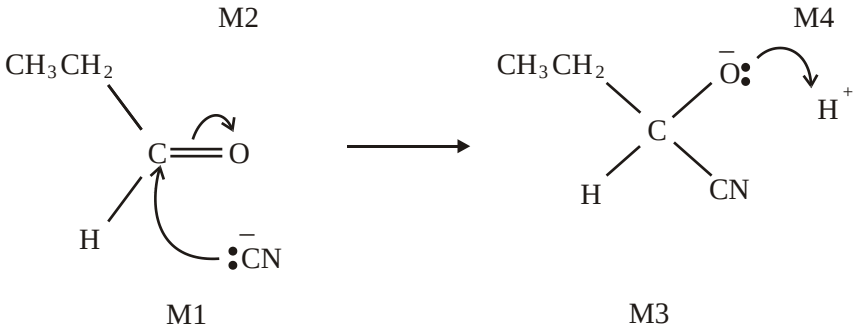
4.4, 4.5 HW MS

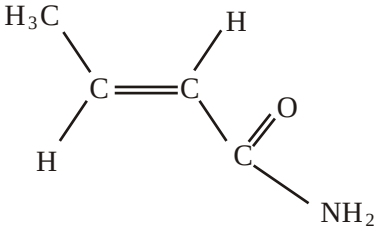
1. (a) nucleophilic addition 1



4

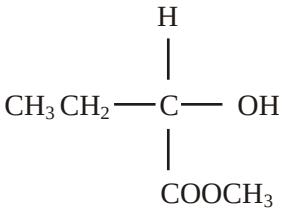
(b) (i) 2-hydroxybutanenitrile 1

(ii) 2

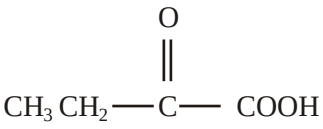


(allow 1 for amide even if not C_4H_7NO, i.e. $RCONH_2$)
(if not amide, allow one for any isomer of C_4H_7NO which shows geometric isomerism)

(c) (i) 1



(ii) 1



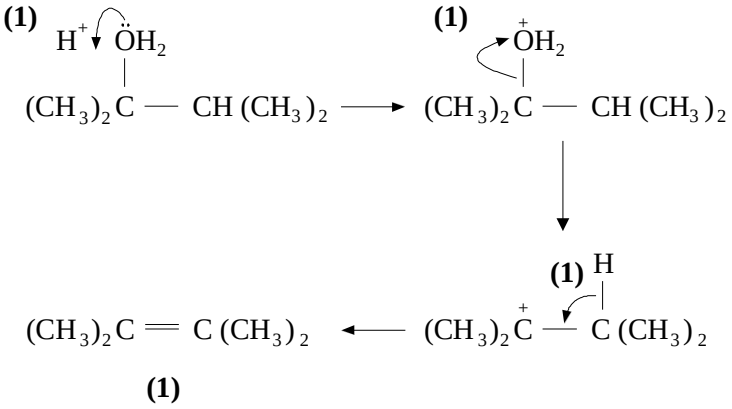
(iii) $CH_3CH=CHCOOH$ 1

[11]

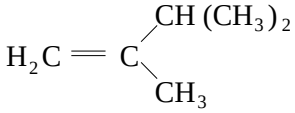
2. (a) (i) 2, 3 – dimethylbutan – 2 – ol **(1)**

(ii) elimination **(1)**

Mechanism



(iii) *Structure*



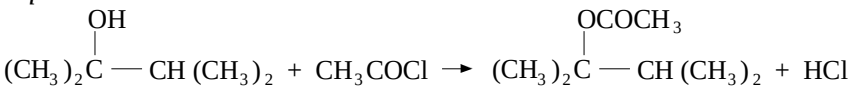
(1)

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

Explanation loss of H^+ <u>or</u> H **(1)**

from end C also possible **(1)** 10

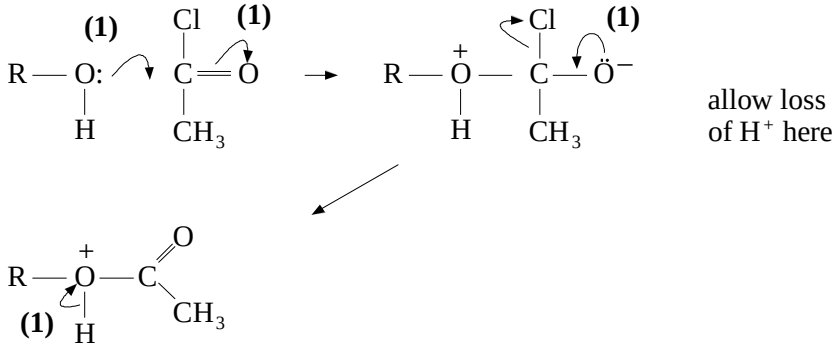
(b) (i) *Equation*



$(CH_3)_2C(OH)-CH(CH_3)_2 + CH_3COCl \rightarrow (CH_3)_2C(OCOCH_3)-CH(CH_3)_2 + HCl$ **(1)**

Name of mechanism addition – elimination **(1)**

Mechanism



(ii) *Type of reaction* esterification **(1)**

Reagent(s) CH_3COOH <u>or</u> ethanoic acid **(1)**

Conditions strong acid catalyst **(1)**

<u>or</u> H_2SO_4 <u>or</u> 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*: $NaHCO_3$ **(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 $K_2Cr_2O_7$	acidified $KMnO_4$	correct metal	UI or stated indicator	PCl_5
Observation with **C**	no reaction	goes green	goes colourless	no reaction	no change	no reaction
observation with **D**	bubbles or CO_2	no change	no change	bubbles or H_2	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

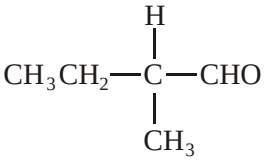
(ii) *Reagent*: Tollen's or Fehling's **(1)**

*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_2/NaOH	acidified $K_2Cr_2O_7$	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

(c)  **(1)** 1

must be aldehyde. Allow C_2H_5 for CH_3CH_2 otherwise this is the only answer

[9]

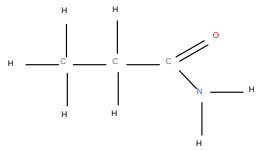
4. (a) (i) **B**: propanoyl chloride (or consequentially on part (a) (ii)) **(1)**

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) $(CH_3CH_2CO)_2O + H_2O \longrightarrow 2CH_3CH_2COOH$ **(1)** 1

allow C_2H_5…..

(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 / H_2SO_4 / strong acid / gaseous hydrogen chloride or HCl allow dilute H_2SO_4 **(1)**

heat / reflux (but only if first mark awarded) **(1)**

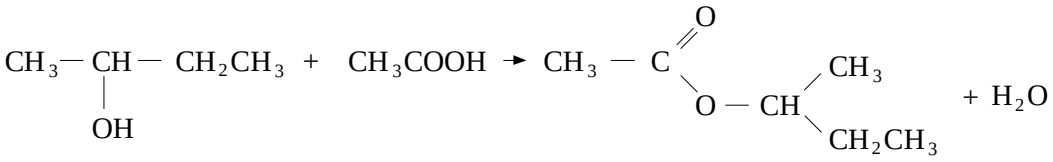
allow 1 mark for acidic conditions / H+ and heat

B: room temperature / in the cold / not heated / cooling **not** acid **(1)**

C: heat / reflux **not** acid **(1)** 4

[11]

5. (a) (i)



(1) eq^n **(1)**

(ii) ester **(1)**

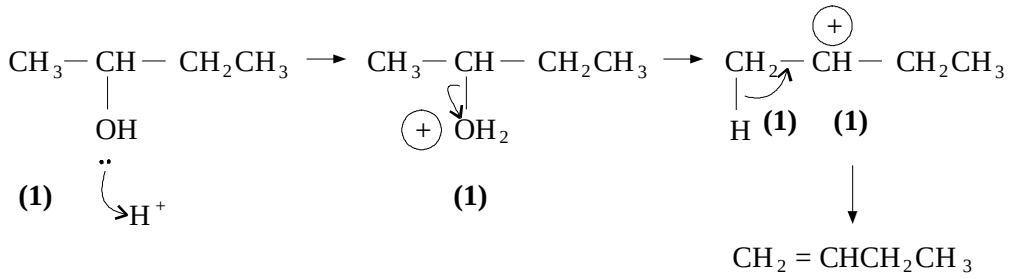
solvent, flavourings **(1)**

(iii) conc H_2SO_4 **(1)**

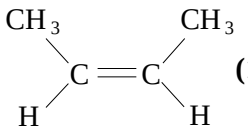
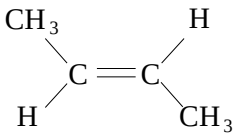
in same physical state **(1)** 6

(b) $C_4H_{10}O + 6O_2 \rightarrow 4CO_2 + 5H_2O$ **(1)** 1

(c) (i)



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

(iii)  **(1)** or 

cis but-2-ene **(1)** trans but-2-ene 7

[14]

6. (a) *Reagents* $NaBH_4$ **(1)**

Type of reaction reduction **(1)** 2

(b) (i) *Reagents(s)* $K_2Cr_2O_7$ **(1)** H_2SO_4 **(1)**

Conditions reflux **(1)**

(ii) $CH_3CH_2CH_2OH + 2[O] \rightarrow CH_3CH_2COOH + H_2O$ **(1)** 4

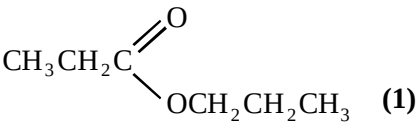
(c) *Reagents* HCN or $NaCN/H^+$ **(1)**

Name of mechanism nucleophilic ∩ addition **(1)** 2

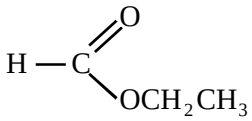
(d) (i) mirror images **(1)**

(ii) plane polarized light **(1)**

rotated in opposite directions **(1)** 3

(e) (i) Structure  **(1)**

Name propyl propanoate **(1)**

(ii)  **(1)** 3

(f) CH_3CH_2CO or $C_3H_6O + 4\ O_2 \xrightarrow{(1)} 3\ CO_2 + 3H_2O$ **(1)** 2

[16]

7. (a) (i) correct graphical formula for tertiary alcohol
allow CH_3 not C_2H_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) $CH_3COCl + CH_3NH_2 \rightarrow CH_3CONHCH_3 + HCl$

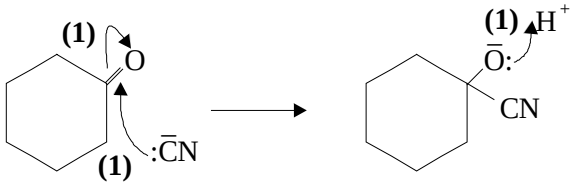
for correct formula of methylamine / HCl product **(1)**

overall correct **(1)** 2

[10]

8. (a) $NaBH_4$ **(1)** 1

(b) nucleophilic ⌒ addition **(1)**



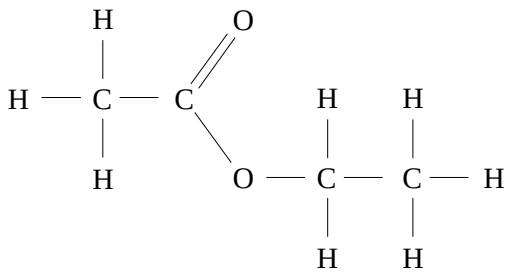
5

(c) (i) hexanedioic acid **(1)**

(ii) $C_6H_{10}O \rightarrow C_6H_{10}O_4$
Mr = 98 **(1)** Mr = 146 **(1)**
2.40 g $\rightarrow$ $\frac{2.40}{98} \times 146 = 3.58$ 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_2SO_4(aq) not water) **(1)**

temp. < 100° / warm / heat / reflux (this mark dependent on sensible reagent) **(1)**

2

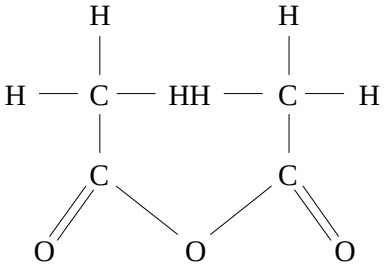
(ii) $CH_3COOC_2H_5 + H_2O \rightarrow CH_3COOH + C_2H_5OH$

(allow $C_4H_8O_2$, $C_2H_4O_2$ but must have C_2H_5OH) **(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



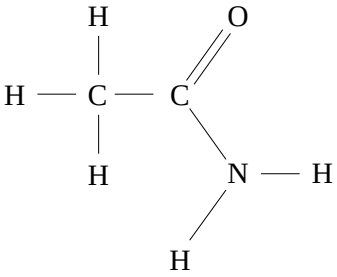
(1) 2

(methyl groups can be shown as $–CH_3$ but the C–C bond must be drawn)

(iii) addition of water / hydrolysis **(1)**

$(CH_3CO)_2O + H_2O \rightarrow 2CH_3COOH$ **(1)** 2

(d) (i) ethanamide **not** ethylamide.



(1) 2

(ii) ammonia (not if dilute implied) / ammonium carbonate /PCl_5 followed by NH_3 (allow formulae) **(1)**

heat or temperature < 100° **(1)** 2

(iii) $CH_3CONH_2 + HCl + H_2O \rightarrow CH_3COOH + NH_4Cl$ **(1)** 1

[17]

10. (a) (i) An appropriate alkene; $CH_3CH_2CHCH_2$ or $(CH_3)_2CCH_2$ 1

Isomer 1 1

Isomer 2 1

Position isomerism 1

Mechanism

electrophilic attack and electron shift to Br (Unless H^+ used) 1

carbocation 1

reaction with carbocation 1

[Allow mechanism marks for the alkene $CH_3CHCHCH_3$]

[Allow one mark if mechanism for minor product given]

(ii) An appropriate carbonyl; CH_3CH_2CHO 1

Mechanism nucleophilic attack and electron shift to O 1

anion intermediate 1

reaction with anion 1

[Allow mechanism marks for the carbonyl $(CH_3)_2CO$]

Isomer 1 1

Isomer 2 1

Optical isomerism 1

NB *Isomer structures must be tetrahedral*

NB *Penalise "stick" structures once in part (a)*

(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]