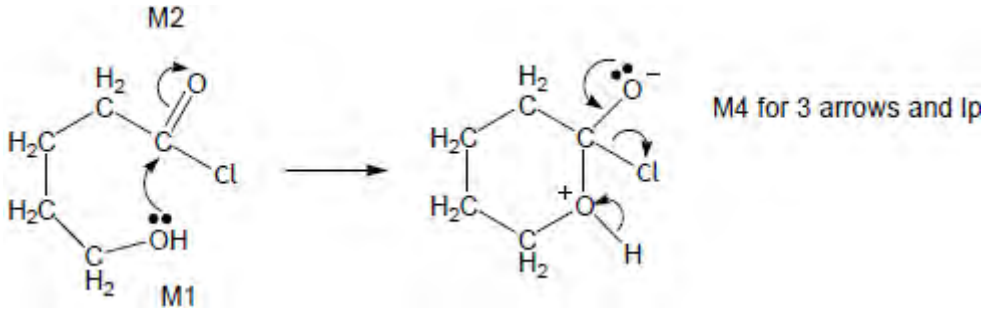
M1.(a) (i) (nucleophilic) addition-elimination

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

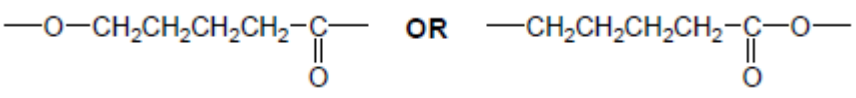
If values not specified as a or b then assume first is a.

1

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

1

(ii)

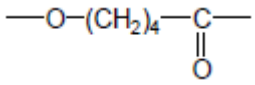


Must have trailing bonds, but ignore n.

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.

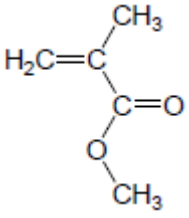
If values not specified as J or K then assume first is J.

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–.

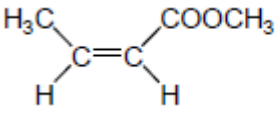
Allow $-CO_2CH_3$ etc.

Allow $CH_2C(CH_3)COOCH_3$.

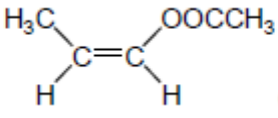
1

M

ester



OR



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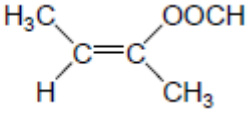
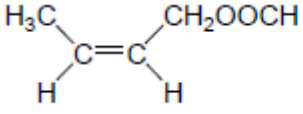
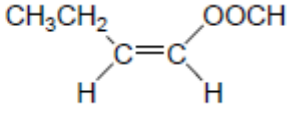


$CH_3CH=CHCOOCH_3$ *$CH_3CH=CHOOCCH_3$* *$CH_3CH=C(CH_3)OOCH$*



OR



OR

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

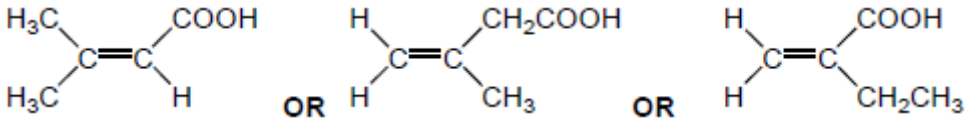
Allow either E–Z isomer.

Allow CH_3– or C_2H_5– but not CH_2CH_3–.

Allow $CH_3CHCHCOOCH_3$ etc.

1

N
acid



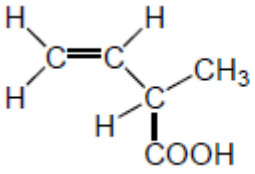
$(CH_3)_2C=CHCOOH$ *$H_2C=C(CH_3)CH_2COOH$* *$H_2C=C(COOH)CH_2CH_3$*

Allow CH_3- or C_2H_5- but not CH_2CH_3-.

Allow $-CO_2H$.

Not cyclic isomers.

Not the optically active isomer.

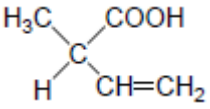


which is P anyway

Allow $(CH_3)_2CCHCOOH$ etc.

1

P
acid



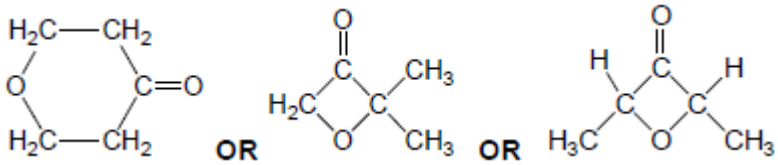
Allow $-CO_2H$.

$CH_3CH(COOH)CH=CH_2$

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

1

Q



Not cyclic esters.

1

[19]

M2. *1-chloropropane* *no visible change*

Accept 'small amount of precipitate' or 'precipitate forms slowly'.

1

ethanoyl chloride *white precipitate*

Accept 'large amount of precipitate' or 'precipitate forms immediately'.

1

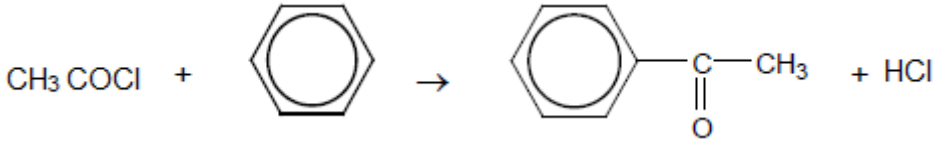
[2]

M3. *(a)* *(i)* $CH_3COCl + C_6H_6 \rightarrow C_6H_5COCH_3 + HCl$

Not molecular formulae *Not allow* $C_6H_5CH_3CO$

1

OR



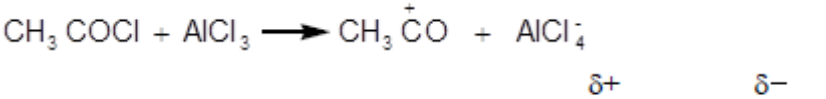
phenylethanone

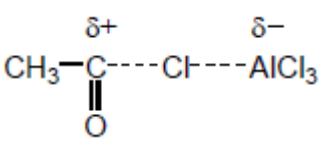
Ignore number 1 in name but penalise other numbers

1

$AlCl_3$ can be scored in equation

1





Allow RHS as

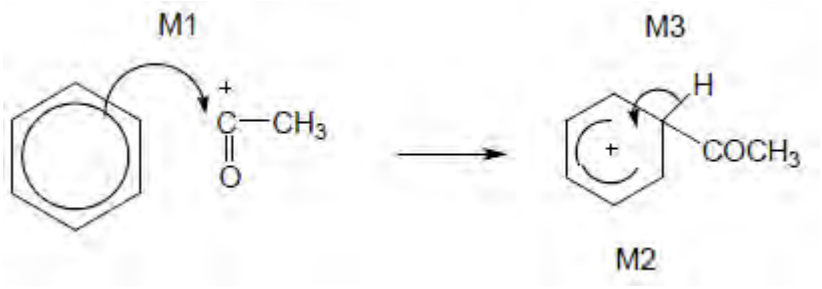
Allow + on C or O in equation but + must be on C in mechanism below

Ignore curly arrows in balanced equation even if wrong

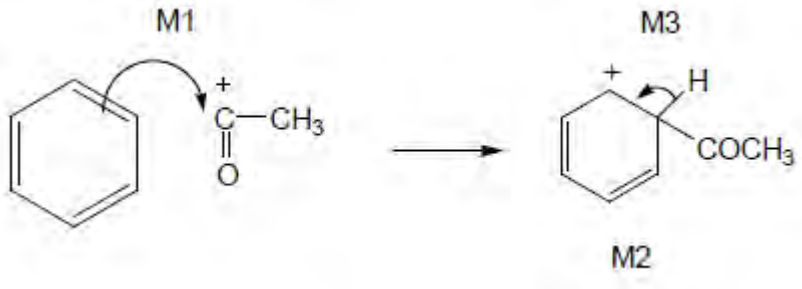
1

(ii) *Electrophilic substitution*

1



OR



- *M1 arrow from within hexagon to C or to + on C*
- *+ must be on C of CH_3CO in mechanism*
- *+ in intermediate not too close to C1*
- *Gap in horseshoe must be centred approximately around C1*
- *M3 arrow into hexagon unless Kekulé*
- *Allow M3 arrow independent of M2 structure,*
- *ie + on H in intermediate loses M2 not M3*
- *Ignore base removing H for M3*

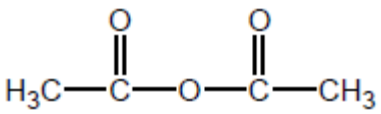
3

(b) *Electron <u>pair donor</u> or lone <u>pair donor</u>*

Allow donator

Allow lone pair used in description of (dative) bond formation

1



Allow $(CH_3CO)_2O$

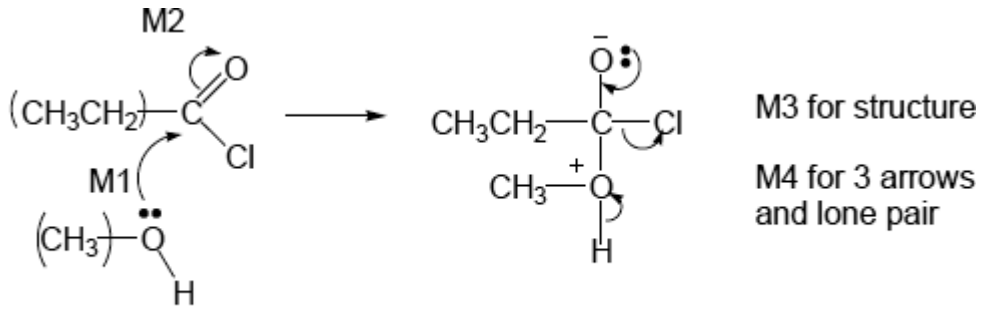
1

(acid) anhydride

Allow ethanoic anhydride but not any other anhydride

1

[11]



M4. *(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

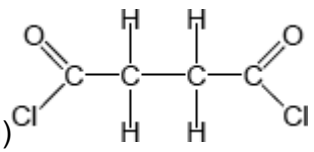
1

(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

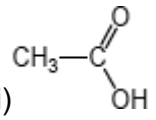
1

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

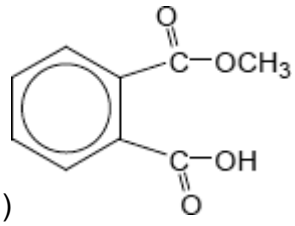
- less volatile

  NOT *COST*

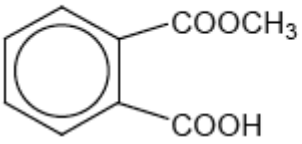
  List principle beyond two answers

2

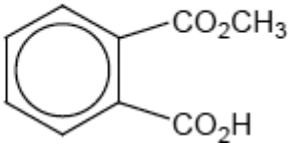
(d)



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) Pink to colourless

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

1

[21]

M5.(a) Side-arm flask / side-arm test tube

Do not allow sealed side-arm flask.

1

Flat-bottomed filter funnel with filter paper clearly shown

Either Buchner or Hirsch versions are suitable.
Allow Hirsch funnel and horizontal filter paper.
Allow three-dimensional filter funnels.
Do not allow standard Y-shaped funnel.
Do not allow sealed funnel.
If it is not clearly air-tight between the funnel and the flask, maximum 1 mark.

1

(b) Heat melting point tube in an oil bath

Accept 'melting point apparatus' or Thiele tube.
Do not accept water bath.

1

slowly near the melting point

Ignore any additional correct details.
Apply list principle for additional incorrect details.

1

[4]

M6. Test silver nitrate (solution) **(M1)**

Allow an alternative soluble silver salt eg fluoride, sulfate.

Do not allow 'silver ions' but can access second mark.

Incorrect formula loses this mark but can access second mark.

*Do not allow 'silver' or an insoluble silver salt and **cannot** access second mark.*

Ignore references to acidification of the silver nitrate.

If an acid is specified it should be nitric acid, but allow sulfuric acid in this case as there are no metal ions present.

If hydrochloric acid is used, CE = 0 / 2.

Do not allow 'add water'.

1

Observation white precipitate **(M2)**

Ignore 'cloudy'.

Do not allow 'white fumes' or 'effervescence'.

Do not allow this mark if test reagent is incorrect or missing.

*Allow named indicator paper or named indicator solution for **M1**.*

*Allow correct colour change for **M2**.*

1

[2]