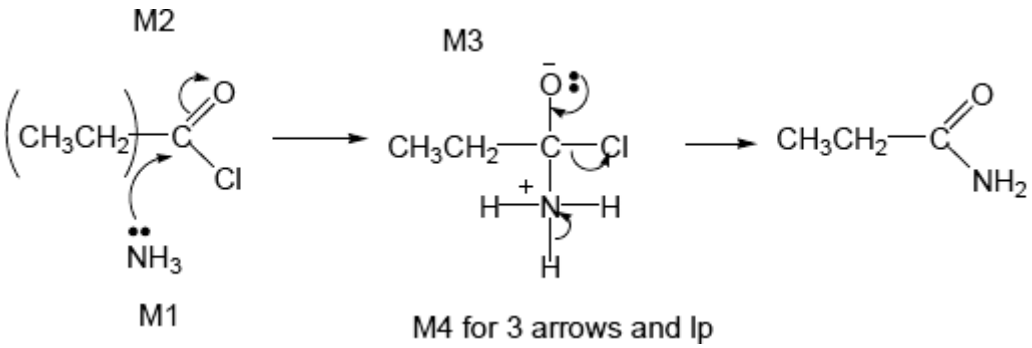
**M1.**(a) (Nucleophilic) addition-elimination

- *Minus sign on $NH_3$ loses M1(but not M4 also)*
- *M2 not allowed independent of M1, but*

**1**




- *allow M1 for correct attack on C+*
- *+ rather than δ+ on C=O loses M2*
- ***If Cl lost with C=O breaking, max1 for M1***
- ***M3*** *for correct structure <u>with charges</u> but lp on O is part of* ***M4***
- *only allow* ***M4*** *after correct/very close* ***M3***
- *For* ***M4****, ignore $NH_3$ removing $H^+$ but lose* ***M4*** *for $Cl^-$ removing $H^+$ in mechanism,*
- *but ignore HCl shown as a product*

**4**

propanamide (Ignore -1- )

*penalise other numbers*

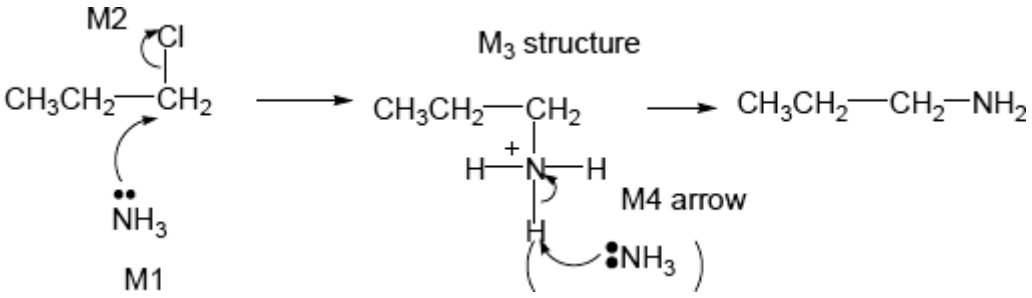
*penalise propaneamide and N-propanamide*

**1**

(b) Nucleophilic substitution

- *Minus sign on $NH_3$ loses M1 (not M4 also)*
- *+ rather than δ+ on C=O loses M2*

**1**




- *ALLOW SN1 so allow M2 for loss of $Cl^-$ before attack of $NH_3$ on C+ for M1*
- *only allow M4 after correct/very close M3*
- *For M4, ignore $NH_3$ removing $H^+$ but lose M4 for $Cl^-$ removing $H^+$ in mechanism,*

Propylamine (ignore number 1)

- *but ignore HCl shown as a product*

**4**

or propan-1-amine or 1-aminopropane (number 1 needed)

*penalise other numbers*

*allow 1-propanamine*

**1**

(c) electron rich ring or benzene or pi cloud repels nucleophile/ammonia

*Allow*

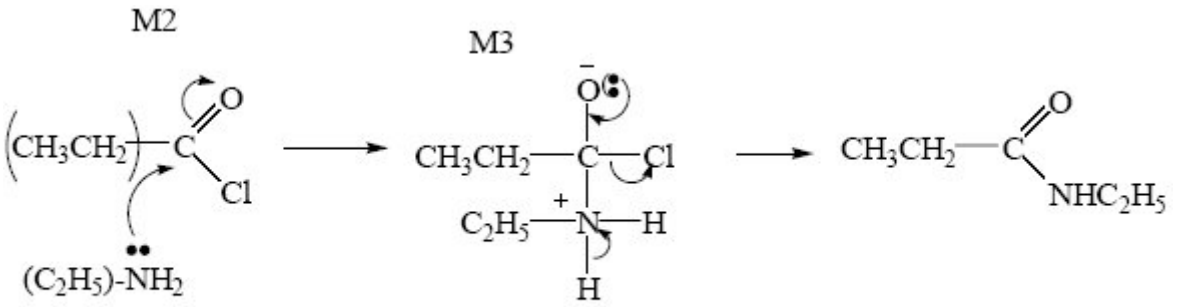
- *C–Cl bond is short/stronger than in haloalkane*
- *C–Cl is less polar than in haloalkane*
- *resonance stabilisation between ring and Cl*

**1**

**[13]**

**M2.** (a) (nucleophilic) addition-elimination

**1**




**4**

N-ethylpropanamide

*minus on $NH_2$ loses M1*
*M2 not allowed independent of M1, but allow M1 for correct attack on C+*
*+C=O loses M2*
*only allow M4 after correct or very close M3*
*lose M4 for $Cl^-$ removing $H^+$ in mechanism, but ignore HCl as a product*
*Not N-ethylpropaneamide*

**1**

(b) $CH_3CN$ or ethan(e)nitrile or ethanonitrile

*not ethanitrile*
*but allow correct formula with ethanitrile*

**1**

for each step wrong or no reagent loses condition mark

*contradiction loses mark*

**1**

Step 1 $Cl_2$
uv or above 300 °C

*wrong or no reagent loses condition mark*

**1**

Step 2 KCN

**1**

aq and alcoholic (both needed)

*allow uv light/(sun)light/uv radiation*

**1**

Step 3 $H_2$/Ni or $LiAlH_4$ or $Na/C_2H_5OH$

*not $CN^-$ but mark on*
*NOT HCN or KCN + acid, and this loses condition mark*
*NOT $NaBH_4$*
*Sn/HCl (forms aldehyde!)*
*ignore conditions*

1

**[12]**

**M3.** (a) **M1** $CH_3CH_2CH_2COOH$

*not $C_3H_7COOH$*

1

**M2** $CH_3CH_2OH$ or $C_2H_5OH$

1

**M3** $CH_3CH_2CH_2COOCH_2CH_3 + H_2O$

*allow $C_3H_7COOC_2H_5$*

*penalise M3 for wrong products and unbalanced equation*

1

**M4** $H_2SO_4$ or HCl or $H_3PO_4$ conc or dil or neither

*not $HNO_3$*

1

(b) **M1** $CH_3CH_2CH_2CH_2OH$

1

*not $C_4H_9OH$*

**M2** $(CH_3CO)_2O$

1

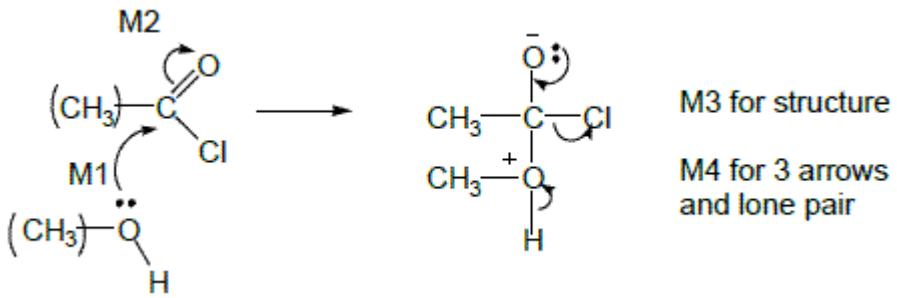
**M3** $\rightarrow CH_3COOCH_2CH_2CH_2CH_3 + CH_3COOH$

*allow $CH_3COOC_4H_9$*

*penalise M3 for wrong products and unbalanced equation*

1

(c) (nucleophilic) addition-elimination



*not acylation alone*

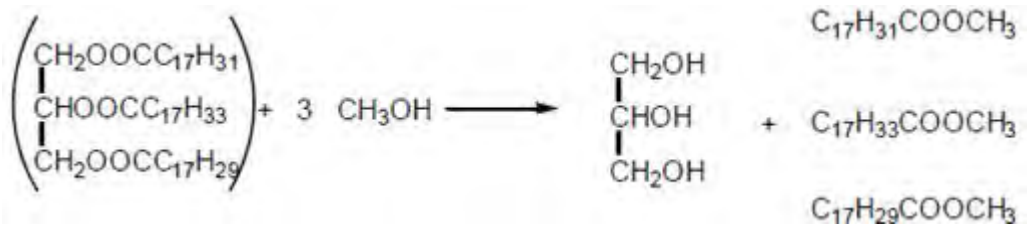
*M2 not allowed indep of M1 but allow M1 for correct attack on C+*

*+C=O loses M2*

*only allow M4 after correct or v close M3*
*ignore $Cl^-$ removing $H^+$*

**5**

(d)




(1) (1) (1)

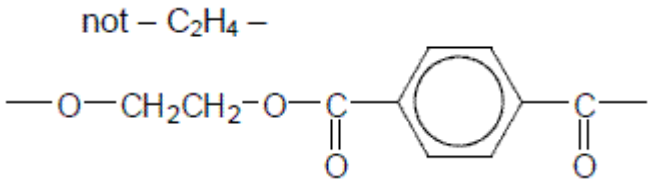
*ignore errors in initial triester*

*First mark for $3CH_3OH$*

*Third mark for all three esters*

**3**

(e)




*First mark for correct ester link second mark for the rest including trailing bonds*

*If ester link wrong, lose second mark also*

**2**

Adv reduces landfill
saves raw materials
lower cost for recycling than making from scratch
reduces $CO_2$ emissions by not being incinerated

*not allow cost without qualification*
*ignore energy uses*

**1**

Disad difficulty/cost of collecting/sorting/processing
product not suitable for original purpose, easily contaminated

*not allow cost without qualification*
*ignore energy uses*

**1**

**[19]**

**M4.** Minimum volume and hot water:

*Note that this question is worth a total of 5 marks.*

Any **two** from:

to obtain saturated solution

to increase yield / reduce amount left in solution

enable crystallisation (on cooling)

*Do not allow 'because acid doesn't dissolve well in cold water'.*

**Max 2**

Filtered hot: to remove <u>insoluble impurities</u> / to prevent crystals forming during filtration

**1**

Cooled in ice: to increase amount of crystals that are formed

*Do not allow 'to cool quickly'.*

**1**

Washed with cold water: to remove <u>soluble impurities</u>

*Allow 'washing with <u>hot</u> water would dissolve some of the crystals'.*

**1**

**[5]**