (2,4)
(allow nylon without numbers but if numbers are present they must be correct)

1

condensation

1

(b) $\text{H}_3\text{N}^+ - \text{CH}_2 - \text{COO}^-$

1

(c) ionic bonding in aminoethanoic acid
(can only score if includes that aminoethanoic is ionic)

1

stronger attractions than Hydrogen bonding in hydroxyethanoic acid
(e.g. stronger Hydrogen bonding in aminoethanoic acid scores 0)
(mention of electrostatic forces between molecules scores 0)

1

[5]

M4. (a) (i) **W** 3

1

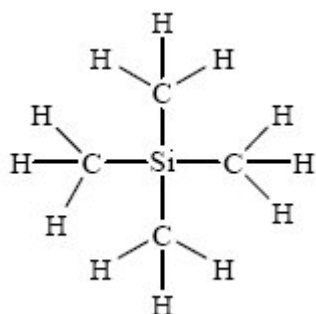
X 4

Y 2

1

1

(ii)



displayed formula shows ALL bonds

1

(b) (i) NO_2^+

*allow + anywhere
can score in equation*

1



1

OR

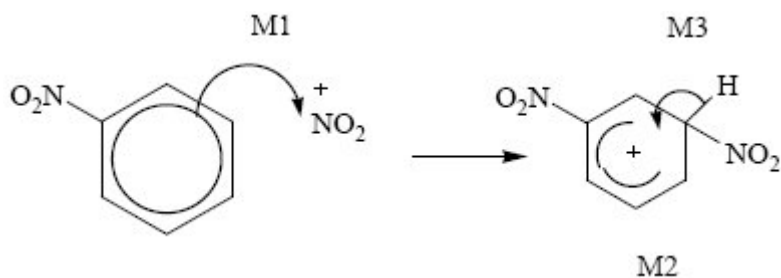


or use two equations via H_2NO_3^+

(ii) electrophilic substitution

Not Friedel Crafts

1



Allow Kekule structures

+ must be on N of $^+\text{NO}_2$ (which must be correct)

both NO_2 must be correctly positioned and bonded to gain M2

*M1 arrow from circle or within it to N or to + on N
horseshoe must not extend beyond C2 to C6 but can be*

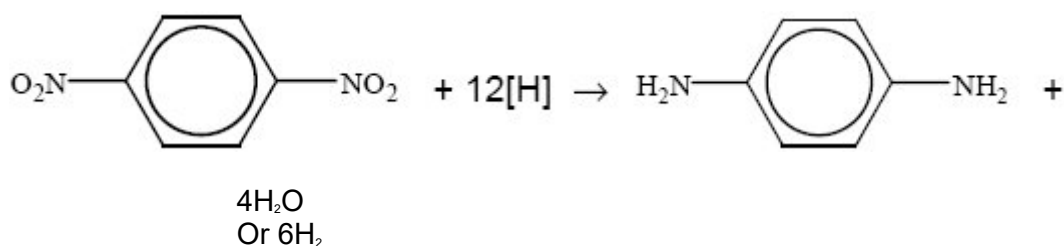
smaller
 + not too close to C1
 M3 arrow into hexagon unless Kekule
 allow M3 arrow independent of M2 structure
 ignore base removing H in M3

3

- (c) (i) H_2/Ni or H_2/Pt or Sn/HCl or Fe/HCl (conc or dil or neither)
 allow dil H_2SO_4
 ignore mention of $NaOH$

Not $NaBH_4$
 Not $LiAlH_4$
 Not Na/C_2H_5OH
 not conc H_2SO_4 or any HNO_3

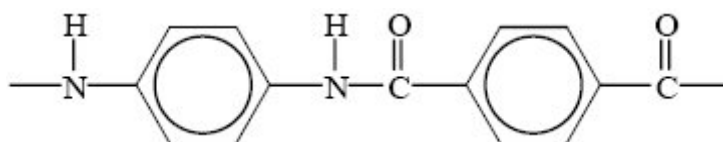
1



allow $C_6H_4(NO_2)_2$ etc ,
 allow NO_2-NH_2-
 i.e. be lenient on structures, the mark is for balancing equ

1

(ii)



allow $-CONH$
 ignore $[]_n$ as in polymer

1st mark for correct peptide link
 2nd mark for the rest correct including trailing bonds

2

- (iii) **M1** Kevlar is biodegradeable but polyalkenes not
 allow Kevlar is more biodegradeable

1

M2 Kevlar has polar bonds/is a (poly) amide/has peptide link
 comment on structure of Kevlar

1

M3 can be hydrolysed/attacked by nucleophiles/acids/
bases/enzymes

1

M4 polyalkenes non polar/has non-polar bonds

*comment on structure of polyalkenes but not just strong
bonds*

1

[18]