M1. (a) **M1** Concentrations of reactants and products remain constant

For M1
NOT "equal concentrations"
NOT "amount"

1

M2 Forward rate = Reverse / backward rate

Credit the use of [ ] for concentration
Ignore dynamic, ignore closed system

1

(b) **M1** The (forward) reaction / to the right is exothermic or releases heat OR converse for reverse reaction.

1

M2 The equilibrium responds by absorbing heat / lowering temperature
OR
Promotes the endothermic reaction by absorbing heat / lowering temperature
OR
Temperature increase is opposed (by shift to the left)
OR
Change is opposed by absorbing heat / lowering temperature.

1

(c) (i) A substance that speeds up / alters the rate but is unchanged at the end / not used up.

Both ideas needed
Ignore references to activation energy and alternative route.

1

(ii) None OR no change OR no effect OR nothing OR Does not affect it / the position (of equilibrium) OR (The position is) the same or unchanged.

1

(d) (i) An activity which has no net / overall (annual) carbon emissions to the atmosphere
OR
An activity which has no net / overall (annual) greenhouse gas emissions to the atmosphere.
OR
There is no change in the total amount of carbon dioxide /

carbon /greenhouse gas present in the atmosphere.

The idea that the carbon / CO_2 given out equals the carbon / CO_2 that was taken in

Ignore carbon monoxide

1

(ii) A method which shows (see below) OR states in words that two times the first equation + the second equation gives the correct ratio.

$2\ (CH_4 + H_2O \rightarrow CO + 3H_2)$

$CH_4 + CO_2 \rightarrow 2CO + 2H_2$

$3CH_4 + 2H_2O + CO_2 \rightarrow 4CO + 8H_2$

Ratio = 1 : 2

1

[8]

M2. (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) <u>one double bond</u>

OR

Contains C=C;

(must be a positive statement)

1

(iii) M1: Bromine water

OR

Br_2(aq)

OR

Bromine

OR

Br_2;

(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 $KMnO_4$ 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]

M3. (a) (i) <u>addition</u> 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

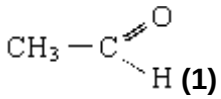
Disadvantage:
slow
low yield
significant land use
has to be distilled
labour intensive

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

3

(b) (i)

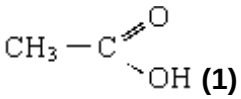
Structure of aldehyde



(1)

NOT CH_3CHO

Structure of carboxylic acid



(1)

NOT CH_3COOH

Penalise incorrect R group once

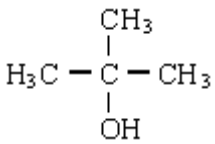
(ii) *Reagent*: sodium (/ potassium) dichromate (VI)
(VI not essential) (1) M1

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 $Cr_2O_7^{2-}$, $K_2Cr_2O_7^{2-}$ etc
M3 mark independent
Credit $KMnO_4$ for M1
Ignore T and P for M2

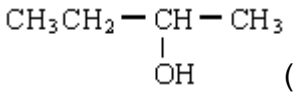
5

(c) (i)



(1)

(ii)



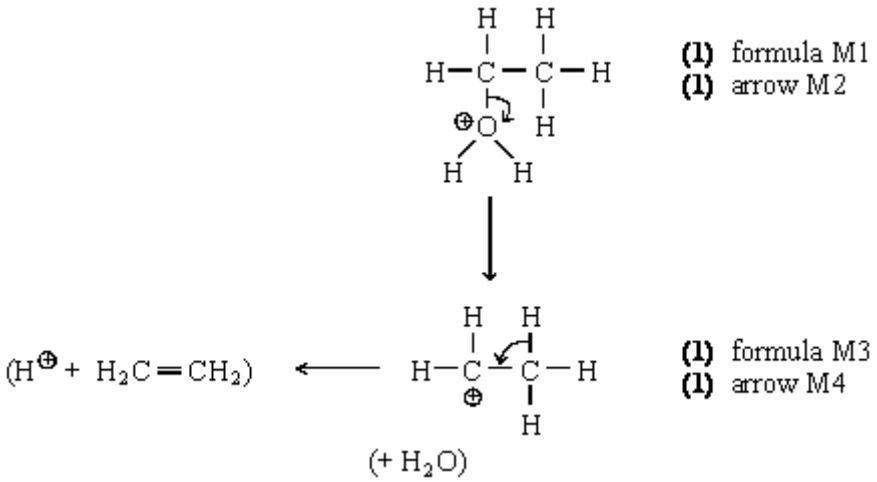
(1)

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 ¾ i.e. penalise M3

5

[15]

M4. (a) M1 fermentation

1

M2 dehydration or elimination

1

(b) (i) yeast OR zymase OR an enzyme

1

(ii) <u>concentrated</u> 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 <u>less</u> pollution or is <u>less</u> smoky or <u>less</u> 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]