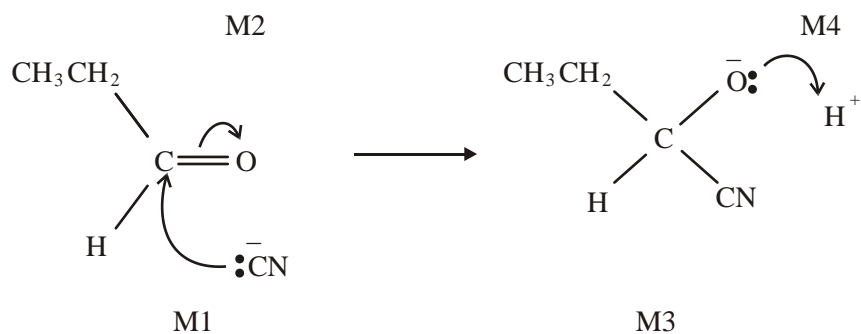


# 4.4, 4.5 HW MS

1. (a) nucleophilic addition

1



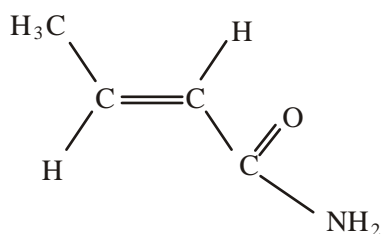
4

- (b) (i) 2-hydroxybutanenitrile

1

- (ii)

2

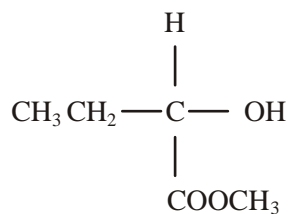


(allow 1 for amide even if not  $C_4H_7NO$ , i.e.  $RCONH_2$ )

(if not amide, allow one for any isomer of  $C_4H_7NO$  which shows geometric isomerism)

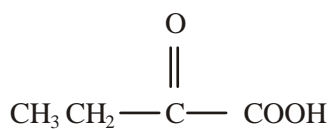
- (c) (i)

1



- (ii)

1



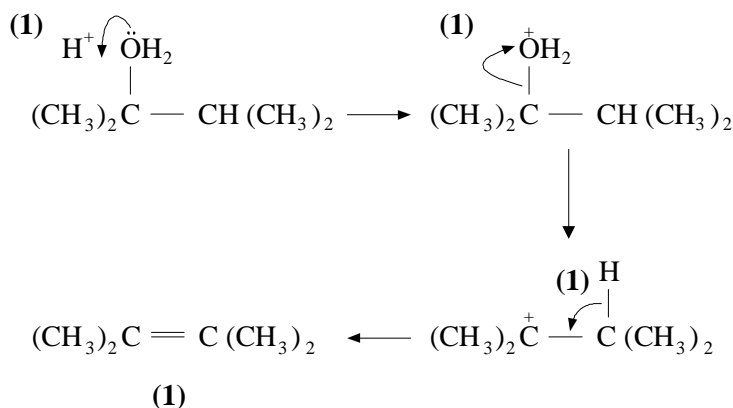
- (iii)  $CH_3CH=CHCOOH$

1

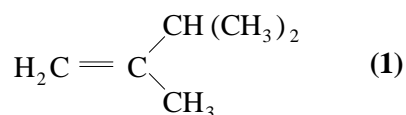
[11]

2. (a) (i) 2, 3 – dimethylbutan – 2 – ol (1)  
(ii) elimination (1)

*Mechanism*



- (iii) *Structure*

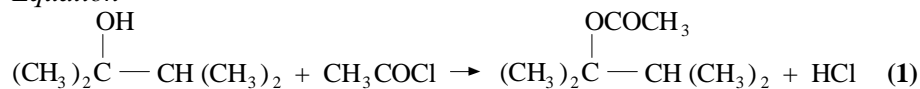


*Name of isomer* 2, 3 – dimethylbut – 1 – ene (1)

*Explanation* loss of  $\text{H}^+$  or H (1)  
from end C also possible (1)

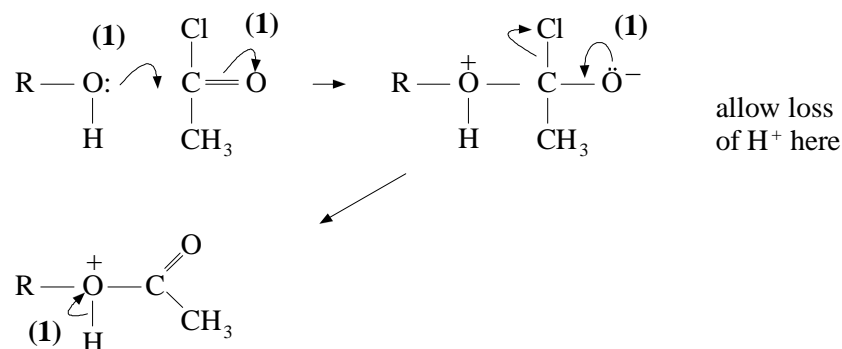
10

- (b) (i) *Equation*



*Name of mechanism* addition – elimination (1)

*Mechanism*



- (ii) *Type of reaction* esterification (1)  
*Reagent(s)*  $\text{CH}_3\text{COOH}$  or ethanoic acid (1)  
*Conditions* strong acid catalyst (1)  
or  $\text{H}_2\text{SO}_4$  or HCL

9

[19]

3. (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: NaHCO<sub>3</sub> (1)

Observation with **C**: no reaction (1)

Observation with **D**: effervescence (1)

4

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

Test	an identified (hydrogen) carbonate	acidified K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	acidified KMnO <sub>4</sub>	correct metal	UI or stated indicator	PCl <sub>5</sub>
Observation with <b>C</b>	no reaction	goes green	goes colourless	no reaction	no change	no reaction
observation with <b>D</b>	bubbles or CO <sub>2</sub>	no change	no change	bubbles or H <sub>2</sub>	red or correct colour pH 3 – 6.9	(misty) fumes

(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)

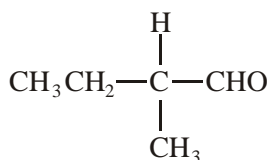
4

for **E** and **F**

Test	Tollens	Fehlings or Benedicts	iodoform or I <sub>2</sub> /NaOH	acidified K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	Schiff's
observation with <b>E</b>	no reaction	no reaction	yellow (ppt)	no change	no reaction
observation with <b>F</b>	silver or mirror or grey or ppt	red or ppt not red solution	no reaction	goes green	goes pink

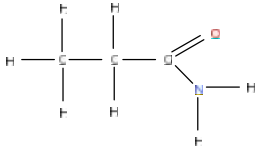
(c) (1)

1



*must be aldehyde. Allow C<sub>2</sub>H<sub>5</sub> for CH<sub>3</sub>CH<sub>2</sub> otherwise this is the only answer*

[9]

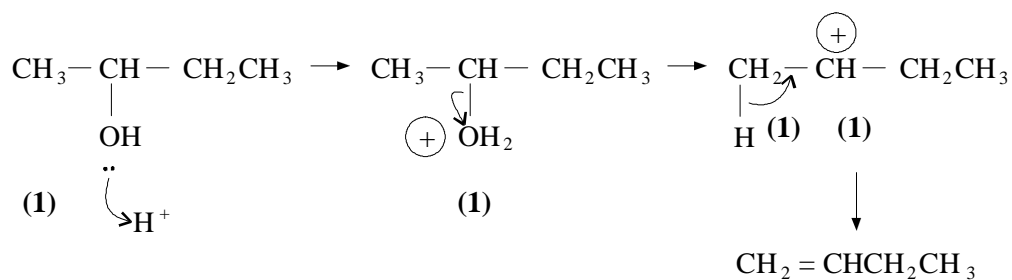
4. (a) (i) **B:** propanoyl chloride (or consequentially on part (a) (ii)) **(1)**  
**C:** propanoic anhydride (or consequentially on part (a) (ii)) **(1)** 2  
do **not** allow formulae
- (ii) effervescence / misty fumes / steamy fumes / fumes /  
solution becomes warm / fizzing **not** just gas **(1)** 1
- (iii)
- 

**(1)** 1
- (the minimum necessary for the mark is C=O and C-N shown)
- (iv)  $(\text{CH}_3\text{CH}_2\text{CO})_2\text{O} + \text{H}_2\text{O} \longrightarrow 2\text{CH}_3\text{CH}_2\text{COOH}$  **(1)** 1  
allow  $\text{C}_2\text{H}_5\text{COOH}$ .....
- (b) (i) methanol **(1)**  
methyl propanoate (or consequentially on part (a) (ii)) **(1)** 2  
do **not** allow formulae
- (ii) **A:** in presence of (concentrated) sulphuric acid  
/  $\text{H}_2\text{SO}_4$  / strong acid / gaseous hydrogen chloride or  $\text{HCl}$   
allow dilute  $\text{H}_2\text{SO}_4$  **(1)**  
heat / reflux (but only if first mark awarded) **(1)**  
allow 1 mark for acidic conditions /  $\text{H}^+$  and heat  
**B:** room temperature / in the cold / not heated / cooling **not** acid **(1)**  
**C:** heat / reflux **not** acid **(1)** 4

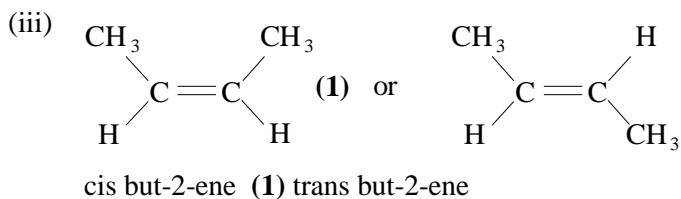
[11]

5. (a) (i)
- $$\text{CH}_3-\underset{\text{OH}}{\text{CH}}-\text{CH}_2\text{CH}_3 + \text{CH}_3\text{COOH} \rightarrow \text{CH}_3-\overset{\text{O}}{\underset{\text{O}}{\text{C}}}-\underset{\text{CH}}{\overset{\text{CH}_3}{\text{CH}_2}}-\text{CH}_2\text{CH}_3 + \text{H}_2\text{O}$$

**(1)** eq<sup>n</sup> **(1)**
- (ii) ester **(1)**  
solvent, flavourings **(1)**
- (iii) conc  $\text{H}_2\text{SO}_4$  **(1)**  
in same physical state **(1)** 6
- (b)  $\text{C}_4\text{H}_{10}\text{O} + 6\text{O}_2 \rightarrow 4\text{CO}_2 + 5\text{H}_2\text{O}$  **(1)** 1



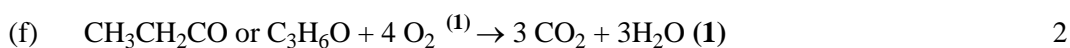
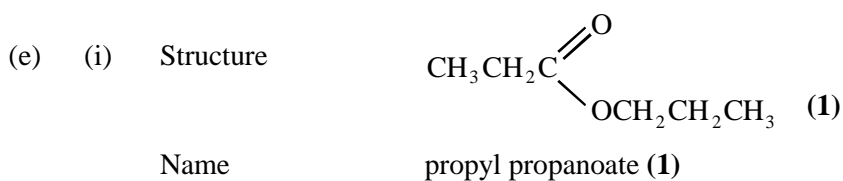
(ii) two H on carbon in double bond **(1)**



7

[14]

- |           |      |   |  |   |
|-----------|------|---|--|---|
| <b>6.</b> | (a)  | <i>Reagents</i>   | NaBH <sub>4</sub> (1)  |   |
|           |      | <i>Type of reaction</i>   | reduction (1)  | 2 |
|           | (b)  | (i) <i>Reagents(s)</i>  | K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> (1) H <sub>2</sub> SO <sub>4</sub> (1) |   |
|           |      | <i>Conditions</i>   | reflux (1)   |   |
|           | (ii) | CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH + 2[O] → CH <sub>3</sub> CH <sub>2</sub> COOH + H <sub>2</sub> O (1) |  | 4 |
|           | (c)  | <i>Reagents</i>   | HCN or NaCN/H <sup>+</sup> (1)   |   |
|           |      | <i>Name of mechanism</i>  | nucleophilic $\curvearrowright$ addition (1)   | 2 |
|           | (d)  | (i)   | mirror images (1)  |   |
|           |      | (ii)  | plane polarized light (1)  |   |
|           |      |   | rotated in opposite directions (1)   | 3 |

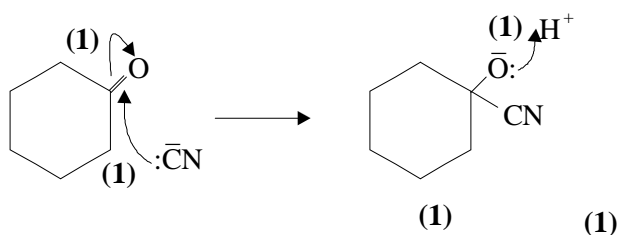


**[16]**

7. (a) (i) correct graphical formula for tertiary alcohol  
allow  $\text{CH}_3$  not  $\text{C}_2\text{H}_5$  (1)  
2-methylbutan-2-ol / 2-hydroxy-2-methylbutane / 2-methyl-2-hydroxybutane award name mark even if it follows incorrect formula (1) 2
- (ii) graphical formula of pent-1-ene (1)  
graphical formula of pent-2-ene (1) 2  
accept geometrical isomers of pent-2-ene if clearly shown to be different
- (iii) dehydration / elimination (1) 1
- (iv) no H atoms on C atom next to C–OH / three methyl groups on C (1) 1
- (b) (i) ethanenitrile / ethanonitrile / methyl cyanide / cyanomethane / acetonitrile (1) 1
- (ii) any hydrolysis (1) 1
- (iii)  $\text{CH}_3\text{COCl} + \text{CH}_3\text{NH}_2 \rightarrow \text{CH}_3\text{CONHCH}_3 + \text{HCl}$   
for correct formula of methylamine / HCl product (1)  
overall correct (1) 2

[10]

8. (a)  $\text{NaBH}_4$  (1) 1
- (b) nucleophilic addition (1)

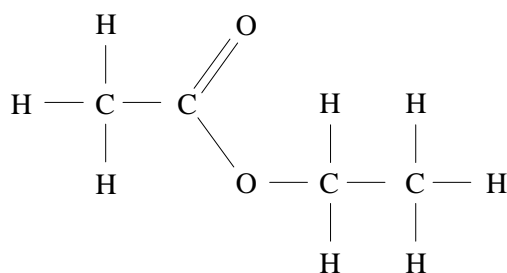


5

- (c) (i) hexanedioic acid (1)
- (ii)  $\text{C}_6\text{H}_{10}\text{O} \rightarrow \text{C}_6\text{H}_{10}\text{O}_4$   
Mr = 98 (1) Mr = 146 (1)  
 $2.40 \text{ g} \rightarrow \frac{2.40}{98} \times 146 = 3.58 \text{ g}$  (1) 4

[10]

9. (a) (i) ethyl ethanoate



(1) 2

- (ii) esterification / condensation / addition - elimination (1) 1

- (b) (i) aqueous / dilute sulphuric / hydrochloric acid (allow HCl(aq); H<sub>2</sub>SO<sub>4</sub>(aq) not water) (1)  
temp. < 100° / warm / heat / reflux (this mark dependent on sensible reagent) (1) 2
- (ii)  $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH}$   
(allow C<sub>4</sub>H<sub>8</sub>O<sub>2</sub>, C<sub>2</sub>H<sub>4</sub>O<sub>2</sub> but must have C<sub>2</sub>H<sub>5</sub>OH) (1) 1
- (c) (i) sodium hydroxide / sodium carbonate / sodium hydrogen carbonate  
(allow formula) (1)  
room temperature / aqueous (2nd mark dependent on correct reagent) (1) 2
- (ii) ethanoic anhydride
- 
- (1) 2
- (methanol groups can be shown as –CH<sub>3</sub> but the C–C bond must be drawn)
- (iii) addition of water / hydrolysis (1)  
(CH<sub>3</sub>CO)<sub>2</sub>O + H<sub>2</sub>O → 2CH<sub>3</sub>COOH (1) 2
- (d) (i) ethanamide **not** ethylamide.
- 
- (1) 2
- (ii) ammonia (not if dilute implied) / ammonium carbonate /PCl<sub>5</sub>  
followed by NH<sub>3</sub> (allow formulae) (1)  
heat or temperature < 100° (1) 2
- (iii)  $\text{CH}_3\text{CONH}_2 + \text{HCl} + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{COOH} + \text{NH}_4\text{Cl}$  (1) 1

[17]

10.	(a)	(i)	An appropriate alkene; $\text{CH}_3\text{CH}_2\text{CHCH}_2$ or $(\text{CH}_3)_2\text{CCH}_2$	1
			Isomer 1	1
			Isomer 2	1
			Position isomerism	1
			Mechanism	
			electrophilic attack and electron shift to Br (Unless $\text{H}^+$ used)	1
			carbocation	1
			reaction with carbocation	1
			<i>[Allow mechanism marks for the alkene <math>\text{CH}_3\text{CHCHCH}_3</math>]</i>	
			<i>[Allow one mark if mechanism for minor product given]</i>	
		(ii)	An appropriate carbonyl; $\text{CH}_3\text{CH}_2\text{CHO}$	1
			Mechanism nucleophilic attack and electron shift to O	1
			anion intermediate	1
			reaction with anion	1
			<i>[Allow mechanism marks for the carbonyl <math>(\text{CH}_3)_2\text{CO}</math>]</i>	
			Isomer 1	1
			Isomer 2	1
			Optical isomerism	1
			<i>NB Isomer structures must be tetrahedral</i>	
			<i>NB Penalise “stick” structures once in part (a)</i>	
	(b)		QoL Large charge on carbonyl carbon atom due to bonding to O and Cl	1
			Nucleophiles have electron pairs which can be donated	1
			Equation Species	1
			Balanced	1

[18]