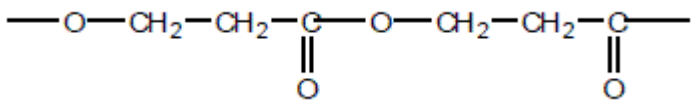
M1. (a) 3-hydroxypropanoic acid

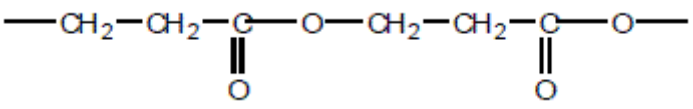
allow 3-hydroxypropionic acid
must be correct spelling

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)

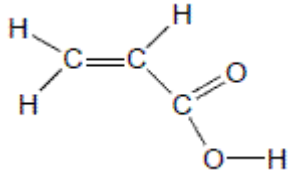
Allow close spelling

1

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

1

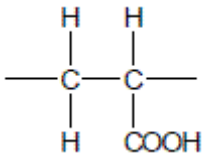
(ii)



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

1

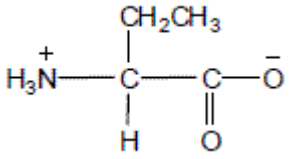
(iii) must show trailing bonds



allow polyalkene conseq on their c(ii)
ignore n

1

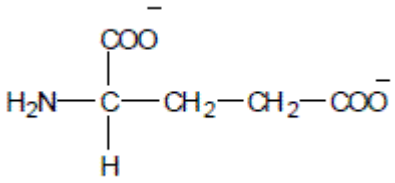
(d)



allow NH_3^+—
allow COO^-

1

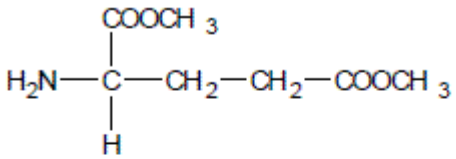
(e) (i)



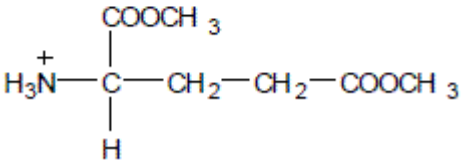
In (e), do not penalise a slip in the number of carbons in the $-CH_2CH_2-$ chain, but all must be bonded correctly
NB two carboxylate groups
Allow COONa or COO^- Na^+ but not covalent bond to Na
allow NH_2–

1

(ii)



OR



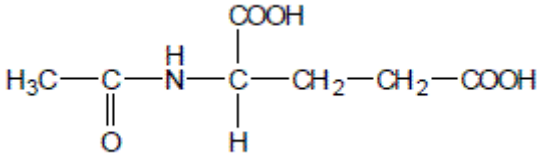
In (e), do not penalise a slip in the number of carbons in the -CH_2CH_2- chain, but all must be bonded correctly

NB two ester groups

allow NH_2– or $^+NH_3$–

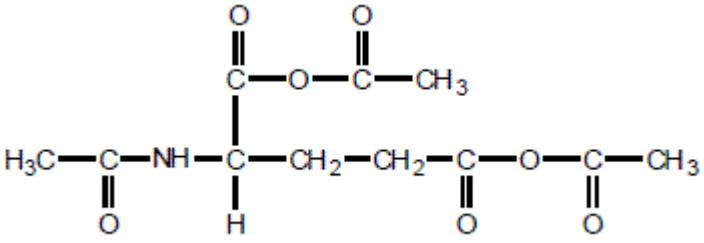
1

(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 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

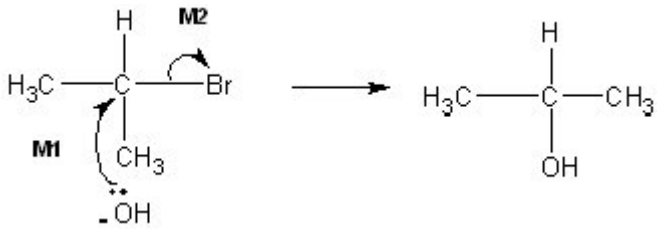
OR
(amino acids have) different R_f values
OR
(amino acids) travel at different speeds or take different times

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)

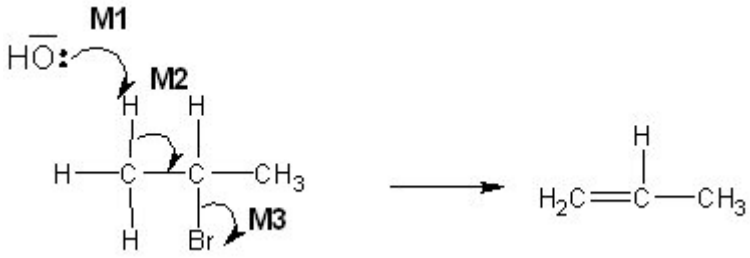
It must be clear that the discussion is about the carbon atom of the C–Br bond. NOT just reference to a polar molecule.
Ignore X for halogen

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)

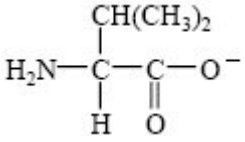
Ignore references to cis and trans or E/Z

Ignore butane

1

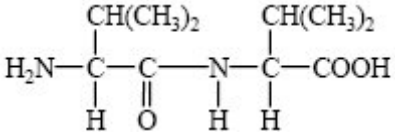
[12]

M3. (a) (i)



1

(ii)



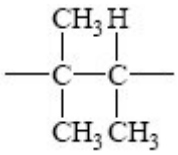
1

(iii) hydrogen bonding (do not allow H-bonding) QWC

do not penalise any error twice.

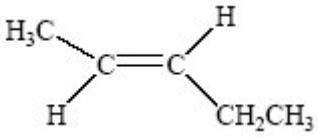
1

(b) (i)



1

(ii)

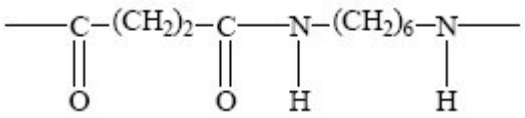


1

(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 <u>hydrolysed</u> (or undergoes <u>hydrolysis</u>) 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) $CH_3CH=CHCH_3$

1

Addition or radical (**QoL**)

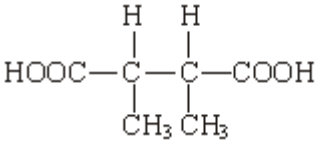
1

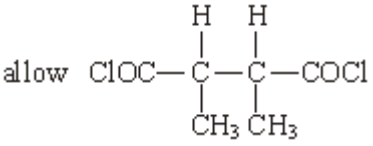
(ii) $CH_3CH(OH)CH(OH)CH_3$ or with no brackets

1

butan(e)–2,3–diol or 2,3–butan(e)diol

1



allow 

1

2,3–dimethylbutan(e)dioic acid 2,3–dimethylbutan(e)dioyl chloride

ignore –1,4–

1

condensation (**QoL**)

1

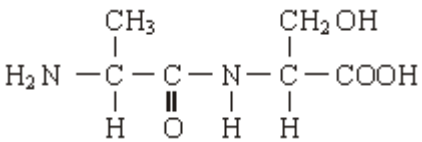
(iii) NaOH or HCl etc or Na_2CO_3

Allow conc sulphuric/nitric

***NOT** water nor acidified water nor weak acids*

1

(b) Structure 1



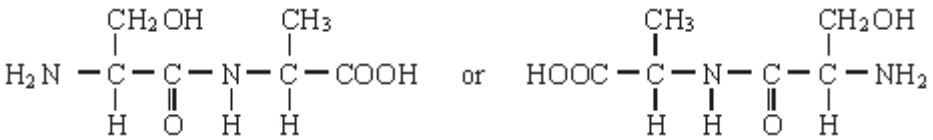
Allow –CONH– and –COHN–

Allow zwitterions

NOT polypeptides/repeating units

1

Structure 2 either of

 or

1

(c) (i) $CH_3CH_2CH_2Br$

allow –Cl, –I

1

(ii) CH_3CH_2CN

1

(iii) (nucleophilic) substitution or from $CH_3CH_2CH_2Br$

if reduction written here, no further marks

1

further substitution/reaction occurs or other products are formed

Allow reduction forms only one product

1

one of
$(CH_3CH_2CH_2)_2NH$
$(CH_3CH_2CH_2)_3N$
$(CH_3CH_2CH_2)_4N^+ Br^-$

Allow salts including NH_4Br

Allow HBr

1

[15]