

- M1.** (a) (base) elimination  
(penalise other words before 'elimination' e.g. nucleophilic) 1
- M1:** curly arrow from lone pair of electrons on oxygen of hydroxide ion  
(insist on a lone pair of electrons on the oxygen atom and a negative charge, but only credit this mark if the attack is to a correct H atom) 1
- M2:** curly arrow from the middle of the C-H bond to the middle of the C-C bond 1
- (only credit this mark if the arrow originates from the correct C-H bond and if an attempt has been made at M1)
- M3:** curly arrow from the middle of the C-Br bond towards/alongside the Br atom
- (credit M3 independently unless the bond breaking is contradicted by an additional arrow)  
(penalise curly arrow if the C-Br has a formal positive charge)  
(credit full marks for an E1 mechanism, with M2 awarded for a correct curly arrow on the correct carbocation)  
(award a maximum of two marks for either an incorrect haloalkane or an incorrect organic product)  
(maximum 2 marks for use of 'sticks' for the haloalkane, unless RE from 2(b), when credit can be given)
- (b) (i) **M1:** compounds with the same structural formula 1
- M2:** but the bonds/groups/atoms have different spatial arrangements or orientation or configuration/are arranged differently in space/3D  
(ignore reference to the same molecular formula for M1) 1
- (ii) **M1:** correct structural representation for cis-but-2-ene and its name or its identification as the cis isomer 1
- M2:** correct structural representation for trans-but-2-ene and its name or its identification as the trans isomer  
(accept representations which are 90° to linear)



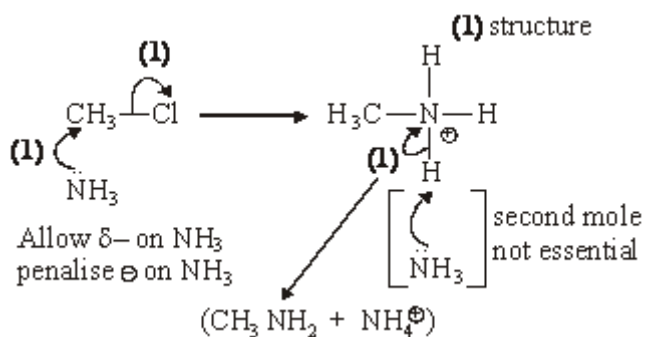
- (iii) C-Br bond is weaker (than C-Cl bond)  
 OR C-Br bond enthalpy is less than C-Cl (1)  
*Ignore electronegativity*

3

- (c) CH<sub>3</sub>COOH OR ethanoic acid (1)

1

- (d) (i)  $\overset{\delta+}{\text{C}}-\overset{\delta-}{\text{Cl}}$  OR C-Cl is polar (1) OR C atom is electron deficient /  $\delta+$   
 (ii) methylamine (1) only  
 (iii) S<sub>N</sub>1 scores full marks



6

[13]

M3.B

[1]

M4.A

[1]

- M5. (a) (i) (Free) radical substitution  
*(Both words needed)*

(ii) M1 initiation ONLY

M2 ultra-violet light OR sunlight OR  $1000^{\circ}\text{C} \geq T \geq 450^{\circ}\text{C}$   
(Ignore reference to temperature if included with uv light)  
(Penalise "high temperature" for M2)

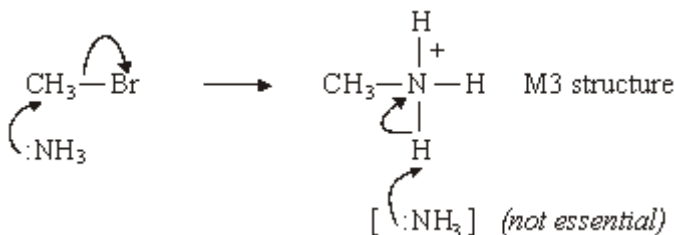
(iii)  $2\dot{\text{C}}\text{H}_3 \rightarrow \text{C}_2\text{H}_6$   
(OR  $\text{CH}_3\text{CH}_3$  as alternative to  $\text{C}_2\text{H}_6$ )

(iv)  $\text{CH}_3\text{Br} + \text{Br}_2 \rightarrow \text{CH}_2\text{Br}_2 + \text{HBr}$

(b) (i) Electron pair donor  
OR species with an electron pair able to form a covalent bond.

(ii) Methylamine  
(Credit "aminomethane")

(iii)



M1 arrow to show breakage of C – Br bond

M2 arrow from lone pair on N of  $\text{NH}_3$  to form bond with C

M4 arrow from bond of N – H to N atom of  $\text{CH}_3\overset{+}{\text{N}}\text{H}_3$   
(Ignore partial charges on haloalkane but penalise if incorrect)

(Accept  $\text{CH}_3\overset{+}{\text{N}}\text{H}_3$  for M3)

(Full credit for carbocation mechanism; M1 for C – Br bond breakage and M2 for lone pair attack on carbocation)

(Second mole of ammonia not essential to mechanism for

full credit)

1

[11]

M6.D

[1]

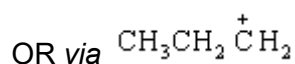
M7.D

[1]

M8. (a) (i) Electrophilic addition  
(Both words required)

1

(ii) M1 the reaction to form 1-bromopropane goes via the primary carbocation OR  $1^\circ$  carbocation



M2 primary carbocations are less stable than secondary carbocations

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

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

1

(b) M1 NaOH OR KOH OR correct name

1

M2 aqueous or solution in water (*ignore heat, reflux etc.*)

*(Penalise M1 for hydroxide ion alone, but mark on and credit M2)*

(Credit M2 ONLY for H<sub>2</sub>O as reagent and heat / warm / T=50 to 100°C)

(NaOH(aq) scores M1 and M2 provided it is not contradicted)

(Penalise M2 if NaOH(aq) followed by concentrated or ethanol)

(Penalise M1 and M2 if followed by acid)

1

- (c) Ethanolic OR alcoholic OR CH<sub>3</sub>CH<sub>2</sub>OH / CH<sub>3</sub>OH solvent OR aqueous ethanol/alcohol

OR higher temperature (must be comparative)

(Ignore heat or heat under reflux)

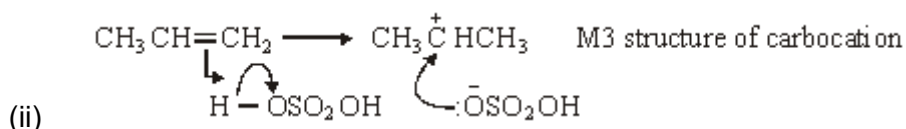
(Credit part (c) independently from part (b))

(Penalise "ethanoic")

1

- (d) (i) Secondary OR 2°

1



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<sub>2</sub>SO<sub>4</sub> or to formal positive charge on H, but ignore partial charges on sulphuric acid unless wrong)

(Credit M2 for H<sup>+</sup> ion)

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

4

- (iii) Catalyst ONLY

(Ignore homogeneous, heterogeneous)

1

[12]