

- 2 (a) Only one C substituent on N ✓ [1]  
 or two H substituents on N  
 or RNH<sub>2</sub> as a general structure  
**NOT** attached to a C only attached to one other carbon ie RCH<sub>2</sub>NH<sub>2</sub>  
**NOT** NH<sub>2</sub> is on the first/end carbon
- (b) C<sub>2</sub>H<sub>5</sub>NH<sub>2</sub> + H<sup>+</sup> ⇌ C<sub>2</sub>H<sub>5</sub>N<sup>+</sup>H<sub>3</sub> balanced eq ✓ [2]  
 structure ✓ (+ is essential)  
 any acid OR water accept in equation  
 or  
 C<sub>2</sub>H<sub>5</sub>NH<sub>2</sub> + HCl ⇌ C<sub>2</sub>H<sub>5</sub>N<sup>+</sup>H<sub>3</sub> Cl<sup>-</sup>  
 (⇌ not essential)
- (c) (i) Stage I: [5]  
 H<sub>2</sub> + catalyst, or H<sub>2</sub> + specified metal catalyst e.g. Ni, Pd, Pt; or  
 metal ✓ **NOT** acid catalyst  
  
 or Sn/HCl] words or formula  
 or Fe/HCl]  
 or Na in ethanol or liq. NH<sub>3</sub>  
  
Stage II:  
 NaNO<sub>2</sub> ✓, an acid e.g. HCl ✓  
 or HNO<sub>2</sub> ✓✓  
 HNO<sub>3</sub> / HCl gets (1)  
**NOT** just HCl only; not eg HCl + H<sub>2</sub>SO<sub>4</sub>  
  
Stage III:  
 Phenol ✓, (aq) NaOH or base or alkali ✓
- (ii) Stage I: [2]  
 C<sub>7</sub>H<sub>7</sub>NO<sub>2</sub> + 3H<sub>2</sub> → C<sub>7</sub>H<sub>9</sub>N + 2H<sub>2</sub>O ✓  
 or 6[H]/6H  
  
Stage III:  
 C<sub>7</sub>H<sub>7</sub>N<sub>2</sub><sup>+</sup>Cl<sup>-</sup> + C<sub>6</sub>H<sub>5</sub>ONa → C<sub>13</sub>H<sub>12</sub>N<sub>2</sub>O + NaCl ✓  
 or without the Cl<sup>-</sup> or without the Na<sup>+</sup> or without both  
 or C<sub>7</sub>H<sub>7</sub>N<sub>2</sub><sup>+</sup>Cl<sup>-</sup> + C<sub>6</sub>H<sub>5</sub>ONa + NaOH → C<sub>13</sub>H<sub>12</sub>N<sub>2</sub>O + NaCl + H<sub>2</sub>O  
  
 Both equations **MUST** be balanced.  
 ecf: if no base in Stage III then allow phenol giving HCl and  
 product in equation
- (iii) Dyes ✓ [1]  
 allow indicators, pharmaceuticals

Total = 11

- 5 (a)  $\text{HOOC}(\text{CH}_2)_4\text{COOH}$  ✓ } words or formula [2]  
 $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$  ✓ }  
 (or any pair of monomers that would work)

- (b) condensation polymerisation ✓ [2]  
 small molecule /  $\text{H}_2\text{O}$  is eliminated ✓

- (c) max of 6 marks from: [7]

- structural similarity  
 e.g. peptide/amide link (1)

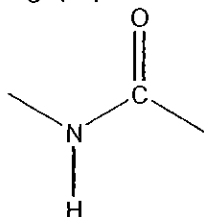


diagram (1)

both form H-bonds between molecules (1) picture of H-bond (1)  
or can be in second bullet point

- chemical similarity  
 e.g. both condensation polymers (1)  
 $\sim\text{NH}_2 + \text{HOOC}\sim \rightarrow \sim\text{NHCO}\sim + \text{H}_2\text{O}$  equation (1)  
 both are hydrolysed (1) back to monomers (1)

- differences

e.g.

- protein can be water-soluble, nylon not (1)
- protein biodegradable, nylon not (1)
- nylon regular, protein irregular (1)
- nylon one or two monomers, protein many (1)
- proteins are made from amino acids (1) which can be chiral (1)
- proteins are natural and nylon is synthetic (owtte) (1)

At least one mark from each bullet point and not more than three from each bullet point. MAX = 6

Plus

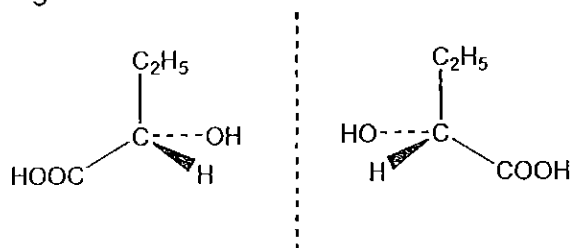
Quality of written communication ✓

Correct reference to **two** chemical terms e.g. condensation, peptide, biodegradeable.

Show as QWC x or ✓

Total = 11

(ii) e.g.



✓✓

with at least one bond shown out of plane of paper

(1) for correct structure of K, but poor 3-D diagrams

(1) for correct 3-D structures of J

watch out for -CN instead of -COOH

allow ecf from (i) e.g. -CH<sub>3</sub> instead of -C<sub>2</sub>H<sub>5</sub>

allow correct 3-D diagrams of amide as hydrolysis product instead of acid

Total = 14

- 7 (a) RCH(NH<sub>2</sub>)COOH or RCH(NH<sub>3</sub><sup>+</sup>)COO<sup>-</sup> ✓ [1]
- (b) (i) H<sub>3</sub>N<sup>+</sup>CH<sub>2</sub>COO<sup>-</sup> ✓ [1]  
accept NH<sub>3</sub><sup>+</sup>CH<sub>2</sub>COO<sup>-</sup>
- (ii) COOH is acidic / loses H<sup>+</sup> ✓ [2]  
NH<sub>2</sub> is basic / has a lone pair / gains H<sup>+</sup> ✓ (not H transfer)
- (iii) High m.p. means strong **intermolecular** / between molecules [3]  
(1) forces in the solid glycine; ✓  
coulombic (ion/ion) forces (1) in zwitterion are strong; ✓  
any comment on why hydroxyethanoic acid is lower ✓  
e.g. H-bonding (1) holds crystal together
- (c) H<sub>3</sub>N<sup>+</sup>CH<sub>2</sub>COOH ✓ ← glycine → H<sub>2</sub>NCH<sub>2</sub>COO<sup>-</sup> ✓ or H<sub>2</sub>NCH<sub>2</sub>COONa [4]  
↓  
H<sub>2</sub>NCH<sub>2</sub>COOCH<sub>3</sub> ✓  
or H<sub>3</sub>N<sup>+</sup>CH<sub>2</sub>COOCH<sub>3</sub>
- any correct balancing ion ✓

Total = 11

<b>Mark Scheme</b> Page 4 of 8	<b>Unit Code</b> 2814	<b>Session</b> June	<b>Year</b> 2002	<b>Final Version</b>
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Qu.	Expected answers:	Marks
4	<p>(at a temperature) &lt; 10° ✓</p> <p>(reagent is) nitrous acid / HNO<sub>2</sub> ✓</p> <p>(made by) sodium nitrite / NaNO<sub>2</sub> ... ✓</p> <p>... (with) hydrochloric acid / HCl ✓</p> <p>... (to give diazonium salt with formula) eg C<sub>6</sub>H<sub>5</sub>N<sub>2</sub><sup>+</sup> / C<sub>6</sub>H<sub>5</sub>N<sub>2</sub>Cl / C<sub>6</sub>H<sub>5</sub>N<sup>+</sup>≡N Cl ✓</p> <p>balanced equation - e.g. C<sub>6</sub>H<sub>5</sub>NH<sub>2</sub> + HNO<sub>2</sub> + H<sup>+</sup> → C<sub>6</sub>H<sub>5</sub>N<sub>2</sub><sup>+</sup> + 2H<sub>2</sub>O ✓</p> <p>(any of the other marks above may be awarded if they appear in an equation)</p> <p style="text-align: center;"><b>MAX 4 from these 5</b></p> <p>(used to form) dyes / colourings / coloured compounds ✓</p>	<p><b>ESSENTIAL</b> mark [1]</p> <p>max [4]</p> <p><b>ESSENTIAL</b> mark [1]</p> <p>[Total: 6]</p>

<b>Mark Scheme</b> Page 5 of 8	<b>Unit Code</b> 2814	<b>Session</b> June	<b>Year</b> 2002	<b>Final Version</b>
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Qu.      **Expected answers:** **Marks**



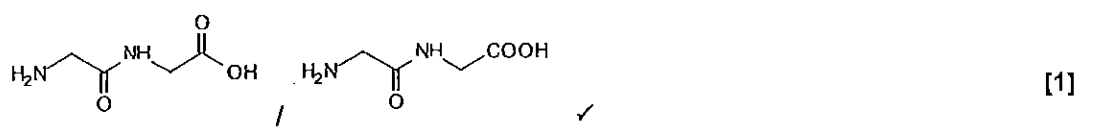
(ii) CH<sub>2</sub> ✓ [1]



(b) (i) peptide / amide ✓ [1]



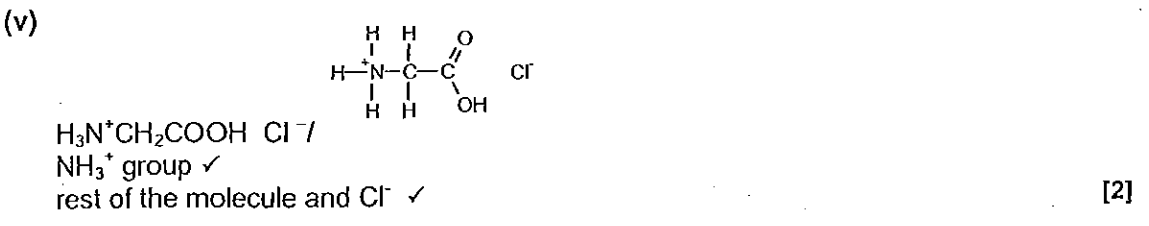
(ii) condensation ✓ [1]



5 (b) (iv) M<sub>r</sub> glycine, C<sub>2</sub>H<sub>5</sub>NO<sub>2</sub> = 75.(0) ✓ [2]  
M<sub>r</sub> C<sub>4</sub>H<sub>8</sub>N<sub>2</sub>O<sub>3</sub> = 132.(0) ✓

use of 2:1 ratio to give 0.009333mol of dipeptide *H* expected / ecf ✓ (or use of 2:1 ratio to give mass ratio of 150:132 / ecf) [1]

answer in the range 89.2 - 89.4 with 3 sf / ecf ✓ (correct answer gets all 4 marks) (answer in the range 44.6 - 44.7 (no 2.1) with 3 sf gets 3 marks overall) [1]



[Total: 14]

<b>Mark Scheme</b> Page 8 of 8	<b>Unit Code</b> 2814	<b>Session</b> June	<b>Year</b> 2002	<b>Final Version</b>
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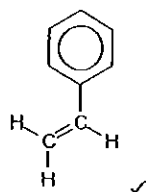
Qu.	Expected answers:	Marks
8	<p>(<b>structural isomerism</b> is) same molecular formula, different structural formulae ✓</p> <p style="padding-left: 40px;">two correct structures of suitable example ✓</p> <p><b>stereoisomerism</b> (is same structural) formula /order of bonds, different spatial arrangements of the atoms ✓</p> <p>(<b>cis-trans / geometric isomerism</b> is due to) non-rotation around a C=C double bond ✓</p> <p style="padding-left: 40px;">two correct structures of suitable example ✓</p> <p>(<b>optical isomerism</b> is when) molecules are non-superimposable mirror images / asymmetric / contain a chiral centre ✓</p> <p style="padding-left: 100px;">(or polymers may be isotactic, atactic or syndiotactic)</p> <p>carbon atom is attached to four distinguishable / different groups / atoms /(or shown in diagram) ✓</p> <p style="padding-left: 100px;">(or polymer side chain on the same, random or alternate sides)</p> <p style="padding-left: 40px;">two correct 3-d structures of suitable example ✓</p> <p style="text-align: center;"><b>8 points on isomerism (3 MAX for optical isomerism / polymers)</b></p> <p>(synthesis of only one stereoisomer of a <b>pharmaceutical</b> is good because . . .)</p> <p>... only one of the two stereoisomers may be active /the two isomers may have different activity in the body ✓</p> <p>... a smaller dose needed /saves cost of materials/separation ✓ (ora)</p> <p>... the other may have (harmful) side effects ✓</p> <p>good example of stereospecific drug e.g Thalidomide / Dopa / Ibuprofen ✓</p> <p style="text-align: center;"><b>4 points on chiral synthesis</b></p> <p><b>Quality of Written Communication</b></p> <p>the answer is coherent, and at least <b>two</b> of the specialist terms: <b>structural, cis-trans/geometric</b> and <b>optical isomerism</b> are assigned correctly ✓</p> <p>the text contains at least two legible sentences with reasonably accurate spelling, punctuation and grammar ✓</p>	<p>max [10]</p> <p>[2]</p> <p>[Total: 12]</p>

- 2 (a) (i) (trigonal) pyramidal ✓ [1]
- (ii) tetrahedral ✓ [1]
- (iii) trigonal (planar) ✓ [1]
- (b) (i)  $\text{H}_3\text{N}^+\text{CH}_2\text{COOH}$  ✓ [1]
- (ii)  $\text{NH}_2\text{CH}_2\text{COO}^-$  ✓ [1]
- (c) (i)  $\text{H}^+$  / acid /  $\text{HCl}$  /  $\text{H}_2\text{SO}_4$  /  $\text{OH}^-$  / alkali ✓  
/heat / reflux ✓  
(or use of an enzyme at 37°ish) [2]
- (ii) hydrolysis ✓ [1]
- (d) (i) carbon with four different / distinguishable groups attached ✓  
(or carbon / part of the molecule / atom which is assymmetric / non-superimposable on its mirror image) [1]
- (ii)
- $$\begin{array}{c} \text{NH}_2 \\ | \\ \text{CH}_3 - \text{C} - \text{H} \\ | \\ \text{COOH} \end{array}$$

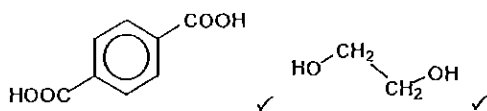
$$\begin{array}{c} \text{NH}_2 \\ | \\ \text{H} - \text{C} - \text{CH}_3 \\ | \\ \text{HOOC} \end{array}$$
- one structure of alanine with at least one 3-d bond ✓  
two optical isomers / reflections of a 3-d structure ✓ [2]
- (iii) one stereoisomer ✓  
natural / from a living system / made by enzymes etc ✓ [2]

[Total: 13]

7 (a) L:

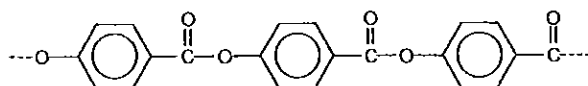


M:



[3]

(b)



at least one correct ester link ✓  
rest of the structure and repeat also correct ✓

[2]

(c)

condensation ✓  
loss of water / small molecule ✓

[2]

(d)

fibres / clothing / bottles etc ✓

[1]

[Total: 8]



- 4 (a) carboxylic acid / phenol / amino acid / named example or correct formula ✓
- equation to give the correct negative ion ✓  
 eg  $\text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}^+$   
 /  $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}_3\text{O}^+$
- (b) (i)  $\text{C}_6\text{H}_5\text{NH}_2 + \text{H}_2\text{O} \rightleftharpoons \text{C}_6\text{H}_5\text{NH}_3^+ + \text{OH}^-$  ✓
- (ii) (base, phenylamine, ethylamine) accepts  $\text{H}^+$  ✓  
 / donates lone pair
- (uses the) lone pair on the nitrogen ✓
- the lone pair (in phenylamine) is delocalised  
 /interacts with the delocalised/ $\pi$  electrons in the ring  
 or  
 inductive effect pulls electrons (from the nitrogen)
- ora ✓
- (c) amino acid /  $\text{RCH}(\text{NH}_2)\text{COOH}$   
 / named example or correct formula ✓
- contains both carboxylic acid/ $\text{COOH}$  and basic amine/ $\text{NH}_2$  groups ✓
- NOT 'HX' or any inorganic acid
- allow ecf on the formula or an inorganic acid from above as long as donation of  $\text{H}^+$  shown [2]
- do not penalise a correct equation using  $\text{H}^+$  or another acid [1]
- allow AW throughout  
 (or shown on a diagram)
- It must be clear which way the electrons are going" [3]
- do not allow non-organic acids for the first mark, but give ecf on good explanation
- allow any explanation describing acidity and basicity eg "can donate and accept  $\text{H}^+$ " [2]

[Total: 8]

7 (a) (i) tin/iron ✓

hydrochloric acid / HCl ✓

allow LiAlH<sub>4</sub> ✓ anyhydrous/ether ✓

[2]

(ii) M<sub>r</sub> of C<sub>6</sub>H<sub>5</sub>NO<sub>2</sub> = 123(.0) ✓M<sub>r</sub> of C<sub>6</sub>H<sub>5</sub>NH<sub>2</sub> = 93(.0) ✓(use of correct M<sub>r</sub> s get 2 marks)theoretical mass of C<sub>6</sub>H<sub>5</sub>NH<sub>2</sub> = 7.56(g) /ecf/ moles of C<sub>6</sub>H<sub>5</sub>NH<sub>2</sub> = 0.08(13) /ecf ✓

answer in the range 89.8-90.0(%) /ecf 3 sf ✓

(correct answer gets 2 more marks)

answer in the range 87-92% due to  
rounding errors and/or with sig figs ≠  
3 gets 3 marks max

[4]

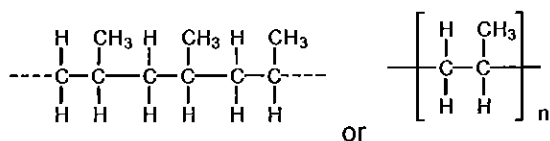
(b) sodium nitrite + (hydrochloric) acid  
/ nitrous acid / HNO<sub>2</sub> ✓✓

&lt; 10°C ✓

[3]

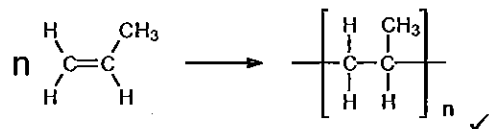
[Total: 9]

8 (a) (i) a correct structure for poly(propene), eg



bonds must extend outside any brackets ✓

equation showing 'n' monomers



[2]

(ii) addition:

monomer has C=C double bond / is an alkene / double bond breaks/ no (other) substance lost ✓

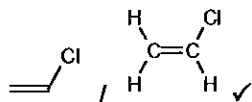
NOT just "monomer has a double bond"

condensation:

water / small molecule lost ✓

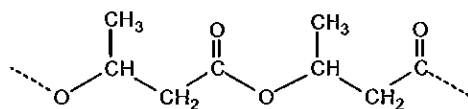
[2]

(b)



[1]

(c) (i)



at least one correct ester link ✓

rest of the structure and repeat also correct ✓

allow a break in the repeat at any point

[2]

(ii) H reacts with NaOH / poly(propene) does not ✓

H is an ester / is polar ... ✓

will be hydrolysed by NaOH ✓

poly(propene) is non-polar ✓

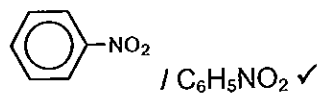
"hydrolysed by NaOH" gets the reacts with NaOH mark as well

ANY 3 out of 4 marks

[3]

[Total: 10]

9 (a)



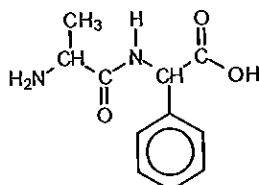
allow poly-nitrated benzene in any positions

[1]

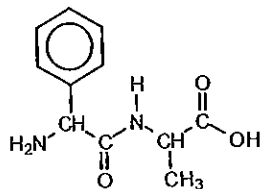
(b) CH<sub>3</sub>COOH ✓CH<sub>3</sub>OH ✓

[2]

(c) two structures made by joining the amino acids



either way round – eg



peptide bond in one structure ✓

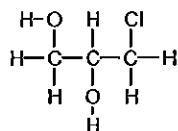
two dipeptides with R groups swapped ✓

allow H<sub>2</sub>O ✓ and one correct dipeptide ✓ as an alternative answer

[2]

[Total: 5]

3 (a) (i)



the correct compound .... ✓

shown as a correctly displayed formula ✓

[2]

(ii) yes, because there are four different groups  
around the central carbon ✓  
(or ecf on the structure given in (i)) AW

allow asymmetric / non-super-  
imposable on its mirror image

[1]

(b) infra-red/i.r. (spectroscopy) ✓  
peak/absorption at 3230 - 3550 (cm<sup>-1</sup>) ✓

n.m.r. (spectroscopy) ✓  
peak at 3.5–5.5 (ppm) ... ✓  
... which disappears in D<sub>2</sub>O ✓

**Quality of Written Communication**

mark for good organisation / a logical response and  
technical terms, using at least two of the following  
words:

infra-red, nuclear magnetic resonance, spectroscopy,  
wavenumber, cm<sup>-1</sup>, chemical shift, ppm) ✓

[6]

(c) (i) dil/conc/(aq)  
or dil/(aq)  
or dil/conc/(aq)

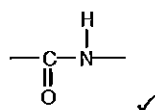
HCl  
H<sub>2</sub>SO<sub>4</sub> /H<sup>+</sup>/acid  
OH<sup>-</sup>/alkali/NaOH etc ✓

if a formula given, there must be  
some indication that it is aqueous

allow an enzyme as long as aq

[1]

(ii)



[1]

(iii) amino acids ✓

allow peptides

[1]

[Total: 12]