EXAM PAPERS PRACTICE

Boost your performance and confidence with these topic-based exam questions

Practice questions created by actual examiners and assessment experts

Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

Time allowed
234 Minutes

Score /195

Percentage %

CHEMISTRY

OCR AS & A LEVEL

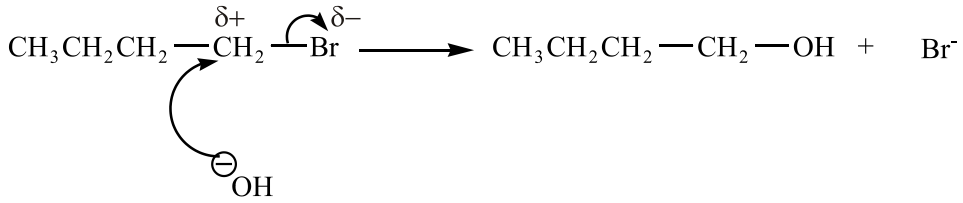
Mark Scheme

Module 4: Core organic chemistry

1. (i) substitution/hydrolysis **(1)** 1

(ii) electron pair donor **(1)** 1

(iii)



correct dipole **(1)**
curly arrow from the O in the OH- to C in the CH_2 **(1)**
curly arrow to show movement of bonded pair in the C–Br bond **(1)**
Br^- as a product **(1)** 4

[6]

2. (i) Any two realistic fragments,
e.g. CH_3^+: 15; $C_2H_5^+$: 29; $C_3H_7^+$: 43; $C_4H_9^+$: 57; OH^+: 17, *etc*. **(1) (1)**
Do not penalise missing charge. 2

(ii) breathalysers/monitoring of air pollution, MOT emission testing, *etc*. **(1)** 1

[3]

3. **Availability of starting materials:**

availability

sugar is renewable because it can be grown **(1)**
ethane is finite because it is obtained by processing of crude oil **(1)**

energy:

fermentation: energy is required for distillation/
hydration: energy is required to generate steam **(1)**

atom economy and waste products:

atom economy for fermentation < atom economy hydration **(1)**
In fermentation, CO_2 is produced in addition to ethanol/ethanol is not the only product **(1)**
In hydration, ethanol is the only product/hydration is an addition reaction (1)
Atom economy of fermentation could be increased by finding a use CO_2 (1)

Atom economy linked to a chemical equation to show that hydration has 100% atom economy/fermentation has 51% atom economy **(1)** 7max

[7]

4. (a) (i) (volatile components) can escape/distil out **(1)**
ethanal is most volatile/bpt less than 60 °C/partial oxidation **(1)** 2

(ii) (volatile components) cannot escape/ refluxed **(1)**
complete oxidation will be achieved/oxidised to the acid **(1)** 2

(b) $C_2H_5OH + 2[O] \rightarrow CH_3COOH + H_2O$
C_2H_5OH, 2[O] and CH_3COOH **(1)**
rest of equation **(1)** 2

[6]

5. (i) $C_6H_{12}O_6$ (aq) $\rightarrow 2C_2H_5OH(l)$ or (aq) $+ 2CO_2(g)$ balanced equation 1
state symbols can be awarded only if equation shows $C_6H_{12}O_6$,
C_2H_5OH and CO_2 1

(ii) anaerobic, aqueous, temp range 25 – 40°C/warm to just above room temp 2

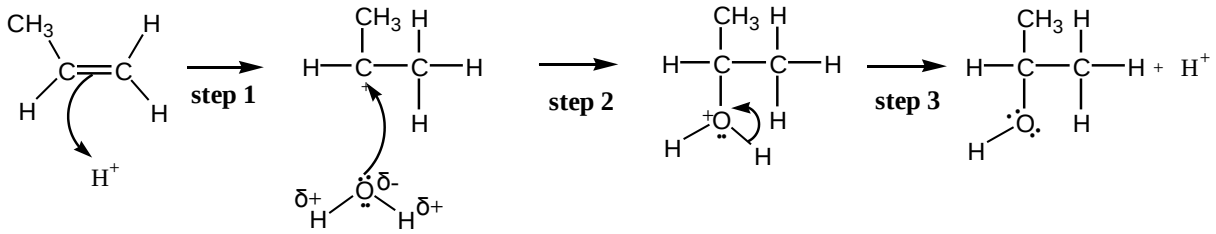
(iii) no more bubbles/gas/CO_2 1

[5]

6. (a) (i) phosphoric acid/H^+/sulphuric acid 1

(ii) lone/electron pair of electrons acceptor 1

(b) (i)



Step 1	curly arrow from π-bond to H^+	1
Step 2	curly arrow from lone pair on the $O^{\delta-}$ to C+	1
Step 3	curly arrow from O—H bond to O+	1

(ii) catalyst … no marks because it is **not** consumed/used up in the reaction/owtte 1

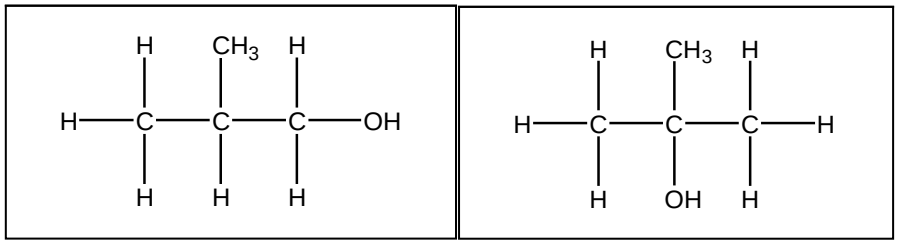
[6]

7. $CH_3CH(OH)CH_3 + 4½O_2 \rightarrow 3CO_2 + 4H_2O$ /C_3H_8O

(1 mark if correct formula for all four chemicals and 1 mark for correct balancing)

[2]

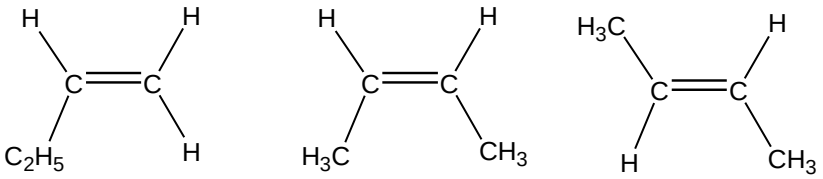
8. (i) 2



(ii) either (2-)methylpropan-1-ol or (2-)methylpropan-2-ol 1

[3]

9.



Minimum – must display/show C=C

[3]

10. (a) (i) H^+ 1

$Cr_2O_7^{2-}$ 1

(ii) Orange to green/black/blue 1

(b) (i) contains a C=O/aldehyde, ketone, carboxylic acid and ester/ carbonyl/carbonyl in an aldehyde — 1

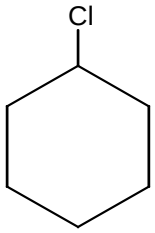
(ii) does **not** contain a O–H/ (hydrogen bonded in a) carboxylic acid — 1

(iii) distillation (no mark) **because** distillation allows loss of volatile components /removes butanal from oxidising mixture — 1

prevents formation of RCOOH/ partial oxidation would be achieved or reverse argument for reflux not being used in that reflux prevents loss of volatile components hence complete oxidation would be achieved/RCOOH would be formed ✓ — 1

[7]

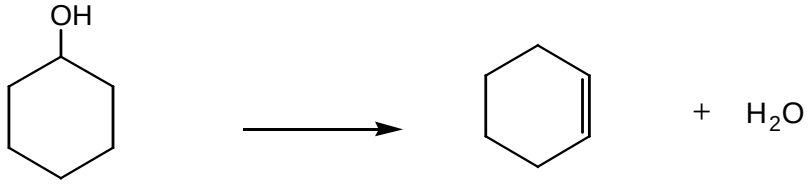
11. (a) (i) — 1



(ii) H_2SO_4/Al_2O_3/(hot) pumice/H_3PO_4 — 1

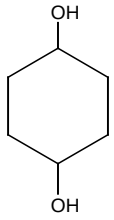
(H_2SO_4(aq) or dil H_2SO_4 loses the mark)

(iii) — 1



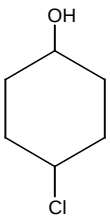
$C_6H_{11}OH$ / $C_6H_{12}O \rightarrow C_6H_{10} + H_2O$

(b) (i) — 1



diol

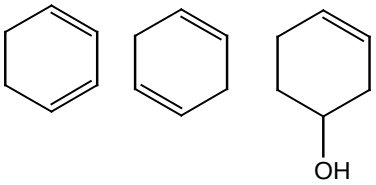
also allow



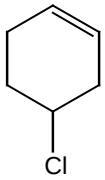
Cl-alcohol

(ii) 2

from the diol allow



from the Cl-alcohol allow



[6]

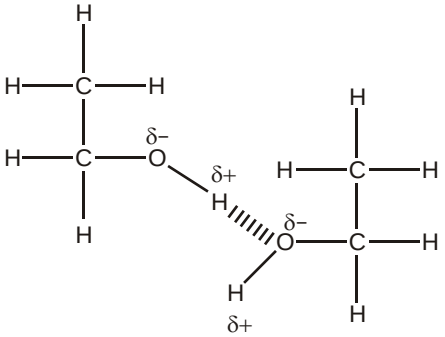
12. (i) *low volatility*, = **high** boiling point/ not easy to vapourise/owtte 1

intermolecular bonds. = bonds/forces/attractions **between** molecules 1

(ii) type of intermolecular bond = hydrogen bond 1

dipoles on both O-H bonds 1

H-bond shown as a 'dashed bond' 1



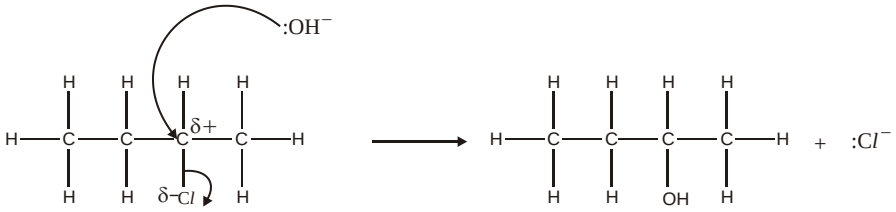
(iii) (The boiling point of glycerol will be higher than ethanol because there are)

more OH groups ∴ <u>more H-bonds</u> 1

[6]

13. (a) (i) butan-2-ol by name or by formula ✓ 1

(ii)



curly arrow from the O of the OH- to $C^{(\delta+)}$ ✓

curly arrow from C-C*l* bond to C*l* **and** correct dipoles ✓

correct products/ allow NaC*l* ✓

curly arrow from lone pair on :OH^- ✓

S_N1 route can still score all 4 marks:

curly arrow from C-C*l* bond to C*l* **and** correct dipoles ✓

curly arrow from the O of the OH^- to C+ ion ✓

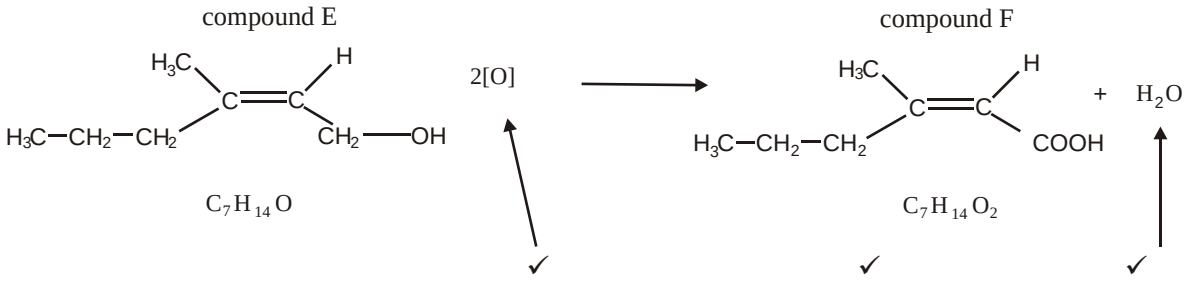
correct products/ allow NaC*l* ✓

curly arrow from lone pair on :OH^- ✓ 4

[5]

14. (i) H^+ ✓ $Cr_2O_7^{2-}$ 2

(ii)



3

(iii) carboxylic acid would have an absorption between 1680 – 1750 cm^{-1} /1700 cm^{-1} or 2500 – 3300 cm^{-1}. 1

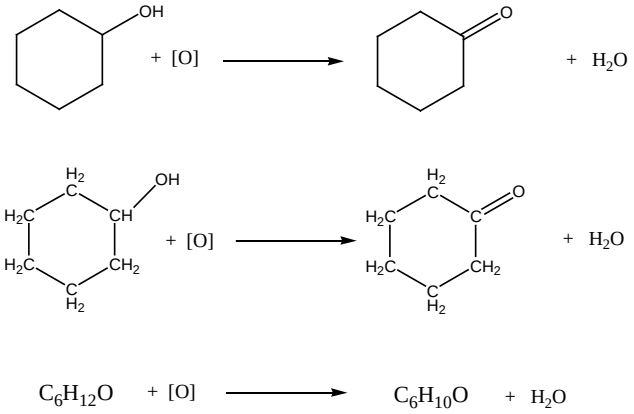
[6]

15. (a) (i) H_2SO_4 – any mention of (aq) loses the mark 1

(ii) any correct formula/structure or name for benzoic acid 1

(b) (i) dichromate/$Cr_2O_7^{2-}$/permanganate 1

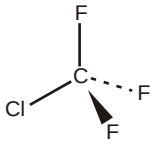
(ii) 1



$C_6H_{12}O$ + [O] → $C_6H_{10}O$ + H_2O

[4]

16. (i) 1



require an attempt at a 3D structure and bond angles must clearly not be 90°.

require at least one 'wedge' bond or one 'dotted' bond

(ii) 108 – 111° 1

(iii) volatile/low boiling/gas/non-toxic/non-flammable/unreactive/liquefied under pressure/inert 1

(iv) homolytic = bonded pair split <u>equally</u>/ each retains 1 electron 1

fission = <u>bond</u> breaking 1

(v) C-C*l* (no mark) because it is the <u>weaker bond</u> 1

(vi) C*l*• 1

•CF_3 (allow CF_3•) 1

(lack of 'dots' penalise once)

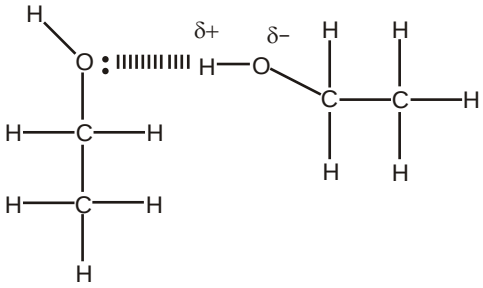
[8]

17. $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

(C_2H_5OH & CO_2 ✓)

[2]

18.



dipoles 1

hydrogen bond between O in one O-H and H in the other O-H 1

lone pair from O involved in the H-bond 1

[3]

19. (a) (i) (volatile components) can escape/distil out 1

ethanal is most volatile/b pt less than 60°C/partial oxidation 1

(ii) (volatile components) cannot escape/ refluxed 1

complete oxidation will be achieved/oxidised to the acid 1

(b) $C_2H_5OH + 2[O] \rightarrow CH_3COOH + H_2O$

($CH_3COOH + H_2O$ ✓) 2

(c) spectrum C 1

spectrum C only shows absorption at 1700 cm^{-1} for the C=O 1

the other two spectra contain the OH group absorption at approx 3000 cm^{-1} 1

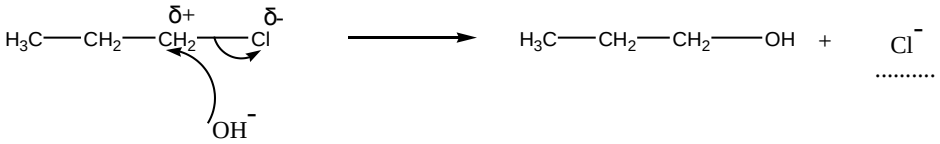
[9]

20. (a) (i) reaction 1 1

(ii) reaction 4 1

(iii) reaction 3 1

(b) (i) lone pair/electron pair donor 1



Correct dipole 1

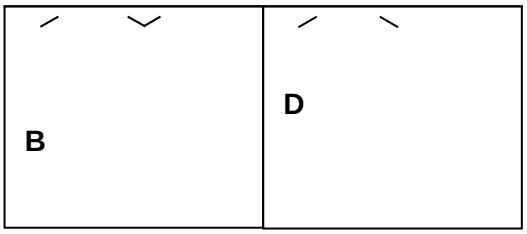
Curly arrow from the O in the OH^- to C in the CH_2 1

Curly arrow to show movement of bonded pair in the C-C*l* bond 1

C*l*$^-$ as a product 1

(c) (i) same molecular formula , different structure/arrangement of atoms. (same formula, different structure.) 2

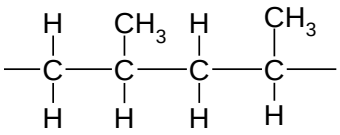
(ii) 2



(d) (i) addition, (not additional) 1

(ii) poly(propene)/ polypropene/ polypro-1-ene, polypropylene 1

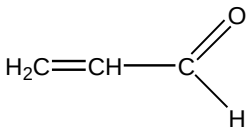
(iii) 1



[15]

21. (a) (i) prop-2-en-1-ol CH_2=$CHCH_2OH$ must show the C=C double bond 1

acrolein



***mus**t clearly show the aldehyde group and the C=C*

1

(ii) alkene/C=C double bond 1

(b) (i) acidified /H^+ 1

dichromate/$Cr_2O_7^{2-}$ 1

(ii) CH_2CHCH_2OH/ C_3H_6O/ $C_3H_5OH + [O] \longrightarrow CH_2CHCHO$/ C_3H_4O/ $C_2H_3CHO + H_2O$

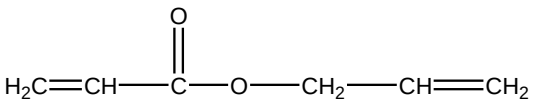
not CH_2CHCOH 1

[6]

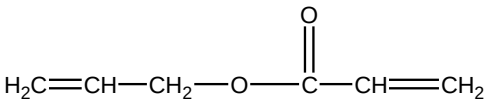
22. (i) $CH_2CHCH_2OOCCHCH_2$ /($C_6H_8O_2$) 1

H_2O 1

(ii) 2



or



1 mark if the ester group, 1 mark for the rest of the molecule.

COO/CO_2 without displaying the ester, they can still get 1 mark.

[4]

23. Essential marks:

Order	RI>RBr>RC*l* /owtte	1
reason for the order	C-I bond weakest/length/C-C*l* bond strongest and mention/intermolc forces loses the mark	1
an equation	$Ag^+ + X^- \longrightarrow$ AgX (solid or ppt) or an equation for hydrolysis/using OH- or H_2O	1

max = 3

Two possible methods of monitoring the reaction

Method 1	**Method 2**	
$AgNO_3$	$AgNO_3$	1
Ethanol & Waterbath/ /hydroxide temp 40 – 80°C not heat/not bunsen	$NaOH/OH^-$ & neutralise with HNO_3	1
relative rate of precipitation	relative amount of precipitation	1

[6]

24. Properties:

Non-toxic/harmless	1
non-flammable	1

any two from: 2

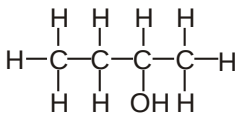
(propellant in) aerosols	because it is volatile/ unreactive/ non-toxic/ easily compressed
blowing polystyrene	because it is unreactive
dry cleaning	because it is a good solvent for organic material
degreasing agent	because it is a good solvent for organic material
fire extinguishers	because it is non-flammable

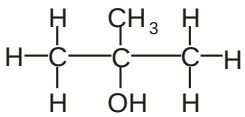
QWC

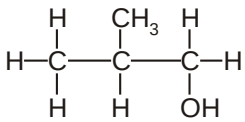
- reasonable spelling, punctuation and grammar throughout

[4]

25. (a) ✓✓✓







3

(b) (i) orange to green/dark green/brown/black ✓ 1

(ii) C_4H_9OH/ $C_4H_{10}O + 2[O] \rightarrow C_3H_7COOH + H_2O$ ✓✓ 2

1 mark available for correct formula of the carboxylic acid

(iii) Identify isomer 2-methylpropan-1-ol by appropriate number/name/formula ✓ 1

(c) (i) CH_2 has mass = 14, $14 \times 4 = 56$ ✓ 1

$\therefore C_4H_8$ ✓ 1

(ii) $C_4H_9OH \rightarrow C_4H_8 + H_2O$ ✓ 1

(iii) Identify butan-2-ol by appropriate number/name/formula 1

(d) (i) H_2SO_4 ✓ 1

(ii) 0.06 ✓ 1

(iii) 60% ✓ 1

[14]

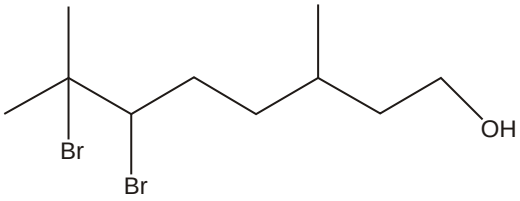
26. (a) (i) alkene ✓ 1

alcohol/hydroxy/hydroxyl ✓ 1

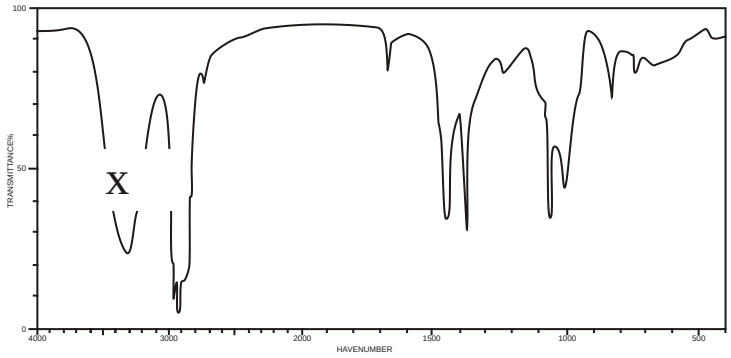
(b) (i) I = alkene & II = alcohol… both are needed ✓ 1

(ii) decolourised / colourless ✓ 1

(iii) ✓ 1



(iv) **X** as shown below ✓ 1



(c) (i) Ni/Pt/Rh/Pd ✓ 1

(ii) compound **B** is $C_{10}H_{22}O$ ✓ 1

(iii) $C_{10}H_{20}O + H_2 \rightarrow C_{10}H_{22}O$ ✓ 1

[9]

27. (a) $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ ✓✓ 2
$2CO_2 + 3H_2O$ gets 1 mark

(b) **Fermentation** 1

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ ✓ 1

Yeast /enzyme / temperature about 30 °C/ batch process ✓ 1

Hydration of ethene. ✓ 1

$C_2H_4 + H_2O \rightarrow C_2H_5OH$ ✓ 1

Temp > 100 °C/Press 370 – 100 atm / 6 –20 MPa/phosphoric acid catalyst/ continuous process ✓ 1

Glucose is obtained from plants ✓ 1

Ethene is obtained from crude oil/cracking/fossil fuel ✓ 1

glucose is renewable/ethene isn't ✓ 1

1 mark available for *Quality of written communication*….. base the award of the mark on the ability to communicate the essential chemistry by correct use of at least two from:

fermentation/hydration/catalyst/renewable/sustainable/biofuel/ enzymes/finite/cracking ✓ 1

[12]

28. (a) (i) C_4H_{10} ✓ 1

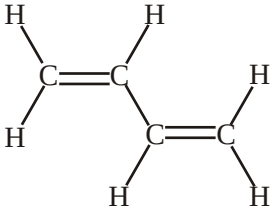
(ii) C_2H_5O ✓ 1

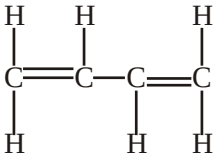
(iii) B and E ✓ 1

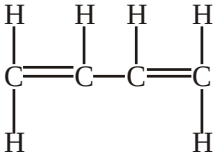
(iv) A and F ✓ 1

(b) ($C_4H_9OH \rightarrow$) $C_4H_8 + H_2O$ ✓ 1

(c) any unambiguous formula: ✓ 1







$CH_2CHCHCH_2$

$CH_2CHCHCH_2$

buta-1,3-diene ✓ 1

name ecf to the structure only if structure above has formula C_4H_6

[7]

29. (a) C*l*$^-$ must be shown as a product ✓ 1

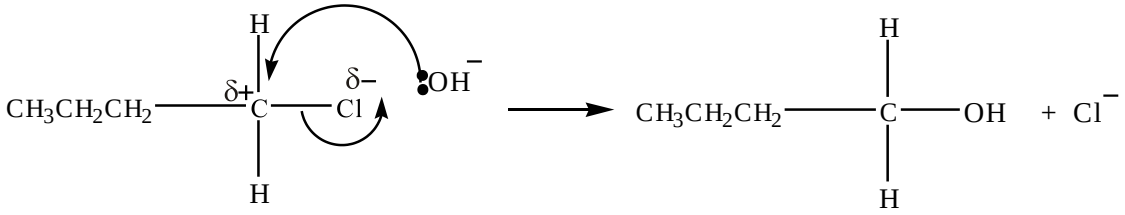
(at least 1) lone pair of electrons on the O in the OH$^-$ with curly arrow

from the lone pair on the OH$^-$ to the C($^{\delta+}$)✓ 1

dipoles on the C-C*l* bond ✓ 1

curly arrow from C-C*l* bond to the C*l*$^{\delta-}$ ✓ 1

The mechanism below would get all 4 marks.



(b) (i) mark for method/dividing by A_r / C, 3.15; H, 6.3; C*l*, 1.58. ✓ 1

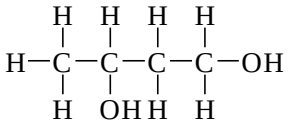
divide by smallest to get C_2H_4Cl ✓ 1

alternative method:

% of each element x 127 ÷ A_r of that element = molecular formula, hence deduce empirical formula

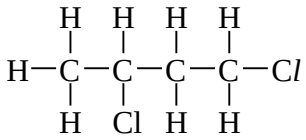
(ii) $C_4H_8Cl_2$ ✓ 1

(iii) any unambiguous form of: ✓



1

(iv) any unambiguous form of: ✓



1

ecf to (iii) provided that there are two OHs in (iii)

[9]

30. (a) (i) Alkene/C=C ✓ 1

Alcohol/ROH/hydroxy/hydroxyl/OH (not OH^- or hydroxide) ✓ 1

(ii) One of the C in both C=C is joined to two atoms or groups that are the same ✓ 1

(b) Observation — decolourisation (of Br_2) ✓ 1

Molecular formula — $C_{10}H_{18}OBr_4$ ✓✓ 2

$C_{10}H_{18}OBr_2$ gets 1 mark

(c) reagent — CH_3COOH ✓ 1

catalyst — $H_2SO_4/H^+/HCl$ (aq) *or dilute loses the mark* ✓ 1

(d) (i) $C_{10}H_{18}O + 2[O] \rightarrow C_{10}H_{16}O_2 + H_2O$ ✓✓ 2

1 mark for H_2O and 1 mark for 2[O]

(ii) The infra-red spectrum was of compound **Y**

because absorption between 1680 – 1750 cm^{-1} indicates a C=O ✓ 1

and the absence of a peak between 2500 – 3300 cm^{-1} shows the absence of the OH hydrogen bonded in a carboxylic acid ✓ 1

[12]