

M1.

Mark Range	<p>The marking scheme for this part of the question includes an overall assessment for the Quality of Written Communication (QWC). There are no discrete marks for the assessment of QWC but the candidates' QWC in this answer will be one of the criteria used to assign a level and award the marks for this part of the question</p> <p style="text-align: center;">Descriptor</p> <p style="text-align: center;">an answer will be expected to meet most of the criteria in the level descriptor</p>
4-5	<ul style="list-style-type: none"> — claims supported by an appropriate range of evidence — good use of information or ideas about chemistry, going beyond those given in the question — argument well structured with minimal repetition or irrelevant points — accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling
2-3	<ul style="list-style-type: none"> — claims partially supported by evidence — good use of information or ideas about chemistry given in the question but limited beyond this — the argument shows some attempt at structure — the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling
0-1	<ul style="list-style-type: none"> — valid points but not clearly linked to an argument structure — limited use of information or ideas about chemistry — unstructured — errors in spelling, punctuation and grammar or lack of fluency

- (a) (i) M_r of $C_6H_5NH_2 = 93$ M_r of $CH_3COCl = 78.5$
total M_r of reagents = 264.5

1

$$\% \text{ atom economy} = \frac{M_r \text{ of wanted product}}{\text{total } M_r \text{ of all reagents}} \times 100 \text{ QWC}$$

1

$$= \frac{135}{264.5} \times 100 = 51.0 \%$$

1

(ii) expected yield = $\frac{10}{93} \times 0.5 \times 135 = 7.26 \text{ kg}$

1

$$\% \text{ yield} = \frac{5.38}{7.26} \times 100 = 74.1 \%$$

1

(iii) Although yield appears satisfactory (74%) % atom economy is only 51% QWC

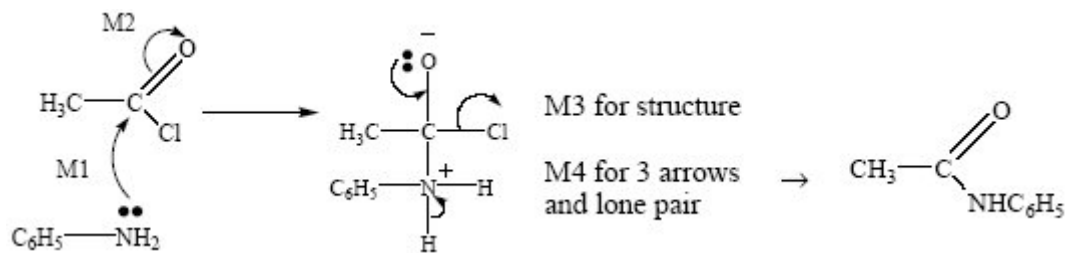
1

nearly half of the material produced is waste and must be disposed of QWC

1

(b) (nucleophilic) addition-elimination

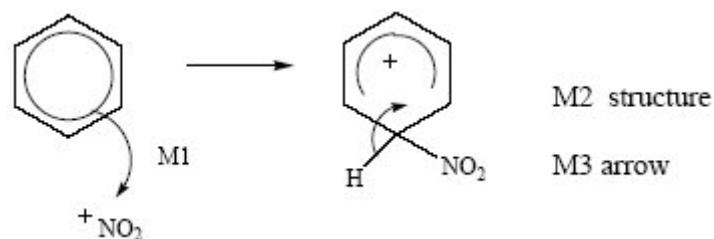
1



4

(c) $\text{HNO}_3 + 2\text{H}_2\text{SO}_4 \rightarrow \text{NO}_2^+ + \text{H}_3\text{O}^+ + 2\text{HSO}_4^-$

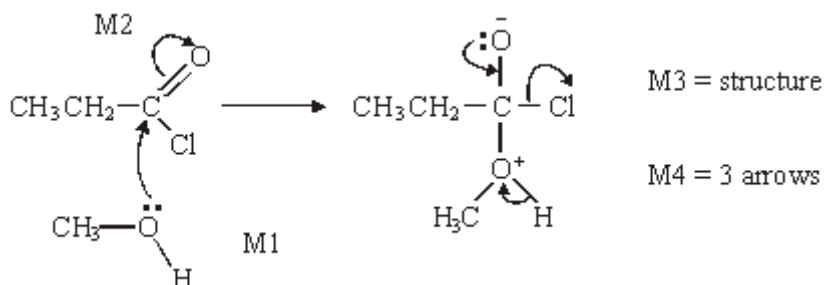
1



3

[16]

M2. X is methyl propanoate



1

M1 for arrow and lone pair,

4

M2 for arrow
addition-elimination

1

Spectrum 2

if thinks Spectrum 1 = X can only score for structure of Y

1

Y is $\text{CH}_3\text{COOCH}_2\text{CH}_3$

1

The two marks for explanation are awarded for discussing one or more of the four peaks (not those for the CH_3 of the ethyl groups)

for stated δ values the integration or the splitting should be related to the structure: e.g. structure of X shows that

at δ 3.7 – 4.1 (1) spectrum of X should have integration 3 / singlet (1)

or

at δ 2.1 – 2.6 (1) spectrum of X should have integration 2 / quartet (1)

Spectrum 2 has these

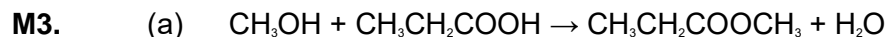
[OR Spectrum 1 has

at 3.7 – 4.1 (1) quartet / integration 2 (1) so not X

at 2.1 – 2.6 (1) singlet / integration 3 (1) so not X]

2

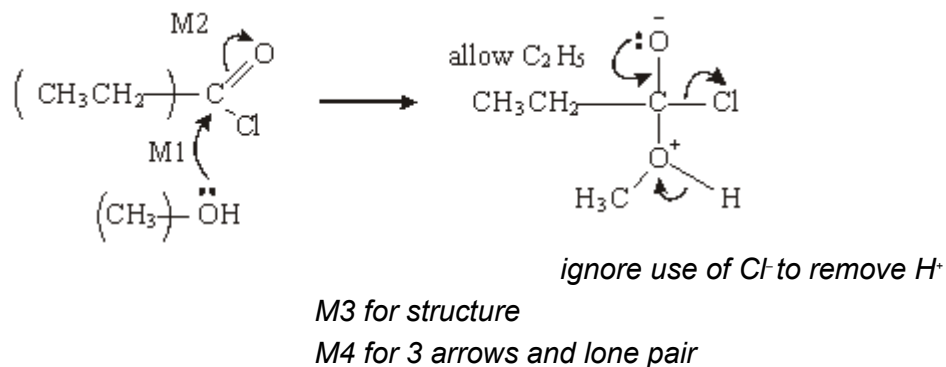
[10]



1

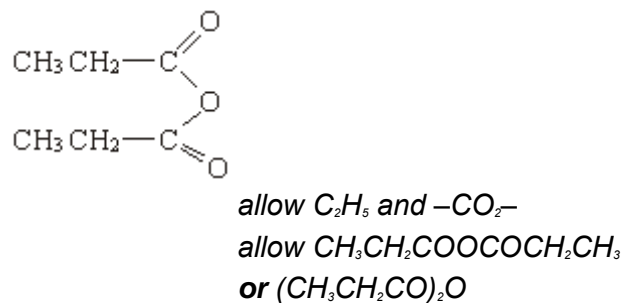
(b) (nucleophilic) addition-elimination NOT acylation

1



4

(c)



1

(d) (i) faster/not reversible/bigger yield/purer product/no(acid) (catalyst) required

1

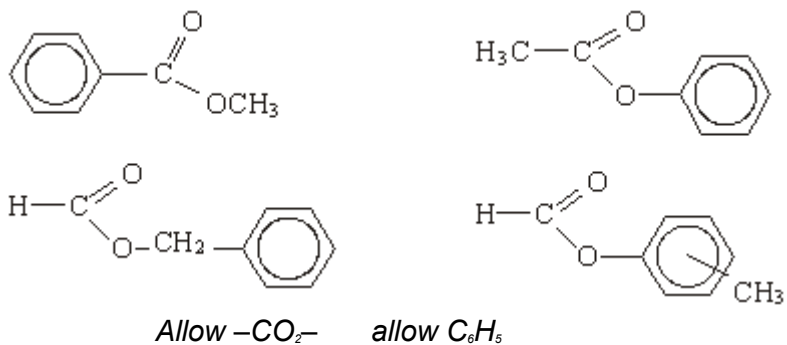
(ii) anhydride less easily hydrolysed or reaction less violent/exothermic
no (corrosive) (HCl) fumes formed or safer or less toxic/dangerous
expense of acid chloride or anhydride cheaper
any one

1

(e) (i) $\text{C}_8\text{H}_8\text{O}_2$

1

(ii) **any two from**



2

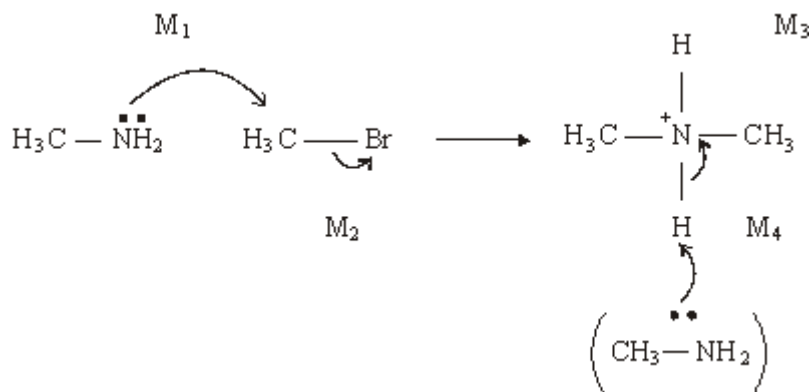
[12]

M4. (a) dimethylamine

1

(b) nucleophilic substitution

1



4

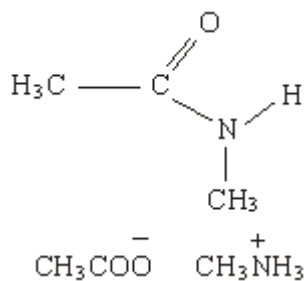
(c) quaternary ammonium salt

1

(cationic) surfactant / bactericide / detergent / fabric softener or conditioner/hair conditioner

1

(d)

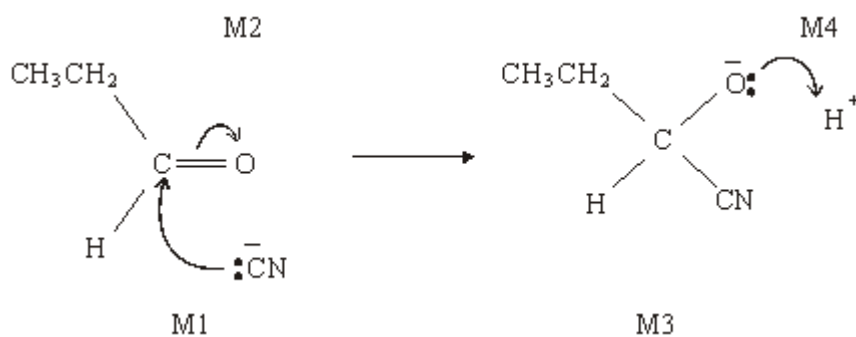


(allow CH_3COOH or $\text{CH}_3\text{COO}^- \text{NH}_4^+$)

2

[10]

M5. (a) nucleophilic addition



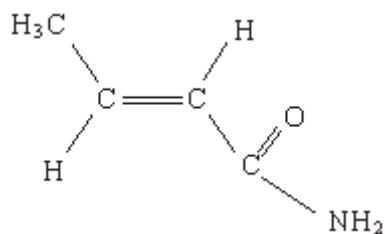
1

4

(b) (i) 2-hydroxybutanenitrile

1

(ii)

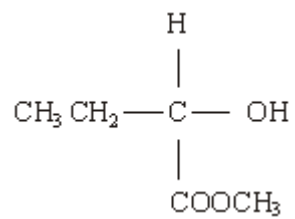


(allow 1 for amide even if not $\text{C}_4\text{H}_7\text{NO}$, i.e. RCONH_2)

(if not amide, allow one for any isomer of $\text{C}_4\text{H}_7\text{NO}$ which shows geometric isomerism)

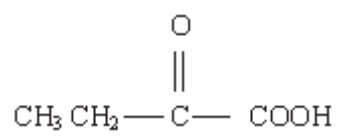
2

(c) (i)



1

(ii)



1

(iii) $\text{CH}_3\text{CH}=\text{CHCOOH}$

1

[11]