Compounds from but-2-ene

A Level

Complete the reaction scheme shown below which starts with but-2-ene. In each of the boxes **A** to **D** give the principal organic product or intermediate compound.

Use the structure editor to generate a SMILES string.

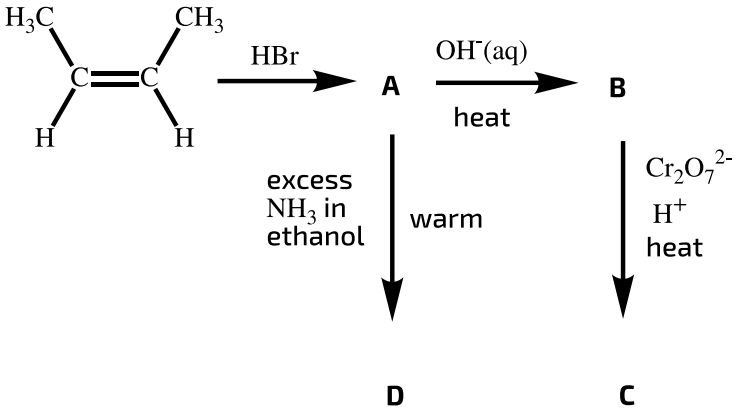

Figure 1: Compounds from but-2-ene

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 **A**

A is:

Part B **B**

B is:

Part C **C**

C is:

Part D **D**

D is:

Adapted with permission from UCLES, A-Level Chemistry, June 1996, Chains and Rings, Question 1

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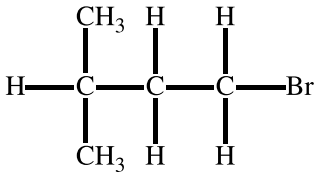
Isopentyl Bromide

A Level

When isopentyl bromide (**F**), $(CH_3)_2CHCH_2CH_2Br$, reacts with hot aqueous ethanolic KOH, two products are formed: compound **G**, $C_5H_{12}O$, and compound **H**, $C_7H_{16}O$.



F

Figure 1: Isopentyl bromide (**F**)

Part A Hydroxide with ethanol

The hydroxide ion and ethanol can take part in an acid-base reaction. Write an equation to represent this. State symbols are not required.

Part B Compound G

What is compound **G**?

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 C Compound H

What is compound **H**?

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 D Type of reaction

State the type of reaction undergone by compound **F**

Part E F with ammonia

Draw the structure of the product derived from compound **F** by reaction with concentrated aqueous ammonia.

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 F Reaction with potassium cyanide

Draw the structure of the product derived from compound **F** by reaction with ethanolic potassium cyanide.

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

Adapted with permission from UCLES, A-Level Chemistry, November 1994, Paper 1, Question 10

Ketones with HCN further

A Level

The initial product of the reaction between HCN and propanone gives **A** which is then subjected to a dehydration reaction to produce **B**.

$$CH_3COCH_3 \xrightarrow{HCN} \mathbf{A} \xrightarrow{\text{dehydration}} \mathbf{B} \xrightarrow{\text{hydrolysis}} \mathbf{C}$$

Part A Propanone with HCN

What is **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 Dehydration

What is **B**?

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 C Hydrolysis

The product of the dehydration reaction **B** is hydrolysed under acidic conditions to give **C**.

What is **C**?

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 and B adapted with permission from UCLES, A-Level Chemistry, June 1992, Paper 4, Question 28;
Part C created for isaacphysics.org by R. Less

Mechanism types

A Level

Part A Perspex intermediate

The following reaction is an intermediate stage in the manufacture of the important polymer known as *Perspex*.

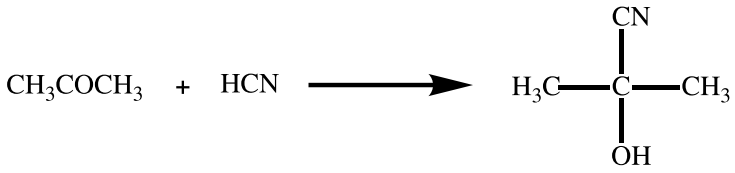


Figure 1: Intermediate in manufacture of *Perspex*

What type of mechanism is involved in this reaction?

- electrophilic addition
- nucleophilic addition
- free radical substitution
- electrophilic substitution
- nucleophilic substitution

Part B Reaction with chlorine

A non-polar organic compound undergoes a reaction with chlorine [$A_r(\mathrm{Cl}) = 35.5$] when light is shone upon the reaction mixture. The relative molecular mass of the product is 34.5 greater than that of the original compound.

The reaction is most likely to be:

- free radical substitution
- nucleophilic substitution
- electrophilic addition
- nucleophilic addition
- electrophilic substitution

Part A adapted with permission from UCLES, A-Level Chemistry, November 1991, Paper 1, Question 23 ;
Part B adapted with permission from OCSEB, A-Level Chemistry, June 1994, Paper 1, Question 21

More nitriles

A Level

Part A Reaction with cyanide ions

Which of the following compounds could be the product of a reaction involving a nucleophilic attack by cyanide ions in aqueous ethanolic solution?

- $(CH_3)_2CHCN$
- $CH_2{=}CHCN$
- CH_3CONH_2
- $CH_3CH_2CH_2CH_2NH_2$

Part B Hydrolysis of CS

CS has the structure shown below, is an active component of 'tear gas' and is readily hydrolysed.

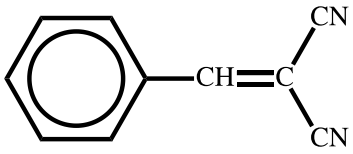
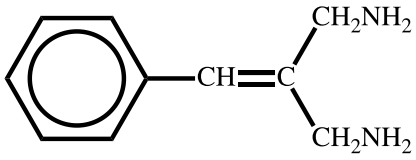


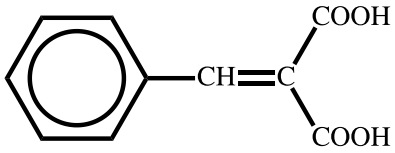
Figure 1: Structure of CS

Which of the following is a possible hydrolysis product of CS?

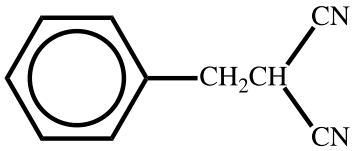
A



B



C



D

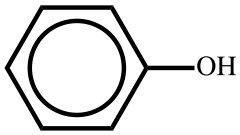


Figure 2: Possible hydrolysis products of CS

- A
- B
- C
- D

Part A adapted with permission from UCLES, A-Level Chemistry, November 1994, Paper 4, Question 23;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1995, Paper 4, Question 25

Organic reaction intermediates

A Level

Part A Hydrobromic acid with ethene

Hydrogen bromide reacts with ethene to form bromoethane. Which of the following is the best description of the organic intermediate?

- It is a free radical
- It has a negative charge
- It contains carbon, hydrogen and bromine
- It is an electrophile
- Its structure is planar

Part B Carbocation intermediate

In which of the following reactions is a cation an intermediate?

- $CH_3CH_2Br + NaOH \xrightarrow{H_2O} CH_3CH_2OH + NaBr$
- $CH_2{=}CH_2 + Br_2 \longrightarrow CH_2BrCH_2Br$
- $CH_3CH_2Cl + 2\,NH_3 \longrightarrow CH_3CH_2NH_2 + NH_4Cl$
- $CH_3CHO + HCN \xrightarrow{CN^-} CH_3CH(OH)CN$
- $CH_3CH_3 + Cl_2 \longrightarrow CH_3CH_2Cl + HCl$

Part A adapted with permission from UCLES, A-Level Chemistry, 1988, Paper 3, Question 23;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1992, Paper 4, Question 22

Reactions of NH_3

A Level

Part A With haloalkanes

An amine is produced in the following reaction.

$$C_2H_5I + 2\,NH_3 \longrightarrow C_2H_5NH_2 + NH_4I$$

What is the mechanism?

- nucleophilic addition
- electrophilic substitution
- nucleophilic substitution
- electrophilic addition

Part B With aldehydes

Ethanal can react with ammonia as shown.

$$CH_3CHO + NH_3 \longrightarrow CH_3CH(OH)NH_2$$

Which kind of chemical reaction takes place?

- free-radical addition
- addition-elimination
- nucleophilic addition
- electrophilic addition

Part A adapted with permission from UCLES, A-Level Chemistry, June 1996, Paper 3, Question 22;
Part B adapted with permission from OCR, A-Level Chemistry, June 1999, Paper 3, Question 21

Reaction types

A Level

Part A Sunburn ointment

Many sunburn ointments contain benzocaine which relieves the pain caused by sunburn. It can be made in the laboratory by using the following reaction scheme.

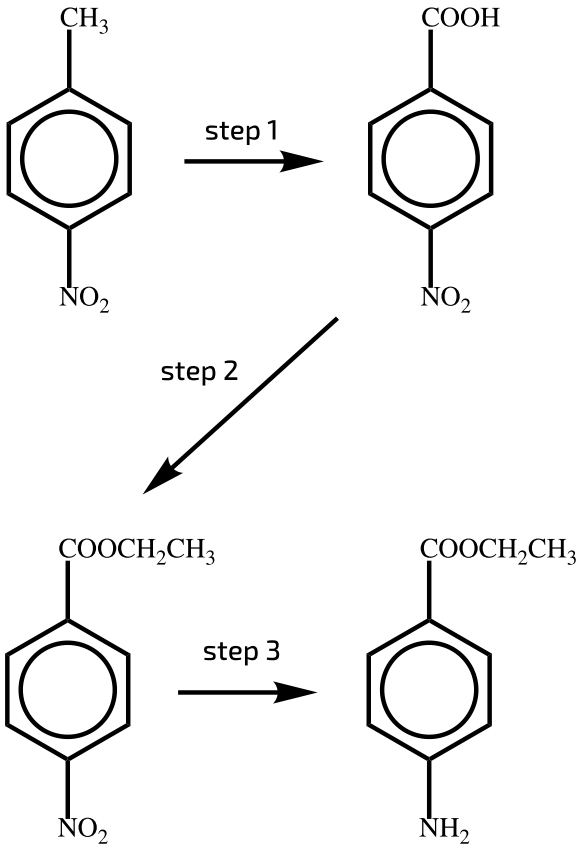


Figure 1: Preparation of benzocaine

Which of the following statements about this reaction scheme are correct?

1 Step 1 is an oxidation.
2 Step 2 is an esterification.
3 Step 3 is a reduction.

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

Part B Aldol

The Russian composer Borodin was also a research chemist who discovered a reaction in which two ethanal molecules combine to form a compound commonly known as aldol (reaction I). Aldol forms another compound on heating (reaction II).

(I) $2\,CH_3CHO \longrightarrow CH_3CH(OH)CH_2CHO$

(II) $CH_3CH(OH)CH_2CHO \longrightarrow CH_3CH{=}CHCHO + H_2O$

Which of the following best describes reactions I and II?

	I	II
A	addition	elimination
B	addition	reduction
C	elimination	reduction
D	substitution	elimination

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

Part A adapted with permission from UCLES, A-Level Chemistry, November 1993, Paper 4, Question 36;
Part B adapted with permission from UCLES, A-Level Chemistry, November 1994, Paper 4, Question 21

Role of reagent

A Level

Part A Bradosol

Bradosol is a compound used for the relief of sore throats. It is produced in the following reaction.

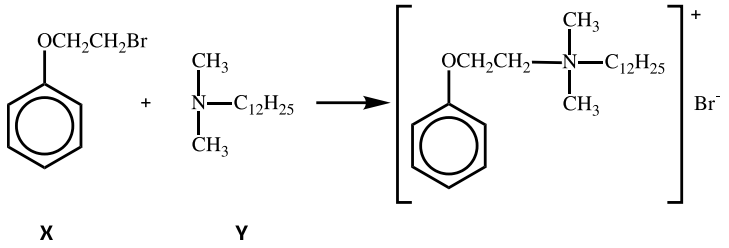


Figure 1: *Bradosol* synthesis

What is the role of compound **Y** in this reaction?

- a nucleophile
- a ligand
- an electrophile
- a reducing agent

Part B Inorganic reagent

In which reaction does the inorganic reagent act as a nucleophile?

- $CH_3CH_2NH_2 + HCl \longrightarrow [CH_3CH_2NH_3]^+Cl^-$
- $CH_3CH_3 + Cl_2 \xrightarrow{h\nu\ (\text{light})} CH_3CH_2Cl + HCl$
- $CH_3CH{=}CH_2 + Br_2 \longrightarrow CH_3CHBrCH_2Br$
- $CH_3CH_2Br + NaOH \longrightarrow CH_3CH_2OH + NaBr$

Part A adapted with permission from UCLES, A-Level Chemistry, June 1998, Paper 3, Question 19;
Part B adapted with permission from UCLES, A-Level Chemistry, November 1998, Paper 3, Question 20