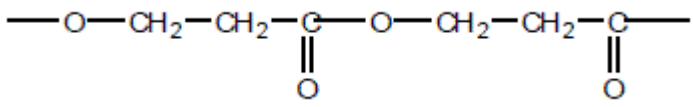
M1. (a) 3-hydroxypropanoic acid

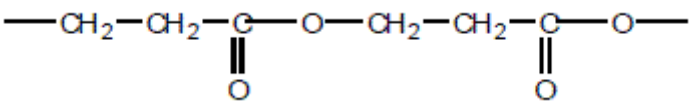
allow 3-hydroxypropionic acid
must be correct spelling

1

(b) (i) must show trailing bonds



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



not allow dimer
allow –O–$CH_2CH_2COOCH_2CH_2CO$–
or –$CH_2CH_2COOCH_2CH_2COO$–
ignore ( ) or n
NB answer has a total of 6 carbons and 4 oxygens

1

(ii) condensation (polymerisation)

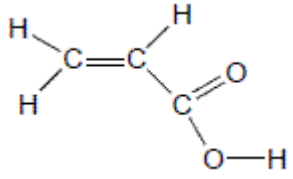
Allow close spelling

1

(c) (i) C=C or carbon-carbon <u>double</u> bond

1

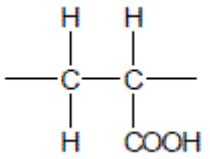
(ii)



*must show **ALL** bonds including O–H*

1

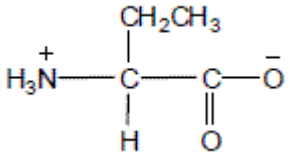
(iii) must show trailing bonds



allow polyalkene conseq on their c(ii)
ignore n

1

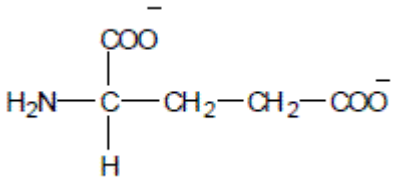
(d)



allow NH_3^+—
allow COO^-

1

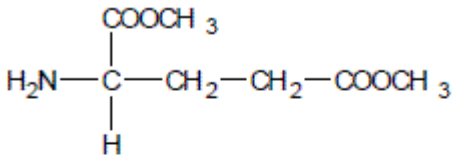
(e) (i)



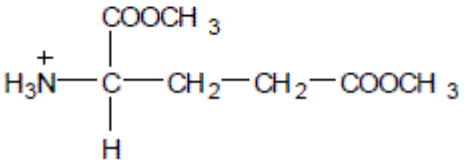
In (e), do not penalise a slip in the number of carbons in the $-CH_2CH_2-$ chain, but all must be bonded correctly
NB two carboxylate groups
Allow COONa or COO^- Na^+ but not covalent bond to Na
allow NH_2–

1

(ii)



OR



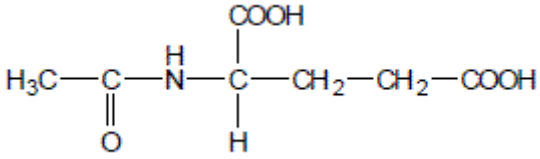
In (e), do not penalise a slip in the number of carbons in the -CH_2CH_2- chain, but all must be bonded correctly

NB two ester groups

allow NH_2– or $^+NH_3$–

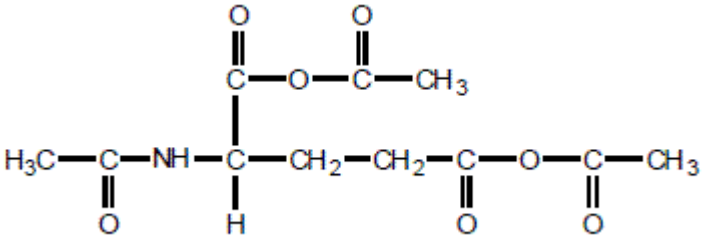
1

(iii)



In 4(e), do not penalise a slip in the number of carbons in the -CH_2CH_2- chain, but all must be bonded correctly

allow anhydride formation on either or both COOH groups (see below) with or without amide group formation



1

(f) **M1** phase or eluent or solvent (or named solvent) is <u>moving or mobile</u>

1

M2 stationary phase or solid or alumina/silica/resin

1

M3 separation depends on balance between solubility or affinity (of compounds) in each phase
OR
different adsorption or retention

OR
(amino acids have) different R_f values
OR
(amino acids) travel at different speeds or take different times

1

[13]

M2. (a) **M1** $CH_3CH_2CH_2COOH$
not C_3H_7COOH

1

M2 CH_3CH_2OH or C_2H_5OH

1

M3 $CH_3CH_2CH_2COOCH_2CH_3 + H_2O$
allow $C_3H_7COOC_2H_5$
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** $CH_3CH_2CH_2CH_2OH$

1

not C_4H_9OH

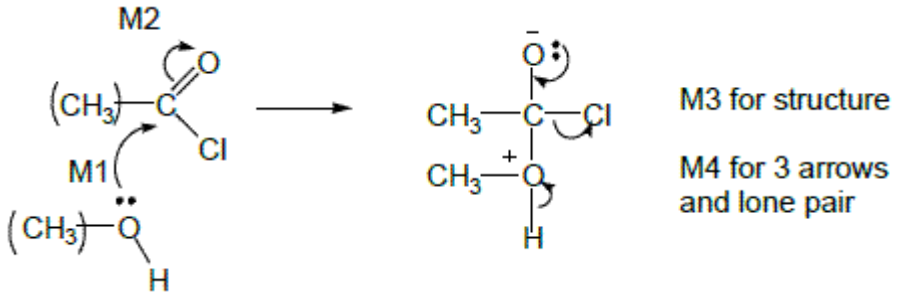
M2 $(CH_3CO)_2O$

1

M3 $\rightarrow CH_3COOCH_2CH_2CH_2CH_3 + CH_3COOH$
allow $CH_3COOC_4H_9$
penalise M3 for wrong products and unbalanced equation

1

(c) (nucleophilic) addition-elimination



not acylation alone

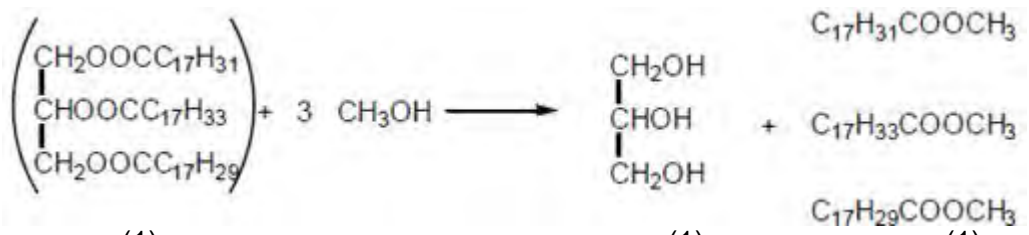
M2 not allowed indep of M1 but allow M1 for correct attack on C+

+C=O loses M2

only allow M4 after correct or v close M3
ignore Cl^- removing H^+

5

(d)



(1) (1) (1)

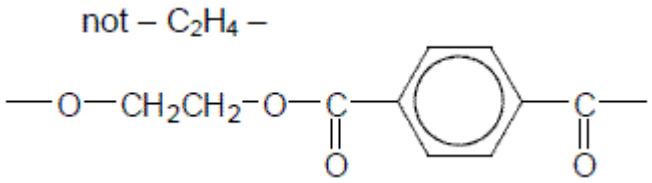
ignore errors in initial triester

First mark for $3CH_3OH$

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 CO_2 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]

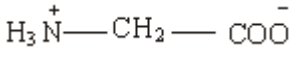
M3. (a) polyamide or nylon (2,4)

(allow nylon without numbers but if numbers are present they must be correct)

1

condensation

1

(b) 

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

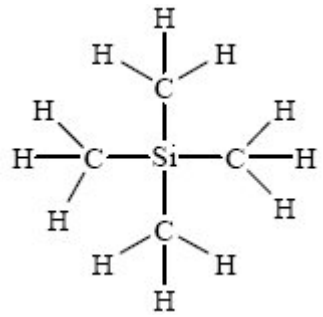
X 4

1

Y 2

1

(ii)



displayed formula shows ALL bonds

1

(b) (i) NO_2^+

allow + anywhere
can score in equation

1

$HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + 2HSO_4^- + H_3O^+$

1

OR

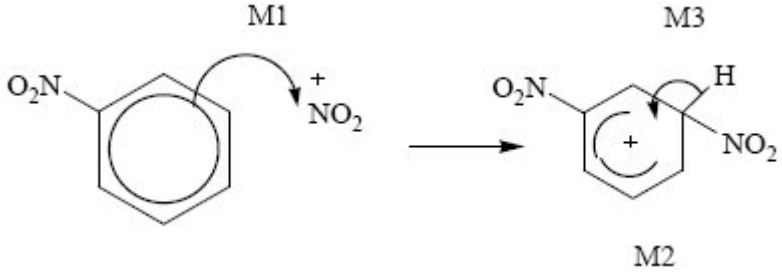
$HNO_3 + H_2SO_4 \rightarrow NO_2^+ + HSO_4^- + H_2O$

or use two equations via $H_2NO_3^+$

(ii) electrophilic substitution

Not Friedel Crafts

1



Allow Kekule structures
+ must be on N of $^+NO_2$ (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

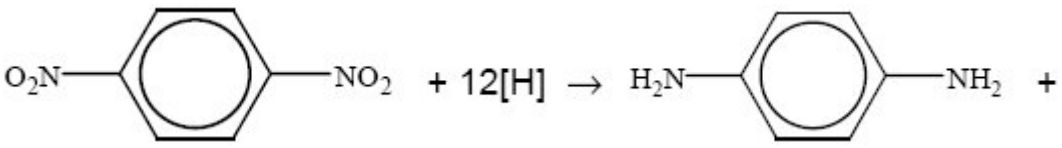
smaller
+ not too close to C1
M3 arrow into hexagon unless Kekule
allow M3 arrow independent of M2 structure
ignore base removing H in M3

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

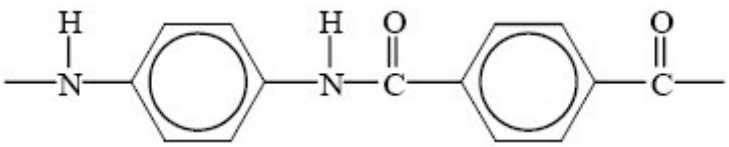


$4H_2O$
Or $6H_2$

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 <u>biodegradeable</u> but polyalkenes not
allow Kevlar is <u>more</u> biodegradeable

1

M2 Kevlar has <u>polar</u> 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]