

- M1. (a) (i)  $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ ;  
*(penalise  $C_2H_6O$  once only in this question)* 1
- (ii) Concentrated  $H_2SO_4$  OR concentrated  $H_3PO_4$  OR  $Al_2O_3$ ;  
*(penalise aqueous or dilute as a contradiction)* 1
- $C_2H_5OH \rightarrow C_2H_4 + H_2O$  OR  $C_2H_5OH \rightarrow H_2C = CH_2 + H_2O$ ;  
*(penalise  $CH_2CH_2$  and  $CH_2-CH_2$  and  $CH_2 : CH_2$  for ethene)* 1
- (b) Nickel OR Ni OR platinum OR Pt OR palladium OR Pd; 1
- Hydrogen OR  $H_2$ ; 1
- (c) (i)  $C_{18}H_{34}O_2$  Only; 1
- $C_9H_{17}O$  Only;  
*(empirical formula is not consequential on molecular formula)* 1
- (ii) (An unsaturated compound) contains (at least) one double bond  
 OR  
 Contains  $C=C$ ;  
*(must be a positive statement)* 1
- (iii) M1: Bromine water  
 OR  
 $Br_2(aq)$   
 OR  
 Bromine  
 OR

Br<sub>2</sub>;

*(penalise "bromide water", but mark on)*

1

M1: decolourised or goes colourless

OR

from brown/red/orange/yellow to colourless;

*(Must be "colourless" not "clear" for M2)*

*(chemical error if no reagent or wrong reagent, loses both marks) (credit KMnO<sub>4</sub> for M1, (purple) to colourless for M2 (if acidified) OR (purple) to brown/brown precipitate (if alkaline or unspecified) (No credit for hydrogen or iodine as reagents)*

1

[10]

- M2.** (a) (i) *Reagent: Hydrogen of H<sub>2</sub> (1)*  
*Conditions: Ni (catalyst) (Ignore Pt) (1)*  
*100 – 200 °C or heat (1)*

*Not 'high temp' or 'warm'*

*M1 = 0, M2 = 1 then M3 = 0 max*

*or M1 = M2 = 0 then M3 = 0*

*M3 tied to M1. Only award M3 if M1 earned*

- (ii) *Difference in structure: soft margarine less hydrogenated or has more C=C bonds or is more unsaturated than hard margarine (1)*

*Difference in melting point: soft has lower melting point (1)*

*Must be comparison*

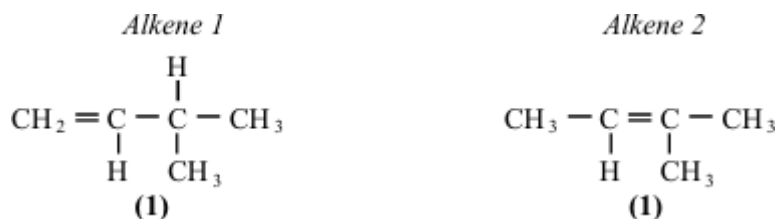
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- (b) (i) 3-methylbutan-2-ol (1)  
*No alternatives*

- (ii) elimination or dehydration (1)

(iii) (c) H<sub>2</sub>SO<sub>4</sub> or (c) H<sub>3</sub>PO<sub>4</sub> – name or correct formula **(1)**

(iv)



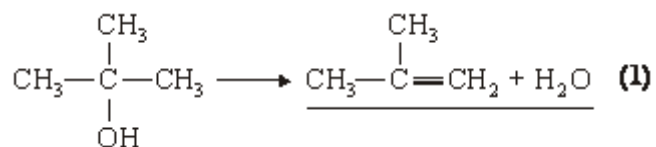
*Double bond must be shown*  
*Accept any correct unambiguous structures*  
*if but-1-ene and but-2-ene offered, allow M2*

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[10]

**M3.** (a) (i) 2-methylpropan-2-ol **(1)** OR the second one

(ii) *Dehydrating agent:*  $\text{conc H}_2\text{SO}_4$  OR  $\text{conc H}_3\text{PO}_4$  OR  $\text{Al}_2\text{O}_3$  **(1)**  
*ignore additional (aq)*



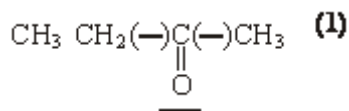
*Equation:*

*Allow C<sub>4</sub>H<sub>9</sub>OH in equation provided RHS is correct*  
*if b(i) is blank, b(ii) equation must be full for credit*  
*i.e. NOT C<sub>4</sub>H<sub>9</sub>OH*  
*Mark consequential on b(i)*

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- (b) (i) *Isomer: butan-2-ol OR the fourth one*  
*[look at name in table]*  
*wrong isomer = CE*

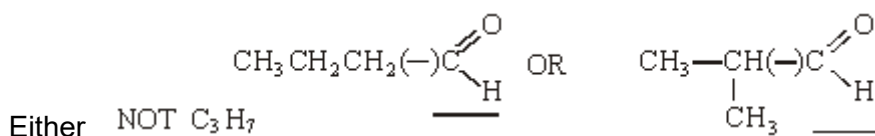
*Structure of the ketone:*



- (ii) *Isomer: butan-1-ol OR the first one*  
*OR 2-methylpropan-1-ol OR the third one*  
*[look at name in table]*

*Wrong isomer = CE*

*Structure of the aldehyde:*



(iii)

| Reagent                   | M1 | Tollen's<br>(AgNO <sub>3</sub> /NH <sub>3</sub> ) | Fehling's  |
|---------------------------|----|---|--|
| Observation with ketone   | M2 | Stays colourless<br>no change                     | stays blue<br>no change  |
| Observation with aldehyde | M3 | Silver mirror<br>black ppt                        | <u>red solid</u><br><u>orange/red</u><br><u>brown/ red</u><br><u>ppt/solid</u> |

Other include(\*)

K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> / H<sub>2</sub>SO<sub>4</sub>

KMnO<sub>4</sub>/H<sub>2</sub>SO<sub>4</sub>

Schiff's

Benedict's

Wrong reagent R

No reagent = CE

Penalise AgNO<sub>3</sub> [Ag(NH<sub>3</sub>)<sub>2</sub>] but allow M2 and M3 sequentially.

(\*) K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> / H<sub>2</sub>SO<sub>4</sub> acidified ketone aldehyde

|   |                     |                              |
|---|---------------------|------------------------------|
|   | orange<br>no change | green                        |
| KMnO <sub>4</sub> /H <sub>2</sub> SO <sub>4</sub> acidified | purple<br>no change | colourless<br>(v. Pale pink) |

*Benedict's*  $\equiv$  *Fehling's* ; *Schiff's* colourless  $\rightarrow$  pink with CHO  
violet

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(c) *Equation:* CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>OH (or C<sub>4</sub>H<sub>9</sub>OH) + 2[O]  $\rightarrow$  CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH  
(or C<sub>3</sub>H<sub>7</sub>COOH) + H<sub>2</sub>O (1)

*Name of product:* butanoic acid (1)

*Accept butaneic acid*

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[12]

**M4.** (a) Reaction 2: NaOH OR KOH (1) M1 alcohol (ic) OR ethanol (ic)(1) M2

*ignore heat*

*Condition mark linked to correct reagent but award M2 if OH  
or base or alkali mentioned*

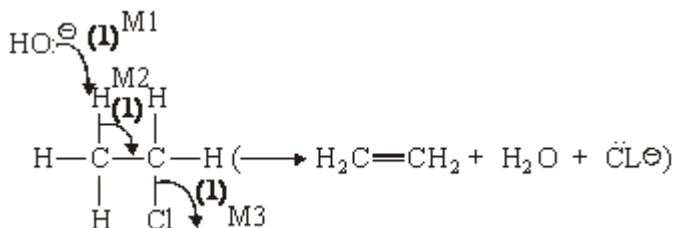
Reaction 3: concentrated H<sub>2</sub>SO<sub>4</sub> OR H<sub>3</sub>PO<sub>4</sub> M1 (1) heat (1) M2  
OR 150°C - 200°C

*Condition mark linked to correct reagent but award M2 if  
H<sub>2</sub>SO<sub>4</sub> or H<sub>3</sub>PO<sub>4</sub>, but not concentrated*

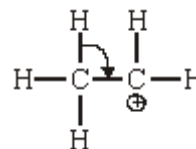
*Penalise reagent and condition if dilute H<sub>2</sub>SO<sub>4</sub> / H<sub>3</sub>PO<sub>4</sub>*

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(b) Mechanism:



Award M3 (C-Cl) independently  
 M1 and M2 must be to / from correct places



E1 mechanism possible in which M2

Name: of mechanism = elimination (1)

NOT dehydrohalogenation

Ignore "base" OR "nucleophilic" before elimination

Reason: Reaction 2 has (very) low yield (1)

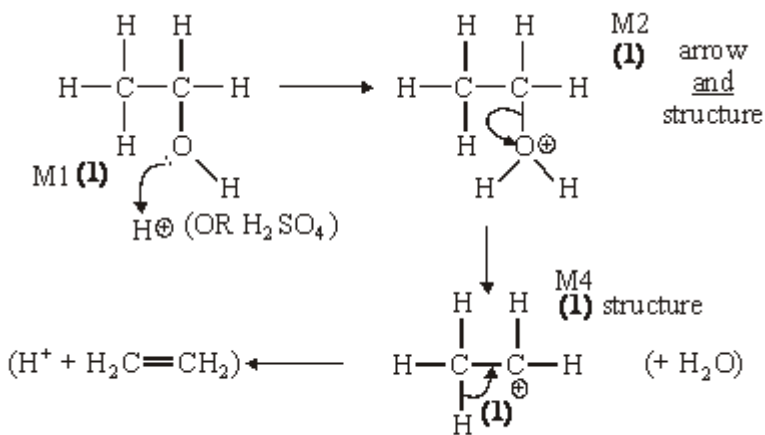
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QoL OR chloroethane has to be made (from ethane)

OR chloroethane is expensive

OR chloroethane is not readily available

(c) Mechanism:



(M3 could be awarded on protonated alcohol) M3

Name of mechanism = elimination (1)

NOT dehydration alone

Reason: Ethanol could come from (fermentation of) renewable

QoL sugars / glucose / carbohydrates / sources (1)

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[15]

M5.B

[1]

- M6. (a) M1 fermentation 1
- M2 dehydration or elimination 1
- (b) (i) yeast OR zymase OR an enzyme 1
- (ii) concentrated sulphuric or phosphoric acid  
*(penalise aqueous or dilute as a contradiction)* 1
- (c) (i) primary or 1° 1
- (ii) sugar or glucose or ethanol is renewable  
OR ethanol does not contain sulphur-containing impurities  
OR ethanol produces less pollution or is less smoky or less CO/C  
*(the objective is a positive statement about ethanol)*  
*(penalise the idea that ethanol is an infinite source or vague statements that ethanol has less impurities)* *(penalise the idea that ethanol produces no pollution)* 1
- (d)  $C_2H_6 \rightarrow C_2H_4 + H_2$  1
- (e) Addition  
*(ignore self or chain as a preface to "addition")*  
*(penalise additional)* 1

[8]

**M7.D**

**[1]**