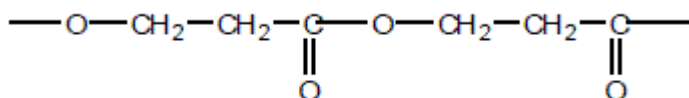


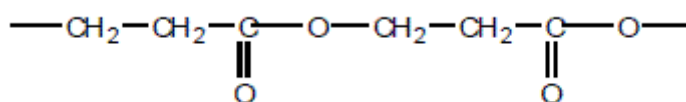
- M1. (a) 3-hydroxypropanoic acid
allow 3-hydroxypropionic acid
must be correct spelling

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

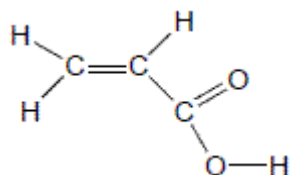
- (ii) condensation (polymerisation)
Allow close spelling

1

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

1

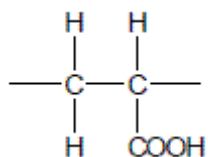
- (ii)



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

1

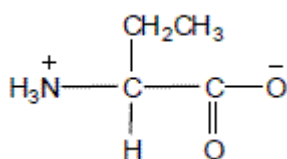
(iii) must show trailing bonds



allow polyalkene conseq on their c(ii)
ignore n

1

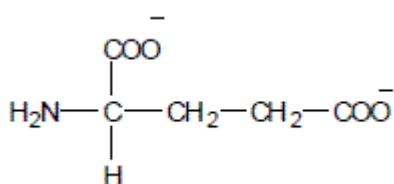
(d)



allow NH_3^+ —
allow COO^-

1

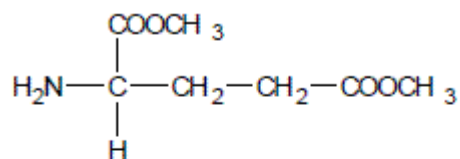
(e) (i)



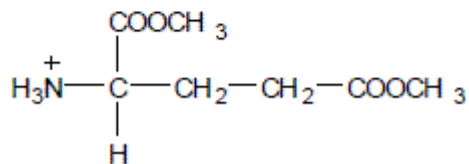
In (e), do not penalise a slip in the number of carbons in the $-\text{CH}_2\text{CH}_2-$ chain, but all must be bonded correctly
NB two carboxylate groups
Allow COONa or $\text{COO}^- \text{Na}^+$ but not covalent bond to Na
allow NH_2-

1

(ii)



OR



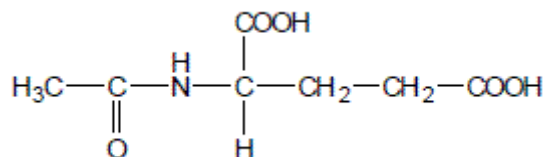
In (e), do not penalise a slip in the number of carbons in the -CH₂CH₂- chain, but all must be bonded correctly

NB two ester groups

allow NH₂- or ⁺NH₃-

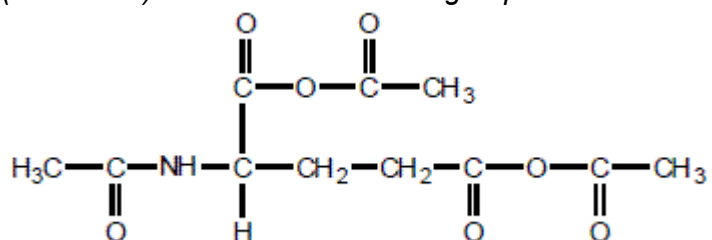
1

(iii)



In 4(e), do not penalise a slip in the number of carbons in the -CH₂CH₂- 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 moving or mobile

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

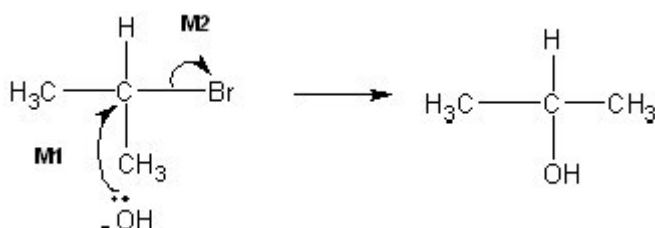
(amino acids) travel at different speeds or take different times

1

[13]

M2. (a) (i) Nucleophilic substitution

1



2

M1 must show an arrow from the lone pair of electrons on the oxygen atom of the negatively charged hydroxide ion to the central C atom.

M2 must show the movement of a pair of electrons from the C-Br bond to the Br atom. Mark M2 independently.

Penalise M1 if covalent KOH is used

Penalise M2 for formal charge on C or incorrect partial charges

Penalise once only for a line and two dots to show a bond.

*Max 1 mark **for the mechanism** for the wrong reactant and/or "sticks"*

Ignore product

Award full marks for an S_N1 mechanism in which M1 is the attack of the hydroxide ion on the intermediate carbocation.

(ii) 2-bromopropane ONLY

1

(iii) Polar C-Br OR polar carbon-bromine bond OR dipole on C-Br
OR δ^+ (δ^-)
C atom of carbon-bromine bond is δ^+ /electron deficient OR C-Br

(Credit carbon-halogen bond as an alternative to

carbon–bromine bond)

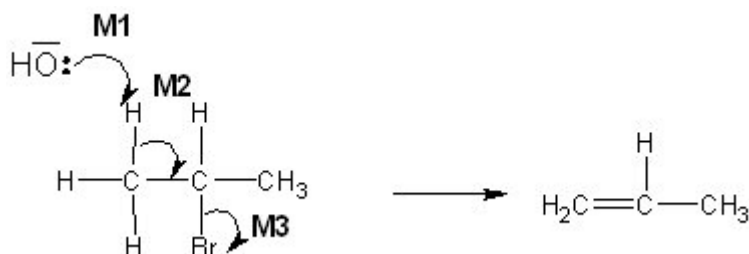
It must be clear that the discussion is about the carbon atom of the C–Br bond. NOT just reference to a polar molecule. Ignore X for halogen

1

(b) Elimination

*Credit “base elimination” but NOT “nucleophilic elimination”
No other prefix.*

1



3

M1 must show an arrow from the lone pair on oxygen of a negatively charged hydroxide ion to the correct H atom

M2 must show an arrow from the correct C-H bond to the C-C bond and should only be awarded if an attempt has been made at M1

M3 is independent.

Mechanism

Penalise M1 if covalent KOH

Penalise M3 for formal charge on C or incorrect partial charges

Penalise once only for a line and two dots to show a bond.

*Max 2 marks **for the mechanism** for wrong reactant and/or “sticks”*

Ignore product

Award full marks for an E1 mechanism in which M2 is on the correct carbocation.

(c) *Any one condition from this list to favour elimination;*

Apply the list principle

- alcohol(ic)/ethanol(ic) (solvent)
- high concentration of KOH/alkali/hydroxide **OR** concentrated KOH/hydroxide
Ignore “aqueous”
- high temperature or hot or heat under reflux or $T = 78$ to 100°C
Ignore “excess”

1

- (d) (i) Addition (polymerisation) ONLY
Penalise "additional"

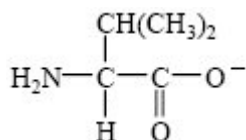
1

- (ii) But-2-ene ONLY (hyphens not essential)
Ignore references to cis and trans or E/Z
Ignore butane

1

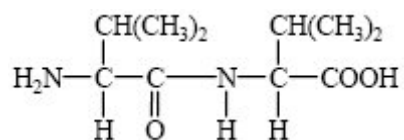
[12]

- M3.** (a) (i)



1

- (ii)

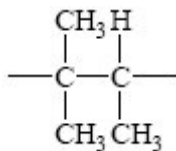


1

- (iii) hydrogen bonding (do not allow H-bonding) QWC
do not penalise any error twice.

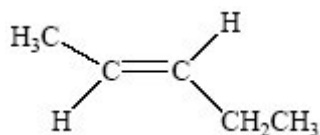
1

- (b) (i)



1

(ii)

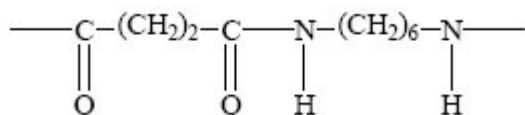


1

(iii) Isomer must be saturated or must not contain a double bond

1

(c)



2

(d) (i) heat/reflux with aqu NaOH

1

poly(alkene) is inert/ no reaction

1

polyamide is hydrolysed (or undergoes hydrolysis)
to form acid salt and alcohol QWC

1

(ii) e.g combustion

1

heat energy produced

1

toxic gases produced

1

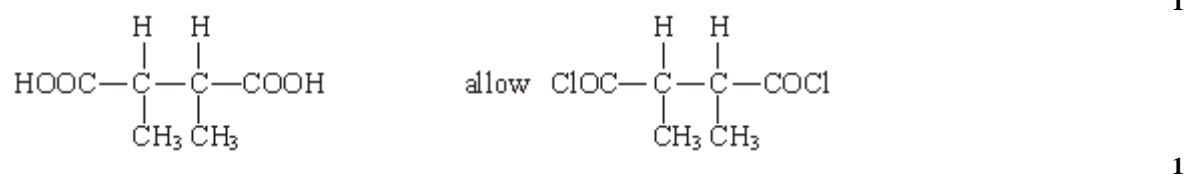
[14]

M4. (a) (i) $\text{CH}_3\text{CH}=\text{CHCH}_3$ 1

Addition or radical (**QoL**) 1

(ii) $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{OH})\text{CH}_3$ or with no brackets 1

butan(e)-2,3-diol or 2,3-butan(e)diol 1

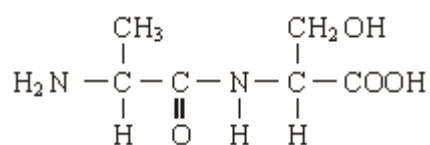


2,3-dimethylbutan(e)dioic acid 2,3-dimethylbutan(e)diol chloride
ignore -1,4- 1

condensation (**QoL**) 1

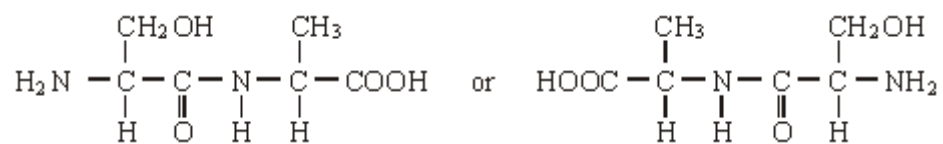
(iii) NaOH or HCl etc or Na_2CO_3 1
Allow conc sulphuric/nitric
NOT water nor acidified water nor weak acids

(b) Structure 1

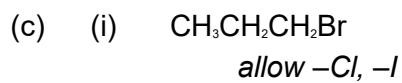


Allow -CONH- and -COHN-
Allow zwitterions
NOT polypeptides/repeating units 1

Structure 2 either of



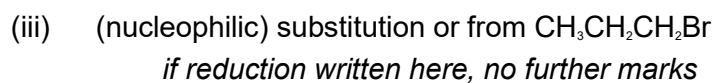
1



1



1



1

further substitution/reaction occurs or other products are formed
Allow reduction forms only one product

1

one of
 $(\text{CH}_3\text{CH}_2\text{CH}_2)_2\text{NH}$
 $(\text{CH}_3\text{CH}_2\text{CH}_2)_3\text{N}$
 $(\text{CH}_3\text{CH}_2\text{CH}_2)_4\text{N}^+ \text{Br}^-$
Allow salts including NH_4Br
Allow HBr

1

[15]