2.10 ALCOHOLS EXTRA QUESTIONS MS

1. (a) $C_4H_8O \rightarrow C_5H_9NO$

Mr = 72 **(1)** Mr = 99 **(1)**

If MF shown lose 1 for wrong Mr.

If no MF shown max 2 if Mr wrong

$5g \rightarrow \frac{5}{72} \times 99$ **(1)** (= 6.88g)

64% yield = $0.64 \times \frac{5}{72} \times 99 = 4.40g$ **(1)**

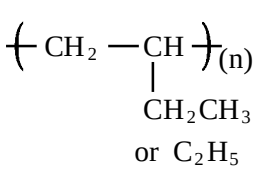
(allow answer 4.36 – 4.42) 4

(b) butanone has peak at ~ 1700 cm^{-1} **(1)**

(but not at ~ 3350 cm^{-1})

B has peak at ~ 3350 cm^{-1} **(1)**

(but not at ~ 1700 cm^{-1}) 4

(c)  **(1)** 1

or C_2H_5

[9]

2. *Catalyst* (c) phosphoric acid or (c) sulphuric acid **(1)**

Not dilute

accept correct formula

Conditions Temp = High or 200–500°C **(1)**

Temp = medium or moderate or 50-100°C

Pressure = High or 5–20 Mpa or 50–200 atoms

Pressure = High or 2–4 Mpa or 20–40 atoms

If. wrong, no catalyst given, allow phosphoric acid conditions

Equation $CH_2 = CH_2 + H_2O \rightarrow CH_3CH_2OH$

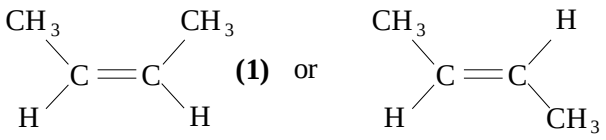
allow C_2H_4 *allow C_2H_5OH*

not CH_2CH_2 4

[4]

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

(b) (i) two H on carbon in double bond **(1)**

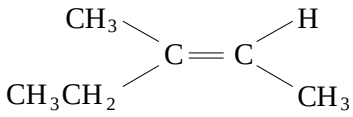
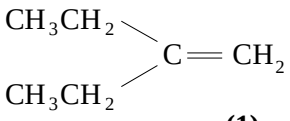
(ii)  **(1)** or

Z but-2-ene **(1)** E but-2-ene 3

[4]

4. (a) (i) 3-methylpentan-3-ol **(1)**

(ii) carbonium ion/carbocation **(1)**

(iii)  **(1)** 

(1)

C **(1)**

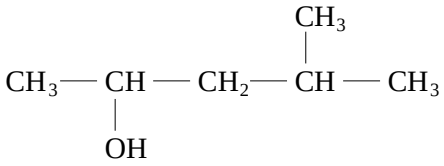
5

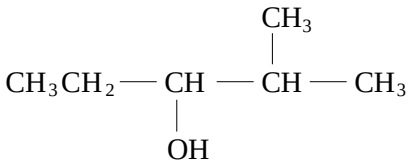
(b) lone pair **(1)**

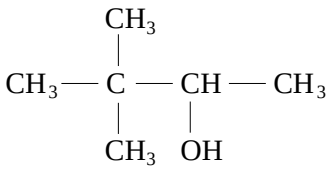
(c) (i) orange **(1)**

tertiary alcohol **(1)**
not oxidised **(1)**

(ii) two from:







(2x1) 5

[11]

5. (a) **A** = tertiary alcohol/ 3° **(1)**
B = secondary alcohol/ 2° **(1)** 2

(b) (2)-methylpropan-2-ol **(1)** 1

(c) (i) (selects isomer **C** and) gives suitable structure for butanal **(1)**
or
(selects isomer **D** and) gives suitable structure for
2-methylpropanal **(1)** 1

(ii) (sodium / potassium) dichromate / manganate VII **(1)**

acidic conditions / H^+ (this mark dependent on first mark) **(1)**
not HCl with $KMnO_4$

distill(ation) **not** reflux **(1)** 3

(d) (i) removal of water **(1)** 1

(ii) alkene / ether (**not** a named example) **(1)** 1

(iii) concentrated sulphuric acid / concentrated or solid phosphoric acid
(strong) heat / high temperature / 150 – 200 °C / reflux
or
suitable catalyst eg aluminium oxide / broken porcelain **(1)**
strong heat / high temperature / 300+ °C **(1)**

mark for conditions dependent on mark for reagents 2

(iv) (selects isomer **C** and) gives suitable structure for but-1-ene
(accept but-2-ene structure if primary to secondary carbocation rearrangement mentioned)
or
(selects isomer **A** or **D** and) gives suitable structure for
2-methylpropene **(1)**
also accept structures for ethers 1

(v) selects isomer **B** **(1)**

suitable structure for but-1-ene (mark independently of isomer chosen) **(1)**

suitable structure for but-2-ene (either cis or trans **not** both) **(1)**

dehydration 'involves the removal of OH and H to make water, and H can be
either from C_1 or from C_3 so two isomers formed **(1)** 4

[16]

6. (a) (i) *Equation*

(1)

$$CH_3CH_2CH_2CH_2OH + [O] \longrightarrow CH_3CH_2CH_2{-}C(=O)H + H_2O$$ **(1)**

Colour change orange → green

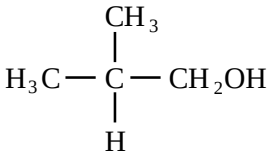
(ii) *Reagent* ammoniacal silver nitrate/Tollens **(1)**

Observation with oxidation product of butan-1-ol silver mirror **(1)**

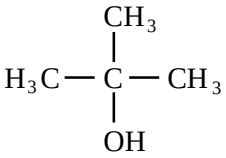
Observation with oxidation product of butan-2-ol no reaction **(1)** 6

(b) Butanoic acid **(1)** 1

(c) *Structure of isomer 1* *Structure of isomer 2*



(1)



(1)

Name of isomer 1 2-methylpropan-1-ol **(1)**

Name of isomer 2 2-methylpropan-2-ol **(1)** 4

[11]

7. (a) (i) Electron pair/ lone pair acceptor OR seeking/bonds with an electron pair 1
(insist on reference to a pair of electrons)

(ii) M1 curly arrow from middle of C=C bond of the alkene towards/ alongside the H atom of the H-Br; 1
(penalise arrows which go towards one of the carbon atoms)
(ignore a partial negative charge on the C=C)

M2 curly arrow from H-Br bond to side of Br atom; 1
(penalise M2 if there are formal charges on HBr or if there are partial charges which are the wrong)
(penalise M2 if the single bond has two dots in addition to the line)

M3 correct structure for carbocation; 1
(penalise M3 if the positive charge is placed on the end of a bond)
(penalise M3 if any alkene other than ethene is used - all other marks can score)

M4 curly arrow from lone pair on bromide ion to the positive carbon of carbocation, ensuring that bromide ion has a negative charge; 1

(b) (i) M1: potassium cyanide OR KCN OR sodium Cyanide OR NaCN; 1
(ignore conditions - dissolved in (aq) or (alc) or KOH(aq) all work) (penalise HCN)

M2: propanenitrile; 1
(credit propan-1-nitrile OR propan nitrile, but not propanitrile)

(ii) M1: ammonia OR NH_3; 1
(If formula is written, insist that it is correct)
(ignore conditions, but penalise acidic)

M2: ethylamine; 1
(credit aminoethane)

(iii) M1: curly arrow <u>from lone pair</u> on nitrogen of (correct formula for) ammonia towards/alongside C atom of C-Br; 1

(penalise M1 if formula of ammonia is wrong or has a negative charge or has no lone pair or arrow is from negative charge)

M2: curly arrow <u>from C-Br bond</u> towards/alongside side Br atom; 1

(credit M2 independently)
(penalise M2 if formal positive charge on C atom of C-Br)

M3: correct structure of the ethylammonium ion; 1

(credit the structure drawn out with all four bonds around the nitrogen atom OR written as $C_2H_5NH_3^+$ OR $CH_3CH_2NH_3^+$)

M4: curly arrow <u>from the middle of one of the H-N bonds</u> towards the positive <u>N atom</u>; 1

(possible to credit M4 on an incorrect ethylammonium ion with no positive charge)
(ignore use of ammonia or bromide ion etc. to remove proton from ethylammonium ion)
(If the wrong haloalkane is used, award MAX. 3 marks for the mechanism) (If S_N1 mechanism is used, give full credit in which M1 is for a curly arrow from the lone pair of the N atom of (correct formula for) ammonia towards/alongside the positive carbon atom of $CH_3CH_2^+$)

[17]

8. (a) *Reagents* H_2SO_4 <u>or</u> H_3PO_4 <u>or</u> Al_2O_3 **(1)**

Name of mechanism elimination **(1)**

Mechanism

(b) *Type of isomerism* geometrical <u>or</u> cis-trans **(1)**

Explanation restricted rotation <u>or</u>
double bond rigid **(1)** 2

[4]

9. (a) electrophilic addition 1

M1: curly arrow <u>from C=C</u> bond towards/alongside the side of H atom on H_1OSO_2OH 1
(penalise M1 if arrow to H_2SO_4 OR to formal charge on H of H_1O bond)
(ignore partial charges on H and O of H_2SO_4, but penalise if these are incorrect on the H atom being attacked)
(credit M1 and M2 if correct curly arrow to H+ provided the anion is present)

M2: curly arrow from <u>H–O bond</u> towards/alongside the side of the O atom on $H–OSO_2OH$ 1
(credit the arrow even if there are partial or formal charges on H and O but the structure of H_2SO_4 is correct)

M3: correct structure of the carbocation 1
(penalise use of 'sticks' in this structure)
M4: curly arrow <u>from lone pair on an individual oxygen atom</u> of (correct formula for) hydrogensulphate ion towards/alongside C atom bearing the positive charge 1
(insist that the an ion has the correct formula with a lone pair of electrons and a negative charge)

(b) (i) ethanal 1
correct structure for ethanal 1
(aldehyde functional group must be drawn out)

(ii) oxidation or redox 1

[8]

10. (a) (i) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ 1
(Or CH_3CH_2OH)
(Ignore state symbols in the equation)

(ii) Fermentation 1

(b) (i) $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ 1
(Or C_2H_6O or CH_3CH_2OH)

(ii) CO or carbon monoxide or C or carbon ONLY 1

(iii) $2CO + 2NO \rightarrow 2CO_2 + N_2$
OR $2NO \rightarrow N_2 + O_2$
OR $2NO + C \rightarrow N_2 + CO_2$
OR $C_8H_{18} + 25NO \rightarrow 8CO_2\ 12½N_2 + 9H_2O$ 1
(In equation 2, allow additional O_2 on both sides of the equation)

(c) Elimination 1
(Penalise additional words such as "electrophilic")

[6]

11. *Step 3*

dehydration <u>or</u> elimination **(1)**

H_2SO_4 <u>or</u> H_3PO_4 <u>or</u> $A1_2O_3$ **(1)** 2

[2]

12. (a) % O = 21.6 % **(1)**

If % O not calculated only M2 available

C $\frac{64.9}{12}$ H $\frac{13.5}{1}$ O $\frac{21.6}{16}$ **(1)**

= 5.41 = 13.5 = 1.35

Ratio: 4 : 10: 1 ($\therefore C_4H_{10}O$) **(1)**

If arithmetic error in any result lose M3

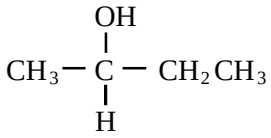
If percentage composition calculation done zero

3

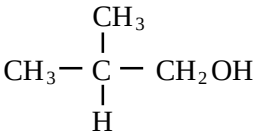
(b) (i) *Type of alcohol*: Tertiary **(1)**

Reason: No <u>hydrogen</u> atom on <u>central</u> <u>carbon</u> **(1)**

(ii)



(1)



(1)

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

(ii) $CH_3CH_2CH_2CH_2OH + [O] \rightarrow CH_3CH_2CH_2CHO + H_2O$ **(1)**

Balanced **(1)**

$C_4H_{10}O$ is OK as a reactant

[O] can be over arrow

C_3H_7CHO not accepted for product, but $C_2H_5CH_2CHO$ is OK

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

(iii) *Name* Butanoic acid **(1)**

Structure: $CH_3CH_2CH_2COOH$ **(1)** 5

(d) *Advantage*: Fast reaction OR pure product OR continuous process OR cheap 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

[14]

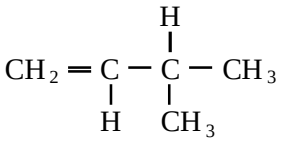
13. (i) 3-methylbutan-2-ol **(1)**
No alternatives

(ii) elimination or dehydration **(1)**

(iii) (c) H_2SO_4 or (c) H_3PO_4 – name or correct formula **(1)**

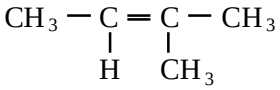
(iv)

Alkene 1



(1)

Alkene 2



(1)

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

5

[5]

14. (i) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$; 1
(penalise C_2H_6O once only in this question)

(ii) Concentrated H_2SO_4 OR concentrated H_3PO_4 OR $A1_2O_3$; 1
(penalise aqueous or dilute as a contradiction)

$C_2H_5OH \rightarrow C_2H_4 + H_2O$ OR $C_2H_5OH \rightarrow H_2C = CH_2 + H_2O$; 1
(penalise $CH_2{\cdot}CH_2$ and CH_2-CH_2 and $CH_2{:}CH_2$ for ethene)

[3]

15. (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

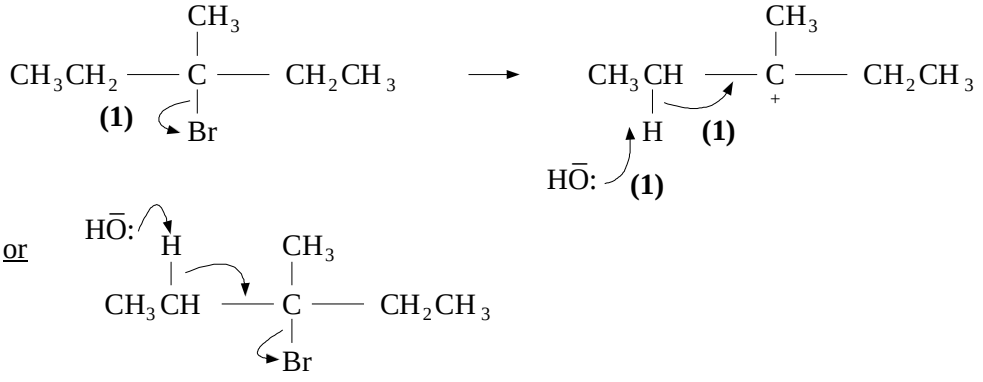
[4]

16. (a) (i) nucleophilic substitution **(1)**

(ii) tertiary alcohol or no H atom available **(1)** 2

(b) *Name of mechanism* elimination **(1)**

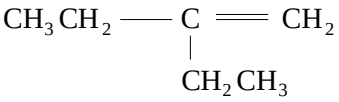
Mechanism



or

4

(c) *Structure*



(1)

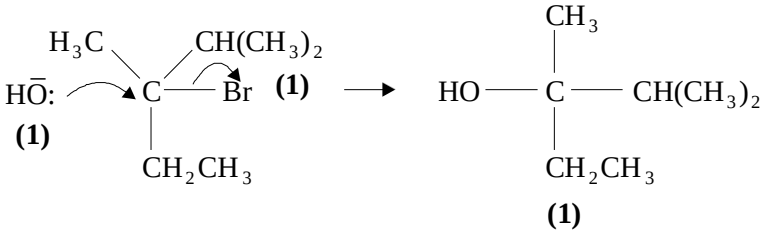
Name 2-ethylbut-1-ene **(1)** 2

[8]

17. (i) substitution or hydrolysis **(1)**

nucleophile **(1)**

(ii)



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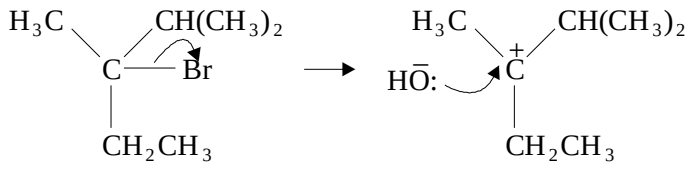


(iii) tertiary or no C–H **(1)** 6

[6]

18. (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 1
(penalise aqueous or dilute as a contradiction)

(c) (i) primary or 1° 1

(ii) sugar or glucose or ethanol is renewable 1
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)

(d) $C_2H_6 \rightarrow C_2H_4 + H_2$ 1

(e) Addition 1
(ignore self or chain as a preface to "addition ")
(penalise additional)

[8]

19. (a) (i) $CH_3\,CH_2\,CH_2\,CH_2\,CH_2\,OH + [O] \rightarrow CH_3\,CH_2\,CH_2\,CH_2\,CHO + H_2O$ **(1)**
*(equation balances **(1)**)*

allow $C_4\,H_9\,CH_2\,OH$ *product must show aldehyde group*
or $C_5\,H_{11}\,OH$ *e.g. C4 H9 CHO*
If ketone shown here, allow balance

If wrong alcohol used, allow balance

(ii) $CH_3\,CH_2\,CH_2\,CH(OH)CH_3 + [O] \rightarrow CH_3\,CH_2\,CH_2\,COCH_3 + H_2O$ **(1)**
*(equation balances **(1)**)*

allow $C_3\,H_7\,C(OH)\,CH_3$ *product must show CO in ketone*
or $C_5\,H_{11}\,OH$ *e.g. $C_3\,H_7\,COCH_3$*

If aldehyde show here, allow balance

If wrong alcohol used, allow balance 4

(b) Fehling's solution or Tollen's reagent or Potassium dichromate **(1)**

⟵ Boil, heat, warm ⟶ ammoniacal silver nitrate
Conditions tied to reagent

orange or brown or red precipitate or solid etc

or silver mirror grey/black precipitate of solid

or (orange) turns green or blue
observation tied to reagent

4

No precipitate

or no silver mirror

or no colour change **(1)**

or no reaction ⟶

Not "nothing"

If no reagent or wrong reagent quoted, mark as 'CE'

Any appropriate reagent - e.g. - Benedicts, but if $Cr2O_7^{2-}$ or $[Ag\ CNH_3)_2]^+$

or MnO_4^- given, do not allow reagent mark.

[8]

20. (a) M1: $CH_3CH_2CH_2CH_2OH$; 1

M2: $CH_3CH(OH)CH_2CH_3$; 1

(penalise incorrect alcohols in part (a), but mark consequentially in part (b) and in part (c), if relevant)
(if three alcohols drawn, award MAX. 1 mark)

(b) M1, M2 and M3: Correct structures for butanal, butanone and butanoic acid; 3

(award these structure marks wherever the structures appear, but insist that the C=O is shown in each structure and additionally, the C-O in the carboxylic acid

M4: balanced equation for the reaction of butan-1-ol with [O] to produce butanal and water; 1

M5: balanced equation for the reaction of butan-1-ol with [O] to produce butanoic acid and water

OR

balanced equation for the reaction of butanal with [O] to produce butanoic acid; 1

M6: balanced equation for the reaction of butan-2-ol with [O] to produce butanone and water; 1

(Credit condensed structures or molecular formulas in each equation, provided it is obvious to which reaction the equation refers) (Insist that whatever formula is used in each equation that it is a conventional representation of the compound; for example penalise $CH_3CH_2CH_2COH$ for butanal)

(c) M1: Correct structure for 2-methylpropan-2-ol; 1

M2: 2-methylpropan-2-ol

OR

methylpropan-2-ol; 1

(penalise on every occasion in parts (a) and (c), structures for the alcohols that are presented with the alcohol functional group as C-H-O)

[10]

21. (a) $K_2Cr_2O_7/H_2SO_4$ reduced by

$CH_3CH_2CH_2CH_2OH$ **(1)**

oxidised to $CH_3(CH_2)_2CHO$ **(1)**
and $CH_3(CH_2)_2COOH$ **(1)**

$CH_3CH_2CH_2CHO$ **(1)**

oxidised to $CH_3(CH_2)_2COOH$ **(1)**

Equation: $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ **(1)** 6

Note: Deduct one if all three compounds given as reducing agents.

(b) Tollens' reduced by

$CH_3CH_2CH_2CHO$ **(1)**

oxidised to $CH_3(CH_2)_2COOH$ **(1)**

Equation $[Ag(NH_3)_2]^+ + e^- \rightarrow Ag + 2NH_3$ **(1)** 3

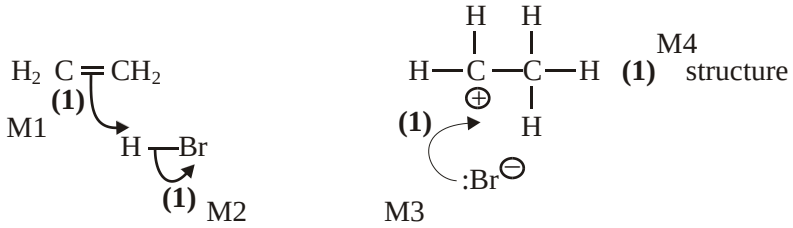
[9]

22. (a) Reaction 1 H_2O or steam **(1)**

Reaction 5 NH_3 **(1)** 2

For Reaction 4; credit dil H_2SO_4 OR H_2SO_4(aq) OR HCl (aq) but NOT steam and NOT NaOH(aq)

(b) 4



Penalise M2 incorrect δ+ / δ–

Penalise δ– on alkene (M1)

Penalise dots on bonds <u>once</u>

Penalise M4 (structure) for use of wrong alkene

Penalise M1 for use of Br_2

(c) Water OR aqueous solution OR (aq) in equation **(1)** M1

Yeast OR enzyme/zymase OR T ≤ 45°C M2

but T not below 20°C and allow warm

N.B. yeast and T=60° ✗ con

Ignore pH

Ignore anaerobic / oxygen

Ignore time

Ignore pressure

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH$ (or CH_3CH_2OH) + $2CO_2$ M3

Allow $C_{12}H_{22}O_{11}$ if balanced equation

M4 <u>OR</u> M5 needs the use of good English <u>and</u> correct chemistry to gain credit

M4: The rate of fermentation is slow<u>er</u> **(1)**
OR The rate of hydration is fast<u>er</u>
QoL OR (The rate of) fermentation is slow <u>and</u>
(the rate of) hydration is fast
reference <u>correctly</u> to time rather than rate gains credit

M5: The product of fermentation is <u>less pure</u> or low<u>er</u> purity
OR The product of hydration is more pure or high<u>er</u> purity
OR The product of fermentation is impure <u>and</u> that of hydration is pure
OR Specific reference to 10–15% versus 90–100%
OR correct reference to higher or lower yield 5

[11]

23.

CH_3CH_2Br **(1)**

↓ NaOH **(1)** aqu or warm **(1)**
nucleophilic substitution **(1)**

CH_3CH_2OH **(1)**

↓ $K_2Cr_2O_7$ H_2SO_4
Reflux **(1)**

CH_3COOH

$CH_3CH_2OH + 2[O] \rightarrow CH_3COOH + H_2O$ **(1)**

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24. (a) $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ **(1)**

Initiation: $Cl_2 \rightarrow 2Cl\cdot$ **(1)**

Propagation: $CH_4 + Cl\cdot \rightarrow CH_3\cdot + HCl$ **(1)**
$CH_3\cdot + Cl_2 \rightarrow CH_3Cl + Cl\cdot$ **(1)**

Termination: $CH_3\cdot + Cl\cdot \rightarrow CH_3Cl$ **(1)**
or $CH_3\cdot + CH_3\cdot \rightarrow C_2H_6$ 5

(b) Hydration: H_3PO_4 **(1)**
300°C **(1)**
65 atmos **(1)**

Fermentation: yeast **(1)**
35°C **(1)**
air free **(1)**

Advantages: Two from
faster/purer product/continuous process
(cheaper on manpower) **(2)**

Disadvantage: ethene is non-renewable resource **(1)** 9

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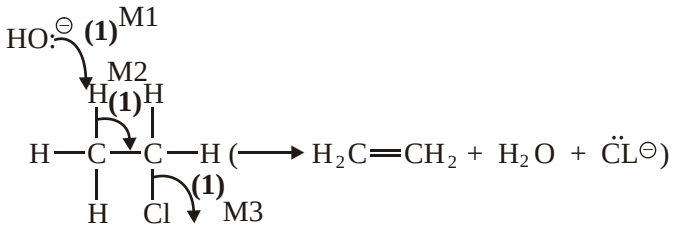
25. (a) Reaction 2: NaOH OR KOH **(1)** M1 alcohol (ic) OR ethanol (ic)**(1)** M2
ignore heat

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

Reaction 3: concentrated H_2SO_4 OR H_3PO_4 M1 **(1)** heat **(1)** M2
OR 150°C - 200°C 4

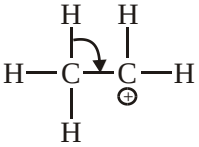
Condition mark linked to correct reagent but award M2 if H_2SO_4 or H_3PO_4, but not concentrated
Penalise reagent and condition if dilute H_2SO_4 / H_3PO_4

(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)** 5
QoL OR chloroethane has to be made (from ethane)
OR chloroethane is expensive
OR chloroethane is not redily available

(c) Name of mechanism = elimination **(1)**
NOT dehydration alone

Reason: Ethanol could come from (fermentation of) renewable 2
*QoL sugars / glucose / carbohydrates / sources **(1)***

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26. (a) **A –** alkene **(1)**

B – halogenoalkane / bromoalkane / alkyl halide / haloalkane **(1)**

C – alcohol (ignore primary, secondary) **(1)** 3

(b) (i) addition ignore nucleophilic / electrophilic / free radical **(1)** 1

(ii) substitution **not** replacement / displacement **(1)** 1

(iii) oxidation **not** reduction; **not** redox; allow dehydrogenation **(1)** 1

(c) Sodium hydroxide / NaOH / KOH **not** just hydroxide **(1)**

(**B** to **C**) aqueous **not** dilute **(1)**
(**B** to **A**) alcoholic **(1)**

mark alternatives as (d)
ignore references to concentration and temperature 3

(d) sodium (or potassium) dichromate / $Na_2Cr_2O_7$ **or** **(1)**
named alkali **or** water **or** aqueous

sulphuric acid / H_2SO_4
ignore dilute / concentrated **(1)**
allow HCl, H_3PO_4, HNO_3

allow $KMnO_4$ with H_2SO_4 / H_3PO_4 / HNO_3 **not** HCl
allow 1 mark for acidified dichromate or dichromate / H^+

heat / reflux / boil / warm / temperature 40°C → 100°C **(1)**
this mark dependent on 'dichromate' or 'manganate' 3

(e) (i) $CH_3CH(CH_3)Br + NaOH \rightarrow CH_3CH{=}CH_2 + NaBr + H_2O$ **(1)**

(ii) $CH_3CH(CH_3)Br + NaOH \rightarrow CH_3CH(CH_3)OH + NaBr$ **(1)**

allow molecular formulae C_3H_7Br; C_3H_8O; C_3H_6
allow ionic versions (with OH^-, Br^-) 2

(f) arrow from O of OH^- to C joined to Br **(1)**
lone pair not needed

C–Br polarity shown by $\delta+$ $\delta-$ **or**
heterolytic fission of C–Br bond shown by arrow from bond between C and Br to Br **or**
intermediate with partial bonds and minus sign **(1)**

Br^- as product **(1)**

allow all 3 marks if 1-bromopropane identified as **B** 3

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