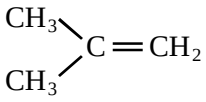
1. (i) but-1-ene **(1)**

(ii) two H on one carbon of double bond **(1)**

(iii) $CH_3CH=CHCH_3$ **(1)**

(iv)



(1) 4

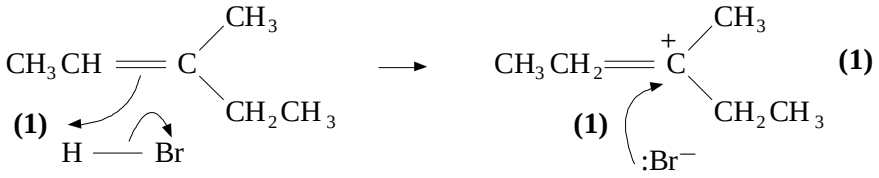
[4]

2. (a) *Name of alkene* 3-methylpent-2-ene **(1)**

Type of stereoisomerism geometrical <u>or</u> cis-trans **(1)** 2

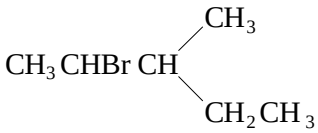
(b) *Name of mechanism* electrophilic addition **(1)**

Mechanism



(1) **(1)** **(1)** **(1)** 5

(c) *Structure*



(1)

Explanation $(CH_3CH_2)_2\overset{+}{C}CH_3$ <u>or</u> tertiary carbonium ion more stable **(1)**

than $CH_3\overset{+}{C}HCH(CH_3)CH_2CH_3$ <u>or</u> secondary carbonium ion **(1)**

3

[10]

3. (i) $C_{18}H_{34}O_2$ Only; 1

$C_9H_{17}O$ Only; 1

(empirical formula is not consequential on molecular formula)

(ii) (An unsaturated compound) contains (at least) <u>one double bond</u>

OR

Contains C=C; 1

(must be a positive statement)

(iii) M1: Bromine water

OR

Br_2(aq)

OR

Bromine

OR

Br_2; 1

(penalise " bromide water" , but mark on)

Ml: decolourised or goes colourless

OR

from brown/red/orange/yellow to colourless; 1

(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)

[5]

4. (a) (i) Electrophilic addition 1

(Both words required)

(ii) M1 the reaction <u>to form 1-bromopropane</u> goes *via* the <u>primary carbocation</u> OR 1^o carbocation 1

OR *via* $CH_3CH_2\overset{+}{C}H_2$

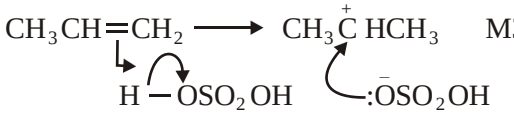
M2 <u>primary carbocations are less stable than secondary carbocations</u>. 1

(Credit converse arguments for M1 and M2 i.e. the reaction <u>to form 2-bromopropane</u> goes via the <u>secondary carbocation</u> , M1, and <u>secondary carbocations are more stable than primary carbocations, M2</u>)

(Accept the use of " carbonium ions" as an alternative to carbocation)

(b) (i) Secondary OR 2^o 1

(ii)



M3 structure of carbocation 4

M1 arrow from double bond to H of H – O bond
M2 arrow from bond to oxygen atom to show H – O bond breakage
M4 arrow from lone pair of electrons to carbon atom of carbocation

(Penalise M1 if arrow goes to H_2SO_4 or to formal positive charge on H, but ignore partial charges on sulphuric acid unless wrong)

(Credit M2 for H^+ ion)

(For M4, accept negative charge anywhere on the ion)

(iii) Catalyst ONLY 1

(Ignore homogeneous, heterogeneous)

[9]

5. (a) (i) the joining together of monomers / small molecules **(1)**

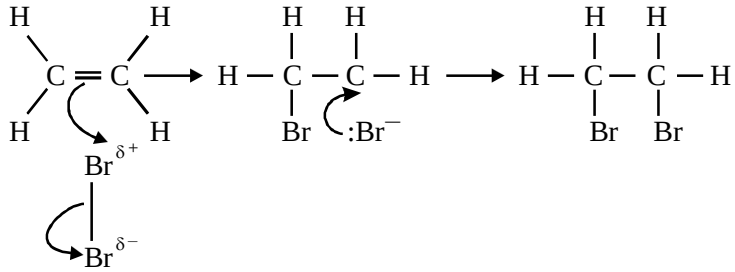
to form long chains / large molecules **(1)** 2

(ii) nCH2 = CH2 → (-CH2–CH2-)n **(1)**

allow n CH_2 CH_2 **not** n C_2H_4 1

(b) 1,2-dibromoethane **(1)** 1

(c) electrophilic addition **(1)**



words or diagrams to show attack by p electrons on Br atom
and either δ+/δ– on Br_2 or e^- shift on Br–Br **(1)**

correct carbocation intermediate (allow triangular representation) **(1)**

attack by Br^- (onto +ve carbon) leading to correct product **(1)** 4

(d) (i) C 38.71/12 = 3.23 ; H 9.68/1 = 9.68 ; O 51.61/16 = 3.23 **(1)**

ratio C:H:O = 1:3:1 /empirical formula = CH_3O **(1)**

empirical mass = 31 so molecular formula = 2 × CH_3O = $C_2H_6O_2$ **(1)** 3

(ii) reagent = NaOH / KOH **(1)**

conditions = <u>aqueous</u> solution (dependent on first mark) **(1)** 2

(iii) $CH_2BrCH_2Br + 2NaOH \rightarrow CH_2(OH)CH_2OH + 2NaBr$

product = $CH_2(OH)CH_2OH$ (condone missing brackets) **(1)**

correctly balanced **(1)** 2

if $C_2H_6O_2$ given, allow second mark only

for $CH_2 Br CH_2 Br + 2H_2O \rightarrow CH_2(OH)CH_2(OH) + 2HBr$
allow 2 marks if reagent in (ii) is H_2O or aqueous solution

[15]