



A-Level Chemistry

Alkenes Structure

Mark Scheme

Time available: 53 minutes

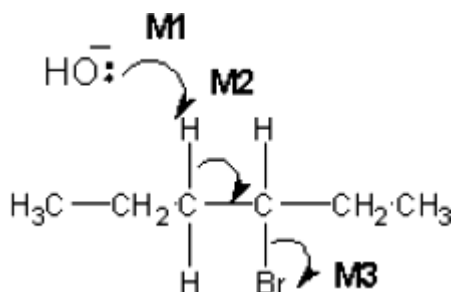
Marks available: 53 marks

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Mark schemes

1.

(a) (i)



Penalise one mark from their total if half-headed arrows are used

Penalise **M3** for formal charge on C of the C-Br or incorrect partial charges on C-Br

Ignore other partial charges

M1 must show an arrow from the lone pair on oxygen of a negatively charged hydroxide ion to the correct H atom

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

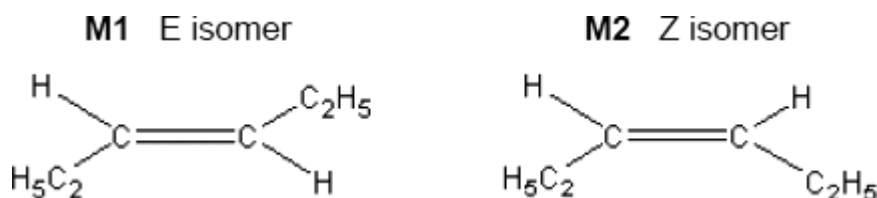
M2 must show an arrow from the correct C-H bond to the correct C-C bond. Only award if an arrow is shown attacking the H atom of the correct C-H bond in **M1**

M3 is independent but **CE=0** if nucleophilic substitution

N.B these are double-headed arrows

3

(ii)



Award 1 mark if both correct stereoisomers but in the wrong places

Accept no other alkenes.

Be reasonably lenient on the bonds to ethyl (or to CH_2CH_3) since the question is about E and Z positions but penalise once only if connection is clearly to the CH_3 of CH_2CH_3

Accept linear structures

2

(iii) **M1** (Compounds / molecules with) the same structural formula

*Penalise **M1** if "same structure"*

M2 with atoms/bonds/groups arranged differently in space

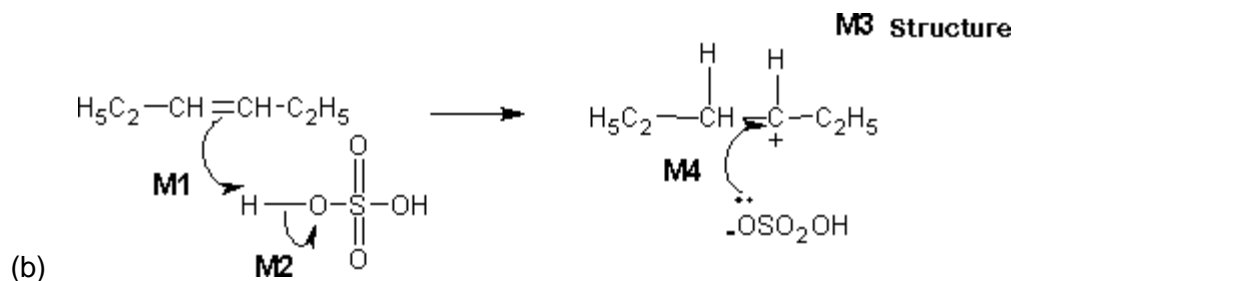
Ignore references to "same molecular formula" or "same empirical formula" or any reference to "displayed formula"

OR

atoms/bonds/groups that have different spatial arrangements / different orientation.

Mark independently

2



M1 must show an arrow from the double bond towards the H atom of the H – O bond
OR HO on a compound with molecular formula for H_2SO_4

M1 could be to an H^+ ion and **M2** an independent O – H bond break on a compound with molecular formula for H_2SO_4

M1 Ignore partial negative charge on the double bond.

M2 must show the breaking of the O – H bond.

M2 Penalise partial charges on O – H bond if wrong way and penalise formal charges

In **M2** do not penalise incorrect structures for H_2SO_4

M3 is for the structure of the carbocation.

M4 must show an arrow from the lone pair of electrons on the correct oxygen of the negatively charged ion towards a correct (positively charged) carbon atom.

M4 NOT HSO_4^-

For **M4**, credit as shown or $^-OSO_3H$ ONLY with the negative charge anywhere on this ion

OR correctly drawn out with the negative charge placed correctly on oxygen

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

NB The arrows here are double-headed

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

Accept the correct use of “sticks”

4

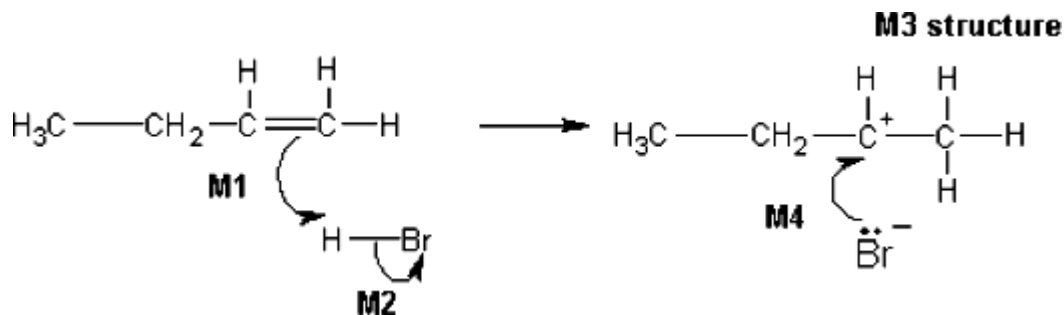
[11]

2.

(a) Position(al) (isomerism)

1

(b)



Penalise one mark from their total if half-headed arrows are used

M1 must show an arrow from the double bond towards the H atom of the H-Br molecule

M1 Ignore partial negative charge on the double bond.

M2 must show the breaking of the H-Br bond.

M2 Penalise partial charges on H-Br bond if wrong way and penalise formal charges

M3 is for the structure of the secondary carbocation.

Penalise M3 if there is a bond drawn to the positive charge

M4 must show an arrow from the lone pair of electrons on the negatively charged bromide ion towards the positively charged carbon atom of either a primary or secondary carbocation.

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

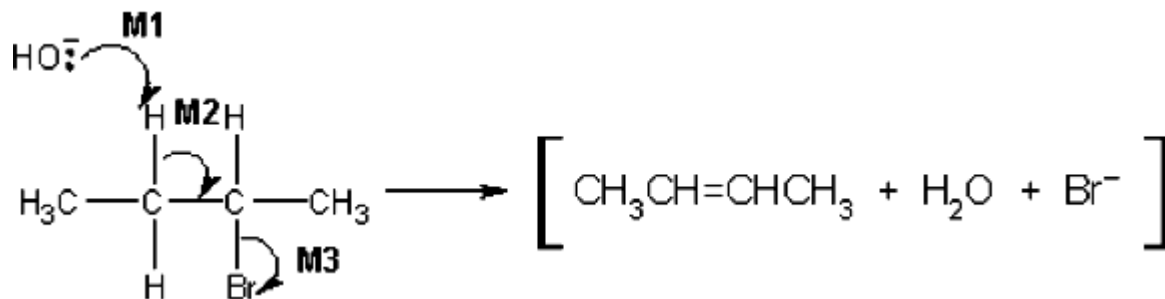
Maximum any 3 of 4 marks for wrong reactant or primary carbocation.

If Br₂ is used, maximum 2 marks for their mechanism

Do not penalise the use of "sticks"

NB The arrows here are double-headed

(c)



Penalise one mark from their total if half-headed arrows are used

M1 must show an arrow from the lone pair on oxygen of a negatively charged hydroxide ion to a correct H atom

Penalise M1 if covalent KOH

M2 must show an arrow from a C–H bond adjacent to the C–Br bond towards the appropriate C–C bond. Only award if an arrow is shown attacking the H atom of an adjacent C–H (in M1)

M3 is independent provided it is from their original molecule.

Penalise M3 for formal charge on C of the C–Br or incorrect partial charges on C–Br

Penalise M3 if an extra arrow is drawn from the Br of the C–Br bond to, for example, K^+

Ignore other partial charges

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

Maximum any 2 of 3 marks for wrong reactant or wrong product (if shown) or a mechanism that leads to but-1-ene

Accept the correct use of “sticks” for the molecule except for the C–H being attacked

Award full marks for an E1 mechanism in which M2 is on the correct carbocation.

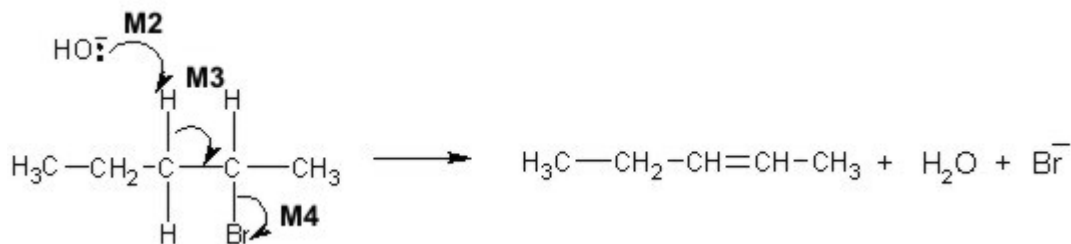
NB The arrows here are double-headed

3

[8]

3.

(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

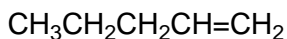
Penalise once only in any part of the mechanism for a line and two dots to show a bond.

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**

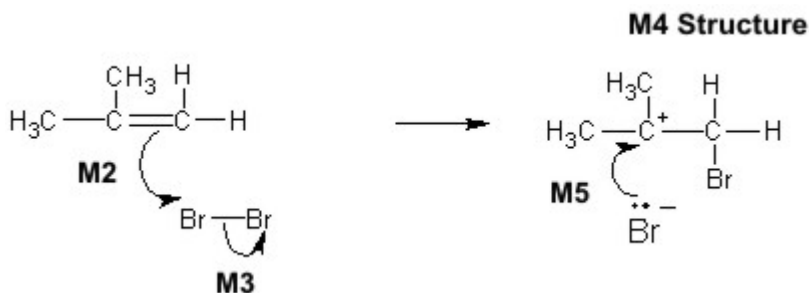


Penalise C_3H_7

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

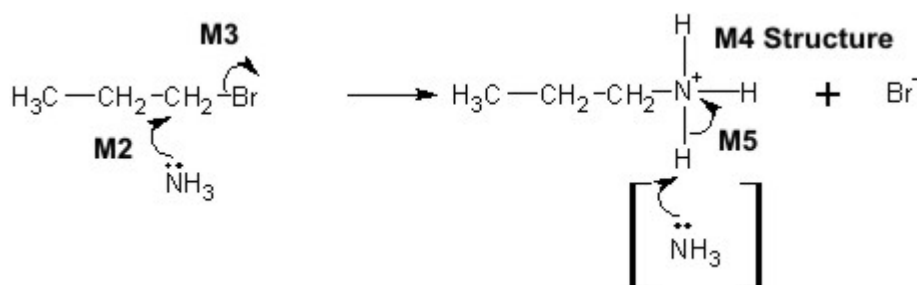
wrong organic reactant or wrong organic product (if shown) or primary carbocation.

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 S_N1 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 NH₃ 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

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4.

(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"

1

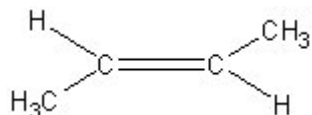
- M2** With atoms/bonds/groups arranged differently in space
OR

atoms/bonds/groups have different spatial arrangements/ different orientation.

Mark independently.

1

(ii)



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

Do not penalise poor C–C bonds

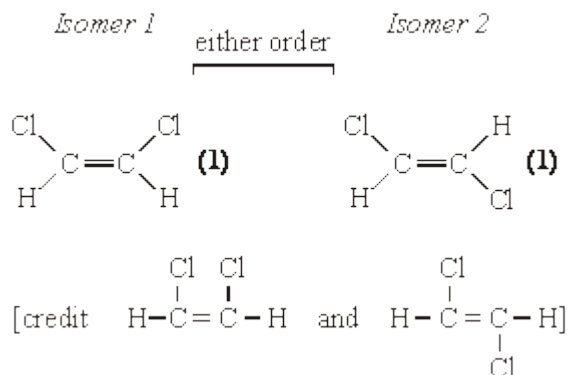
Trigonal planar structure not essential

1

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5.

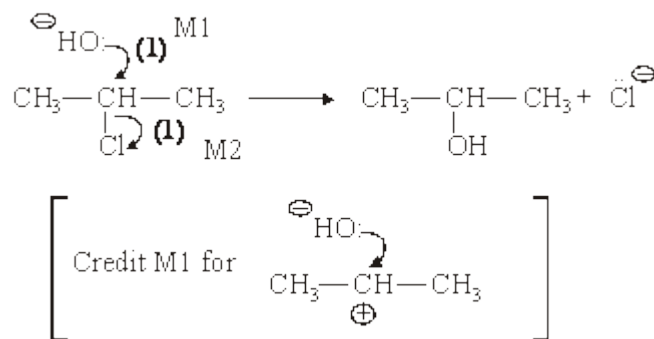
(a) (i)



(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

Role of the hydroxide ion: nucleophile (1)

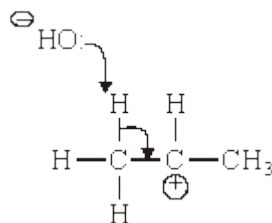
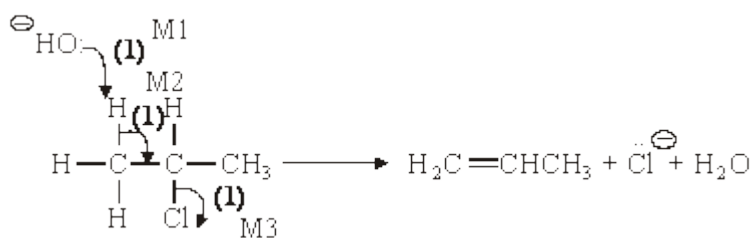
electron pair donor

lone pair donor

NOT nucleophilic substitution

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(ii) Mechanism:



Only allow M1 and M2 for incorrect haloalkane unless RE on (i)

+ charge on H on molecule, penalise M1

M3 independent

M2 must be to correct C-C

M1 must be correct H atom

Credit M1 and M2 via carbocation mechanism

No marks after any attack of C[⊕] by OH⁻

Role of the hydroxide ion: base (1)

proton acceptor

accepts H⁺

7

[10]