

M1. (a) (i)

Reagent	Tollens	Fehlings or Benedicts	$K_2Cr_2O_7/H^+$ or acidified	$KMnO_4/H^+$	$I_2/NaOH$
Propanal	silver (mirror)	red ppt or goes red (<i>not red solution</i>)	goes green	goes colourless	No reaction
Propanone	no reaction	no reaction	no reaction	no reaction	Yellow (ppt)

(penalise incomplete reagent e.g. $K_2Cr_2O_7$ or $Cr_2O_7^{2-}/H^+$ then mark on)

3

(ii) propanal 3 peaks
ignore splitting even if wrong

1

propanone 1 peak

1

(b) X is CH_3CH_2COOH or propanoic acid if both name and formula given,
both must be correct, but

1

Y is $CH_3CH(OH)CH_3$ or propan-2-ol allow propanol with correct formula

1

**Mark the type of reaction and reagent/condition independently.
The reagent must be correct or close to score condition**

Step 1 Oxidation

$K_2Cr_2O_7/H^+$ or other oxidation methods as above
allow $Cr_2O_7^{2-}/H^+$ if penalised above (ecf)
reflux (not Tollens/Fehlings) or heat or warm

1

Step 2

reduction or nucleophilic addition	reduction or nucleophilic addition	reduction or hydrogenation	1
$NaBH_4$	$LiAlH_4$	H_2	1
in (m)ethanol or water or ether	ether or dry	Ni / Pt etc	1

or dry		
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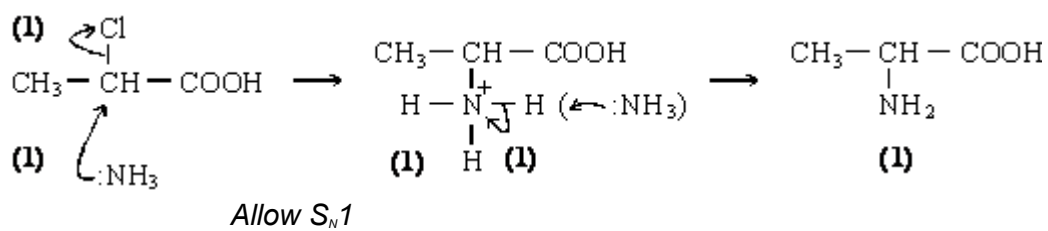
- Step 3 esterification or (nucleophilic) addition-elimination or condensation 1
- (conc) H_2SO_4 or HCl 1
- warm (allow without acid reagent if **X** and **Y** given as reagents) 1
- or reflux or heat 1

[15]

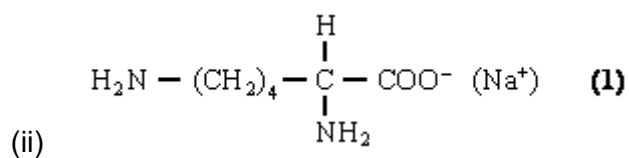
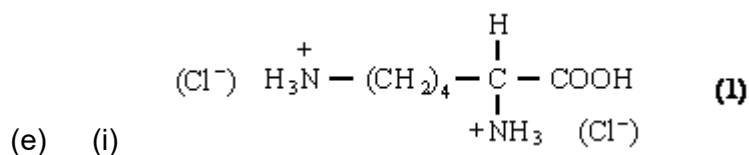
M2.B

[1]

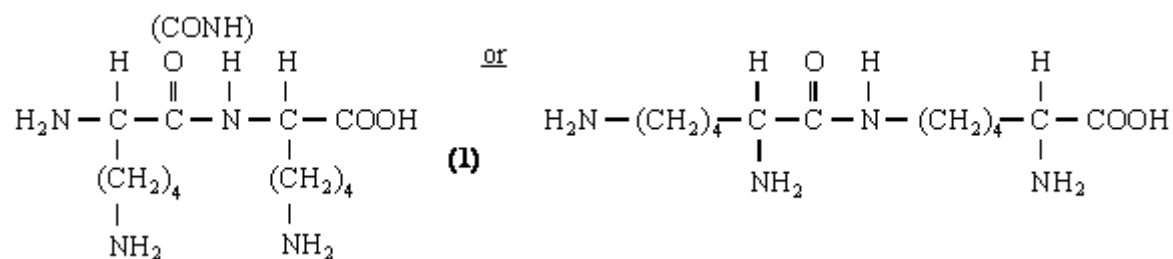
- M3.** (a) 2-chloropropanoic acid (**1**) 1
- (b) δ 1.72 Doublet \therefore next to CH (**1**)
- δ 4.44 Quartet \therefore next to CH_3 (**1**) 2
- (c) Two triplets (**1**) 1
- (d)



5



(iii)

Or anhydride

3

[12]

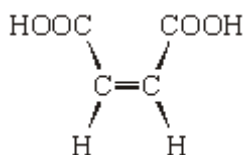
M4.B

[1]

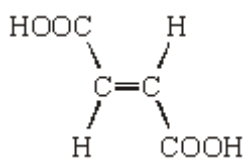
M5.D

[1]

M6. (a)



1



1

NB The bonds shown in the structure must be correct

Isomerism: E-Z isomerism

If written answer is correct, ignore incorrect labelling of structures.

If no written answer, allow correctly labelled structures.

1

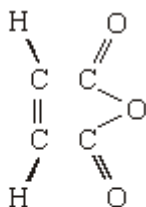
Both COOH groups must be on the same side/ close together/ cis

1

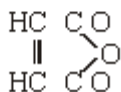
No rotation about C=C axis

1

Structure

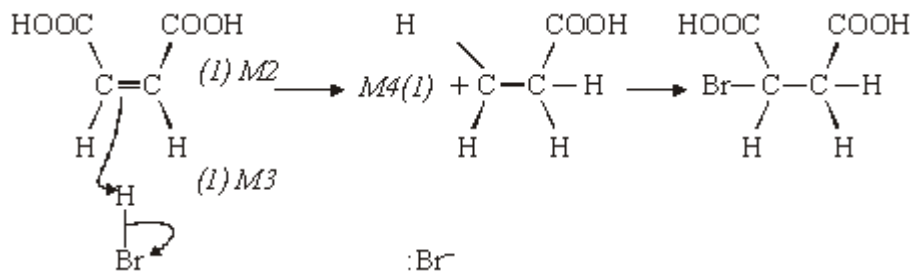


Allow



1

(b) $\text{Br}_2 / \text{HBr} / \text{H}_2\text{SO}_4 / \text{H}^+ / \text{Br}^- / \text{NO}_2^+$ (Mark M1)



NB If electrophile H^+ / Br^- / NO_2^+ allow M1, M2 and M4
 If the acid is incorrect, M2 and M3 can still be scored
 Allow M4 consequentially if repeat error from part (a)

4

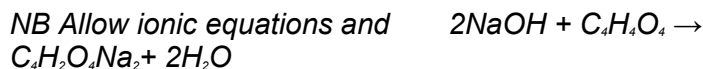


Both H replaced

1

Balanced for atoms and charges

1



Allow one if structure incorrect but molecular formula correct

Allow one for a correct equation showing one H replaced

(d) M1 Two peaks

1

M2 No splitting or singlets

1

M3 (Two) non-equivalent protons or two proton environments

1

M4 No adjacent protons

1

M5 Same area under the two peaks or same relative intensity

1

NB Doublet could score M1 and M3 or M5 (Max 2)

More than two peaks CE = 0

Apply the "list principle" to incorrect answers if more than 3 given

Max 3

[15]

- M7.** (a) *M1* $K_p = \frac{(p_Y)^3 \cdot (p_Z)^2}{(p_W)^2 \cdot (p_X)}$ *NB [] wrong* 1
- M2* temperature 1
- M3* increase 1
- M4* particles have more energy or greater velocity/speed 1
- M5* more collisions with $E > E_a$ or more successful collisions 1
- M6* Reaction exothermic or converse 1
- M7* Equilibrium moves in the left 1

Marks for other answers

<i>Increase in pressure or concentration</i>	<i>allow M1, M5, M6</i>	<i>Max 3</i>
<i>Addition of a catalyst;</i>	<i>allow M1, M5, M6</i>	<i>Max 3</i>
<i>Decrease in temperature;</i>	<i>allow M1, M2, M6</i>	<i>Max 3</i>
<i>Two or more changes made;</i>	<i>allow M1, M6</i>	<i>Max 2</i>

- (b) (i) Advantage; reaction goes to completion, not reversible or faster 1

Disadvantage; reaction vigorous/dangerous
(*exothermic must be qualified*)

or HCl(g) evolved/toxic
or CH₃COCl expensive

NB Allow converse answers

Do not allow reactions with other reagents e.g. water or ease of separation

1

- (ii) $\Delta S = \Sigma S \text{ products} - \Sigma S \text{ reactants}$ 1

□□□□□□□□ $\Delta S = (259 + 187) - (201 + 161)$

1

□□□□□□□□ $\Delta S = 84 \text{ (JK}^{-1} \text{ mol}^{-1})$ (*Ignore units*)
Allow – 84 to score (1) mark

1

□□□□□□□□ $\Delta G = \Delta H - T\Delta S$

1

$= -21.6 - 298 \times 84/1000$
 $= -46.6 \text{ kJ mol}^{-1}$ or $-46\,600 \text{ J mol}^{-1}$

1

Allow (2) for – 46.6 without units
(Mark ΔG consequentially to incorrect ΔS)
(e.g. $\Delta S = -84$ gives $\Delta G = +3.4 \text{ kJ mol}^{-1}$)

1

[15]