1 (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 *(not red solution)*	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
$NaBH_4$	$LiAlH_4$	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) 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]

2 (a) (i) An appropriate alkene; $CH_3CH_2CHCH_2$ or $(CH_3)_2CCH_2$

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

[Allow mechanism marks for the alkene $CH_3CHCHCH_3$]
[Allow one mark if mechanism for minor product given]

1

(ii) An appropriate carbonyl; CH_3CH_2CHO

1

Mechanism nucleophilic attack and electron shift to O

1

anion intermediate

1

reaction with anion

[Allow mechanism marks for the carbonyl $(CH_3)_2CO$]

1

Isomer 1

1

Isomer 2

1

Optical isomerism

NB Isomer structures must be tetrahedral

NB Penalise "stick" structures once in part (a)

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]

A

3

[1]

C

4

[1]

5 (a) (i) Potassium (OR sodium) dichromate(VI) OR <u>correct</u> 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

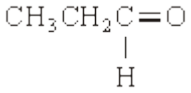
(ii) $NaBH_4$ OR $LiAlH_4$ OR H_2/Ni

1

$CH_3COCH_3 + 2[H] \rightarrow CH_3CH(OH)CH_3$

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

1

(b) (i) 

(Structure must show aldehyde structure)

(Credit C_2H_5 as alternative to CH_3CH_2)

(ii)

M1 Tollens' reagent OR ammoniacal silver nitrate OR $AgNO_3 + NH_3$	OR Fehling's solution	OR <u>acidified</u> 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 <u>mirror</u> / <u>deposit</u> OR black / grey <u>precipitate</u>	red / brown / orange <u>precipitate / solid</u>	goes green	**1**

(Credit other correct reagents and observation)

(For M1, penalise $AgNO_3$ alone, penalise $Ag(NH_3)_2^+$, 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]

6 (a) Pentan-2-one

1

(b) (i) 1680 – 1750 (cm^{-1})

1

(ii) 3230 – 3550 or 1000 – 1300 (cm^{-1})

1

(iii) 4

1

(c)

Reagent	$K_2Cr_2O_7/H^+$	$KMnO_4/H^+$	Na	CH_3COOH/H_2SO_4	
with **C**	no reaction	no reaction	no reaction	no reaction	**1**
with **D**	goes green	goes colourless	effervescence	smell	**1**

1

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

(d)

Reagent	Tollens	Fehlings or Benedicts
with **E**	silver (mirror)	red ppt or goes red *(not red solution)*

1

1

[9]

7 B

[1]

8

(a) (i) propyl methanoate **(1)**

not propanyl

- *A wrong reagent or no reagent scores zero*
- *An incomplete reagent such as silver nitrate for Tollens, or potassium dichromate loses the reagent mark, but can get both observation marks*
- *penalise observations which just say colour change occurs or only state starting colour*

(ii) *Reagent*: $NaHCO_3$ **(1)**
*Observation with **C***: no reaction **(1)**
*Observation with **D***: effervescence **(1)**

*for **C** and **D** NOT Tollens*

Test	an identified (hydrogen) carbonate	acidified $K_2Cr_2O_7$	acidified $KMnO_4$	correct metal	UI or stated indicator	PCl_5
Observation with C	no reaction	goes green	goes colourless	no reaction	no change	no reaction
observation with D	bubbles or CO_2	no change	no change	bubbles or H_2	red or correct colour pH 3 – 6.9	(misty) fumes

4

(b) (i) *Reagent*: pentan-2-one **(1)**

or 2-pentanone

but not pent-2-one or pentyl

(ii) *Reagent*: Tollen's or Fehling's **(1)**

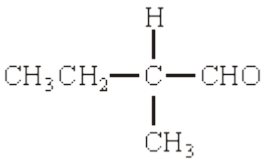
*Observation with **E***: no reaction **(1)**

*Observation with **F***: silver mirror or red ppt **(1)**

for **E** and **F**

Test	Tollens	Fehlings or Benedicts	iodoform or I_2/NaOH	acidified $K_2Cr_2O_7$	Schiff's
observation with E	no reaction	no reaction	yellow (ppt)	no change	no reaction
observation with F	silver or mirror or grey or ppt	red or ppt not red solution	no reaction	goes green	goes pink

4

(c)  **(1)**

must be aldehyde. Allow C_2H_5 for CH_3CH_2 otherwise this is the only answer

1

[9]

9 (a) $K_2Cr_2O_7/H_2SO_4$ reuced by

$CH_3CH_2CH_2CH_2OH$ **(1)**

oxidised to $CH_3(CH_2)_2CHO$ **(1)**
and $CH_3(CH_2)_2COOH$ **(1)**

$CH_3CH_2CH_2CHO$ **(1)**

oxidised to $CH_3(CH_2)_2COOH$ **(1)**

Equation: $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ **(1)**

Note: Deduct one if all three compounds given as reducing agents.

6

(b) Tollens' reduced by

$CH_3CH_2CH_2CHO$ **(1)**

oxidised to $CH_3(CH_2)_2COOH$ **(1)**

Equation $[Ag(NH_3)_2]^+ + e^- \rightarrow Ag + 2NH_3$ **(1)**

3

(c) $CH_3CH_2CH_2CH_2OH$ **(1)**

Product $CH_3CH_2CH_2CH_2OOCCH_3$ **(1)**

$(CH_3)_3COH$

Product $(CH_3)_3COOCCH_3$ **(1)**

4

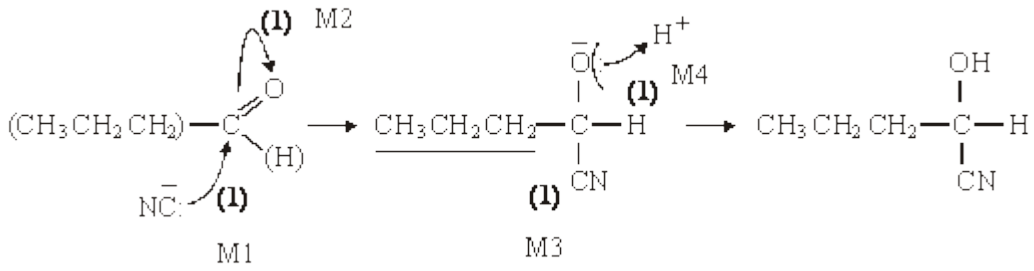
(d) $CH_3CH_2CH_2OH$ has five peaks **(1)**

$(CH_3)_3COH$ has two peaks **(1)**

2

[15]

10 (a) *Mechanism*



Allow C_3H_7 if structure shown elsewhere

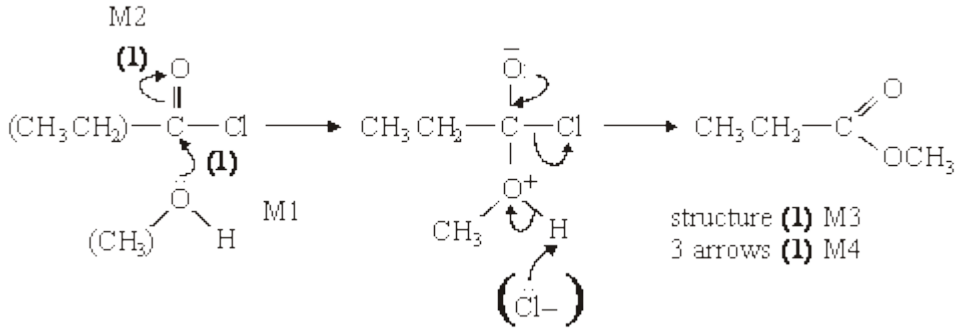
penalise HCN splitting if wrong

Name of product: 2-hydroxypenta(neo)nitrile **(1)**

or 1-cyanobutan-1-ol

5

(b) *Mechanism*

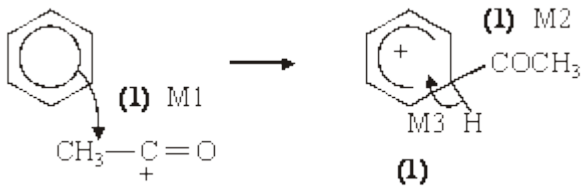


Name of organic product: methylpropanoate **(1)**

5

(c) (i) ([] CH_3CO [])$^+$ **(1)**

(ii)



4

Notes

(abc) extra curly arrows are penalised

(a) be lenient on position of negative sign on : CN^- but arrow must come from lp

(a)/(b) C=O alone loses M2 but can score M1 for attack on C+, similarly C—Cl

(a) allow 2-hydroxypentanonitrile or 2-hydroxypenta(ne)nitrile ... pentylnitrile

(b) in M4, allow extra: Cl^- attack on H, showing loss of H^+

(c) (i) allow formula in an "equation"(balanced or not)
be lenient on the position of the + on the formula

(ii) for M1 the arrow must go to the C or the + on the C
don't be too harsh about the horseshoe, but + must not be close to the saturated C
M3 must be final step not earlier; allow M3 even if structure (M2) is wrong

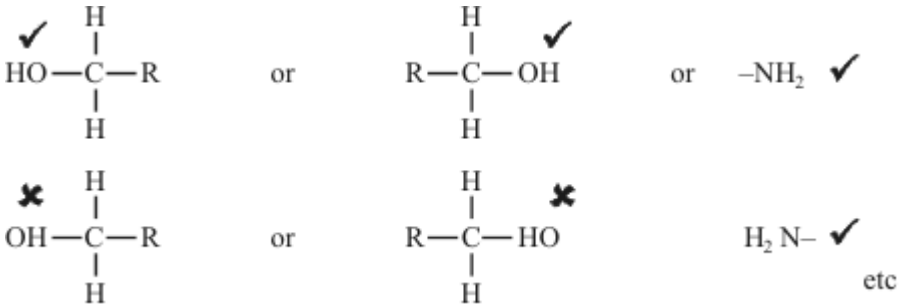
[14]

Organic points

(1) Curly arrows: must show movement of a pair of electrons,
i.e. from bond to atom or from lp to atom / space
e.g.

(2) Structures

penalise sticks (i.e. ) once per paper



Penalise once per paper

allow CH_3– or $-CH_3$ or  or CH_3
or H_3C–

11 A **[1]**

12 D **[1]**

13 B **[1]**