

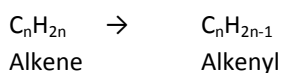
## ALKENES

### Introduction

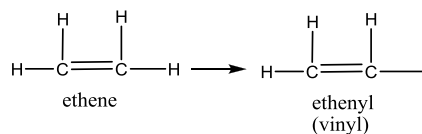
- Unsaturated hydrocarbons containing C=C bond are called alkenes.
- Carbon atoms having double bond make  $sp^2$  hybridization.
- They are also known as olefins, because they react with chlorine to form an oil-like liquid.
- General formula is  $C_n H_{2n}$ .
- Simplest member is ethene,  $C_2H_4$ .
- Change -ane ending with -ene to name alkenes.

### 1. Alkenyl Groups

- When one hydrogen is removed from an alkene an alkenyl group is formed.
- General formula of alkenyl group is  $C_n H_{2n-1}$ .



#### Example 1



#### Example 2

What is the molecular formula of an alkene having 3.6 g of carbon in its structure? (C:12, H:1)

#### Example 3

When 5.6 g of an alkene is burnt, 17.6 g of  $CO_2$  is produced. What is the molecular formula of the alkene? (C:12, H:1)

#### Example 4

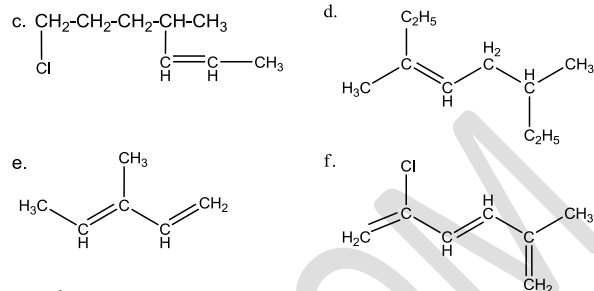
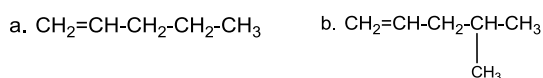
How many liters of air is needed to burn 2.1 g of propene at STP? (C:12, H:1)

### 2. Nomenclature of Alkenes

- Select longest carbon atom chain containing a double bond.
- Number the carbon atoms in the chain starting at the end nearest to the double bond.
- Add the position of double bond before the parent name.
- Use -diene suffix instead of -ene for alkadienes.

#### Example 5

Name the following alkenes.

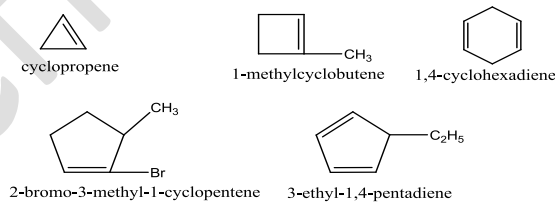


- a. 1-pentene  
b. 4-methyl-1-pentene  
c. 7-chloro-4-methyl-2-heptene  
d. 3,6-dimethyl-3-octene  
e. 3-methyl-1,3-pentadiene  
f. 2-chloro-5-methyl-1,3,5-hexatriene

### Cycloalkenes

Alkenes may have cyclic structures. Their naming are similar to cycloalkanes. Position of double bond must be indicated

#### Example 6



#### Example 7

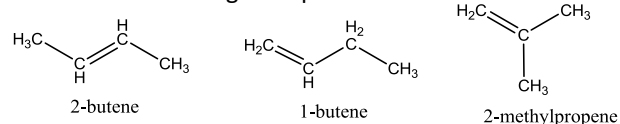
Draw the structures of the following alkenes.

- a. 2-ethyl-1-butene  
b. 1,3-butadiene  
c. 3-propyl-1-heptene  
d. 2-chloro-1-cyclopentene  
e. 1,3-dibromo-2-butene

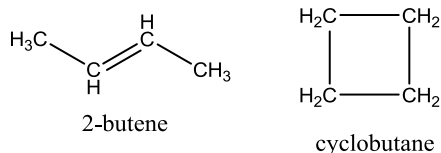
### 3. Isomerism

#### Structural Isomerism

Additionally, in alkenes according to position of double bond different structures might be possible.

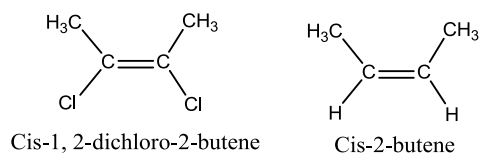


Cycloalkanes and alkenes have same general formula,  $C_nH_{2n}$ .

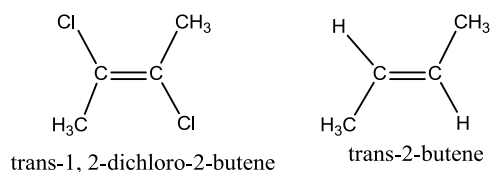


### Geometric Isomerism

If the same groups are on the same side of the double bond, it is **cis** arrangement.



If the same groups are on the different side of the double bond, it is **trans** arrangement.



## 4. Physical Properties of Alkenes

- Alkenes containing 2-4 carbon atoms are gaseous, 5-17 carbon atoms are liquids and higher ones are solid.
- Boiling points increase as the number of carbon atom increases.
- Branching decreases boiling point.

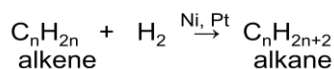
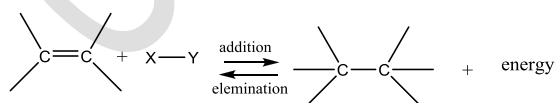
## 5. Chemical Properties of Alkenes

- Alkenes are reactive substances because of weak pi bond.

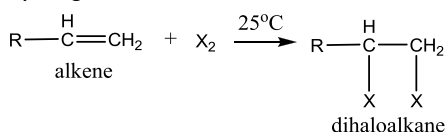
### 1. Combustion Reactions



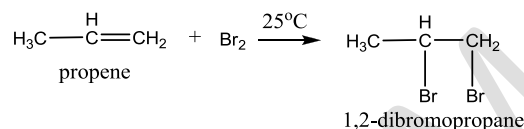
### 2. Addition Reactions



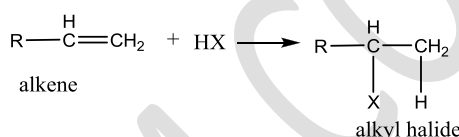
### Hydrogenation



## Halogenation

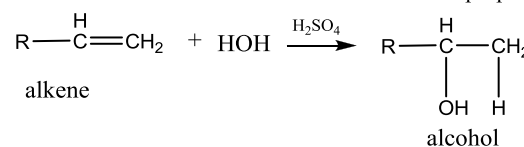


Addition of  $\text{Br}_2$  to hydrocarbons is a useful reaction to test them whether they are saturated or unsaturated. If brown  $\text{Br}_2$  color disappears they contain double or triple bond.



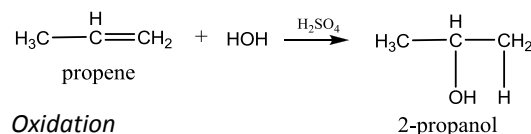
## Hydrohalogenation

Addition of hydrogen halides (HCl, HBr) to alkenes follow **Markovnikov's Rule**. He said that hydrogen in hydrogen halides attaches to carbon atom which have greater number of hydrogen atoms.

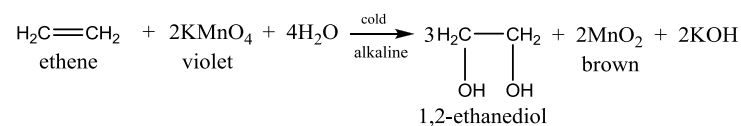


## Hydration

Addition of water to alkenes follows Markovnikov's Rule.



## Oxidation



Alkenes undergo oxidation upon addition of  $\text{KMnO}_4$  in cold medium and produce diols, alcohol, and color of  $\text{KMnO}_4$  turns to brown. This method is used to detect alkenes, and is known as **Baeyer's Test**.

### Example 8

Write an equation for each of the following reactions.

- hydrogenation of 2-methyl propene
- addition of chlorine to 1-butene
- acid-catalyzed addition of water to 2-pentene
- Addition of HCl to 2-butene

### Example 9

If 3.6 g of water is added to an alkene, 12 g of alcohol is obtained. What is the formula of the alkene?

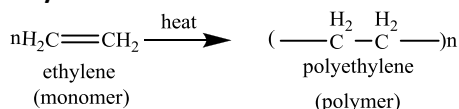
### Example 10

If 32 g of bromine (Br<sub>2</sub>) can be added to a 10 g mixture of ethylene and ethane, what is the percentage by mass of ethene in the mixture?

### Example 11

11.2 L of hydrogen gas at STP are required to saturate a 14.6 g mixture of ethene and propene. What is the mass of each gas in the mixture?

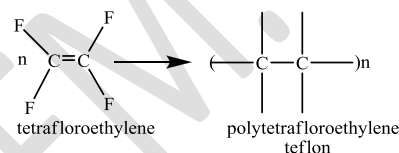
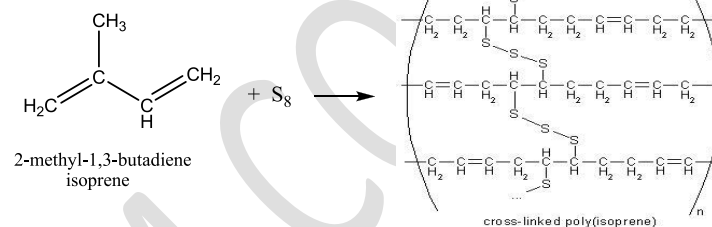
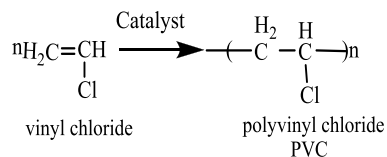
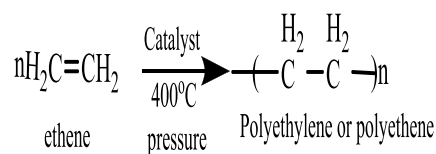
### Polymerization



Polymers are large molecules that contain repeating structural units. The simple molecule from which these repeating units are derived is called a monomer, and the process of converting a monomer to polymer is called **polymerization**.

### 6. Polymers

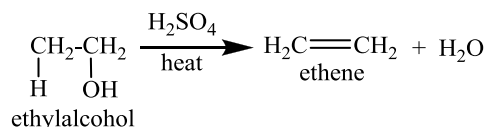
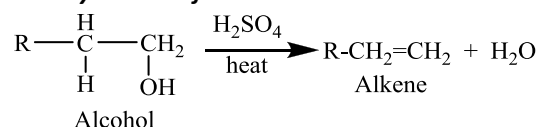
- Proteins, starch, nucleic-acids, cellulose, silk and natural rubber are the most widely encountered natural polymers..
- Polyethylene, PVC, teflon, polyacrylonitrile, polystyrene, and polypropylene are synthetic polymers.
- There are two types of synthetic polymers, addition polymers and condensation polymers.
- A condensation polymerization occurs when a polymer is formed by a reaction that leaves behind a small molecule, such as water.
- Addition polymerization is a reaction when a polymer is formed from its monomer with no other molecules produced.



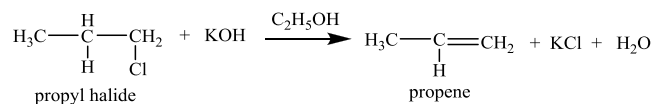
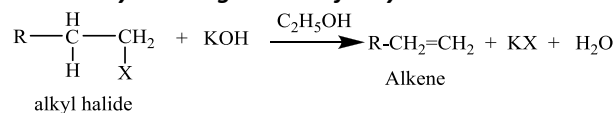
- Invented in US in 1930s
- 1946, first marketed by DuPont as Teflon
- Has the lowest coefficient of friction of any solid material known to man
- Found on pots, pans, overcoats, bullets and pine lining

### 7. Preparation of Alkenes

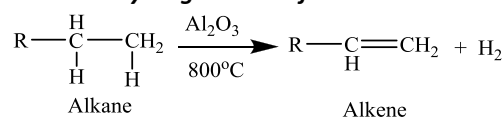
#### 1. Dehydration of Monoalcohols



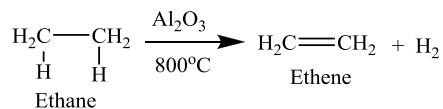
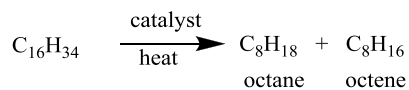
#### 2. Dehydrohalogenation of Alkyl Halides



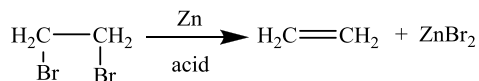
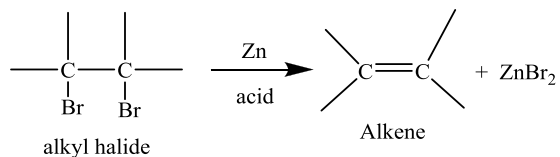
#### 3. Dehydrogenation of Alkanes



#### 4. Cracking of Alkanes



#### 5. Dehalogenation of Dibromines



#### Example 12

Write an equation for each of the following reactions.

- Dehydration of propyl alcohol
- Dehydrohalogenation of propyl chloride
- Dehydrogenation of propane
- Dehalogenation of 1, 2-dibromopropane

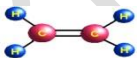
#### Example 13

How many grams of ethylene can be produced from 230 g of ethyl alcohol,  $\text{C}_2\text{H}_5\text{OH}$ , by 80% production?

#### Example 14

How many grams of butene can be produced from 13.7 g of 2-bromobutane?

#### Ethylene (Ethene)



- simplest alkene, colorless, with specific odor, slightly soluble in water, and organic solvents.
- produced from coal gas and petroleum by cracking methods.
- used as monomer to produce many useful polymers.