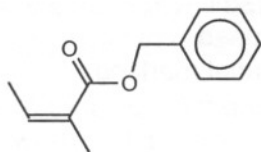


1 (a) (i) alkene ✓
ester ✓

allow "C=C double bond"

[2]

i.



[1]

ii. $C_{12}H_{14}O_2$ ✓

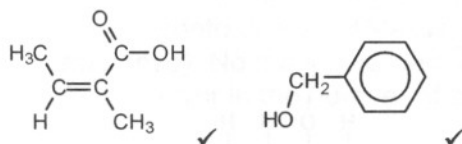
[1]

b. same structural formula/order of bonds,
different spacial arrangement AW ✓

description or diagram showing B and how it is different from A ✓

[2]

c.



[2]

d. i. peak at 1680-1750 (cm^{-1}) due to C=O ✓

peak at 1000-1300 (cm^{-1}) due to C-O / ✓

[2]

ii. 2500-3300 / 3230-3550 (cm^{-1}) ✓

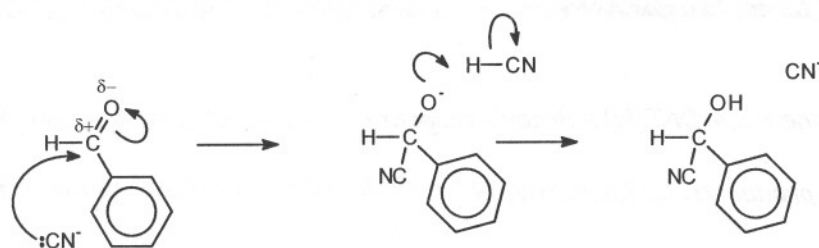
O-H / carboxylic acid / alcohol is **not** present in A ✓

allow 1 mark for ~500-1500 (cm^{-1}) which is a unique fingerprint region etc

[2]

[Total: 12]

2 (a) (i)



polarisation of $C^{\delta+}=O^{\delta-}$ and curly arrow breaking $C=O$ ✓

curly arrow from lone pair on $:CN^-$ to C ✓

structure of intermediate ✓

curly arrows from O^- to $H-CN/H_2O$ and
breaking the $H-CN/H-OH$ bond ✓

allow just a curly
arrow from from
 O^- to H

[4]

iii. nucleophilic addition ✓

[1]

e. lengthening the carbon chain AW ✓

[1]

f. i. heat/reflux ... with a suitable strong acid / acid / H^+ ✓
which is dilute / (aq) / stated concentration ✓

allow 'conc' for HCl

[2]

ii. $C_6H_5CH(OH)CN + 2H_2O + H^+ \longrightarrow C_6H_5CH(OH)COOH + NH_4^+$ ✓

[1]

g. mandelic acid is chiral / has optical isomers / enantiomers ✓

synthetic gives a mixture / natural gives only one (optical) isomer ✓

only one of the (optical) isomers is the (pharmacologically) active
one AW ✓

ignore references to
side effects and
dosage

[3]

h. i. $C_6H_5CH(OH)CH_2NH_2$ / 2-amino-1-phenylethanol
any unambiguous formula/name ✓

[1]

ii. reduction / redox ✓

[1]

[Total: 14]

3 (a) *low boiling point / easily turns to a gas AW ✓* [1]

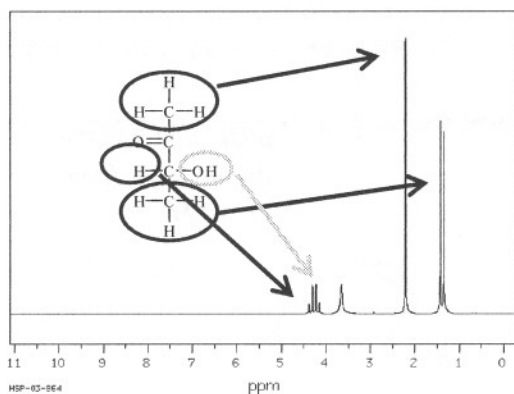
i. *2,4-dinitrophenylhydrozine / 2,4-DNP(H) / Brady's reagent ✓*

purify/recrystallise the product/solid (derivative) ✓

measure the melting point /mp ✓

compare the result with data book/known values ✓ [4]

j. i.



one mark for two peaks assigned ✓

two marks for all three ✓

[2]

ii. *re-run in/add D₂O ✓*
peak (due to OH) disappears ✓

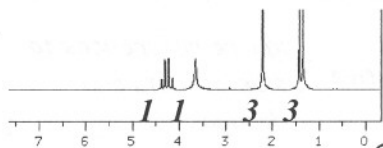
[2]

iii. *Peak at 1.4ppm*
(1:1 due to) one H on the neighbouring /adjacent carbon ✓

Peak at 4.3ppm
(1:3:3:1 due to) three H on the neighbouring /adjacent carbon ✓

[2]

iv.



all four correct ✓

[1]

v. *no of H/protons in the same (chemical) environment/of that 'type' ✓* [1]

[Total: 13]

4 (a) Correct structure of 3-nitrophenol or any multiple nitrated phenol ✓ [1]

k. M_r phenol (C_6H_6O) = 94.0 ✓

M_r 4-nitrophenol ($C_6H_5NO_3$) = 139.0 ✓

expected mass/moles of nitrophenol from 100 g =
148 g/1.06 mol (or ect from wrong M_r s) ✓

at 27% yield gives 40 / 39.9 (g) (or ect) ✓

last mark is for 0.27 x
expected mass to 2 or 3 sf [4]

l. conditions for nitration of benzene:
 HNO_3 is concentrated ✓

conc H_2SO_4 is present ✓

heating or stated temp above $50^\circ C$ ✓

[3]

explanation for greater reactivity of phenol
lone pair from O atom is delocalised into the ring ✓

greater (π) electron density around the ring ✓

(the benzene ring in phenol) is activated ✓

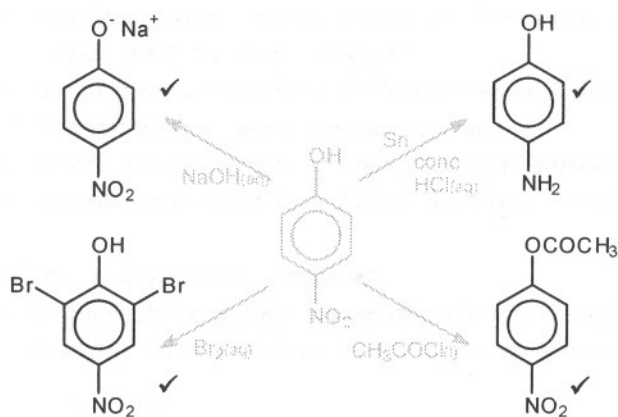
attracts electrophiles/ NO_2 more / makes it more susceptible to
electrophiles AW ✓

[4]

quality of Written Communication mark for at least two legible
sentences with correct spelling, punctuation and grammar

[1]

m.

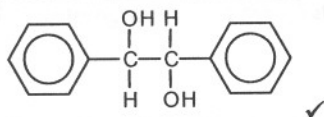


allow bromination in
any positions on the
ring

[4]

[Total: 17]

5 (a) (i)



[1]



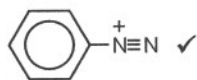
allowed from (i) [1]

- n. *delocalised electrons*
electrons are spread over more than two atoms AW ✓

π -bond
formed by overlap of p-orbitals/ diagram to show ✓ [2]

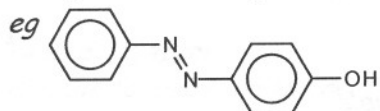
- o. *sodium nitrite + HCl / nitrous acid* ✓

$<10^\circ\text{C}$ ✓



phenol/named example (added to the products from above) AW ✓
alkaline conditions / OH^- ✓

example of an azo dye that could be formed from phenylamine,



[6]

[Total: 10]

6 (a)	$\begin{array}{c} \text{HO}-\overset{\text{O}}{\parallel}{\text{C}}-(\text{CH}_2)_4-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH} \\ \text{H}_2\text{N}-(\text{CH}_2)_6-\text{NH}_2 \end{array}$	$\begin{array}{c} \text{H} \quad \text{CN} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \\ \text{H} \quad \text{H} \end{array} \checkmark$	
	$\left[\begin{array}{c} \text{O} \quad \text{O} \\ \parallel \quad \parallel \\ \text{---C---}(\text{CH}_2)_4\text{---C---N---}(\text{CH}_2)_6\text{---N---} \\ \quad \\ \text{H} \quad \text{H} \end{array} \right]$ <p><i>monomers connected by NHCO ✓</i> <i>correct repeat shown ✓</i></p>	$\left[\begin{array}{c} \text{H} \quad \text{CN} \\ \quad \\ \text{---C---C---} \\ \quad \\ \text{H} \quad \text{H} \end{array} \right]$	
	<i>condensation</i>	<i>addition</i>	<i>✓ for both</i>
	[4]		
p. i.	<i>PCl₅ / SOCl₂</i>		
	[1]		
	ii. <i>HCl</i>		
	[1]		
q.	$\text{H}_3\text{N}^+-(\text{CH}_2)_6-\text{NH}_3^+ \checkmark \quad \text{O}=\text{C}-(\text{CH}_2)_4-\text{C}=\text{O}$		
	<p><i>allow 1 mark for: both H₃N⁺-(CH₂)₆-NH₂ and HO-C(=O)-(CH₂)₄-C(=O)-O⁻</i></p>		
	[2]		
r. i.	<i>4</i>		
	[1]		
ii.	$\begin{array}{c} \text{H} \quad \text{R} \quad \text{O} \\ \quad \quad \parallel \\ \text{N}-\text{C}-\text{C} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{OH} \end{array} \quad \text{where } R = \text{H}, \text{CH}_3, \text{CH}_2\text{OH} \text{ or } \text{CH}_2\text{C}_6\text{H}_5 \checkmark$		
	[1]		
iii.	<p><i>any three different chemically or biologically correct differences between amino acids and the nylon monomers ✓✓✓ - eg</i></p>		
	<ul style="list-style-type: none"> • <i>protein monomers are amino acids / nylon monomers are a (di)amine/base and a (di)acid</i> • <i>protein monomers have different types/R groups / nylon monomers are two types/no variation</i> • <i>protein monomers have stereo/optical isomers/are chiral</i> • <i>protein monomers have higher melting points/form zwitterions</i> 		
other possible answers include:	<ul style="list-style-type: none"> • <i>nylon monomers have longer chain length/no other functional groups / no aromatic content / are symmetrical etc</i> 		
		<i>don't allow comparisons of solubility or M_r</i>	[3]
[Total: 13]			

7 (a) (i) *bromine as an electrophile*

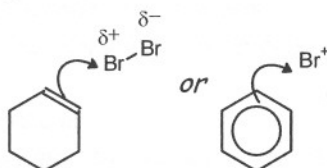
an electrophile accepts an electron pair ✓

NOT a lone pair

bromine is polarised/has + charge (centre)/dipole on Br-Br/Br⁺ shown in diagram ✓

appropriate diagram showing a curly arrow from a double/ π bond to the Br^{δ+}/Br⁺ ✓

eg



[3]

iv. *comparison of reactivity of cyclohexene and benzene*

benzene is (more) stable / more energy required ✓

benzene (π) electrons are delocalised ✓

benzene has lower electron/- charge density ✓

so bromine is less polarised / attracted to it / benzene is less susceptible to electrophiles ✓

ora for cyclohexene

[4]

quality of written communication mark for any two of the the terms:

delocalised/localised, π -electrons/bonds/system, electron density, dative covalent, activation/stabilisation energy, halogen carrier, heterolytic fission, addition/substitution, polarity used appropriately ✓

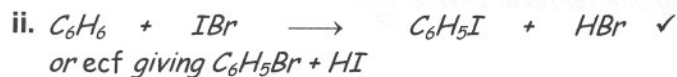
[1]

s. i. *iodobenzene because ...*

Br is more electronegative than I ✓ ora

so the I atom will be positive / δ^+ /the electrophile ✓

[2]



[1]

[Total: 11]