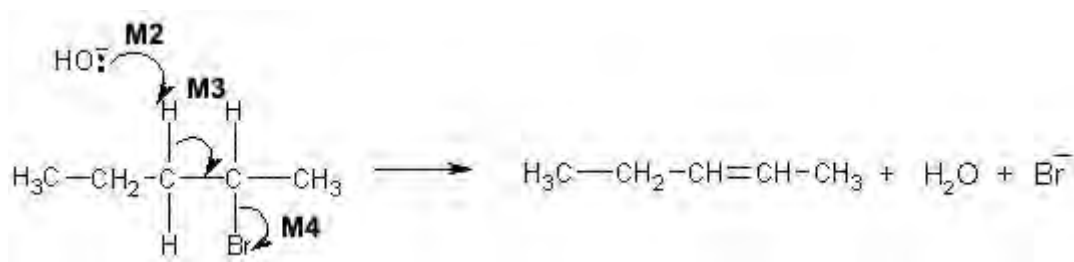


**M1.** (a) (i) **M1** Elimination



**M2** must show an arrow from the lone pair on the oxygen of a negatively charged hydroxide ion to a correct H atom

**M3** must show an arrow from a C-H bond adjacent to the C-Br bond towards the appropriate C-C bond. Only award if a reasonable attempt has been made at the attack on the H atom of the appropriate adjacent C-H

**M4** is independent provided it is from their original molecule

Award full marks for an E1 mechanism in which **M3** is on the correct carbocation.

**N.B. These are double-headed arrows**

*For M1, accept "Base elimination" but no other prefix.*

*Penalise **M2** if covalent KOH*

*Penalise **M4** for formal charge on C of C-Br or incorrect partial charges on C-Br*

*Ignore other partial charges*

*Penalise once only in any part of the mechanism for a line and two dots to show a bond.*

*Max any 2 of 3 marks for the mechanism for wrong reactant (or wrong product if shown).*

*Accept the correct use of "sticks" for the molecule except for the C-H being attacked*

4

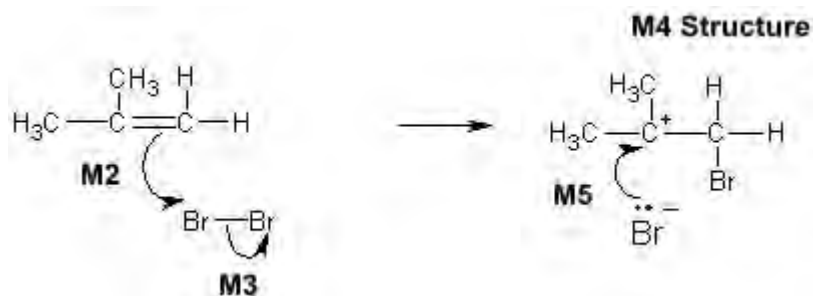
(ii) **Structure for pent-1-ene**



Penalise C<sub>3</sub>H<sub>7</sub>,  
Accept correct "sticks"

1

(b) **M1** Electrophilic addition



**M2** must show an arrow from the double bond towards the Br atom of the Br-Br molecule

**M3** must show the breaking of the Br-Br bond.

**M4** is for the structure of the tertiary carbocation with Br on the correct carbon atom.

**M5** must show an arrow from the lone pair of electrons on the negatively charged bromide ion towards the positively charged carbon atom.

**N.B. These are double-headed arrows**

*For M1, both words required.*

**For the mechanism**

**M2** Ignore partial negative charge on the double bond.

**M3** Penalise partial charges on Br-Br bond if wrong way and penalise formal charges

*Penalise once only in any part of the mechanism for a line and two dots to show a bond*

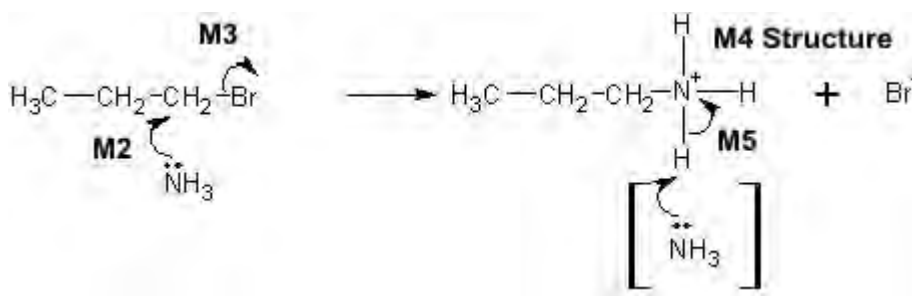
**Max any 3 of 4 marks for the mechanism** for wrong organic reactant or wrong organic product (if shown) or primary carbocation.

*If HBr is used, max 2 marks for their mechanism*

*Accept the correct use of "sticks"*

5

(c) **M1** Nucleophilic substitution



**M2** must show an arrow from the lone pair of electrons on the nitrogen atom of an ammonia molecule to the C atom.

**M3** must show the movement of a pair of electrons from the C-Br bond to the Br atom. **M3** is independent provided it is from their original molecule

**M4** is for the structure of the alkylammonium ion, which could be a condensed formula. A positive charge must be shown on/or close to, the N atom.

**M5** is for an arrow from the N-H bond to the N atom.

Award full marks for an  $\text{S}_{\text{N}}1$  mechanism in which M2 is the attack of the ammonia on the intermediate carbocation.

**N.B. These are double-headed arrows**

*For **M1**, both words required.*

*Penalise **M2** if  $\text{NH}_3$  is negatively charged.*

*Penalise **M3** for formal charge on C or incorrect partial charges*

*The second mole of ammonia is not essential for M5; therefore ignore any species here.*

*Penalise once only for a line and two dots to show a bond.*

*Max any 3 of 4 marks **for the mechanism** for wrong organic reactant (or wrong organic product if shown)*

*Accept the correct use of "sticks"*

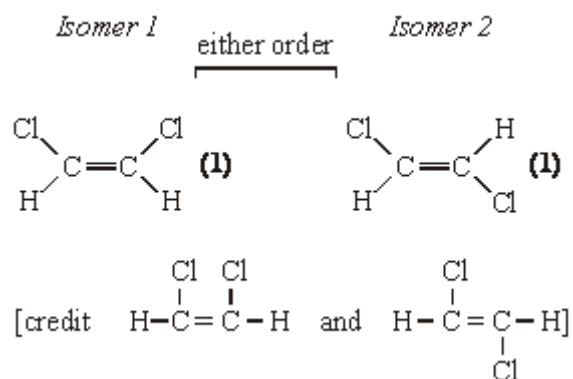
5

[15]

M2.C

[1]

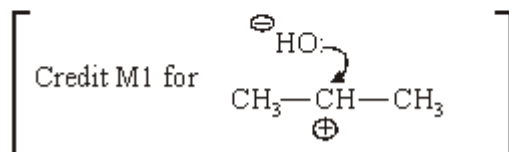
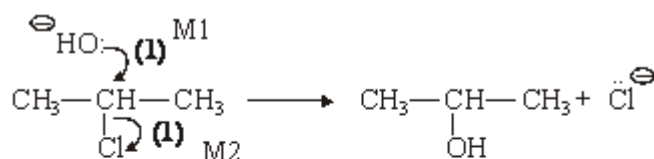
M3. (a) (i)



(ii) restricted rotation OR no rotation OR cannot rotate (1)

3

(b) (i) *Mechanism:*



*M1 and M2 independent*

*Curly arrows must be from a bond or a lone pair*

*Do not penalise sticks*

*Penalise M1 if  $\text{Na}-\text{OH}^-$  precedes (penalise this once)*

*Penalise incorrect  $\delta+$   $\delta-$  for M2*

*Penalise + on C atom for M2*

*Only allow M1 for incorrect haloalkane*





Award M1 if it is obvious that they are referring to the second spectrum (or the bottom one)

M2 depends on a correct M1

Ignore other correctly labelled peaks

Ignore reference to "double bond" or "alkene"

2

(ii) Functional group (isomerism)

1

(iii) Cyclohexane

**OR**

Methylcyclopentane etc.

Named correctly

Ignore structures and ignore numbers on the methyl group of methylcyclopentane

1

[9]

**M5.** (a) Contains a C=C **OR** a double bond

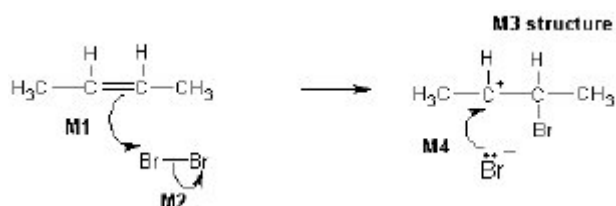
1

(b) **Electrophilic addition**

*Both words needed*

1

Mechanism:



*Ignore partial negative charge on the double bond.*

*M2 Penalise partial charges on bromine if wrong way and penalise formal charges*

*Penalise once only in any part of the mechanism for a line and two dots to show a bond.*

- M1** Must show an arrow from the double bond towards one of the Br atoms on a Br-Br molecule.  
*Deduct 1 mark for sticks.*
- M2** Must show the breaking of the Br-Br bond.
- M3** Is for the structure of the secondary carbocation with Br substituent.
- M4** Must show an arrow from the lone pair of electrons on a negatively charged bromide ion towards the positively charged carbon atom.  
*Deduct 1 mark for wrong reactant, but mark consequentially. If HBr, mark the mechanism consequentially and deduct one mark*  
*If but-1-ene, mark the mechanism consequentially and deduct one mark.*  
*If both HBr and but-1-ene, mark the mechanism consequentially and deduct ONLY one mark.*

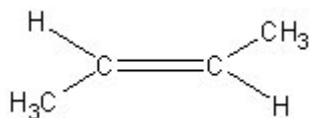
4

- (c) (i) **M1** Compounds with the same structural formula  
*Penalise M1 if “same structure”*  
*Ignore references to “same molecular formula” or “same empirical formula”*
- M2** With atoms/bonds/groups arranged differently in space  
*OR*  
atoms/bonds/groups have different spatial arrangements/ different orientation.  
*Mark independently.*

1

1

(ii)



*Award credit provided it is obvious that the candidate is drawing the trans isomer.*

*Do not penalise poor C–C bonds*

*Trigonal planar structure not essential*

1

[9]



