



Haloalkane Substitution

A Level

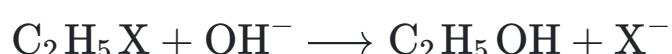
Part A 2-Iodobutane and sodium ethoxide

What is the product of a nucleophilic substitution reaction between 2-iodobutane and sodium ethoxide (NaOC_2H_5)?

- $\text{CH}_3\text{CH}=\text{CHCH}_3$
- $\text{CH}_3\text{CH}_2\text{CH(OCH}_3\text{)CH}_2\text{CH}_3$
- $\text{CH}_3\text{CH}_2\text{CH(CH}_3\text{)OCH}_2\text{CH}_3$
- $(\text{CH}_3)_2\text{CHCH}_2\text{OCH}_2\text{CH}_3$

Part B $\text{C}_2\text{H}_5\text{X} + \text{OH}^-$

Why does the reaction



take place more rapidly in aqueous solution when X is I than when X is Br?

- The I^- ion is a stronger nucleophile than the Br^- ion.
- The I^- ion is less hydrated in solution than the Br^- ion.
- The C–Br bond is weaker than the C–I bond.
- The C–Br bond is stronger than the C–I bond.



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Haloalkane Substitution Mechanism

A Level
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Part A Energy profile

Halogenoalkanes react with aqueous alkali. One mechanism of this reaction has the energy profile shown below.

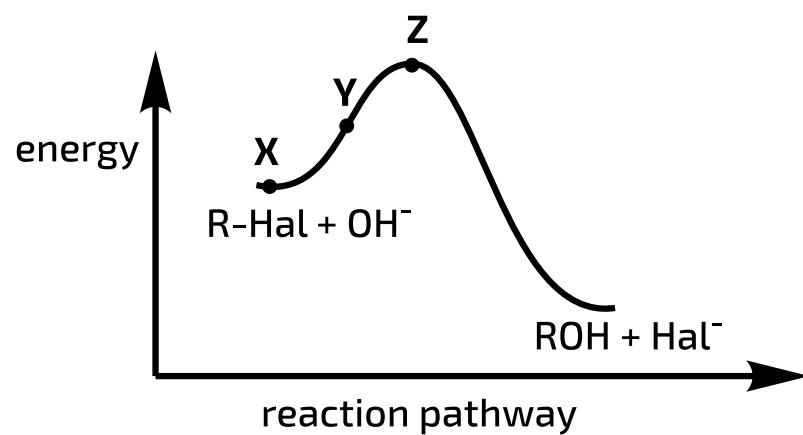


Figure 1: Energy profile for haloalkane with aqueous alkali

Which of the following statements are correct?

1. The reaction is an example of nucleophilic substitution.
2. Between **X** and **Z** the C–Hal bond will be lengthening.
3. The energy difference between **X** and **Y** represents the activation energy.

- 1, 2 and 3 are correct
- 1 and 2 only are correct
- 1 and 3 only are correct
- 2 and 3 only are correct
- 1 only is correct
- 2 only is correct
- 3 only is correct

Part B Curly arrow mechanism

Which diagram correctly represents the transfer of electrons when ammonia reacts with a chloroalkane (alkyl chloride)?

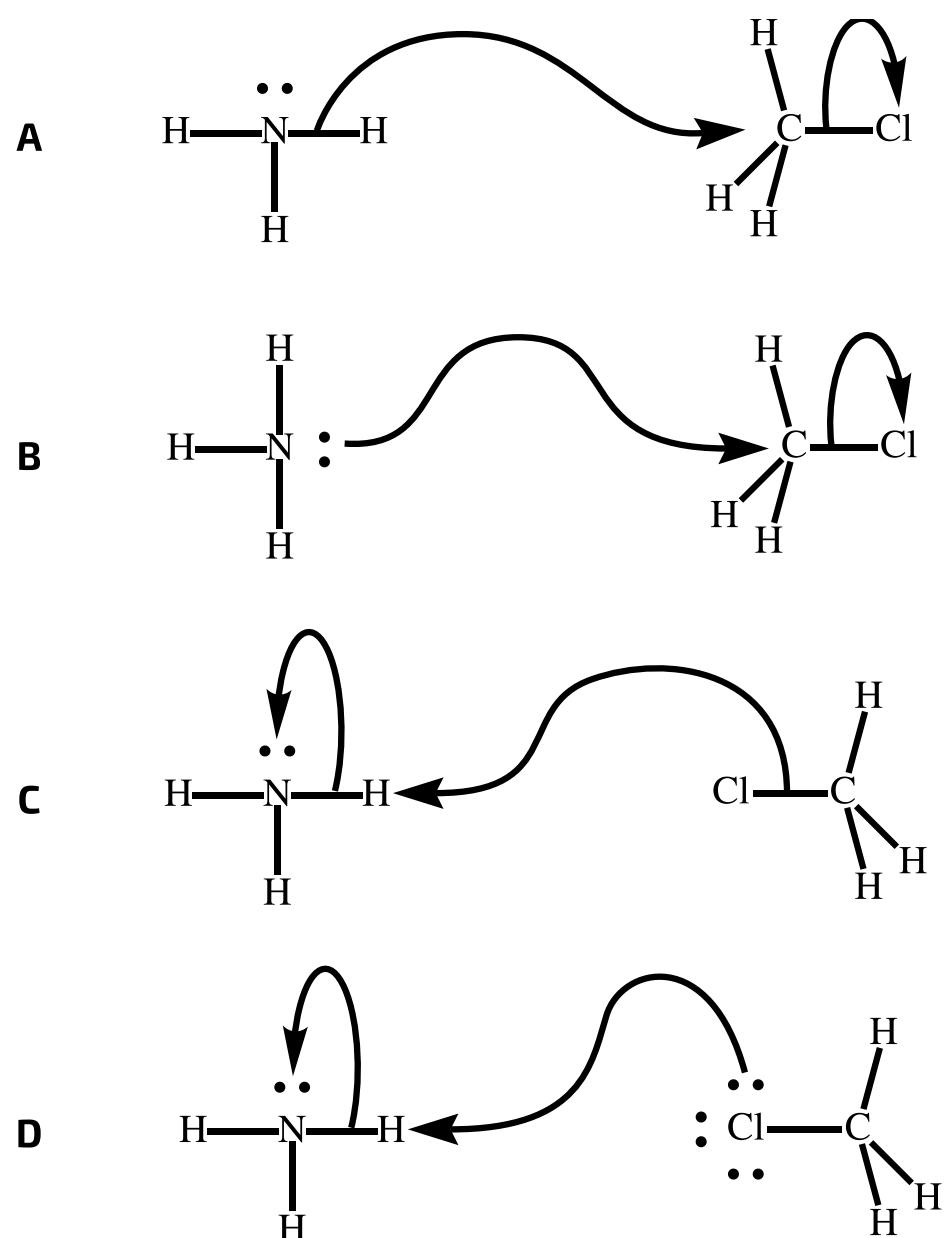


Figure 2: Possible mechanisms for ammonia with chloroalkane

- A
- B
- C
- D

Part A adapted with permission from UCLES, A-Level Chemistry, June 1993, Paper 4, Question 37;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1994, Paper 4, Question 26

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Alkene Bromination

A Level



Part A Bromination of C₄H₈

Which of the following compounds could be formed by the action of bromine on an alkene of formula C₄H₈?

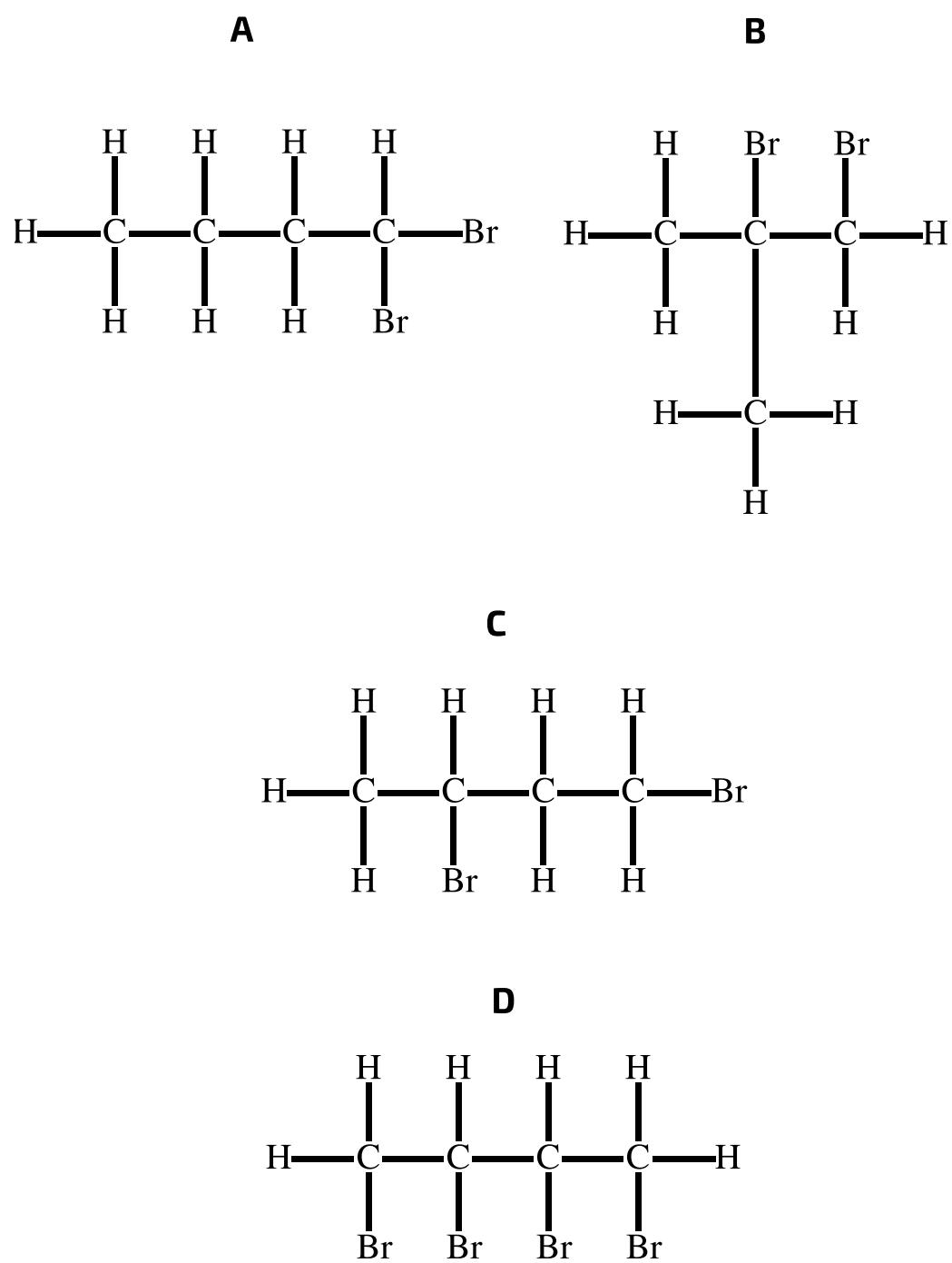
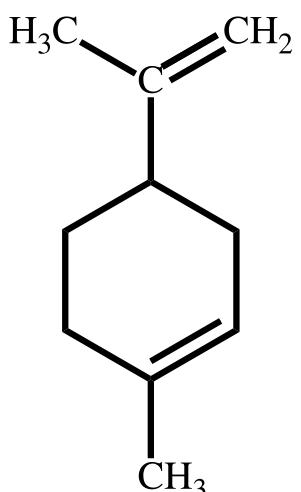


Figure 1: Possible products of C₄H₈ with bromine

- A**
- B**
- C**
- D**

Part B Bromination of limonene

Limonene is an oil formed in the peel of citrus fruits.

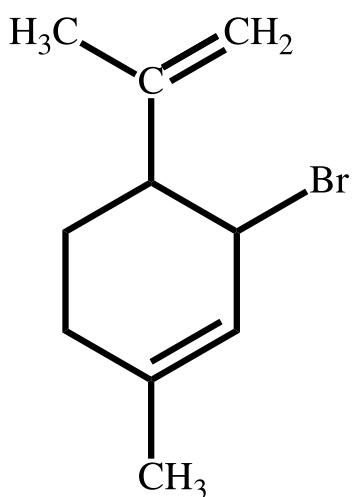


Limonene

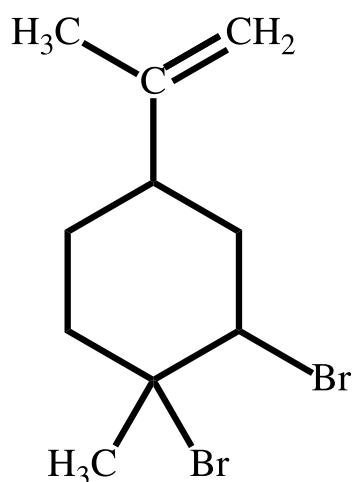
Figure 2: Structure of limonene

Which product is formed when limonene reacts with excess molecular bromine at room temperature in the dark?

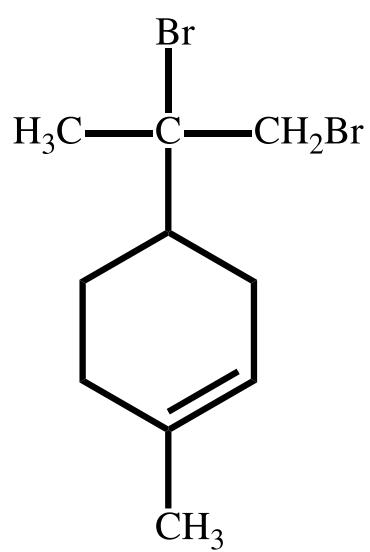
A



B



C



D

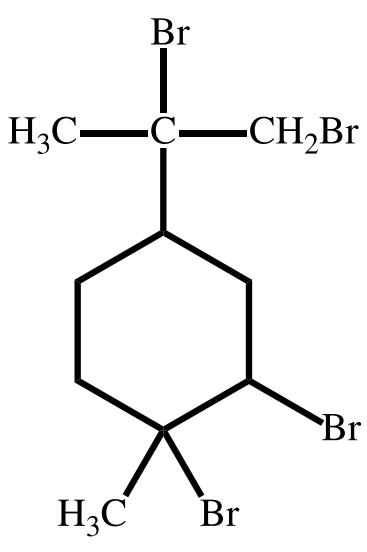


Figure 3: Possible products of limonene bromination

- A
 - B
 - C
 - D
-

Part A adapted with permission from UCLES, A-Level Chemistry, November 1994, Paper 4, Question 22;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1996, Paper 4, Question 22

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Alkene Bromination Mechanism

Part A Curly arrows

What is the sequence of curly arrows denoting movement of electrons in the first step of the reaction between ethene and bromine (below)?

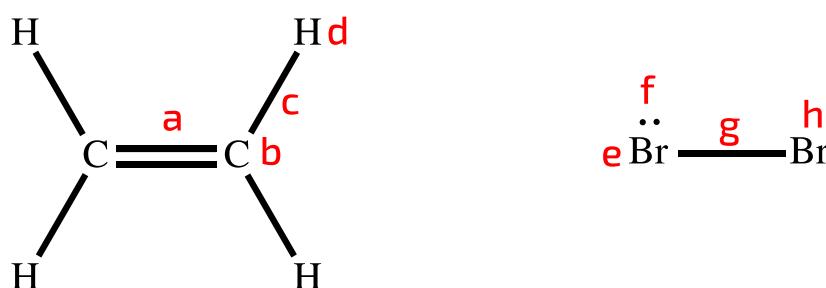


Figure 1: Bromination mechanism

For example in the reaction below, if you think the mechanism is as shown, your answer would be **cdef**.

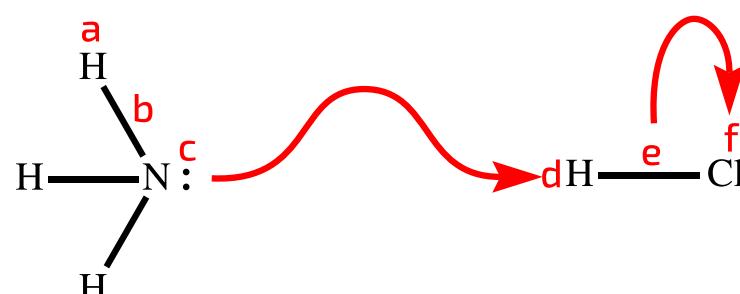


Figure 2: Sequence **cdef**

Ethene bromination sequence:

Part B Reaction type

What type of reaction is this?

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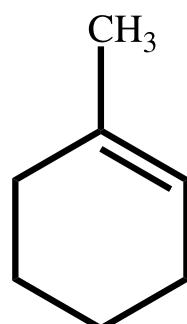
Alkenes With HBr

A Level

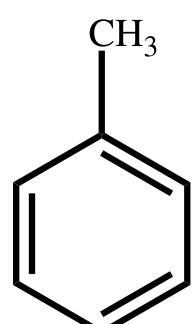


Part A 1-Methylcyclohexene with HBr

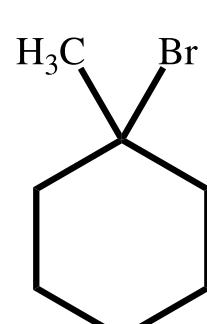
Which of the following structures represents the main organic compound produced when hydrogen bromide is added to 1-methylcyclohexene (shown below)?



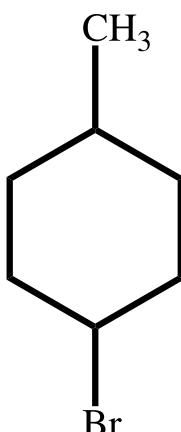
A



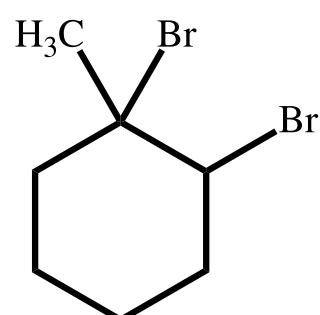
B



C



D



E

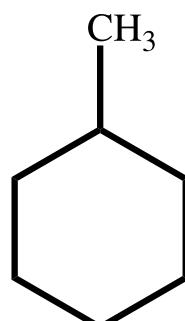


Figure 1: 1-methylcyclohexene and possible products of reaction with HBr

- A
- B
- C
- D
- E

Part B Methylpropene with HBr

Methylpropene has the structure shown below.

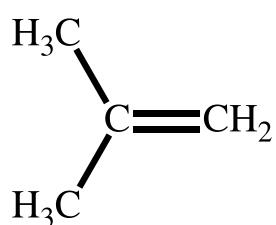


Figure 2: Structure of methylpropene

What is the **major** product formed when methylpropene reacts with HBr?

Use the [structure editor](#) to generate a SMILES string.

In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string.
Copy the SMILES string and paste it in the answer box.

[Using the structure editor](#)

Part A adapted with permission from OCSEB, A-Level Chemistry, June 1998, Paper 1, Question 22;
Part B created for Isaac Physics by R. Less

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Alkene Reactions

A Level

Propene reacts under the following conditions to give compounds **A**, **B** and **C**.

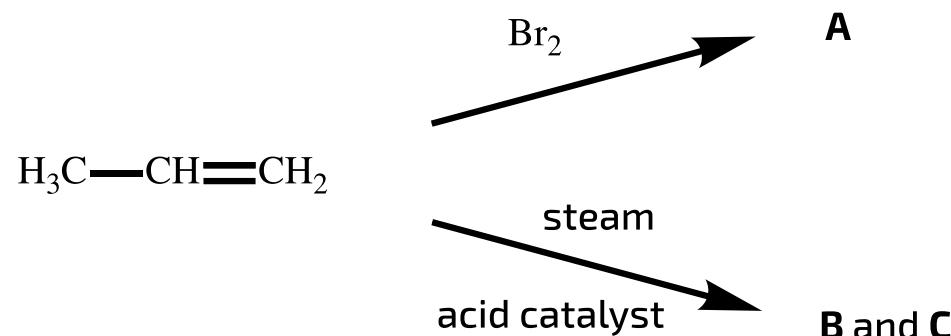


Figure 1: Propene with bromine and steam in presence of an acid catalyst

Part A with Br_2

What is product **A**?

Use the [structure editor](#) to generate a SMILES string.

In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string. Copy the SMILES string and paste it in the answer box.

[Using the structure editor](#)

Part B with steam / acid catalyst

What are products **B** and **C**?

Use the [structure editor](#) to generate SMILES strings.

Give your answer in the format "**B, C**" (space after comma).

In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string.
Copy the SMILES string and paste it in the answer box.

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More Alkene Bromination



Compound A undergoes the following reactions:



Part A Bromination of compound A

What is compound A? (There are two possible isomers: give the structure of either.)

Use the [structure editor](#) to generate a SMILES string.

Click on the round, yellow smiley face to generate a SMILES string. Copy the SMILES string and paste it in the answer box.

[Using the structure editor](#)

Part B Step (II)

What type of reaction is step (II)?

Part C Ethene with aqueous bromine

Ethene reacts with aqueous bromine to give the two products $\text{CH}_2\text{BrCH}_2\text{Br}$ and $\text{CH}_2\text{BrCH}_2\text{OH}$.

Which statement is correct for these products?

- Reaction of ethene with aqueous HBr gives the same products.
- Both products are obtained in this reaction by electrophilic substitution.
- Both products possess an overall dipole.
- Both products can be hydrolysed to form the same diol.
- Both products are obtained in this reaction by nucleophilic addition.

Part A adapted with permission from UCLES, A-Level Chemistry, June 1991, Paper 3, Question 8;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1993, Paper 4, Question 24

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Free Radical Reactions



Part A CFCs

In the upper atmosphere, chlorofluoroalkanes (CFCs) are broken down to give chlorine radicals but not fluorine radicals.

What is the best explanation for this?

- Chlorine has a higher molecular weight.
- Fluorine has a lower atomic number.
- Fluorine has a higher ionisation energy than chlorine.
- The C–F bond is stronger than the C–Cl bond.

Part B Chlorination of methane

Methane reacts with chlorine in the presence of sunlight. Which statement about the intermediates is correct?

- They combine to form HCl.
- They contain an odd number of electrons.
- They are more energetically stable than the reactants.
- They are positively charged ions.



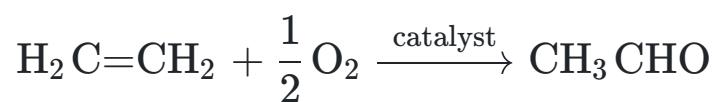
Ethene Oxidation

A Level



Part A Ethene to ethanal

Aldehydes and ketones are produced industrially by the catalytic oxidation of alkenes, e.g. ethanal is manufactured from ethene as shown below:



This process is also used industrially with but-2-ene.

Which of the following represents the structure of the compound which would be produced from but-2-ene?

- CH₃CH₂CHO
- (CH₃)₂CHCHO
- CH₃COCH₂CH₃
- CH₃CH₂CH₂CHO
- CH₃COCH₃

Part B Ethene with bromine and sodium nitrate

When ethene reacts with bromine in the presence of concentrated aqueous sodium nitrate, the product contains the following compound:

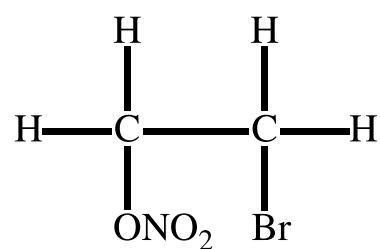


Figure 1: Reaction product

What is the intermediate formed in this reaction?

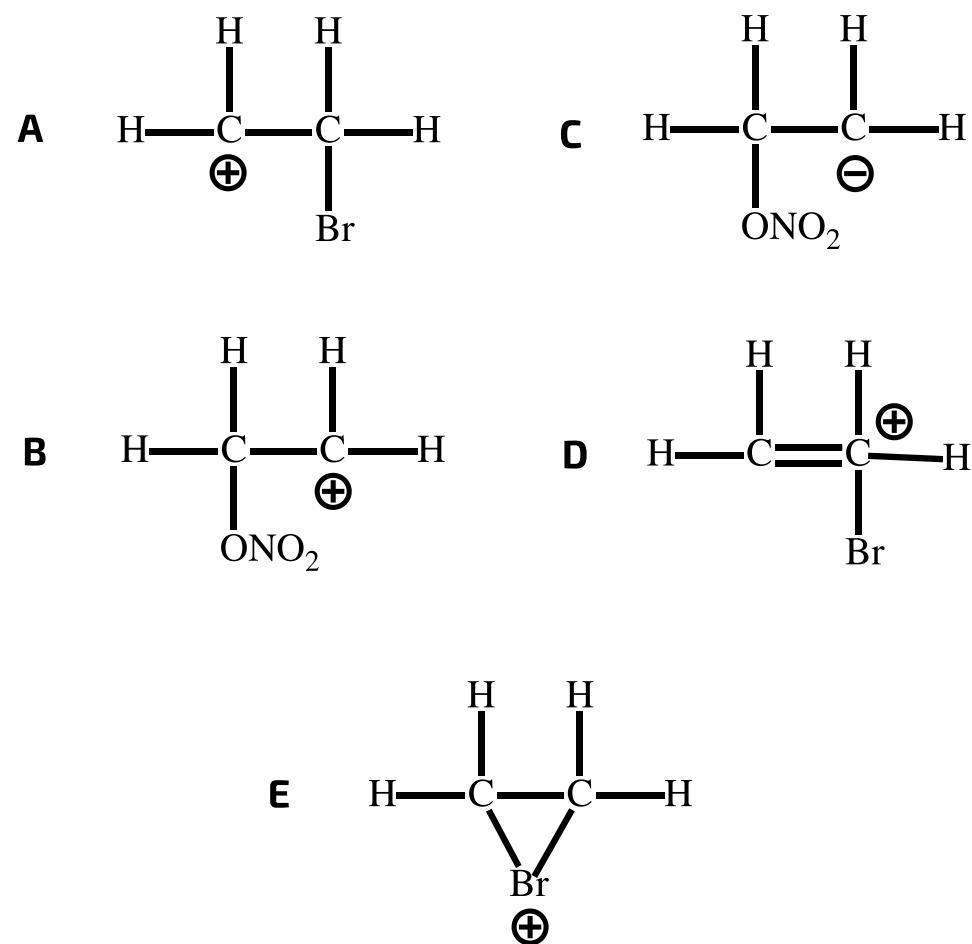


Figure 2: Possible intermediates

- A
- B
- C
- D
- E



Epoxy Precursor

A Level

c	c	c
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Epoxy resins are polymers which are used as adhesives. One monomer used in their manufacture has the displayed formula:

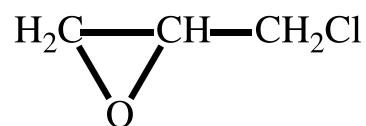


Figure 1: Epoxy resin monomer

This is manufactured from propene in three stages:

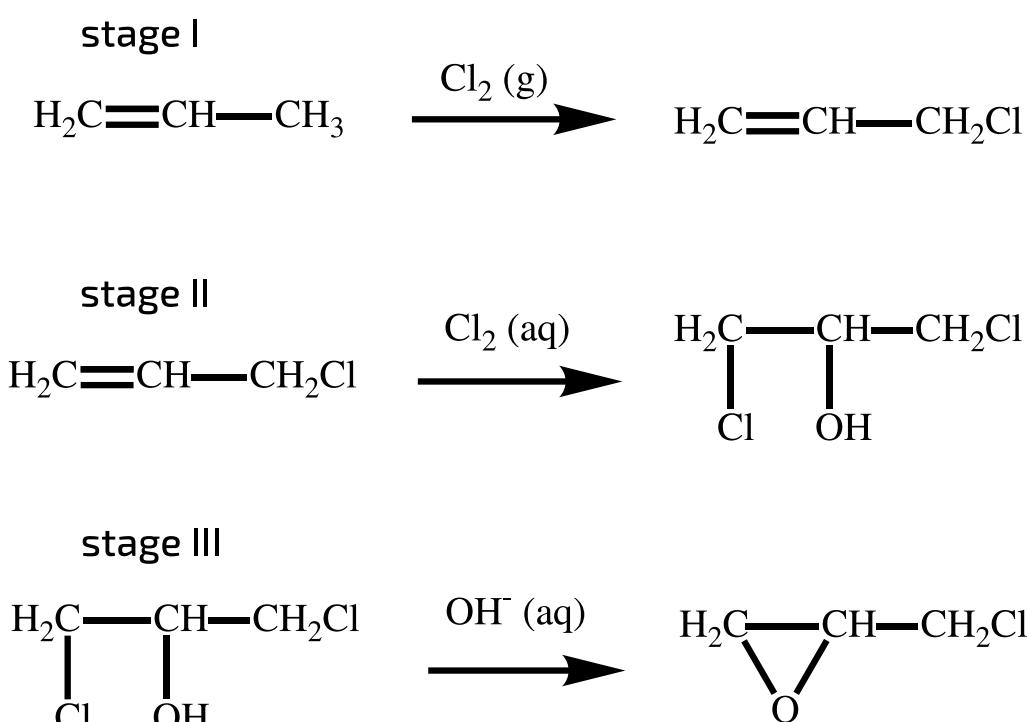


Figure 2: Three stages of epoxy monomer manufacture from propene

Part A Stage I

What type of reaction mechanism takes place between propene and chlorine gas in stage I?

Suggest what conditions are necessary for this reaction.

Part B Stage II

What type of reaction mechanism takes place when the aqueous chlorine reacts in stage II?

Part C Stage III

What type of organic reaction takes place in stage III?

Adapted with permission from UCLES, A-Level Chemistry, November 1994, Paper 3, Question 4