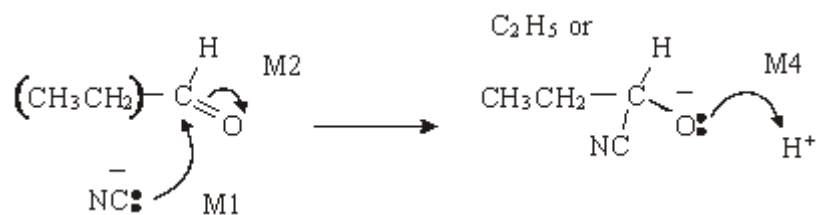


M1. (a) nucleophilic addition;



1

M3 structure;

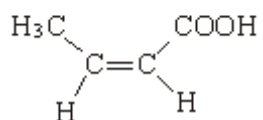
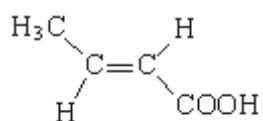
(be lenient on position of charge on CN⁻)
 (M2 not allowed independent of M1,
 but allow M1 for correct attack on C⁺
 if M2 show as independent first.)
 (+on C of C=O loses M2 but ignore δ⁺ if correct)
 (M4 for arrow and lone pair (only allow for correct M3 or
 close))

4

(b) (i) 2-hydroxybutanoic acid

1

(ii)

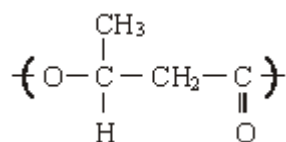


1

geometric(al) or cis-trans

1

(c) (i)



(one unit only) (ignore brackets or n) (trailing bonds are

needed)

1

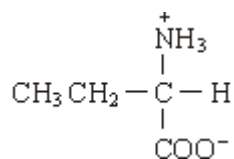
(ii) can be hydrolysed

OR

can be reacted with/attacked by acid/base/nucleophiles/H₂O/OH⁻;

1

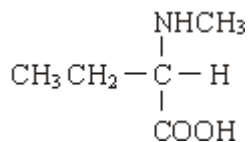
(d) (i)



(allow -NH₃⁺)

1

(ii)



(or zwitterions product)

1

(iii) nucleophilic substitution;

1

[14]

M2.

(a) (i) Potassium (OR sodium) dichromate(VI) OR correct formula
OR potassium manganate(VII)

(Oxidation state not needed, but must be correct if included)

(Penalise errors in the formula or oxidation state, but mark conditions)

1

Acidified OR H_2SO_4 / HCl (*NOT with KMnO_4*) / H_3PO_4 / HNO_3

(Ignore heat or reflux)

(Credit "acidified" as part of reagent)

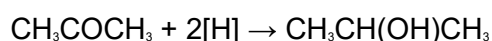
1

Oxidation or redox

1

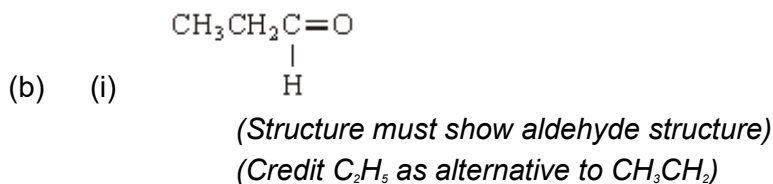
(ii) NaBH_4 OR LiAlH_4 OR H_2/Ni

1



(Credit H_2 in the equation if H_2 has been chosen as reagent)

1



(ii)

M1 Tollens' reagent OR ammoniacal silver nitrate
OR $\text{AgNO}_3 + \text{NH}_3$

OR Fehling's solution

OR acidified potassium dichromate

1

M2 stays colourless stays blue stays orange

1

(Provided reagent is correct, credit "no reaction", "no change", "nothing", "no observation" for M2)

M3 silver mirror / deposit
OR black / grey precipitate

red / brown / orange precipitate / solid goes green

1

(Credit other correct reagents and observation)

(For M1, penalise AgNO_3 alone, penalise $\text{Ag}(\text{NH}_3)_2^+$, penalise "potassium dichromate", etc., but, in each case, mark on and

credit correct M2 and M3)
 (If totally wrong reagent or no reagent, CE = no marks for
 M1, M2 or M3)

1

[9]

M3.C

[1]

M4.A

[1]

M5. (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

Y is CH₃CH(OH)CH₃ or propan-2-ol allow propanol with correct formula

1

1

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

Step 1 Oxidation

K₂Cr₂O₇/H⁺ or other oxidation methods as above
allow Cr₂O₇²⁻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
NaBH ₄	LiAlH ₄	H ₂
in (m)ethanol or water or ether or dry	ether or dry	Ni / Pt etc

1

1

1

Step 3 esterification or (nucleophilic) addition-elimination or condensation

1

(conc) H₂SO₄ or HCl

1

warm (allow without acid reagent if X and Y given as reagents)

1

or reflux or heat

1

[15]

M6. (a) (i) An appropriate alkene; CH₃CH₂CHCH₂ or (CH₃)₂CCH₂

1

Isomer 1

1

Isomer 2	1
Position isomerism	1
Mechanism	
electrophilic attack and electron shift to Br (Unless H ⁺ used)	1
carbocation	1
reaction with carbocation	
<i>[Allow mechanism marks for the alkene CH₃CHCHCH₃]</i>	
<i>[Allow one mark if mechanism for minor product given]</i>	1
(ii) An appropriate carbonyl; CH ₃ CH ₂ CHO	1
Mechanism nucleophilic attack and electron shift to O	1
anion intermediate	1
reaction with anion	
<i>[Allow mechanism marks for the carbonyl (CH₃)₂CO]</i>	1
Isomer 1	1
Isomer 2	1
Optical isomerism	
<i>NB Isomer structures must be tetrahedral</i>	
<i>NB Penalise "stick" structures once in part (a)</i>	1
(b) QoL	
Large charge on carbonyl carbon atom due to bonding to O and Cl	1
Nucleophiles have electron pairs which can be donated	1
Equation Species	1

Balanced

1

[18]