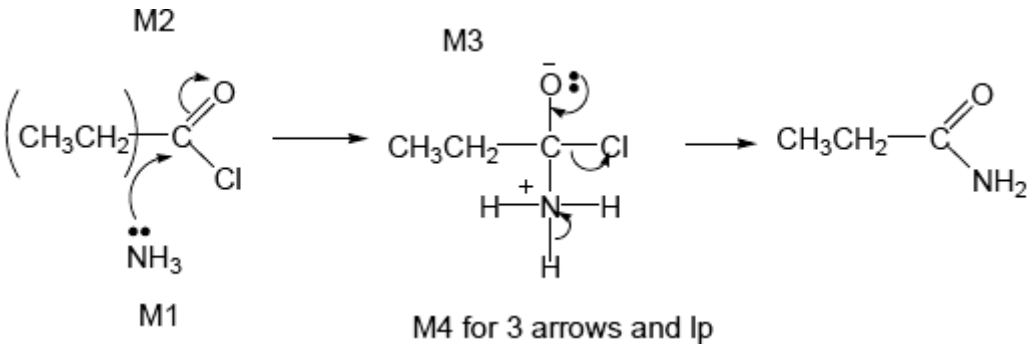
M1.(a) (Nucleophilic) addition-elimination

- *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

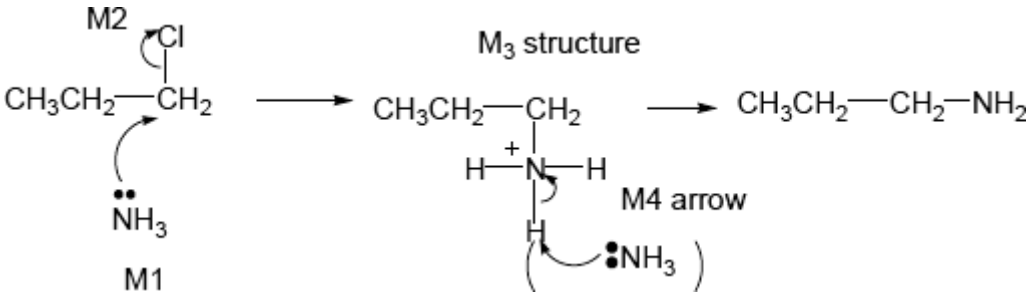
penalise propaneamide and N-propanamide

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

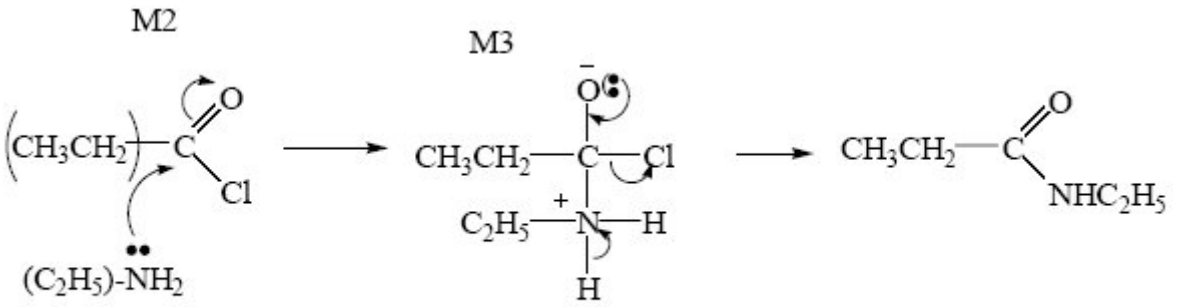
- *C–Cl bond is short/stronger than in haloalkane*
- *C–Cl is less polar than in haloalkane*
- *resonance stabilisation between ring and Cl*

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

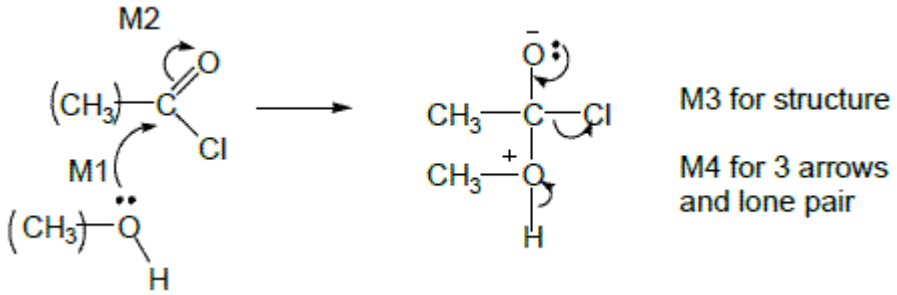
M3 $\rightarrow CH_3COOCH_2CH_2CH_2CH_3 + CH_3COOH$

allow $CH_3COOC_4H_9$

penalise M3 for wrong products and unbalanced equation

1

(c) (nucleophilic) addition-elimination



not acylation alone

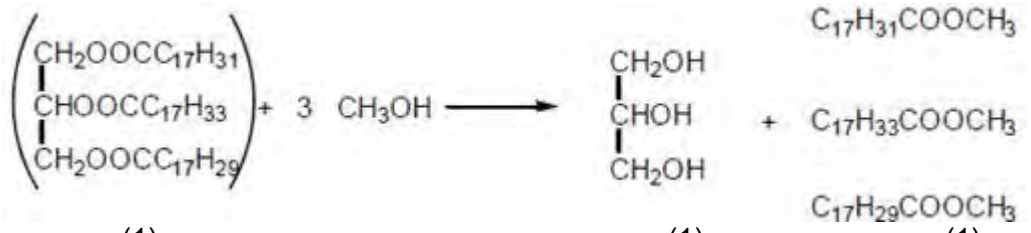
M2 not allowed indep of M1 but allow M1 for correct attack on C+

+C=O loses M2

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

5

(d)



(1) (1) (1)

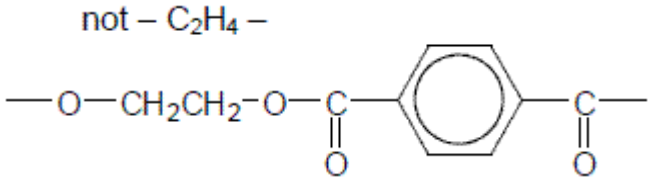
ignore errors in initial triester

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]