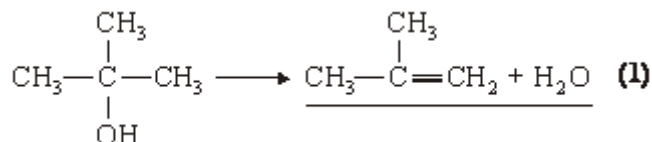


M1. (a) (i) 2-methylpropan-2-ol (1) OR the second one

(ii) Dehydrating agent: $\text{conc H}_2\text{SO}_4$ OR $\text{conc H}_3\text{PO}_4$ OR Al_2O_3 (1)
 ignore additional (aq)



Equation:

Allow $\text{C}_4\text{H}_9\text{OH}$ in equation provided RHS is correct

if b(i) is blank, b(ii) equation must be full for credit

i.e. NOT $\text{C}_4\text{H}_9\text{OH}$

Mark consequential on b(i)

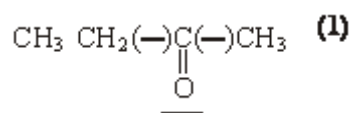
3

(b) (i) Isomer: butan-2-ol OR the fourth one

[look at name in table]

wrong isomer = CE

Structure of the ketone:



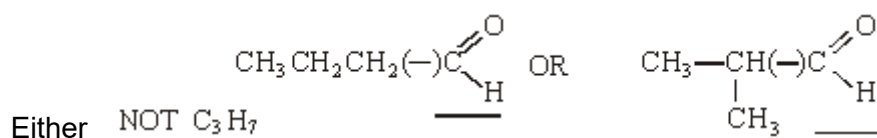
(ii) Isomer: butan-1-ol OR the first one

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

Other include(*)

K₂Cr₂O₇ / H₂SO₄

KMnO₄/H₂SO₄

Schiff's

Benedict's

Wrong reagent R

No reagent = CE

Penalise AgNO₃ [Ag(NH₃)₂] but allow M2 and M3 sequentially.

(*) K ₂ Cr ₂ O ₇ / H ₂ SO ₄ acidified	<u>ketone</u>	<u>aldehyde</u>
	orange no change	green
KMnO ₄ /H ₂ SO ₄ acidified	purple no change	colourless (v. Pale pink)

Benedict's ≡ *Fehling's* ; *Schiff's* colourless → pink with CHO
violet

7

(c) *Equation:* CH₃CH₂CH₂CH₂OH (or C₄H₉OH) + 2[O] → CH₃CH₂CH₂COOH
(or C₃H₇COOH) + H₂O **(1)**

Name of product: butanoic acid **(1)**

Accept butaneic acid

2

[12]

M2. (a) (i) addition of water / steam (1)
Ignore "to the reaction"

(ii) *Advantage:* low technology
renewable feedstock / resource
allowed for use in drinks, perfumes
considered to be green (1)

any one
NOT "infinite" or "non-finite" resource

Disadvantage:

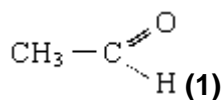
slow
low yield
significant land use
has to be distilled
labour intensive

any one
Ignore yeast
NOT (unqualified) batch production
NOT impure product

3

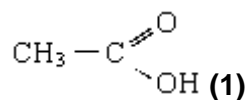
(b) (i)

Structure of aldehyde



NOT CH₃CHO

Structure of carboxylic acid



NOT CH₃COOH

Penalise incorrect R group once

(ii) *Reagent:* sodium (*/* potassium) dichromate (VI)
(VI not essential) (1) M1

Conditions: acidified or sulphuric acid (1) **Can be with reagent M2**
(heat under reflux) (1) **M3**

Or correct formula for M1 and M2

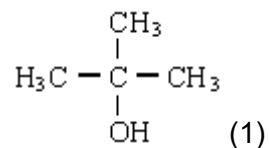
M2 depends on M1 (but M2 correct from Cr₂O₇²⁻, K₂Cr₂O₇²⁻ etc

M3 mark independent

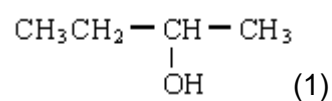
Credit KMnO₄ for M1

Ignore T and P for M2

(c) (i)



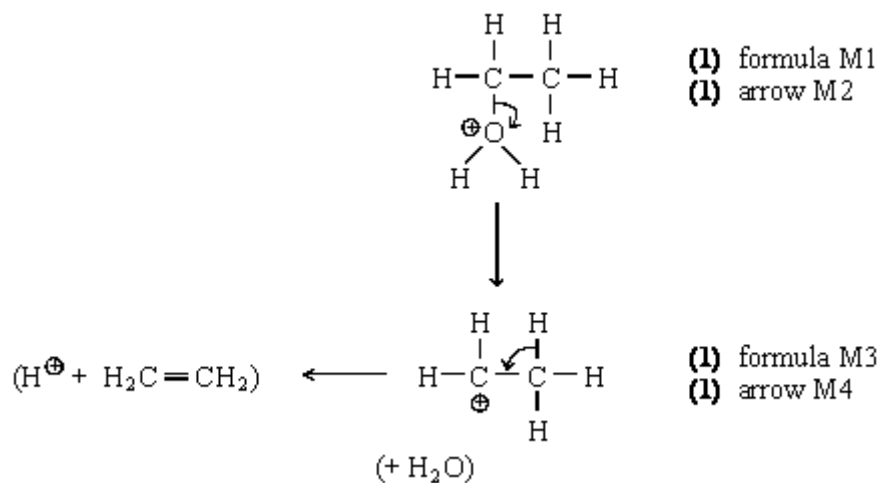
(ii)



2

(d) (i) Al_2O_3 or H_2SO_4 or H_3PO_4 (1)
Name or formula

(ii)



For M1 the + can be on O or H if - OH_2 used
 For M2 the arrow must go to the + or to oxygen
 Synchronous loss without carbocation loses carbocation
 structure mark; can still score $\frac{3}{4}$ i.e. penalise M3

5

[15]

M3.B

[1]

M4. (a) % O = 21.6 % (1)

If % O not calculated only M2 available

$$\begin{array}{ccc} \text{C} \frac{64.9}{12} & \text{H} \frac{13.5}{1} & \text{O} \frac{21.6}{16} \quad (1) \\ = 5.41 & = 13.5 & = 1.35 \end{array}$$

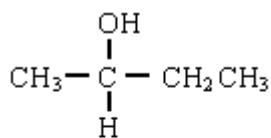
Ratio: 4 : 10: 1 (\therefore C₄H₁₀O) (1)

If arithmetic error in any result lose M3

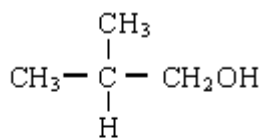
If percentage composition calculation done zero

3

(b) (i) Type of alcohol: Tertiary (1)
Reason: No hydrogen atom on central carbon (1)



(1)

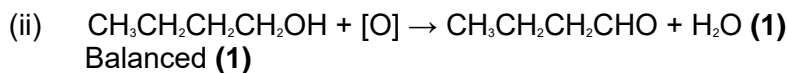


(1)

(ii) *Isomer 3* *Isomer 4*
Penalise missing bonds / incorrect bonds once per paper

4

(c) (i) Aldehyde (1)
*Ignore named aldehydes or their structures,
penalise wrong named compound*

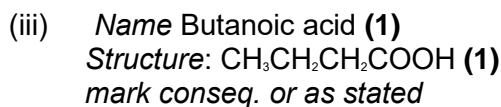


$\text{C}_4\text{H}_{10}\text{O}$ is OK as a reactant

$[\text{O}]$ can be over arrow

$\text{C}_3\text{H}_7\text{CHO}$ not accepted for product, but $\text{C}_2\text{H}_5\text{CH}_2\text{CHO}$ is OK

If use C_3 or C_5 compounds no marks in (ii) C.E of wrong alcohol



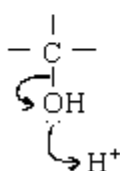
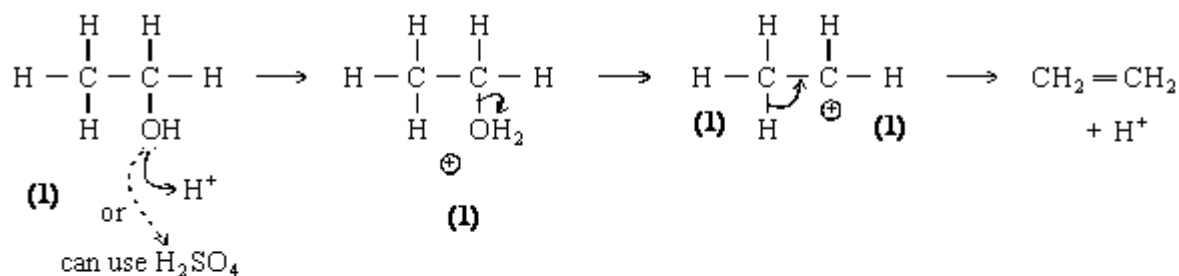
5

- (d) *Advantage*: Fast reaction OR pure product OR continuous process
OR cheap on manpower OR high yield, 100% alcohol (1)
Disadvantage: High technology OR ethene from non renewable source
OR expensive equipment not just costly (1)

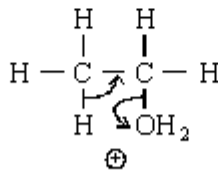
Not answers based on fermentation

2

(e)



scores M1 only



scores M2 & M4
but not carbocation mark, M3.

4

[18]

