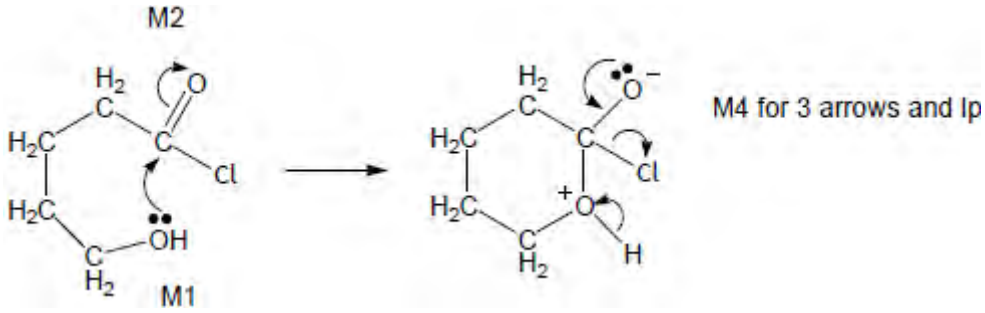
M1.(a) (i) (nucleophilic) addition-elimination

Not electrophilic addition-elimination

Ignore esterification

1



M3 for structure

- *If wrong nucleophile used or O–H broken in first step, can only score M2.*
- *M2 not allowed independent of M1, but allow M1 for correct attack on C+*
- *+ rather than δ+ on C=O loses M2.*
- *If Cl lost with C=O breaking lose M2.*
- *M3 for correct structure <u>with charges</u> but lone pair on O is part of M4.*
- *Only allow M4 after correct / very close M3.*
- *Ignore HCl shown as a product.*

4

a 20-50 (ppm) or single value or range entirely within this range

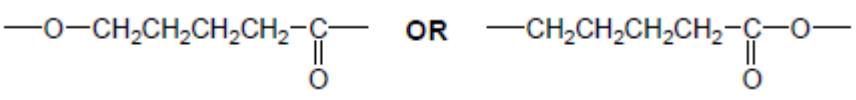
If values not specified as a or b then assume first is a.

1

b 50-90 (ppm) or single value or range entirely within this range

1

(ii)

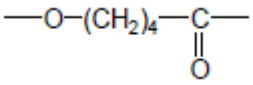


Must have trailing bonds, but ignore n.

1

OR $-OCH_2CH_2CH_2CH_2CO-$ **OR** $-CH_2CH_2CH_2CH_2COO-$

Allow



but not - C_4H_8-

one unit only

Condensation

1

(b)

	Tollens'	*Fehling's / Benedicts*	*Acidified potassium dichromate*

Penalise wrong formula for Tollens or missing acid with potassium dichromate but mark on.

1

J	*No reaction / no (visible) change / no silver mirror*	*No reaction / no (visible) change / stays blue / no red ppt*	*No reaction / no (visible) change / stays orange / does not turn green*

Ignore 'clear', 'nothing'.

Penalise wrong starting colour for dichromate.

1

K	*Silver <u>mirror</u> / grey <u>ppt</u>*	*Red <u>ppt</u>* *(allow brick red or red-orange)*	*(orange) turns green*

1

J *Two (peaks)*

Allow trough, peak, spike.

1

K *Four (peaks)*

Ignore details of splitting.

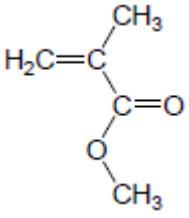
If values not specified as J or K then assume first is J.

1

(c) If all the structures are unlabelled, assume that the first drawn ester is L, the second ester is M; the first drawn acid is N, the second P. The cyclic compound should be obvious.

L

ester



OR *$H_2C=C(CH_3)COOCH_3$*

All $C_5H_8O_2$ L to P must have C=C.

Allow CH_3–.

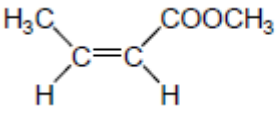
Allow $-CO_2CH_3$ etc.

Allow $CH_2C(CH_3)COOCH_3$.

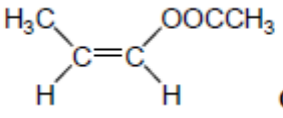
1

M

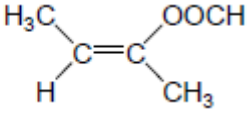
ester



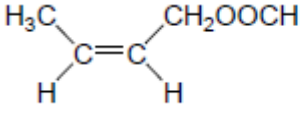
OR



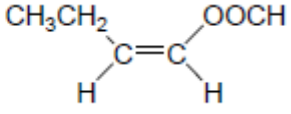
OR



$CH_3CH=CHCOOCH_3$ *$CH_3CH=CHOOCCH_3$* *$CH_3CH=C(CH_3)OOCH$*



OR



OR

$CH_3CH=CHCH_2OOCH$ *$CH_3CH_2CH=CHOOCH$*

Allow either E–Z isomer.

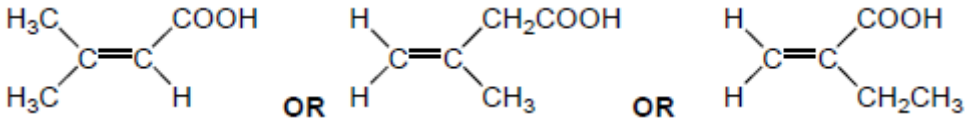
Allow CH_3– or C_2H_5– but not CH_2CH_3–.

Allow $CH_3CHCHCOOCH_3$ etc.

1

N

acid



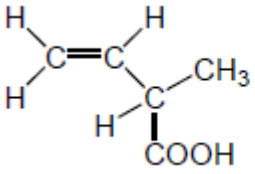
$(CH_3)_2C=CHCOOH$ $H_2C=C(CH_3)CH_2COOH$ $H_2C=C(COOH)CH_2CH_3$

Allow CH_3- or C_2H_5- but not CH_2CH_3-.

Allow $-CO_2H$.

Not cyclic isomers.

Not the optically active isomer.



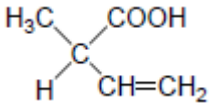
which is P anyway

Allow $(CH_3)_2CCHCOOH$ etc.

1

P

acid



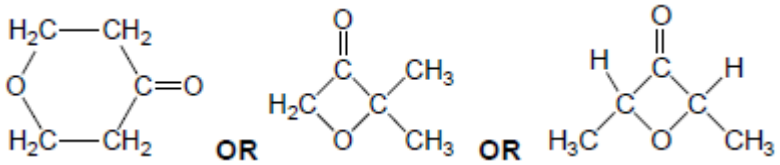
Allow $-CO_2H$.

$CH_3CH(COOH)CH=CH_2$

Allow $CH_3CH(CO_2H)CHCH_2$ or $CH_3CH(CO_2H)C_2H_3$.

1

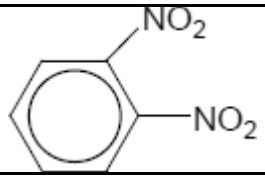
Q



Not cyclic esters.

1

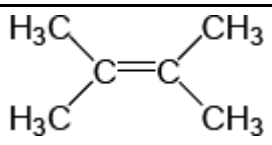
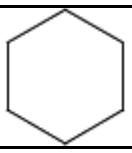
[19]

M2.(a) ***F***	***G***
	

Penalize $-O_2N$ once
Penalise missing circle once
Don't penalise attempt at bonding in NO_2

1

1

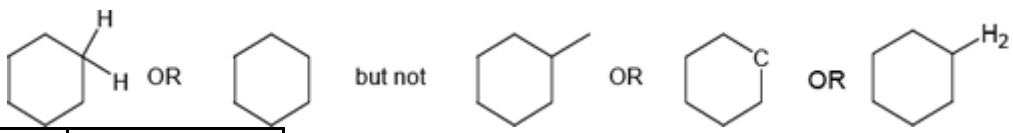
(b) ***H***	***J***
	

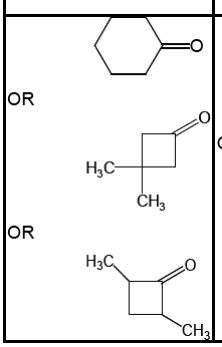
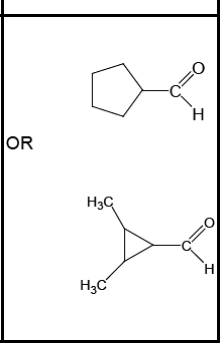
*If **both H** and **J** correct but reversed, award one mark*

1

1

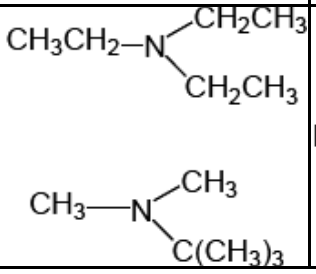
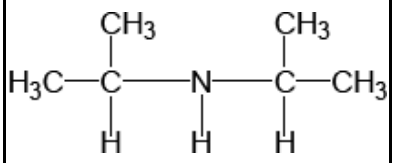
A carbon in saturated ring structures should be shown as



(c) ***K***	***L***
	

1

1

(d) ***M***	***N***
	

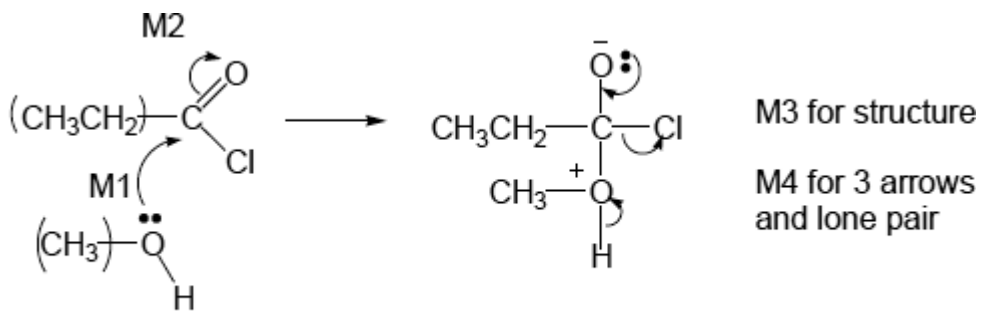
Allow C_2H_5 but
NOT allow C_4H_9 or C_3H_7

1

1

1

[8]



M3.*(a)* methyl propanoate (**NO** mark for name of mechanism)

- *M2 not allowed independent of M1, but 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*
- *ignore Cl^- removing H^+*

4

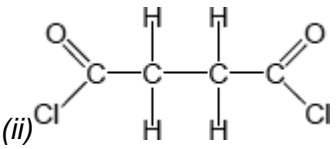
1

(b) (i) pentan<u>e</u>-<u>1,5</u>-diol

Second 'e' and numbers needed

Allow <u>1,5</u>-pentan<u>e</u>diol but this is not IUPAC name

(ii)



Must show ALL bonds

1

(iii) All three marks are independent

M1 (base or alkaline) Hydrolysis (allow close spelling)

1

Allow (nucleophilic) addition-elimination or saponification

M2 <u>δ+ C</u> in polyester

1

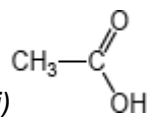
M3 reacts with OH^- or hydroxide ion

1

Not reacts with NaOH

1

(c) (i)



Allow CH_3COOH or CH_3CO_2H

1

(ii) (nucleophilic) <u>addition-elimination</u>

Both addition and elimination needed and in that order

OR

(nucleophilic) addition followed by elimination

*Do **not** allow electrophilic addition-elimination / esterification*

Ignore acylation

1

(iii) *any **two** from: ethanoic anhydride is*

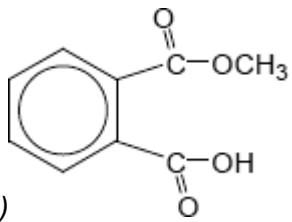
- *less corrosive*
- *less vulnerable to hydrolysis*
- *less dangerous to use,*
- *less violent/exothermic/vigorous reaction OR more controllable rxn*
- *does not produce toxic/corrosive/harmful fumes (of HCl) OR does not produce HCl*
- *less volatile*

***NOT** COST*

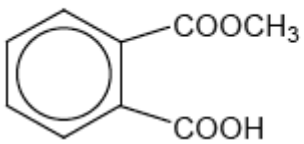
List principle beyond two answers

2

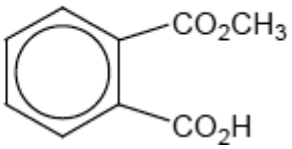
(d)



Allow



or



1

(e) *(i)* *ester*

*Do **not** allow ether*

Ignore functional group/linkage/bond

1

(ii) *12 or twelve (peaks)*

1

(iii) *160 – 185*

Allow a number or range within these limits
Penalize extra ranges given
Ignore units

1

(f) (i) sulfuric acid	*sodium hydroxide*	✓
hydrochloric acid	*ammonia*	*X or blank*
ethanoic acid	*potassium hydroxide*	✓
nitric acid	*methylamine*	*X or blank*

4 correct scores 2
3 correct scores 1
2 or 1 correct scores 0

2

(ii) *<u>Pink to colourless</u>*

Allow 'red' OR 'purple' OR 'magenta' instead of 'pink'
*Do **not** allow 'clear' instead of 'colourless'*

1

[21]

M4.*(a) (i) Single / one (intense) peak / signal **OR** all H or all C in same environment **OR** 12 equiv H or 4 equiv C*

Do not allow non-toxic or inert (both given in Q)
Any 2 from three
Ignore peak at zero

OR

*Upfield / to the right of (all) other peaks **OR** well away from others **OR** doesn't interfere with other peaks*

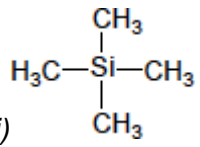
Ignore cheap
Ignore non-polar

OR

*Low bp **OR** volatile **OR** can easily be removed*

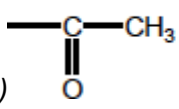
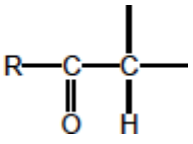
Ignore mention of solubility

2

(ii) 

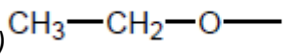
Allow $Si(CH_3)_4$

1

(b) (i)  or with sticks or 

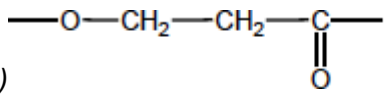
Ignore any group joined on other side of CO
Ignore missing trailing bond
Ignore charges

1

(ii)  or with sticks

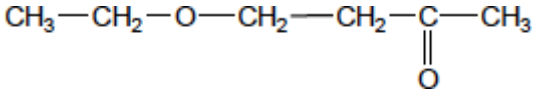
Ignore any group joined on other side of −O−
Ignore missing trailing bond
Ignore charges as if MS fragment

1

(iii)  or with sticks

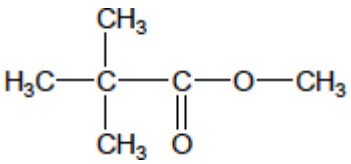
Ignore missing trailing bonds
Ignore charges as if MS fragment

1

(iv) 

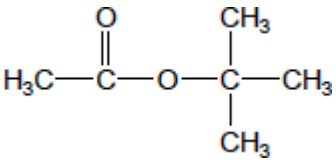
1

(c) (i) *Check structure has 6 carbons*



Allow $(CH_3)_3CCOOCH_3$ or $(CH_3)_3CCO_2CH_3$

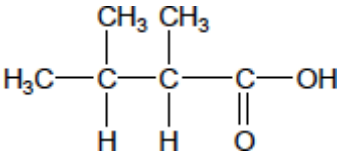
1



Allow $CH_3COOC(CH_3)_3$ or $CH_3CO_2C(CH_3)_3$

1

(ii) Check structure has 6 carbons

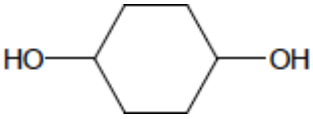


Allow $(CH_3)_2CHCH(CH_3)COOH$ or $(CH_3)_2CHCH(CH_3)CO_2H$

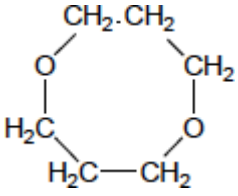
Penalise C_3H_7

1

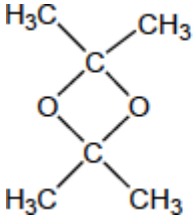
(iii) Check structure has 6 carbons



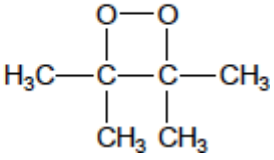
OR



Allow



OR



1

[11]