M1.B

M2. (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*: NaHCO₃ **(1)**
*Observation with **C***: no reaction **(1)**
*Observation with **D***: effervescence **(1)**

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

| Test	an identified (hydrogen) carbonate	acidified K₂Cr₂O₇	acidified KMnO₄	correct metal	UI or stated indicator	PCl₅
Observation with C	no reaction	goes green	goes colourless	no reaction	no change	no reaction
observation with D	bubbles or CO₂	no change	no change	bubbles or H₂	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**

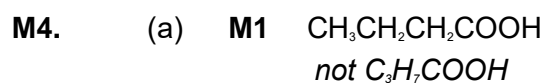| Test	Tollens	Fehlings or Benedicts	iodoform or I₂/NaOH	acidified K₂Cr₂O₇	Schiff's
observation with E	no reaction	no reaction	yellow (ppt)	no change	no reaction
observation with F	silver or mirror or grey or ppt	red or ppt not red solution	no reaction	goes green	goes pink

4

(c)

$$CH_3CH_2-\overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}-CHO \quad \textbf{(1)}$$
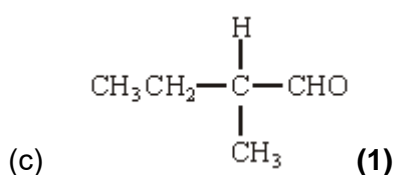
must be aldehyde. Allow C₂H₅ for CH₃CH₂ otherwise this is the only answer

1

[9]

M3.A

[1]

M4.   (a)   **M1**   CH₃CH₂CH₂COOH
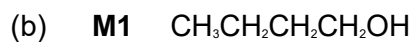   *not C₃H₇COOH*

1

         M2   CH₃CH₂OH or C₂H₅OH

1

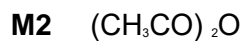   **M3**   CH₃CH₂CH₂COOCH₂CH₃ + H₂O
                     allow C₃H₇COOC₂H₅
                     penalise M3 for wrong products and unbalanced equation

1

         M4   H₂SO₄ or HCl or H₃PO₄ conc or dil or neither
                     not HNO₃

(b) **M1** $CH_3CH_2CH_2CH_2OH$

not C_4H_9OH

M2 $(CH_3CO)_2O$
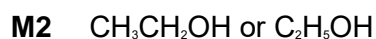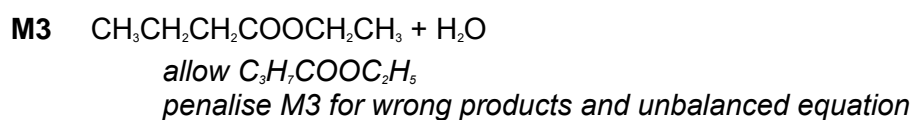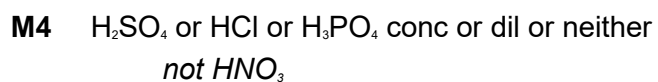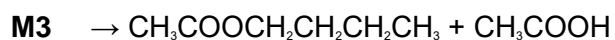
M3 $\rightarrow CH_3COOCH_2CH_2CH_2CH_3 + CH_3COOH$
allow $CH_3COOC_4H_9$
penalise M3 for wrong products and unbalanced equation

(c) (nucleophilic) addition-elimination

M3 for structure

M4 for 3 arrows and lone pair
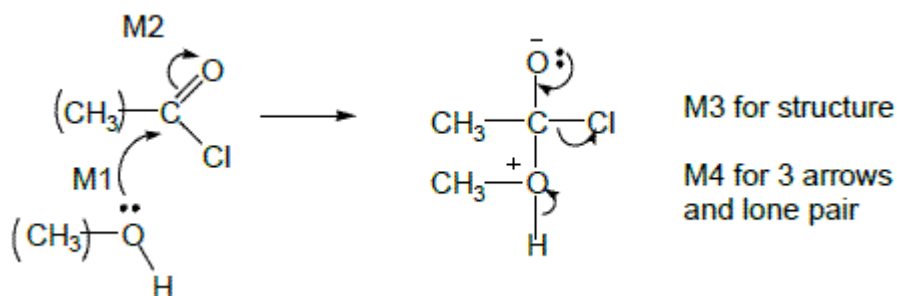
not acylation alone
M2 not allowed indep of M1 but allow M1 for correct attack on C+
+C=O loses M2
only allow M4 after correct or v close M3
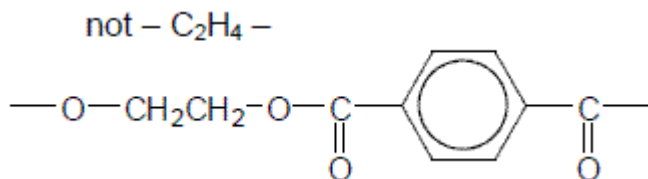*ignore Cl⁻ removing H⁺*

(d)

(1)   (1)   (1)
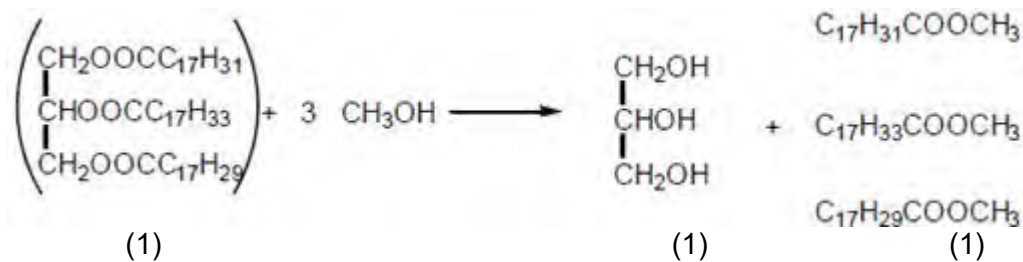
ignore errors in initial triester
First mark for $3CH_3OH$
Third mark for all three esters

(e)

not – C_2H_4 –

$$-O-CH_2CH_2-O-\overset{\underset{\displaystyle O}{\|}}{C}-\bigcirc-\overset{\underset{\displaystyle O}{\|}}{C}-$$

*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

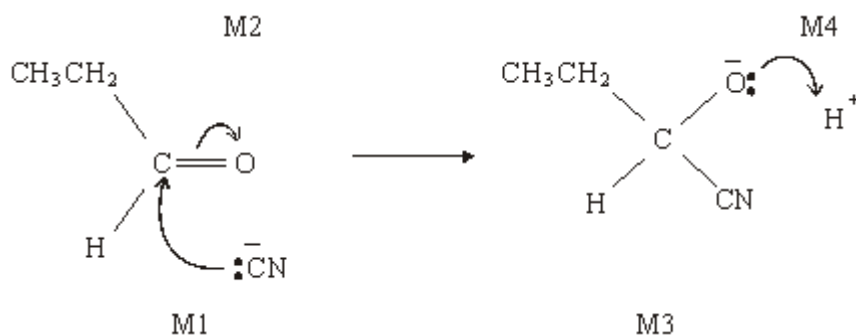*not allow cost without qualification*
ignore energy uses

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]

M5.   (a)   nucleophilic addition

1

4
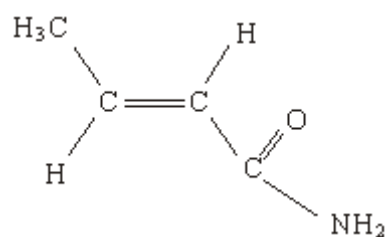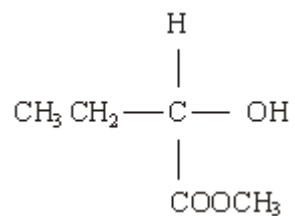
(b)   (i)   2-hydroxybutanenitrile

(ii)

(allow 1 for amide even if not C₄H₇NO, i.e. RCONH₂)

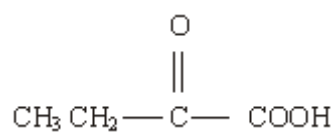*(if not amide, allow one for any isomer of C₄H₇NO which shows geometric isomerism)*

2

(c) (i)

1

(ii)

1

(iii) $CH_3CH=CHCOOH$

1

[11]

M6.D

[1]

M7. (a) propyl methanoate;

$HCOOC_3H_7 + OH^- \rightarrow HCOO^- + C_3H_7OH$

> 1

OR

$HCOOC_3H_7 + NaOH \rightarrow HCOONa + C_3H_7OH$;

> 1

(b) order wrt A = 1;

> 1

order wrt NaOH = 1;

> 1

Initial rate in Exp 4 = 2.4×10^{-3};

> 1

(c) (i) r(ate) = k[A]

OR

r(ate) = $k[A][NaOH]^0$;
(penalise missing [ ] but mark on)
(penalise missing [ ] once per paper)
(if wrong order, allow only units mark conseq on their rate eqs)
(penalise k_a or k_w etc)

> 1

(ii) $k = \dfrac{9.0 \times 10^{-3}}{0.02}$;

> 1

= 0.45;

> 1

s^{-1};

> 1

(iii) (large) excess of OH^- or $[OH^-]$ is large/high;

> 1

$[OH^-]$ is (effectively) constant

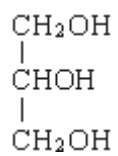OR

[A] is the limiting factor   *(Q of L mark)*

1

(d)   (i)

```
CH₂OH
|
CHOH
|
CH₂OH
```

1

propan(e)-1,2,3-triol

OR

1,2,3-propan(e)triol

OR

Glycerol;

1

(ii) $CH_3(CH_2)_{16}COONa$ or $C_{17}H_{35}COONa$ or $C_{18}H_{35}O_2Na$;
       (ignore 3 in front of formula but not if indicating trimer)

1

(not just anion and penalise Na shown as covalently bonded) soap - allow with detergent but not detergent alone;

1

[15]

M8.D

[1]