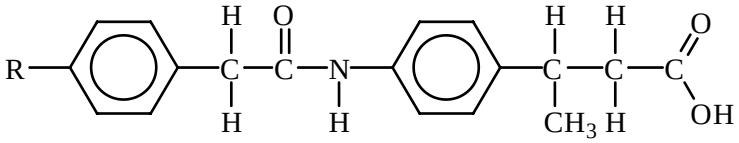
Nitrogen Compounds - MS

1. (a) (i) is an amine and a carboxylic acid /
contains both NH2 and COOH functional groups **(1) AW** 1

(ii) $RCH(NH_2)COOH$ **(1)**

Does not fit the formula because NH_2 and COOH are not attached to the same carbon **(1) AW** 2

(c)



displayed amide bond **(1)**
rest of the structure also correct **(1)**
(allow full marks for a correct anhydride structure) 2

[7]

2. (i) one amide link shown correctly **(1)**
glycine and phenylalanine parts shown correctly **(1)**
proline linked correctly **(1)** 3

(ii) 6 **(1)** 1

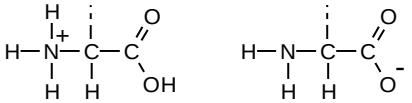
[4]

3. (i) water / evidence of a solution in water – eg
(aq), 'dil' ,'6M' or ' conc' for HC*l* **(1)**
NOT conc HNO_3
or conc H_2SO_4

a named strong acid or alkali (heated under) reflux /**(1)** 2

(ii) amino acids **(1)** 1

(iii) correct structure for one of the amino acids **(1)**
correct ionic form for reagent used in a(i) – eg



/ **(1)** 2

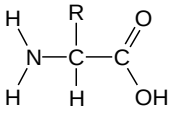
(iv) reaction with water to split/break down the compound **(1)**

peptide bond in the compound is broken / diagram to show AW **(1)** 2

[7]

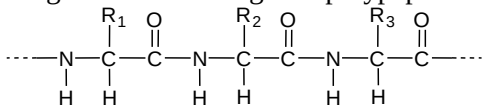
4. General formula of an α-amino acid

$RCH(NH_2)COOH$ /



(1)

Diagram to show length of polypeptide / repeat unit – eg



with:

displayed peptide bond **(1)**

correct structure with a minimum of two amino acids joined
(can be scored by a dipeptide) **(1)**

idea of polymerisation shown by 'end bonds' **(1)**

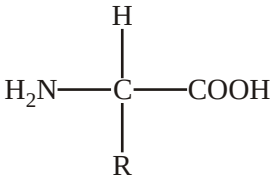
loss of water **(1)**

relate variety to different R groups / sequence of amino acids
(1) AW 6

Quality of written communication:
correct organisation and use of **both** of the terms:
condensation polymer(isation) and peptide bond/link **(1)** 1

[7]

5. (i)



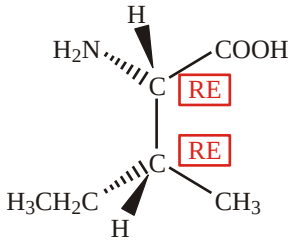
✓

ALLOW *$RCH(NH_2)COOH$ any order for R, NH_2 and COOH but C must be next to H 'CH' must be shown*
ALLOW *CO_2H*
brackets around NH_2 are ***not*** *essential*
ALLOW *structure*

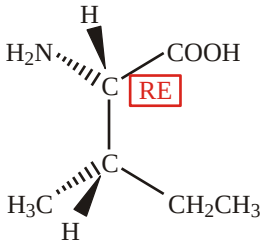
1

(ii) must attempt 3D

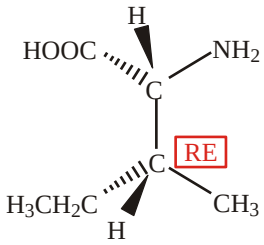
use RE symbol in the "tools" to denote whether or not each chiral C is a reflection of the one given in the question



both chiral Cs
are mirror images



top chiral C only
is a mirror image



bottom chiral C only
is a mirror image

*each chiral C must have 2 — bonds, 1 wedge bond (****IGNORE*** *shading) & 1 dash bond (****IGNORE*** *wedge)*
check the clockwise orientation of each C. For each C start with the H and if on the:

- *top C the H is followed by COOH it is not a mirror image. If it is a mirror image annotate using RE.*
- *bottom C the H is followed by CH_3 it is not a mirror image. If it is a mirror image annotate using RE.*

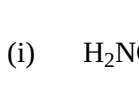
the four groups can be attached in any order. If the molecule is drawn upside down – clockwise becomes anti-clockwise.

MUST *check that the drawn structure is non-superimposable irrespective of the orientation or the way it has been drawn.*

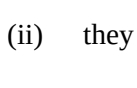
IGNORE *bond linkage for all groups*

3

[4]

6. (a) (i) $H_2NCHRCOOH$ /  **(1)** 1

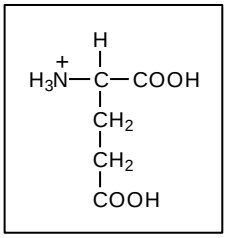
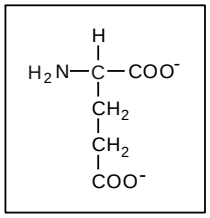
allow R CH NH_2 and COOH in any order

(ii) they both have the  group / or in words **(1)**

NOT just "they both have NH_2 and COOH"

R group is H in glycine and CH_2CH_2COOH in glutamic acid **(1)** 2

(b)

	$-NH_3^+$ **(1)** -COOH and side chain unaffected **(1)**		one $-COO^-$ **(1)** both $-COO^-$ **(1)** H_2N- and rest of molecule **(1)**

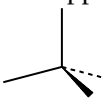
5

(c) **glutamic acid/molecule with optical isomers …**

… is <u>chiral</u> **(1)**

… has four different / distinguishable groups attached to a carbon **(1)**
NOT just "different atoms"

… the mirror images/isomers cannot be superimposed **AW (1)**

one diagram showing **two** 3-D bonds not opposite each other,
and not with angles looking like 90°  **(1)**

3-D diagram of the other isomer (allow ecf on one 3-D error) **(1)**

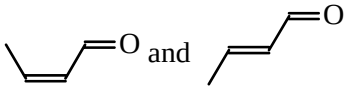
all groups correctly connected for glutamic acid in both diagrams **(1)**

glycine
only has three different groups / two groups are the same /
3-D diagram used to show symmetry **(1)** 8

quality of written communication
for correct use and organisation of at least **one** technical term:
*(in the correct place), non-superimposable, enantiomer, stereoisomer(ism), tetrahedral, assymetric **(1)**

[16]

7.

 and

at least one correct skeletal formula **(1)**
correct *cis* and *trans* isomers of but-2-enal **(1)** 2

[2]

9. $H_2N(CH_2)_6NH_2$ ✓

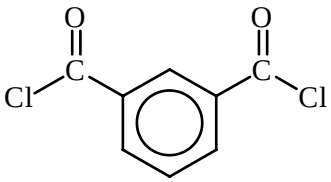
ALLOW *$H_2NCH_2CH_2CH_2CH_2CH_2CH_2NH_2$*

$HOOC(CH_2)_8COOH$ ✓

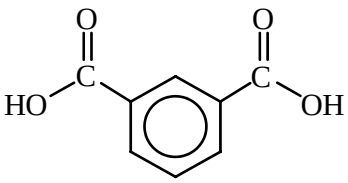
ALLOW *$HOOCCH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$*
ALLOW *CO_2H for COOH*
ALLOW *acid chloride, $ClOC(CH_2)_8COCl$*
ALLOW *displayed formulae or skeletal formulae*

[2]

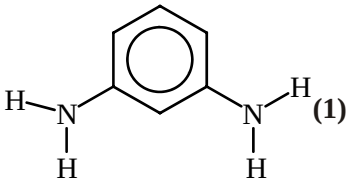
10. (i)



or



(1)



(1)

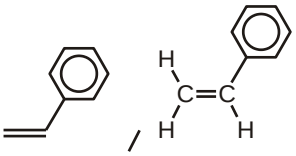
2

(ii) any valid suggestion to explain or describe stronger intermolecular forces – *e.g.* Nomex is planar so packs together more easily / greater H-bonding / London forces between molecules **(1) AW**
(ignore arguments based on *M*r) 1

[3]

11. (i) addition (polymerisation) **(1)** 1
NOT additional

(ii)



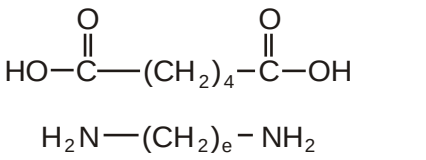
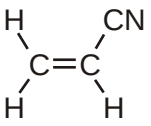
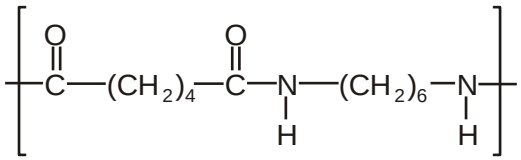
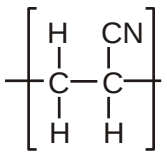
(1) 1

(iii) π-bond breaks **(1)**

many molecules join / a **long** chain forms / equation to show this using 'n' **(1)** 2

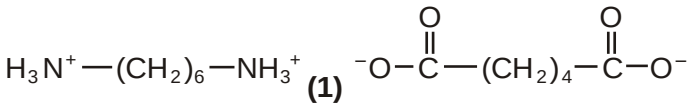
[4]

12. (a)

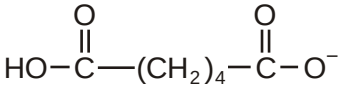
	 **(1)**	
 monomers connected by NHCO **(1)** correct repeat shown **(1)**		
condensation	addition	**(1)** for both

4

(b) HC*l* 1

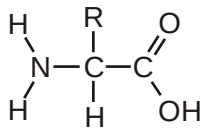
(c)  **(1)** 2

allow 1 mark for: both $H_3N^+–(CH_2)_6–NH_3^+$ *and*



(d) (i) 4 1

(ii)

 where R=H, CH_3, CH_2OH or $CH_2C_6H_5$ **(1)** 1

(iii) any three different chemically or biologically correct differences between amino acids and the nylon monomers **(1)(1)(1)** - eg

- protein monomers are amino acids / nylon monomers are a (di)amine/base and a (di)acid
- protein monomers have different types/R groups / nylon monomers are two types/no variation
- protein monomers have stereo/optical isomers/are chiral
- protein monomers have higher melting points/ form zwitterions

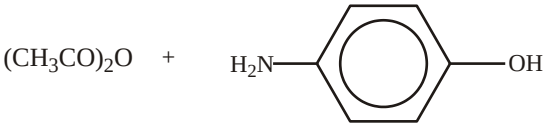
other possible answers include:

- nylon monomers have longer chain length/no other functional groups / no aromatic content / are symmetrical etc 3

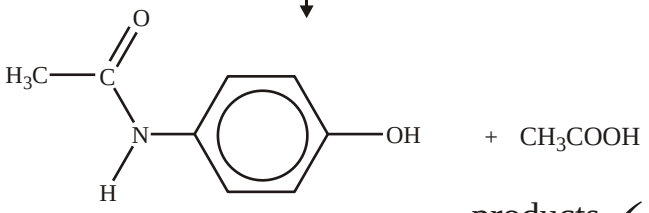
don't allow comparisons solubility or M_r

[12]

13. (i) equation



reactants ✓



products ✓

ALLOW

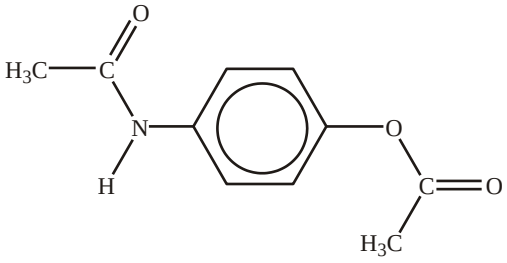
$(CH_3CO)_2O + H_2NC_6H_4OH \rightarrow CH_3CONHC_6H_4OH + CH_3COOH$

ALLOW

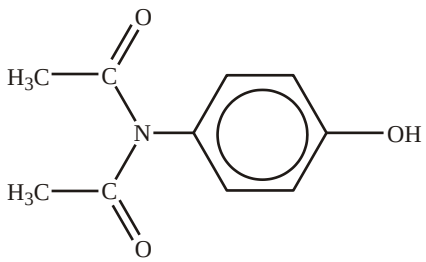
DO NOT ALLOW *molecular formulae*

2

(ii) $C_{10}H_{11}NO_3$ is



OR



✓

ALLOW *amide shown as either $CH_3CONH–$* ***OR*** *$H_3CCONH–$* ***OR*** *$CH_3COHN–$* ***OR*** *$H_3CCOHN–$*

ALLOW *ester shown as either $–OCOCH_3$* ***OR*** *$–OOCCH_3$*

1

(iii) to ensure that there are no (harmful) side effects ✓

ALLOW *impurities reduce effectiveness (of drug)* ***OR*** *might be toxic*
OR *avoids litigation* ***OR*** *harmful* ***OR*** *hazardous*
ALLOW *to ensure that the drug/active component is safe*
IGNORE *dangerous* ***OR*** *nasty* ***OR*** *can kill* ***OR*** *increased dosage*

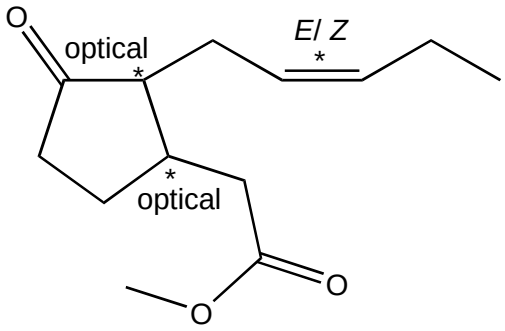
1

[4]

14. (i) $C_{13}H_{20}O_3$ **(1)** 1

(ii) ketone **(1)**
ester **(1)**
alkene **(1)** 3

(iii)



both optical **(1)**
E/*Z* **(1)** 2

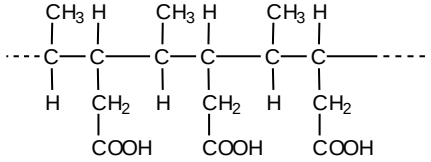
(iv) possible side effects of other chiral compound **(1)**
increased costs/difficulty of separating of isomers **(1)**
using bacteria within synthetic route **(1)** 2 max

[8]

15. (a) (i) $NaBH_4$ **(1)** 1

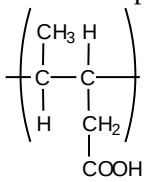
(ii) 4-hydroxypentanoic acid **(1)** 1

(b) (i) section of the polymer **(1)** – e.g.



1

(ii) a correct repeat shown **(1)** – e.g.



1

allow ecf from (i) only if the repeat is every 2 carbons along the chain and has a COOH

(c) (i) $C_7H_{12}O_3$ **(1)** 1

(ii) $C_7H_{12}O_3 + \mathbf{8}½O_2 \rightarrow \mathbf{7}CO_2 + \mathbf{6}H_2O$ or ecf from (i))
formulae **(1)**
balancing **(1)** 2

(iii) idea of providing oxygen /
reducing incomplete combustion **AW (1)** 1

(d) (i) heat/warm/reflux **(1)**
NaOH / KOH(aq) **(1)** 2

(ii) **G** is an ester / sensible argument based on polarity **(1)** 1

[11]

16. (i) a carbon with four different groups attached **(1)**

a chiral carbon /centre **(1)**

different spatial / 3-D arrangement (of the groups) **(1)**

(stereo)isomers / mirror images are non-superimposable / molecules are asymmetric **(1)** 3

ANY 3 out of 4 marks

(ii) contains 2 chiral centres **(1)**

each can have 2 (stereo)isomers/ 2×2 possibilities **AW (1)** 2

(iv) higher doses are required **(1)**

the drug /other stereoisomers may have (harmful) side-effects **(1)** 2

[8]