Republic of Iraq Ministry of Higher
Education & Scientific Research
University of Al-Maarif
College of Dentistry

Alkenes and Cycloalkenes

Lec(9)

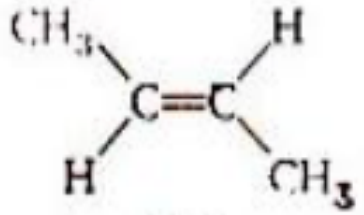
First stage

By

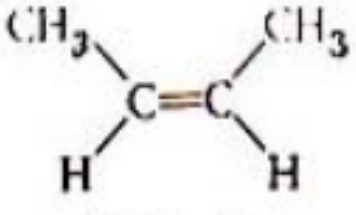
Qusay Abdulsattar

Alkenes and Alkynes

Alkenes can form **geometric isomers.** The **trans** isomer has the two methyl groups across from each other, and the **cis** isomer has the groups adjacent to each other.



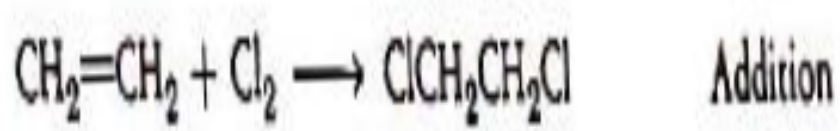
trans-2-Butene



cis-2-Butene

Addition Reactions OF Alkenes

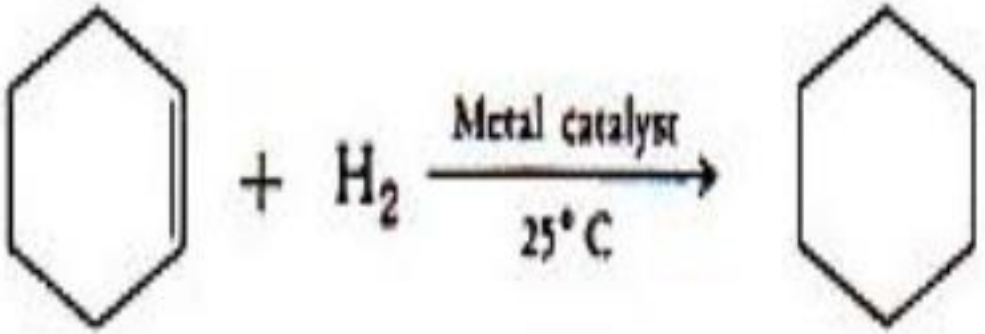
Alkenes and alkanes undergo different types of reactions. Alkanes react by substitution, whereas addition to the double bond is the reaction of alkenes.



1- Addition of Hydrogen: Reduction of the carbon – carbon double bond

The addition of H_2 to alkenes in the presence of a metal catalyst converts them to alkanes.

Some specific examples:



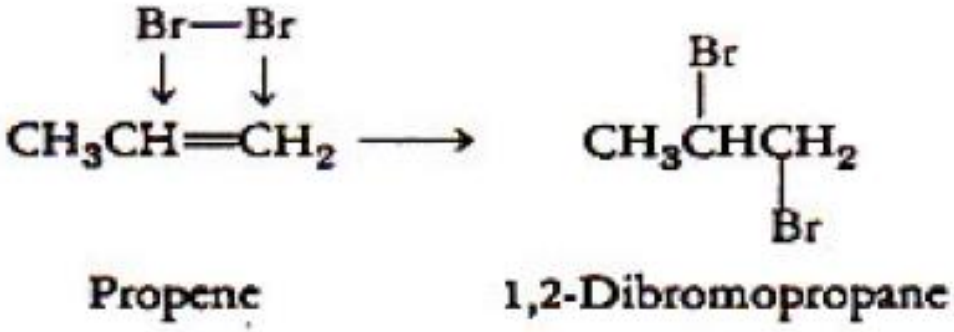
Cyclohexene Cyclohexane

$$CH_2{=}CHCH{=}CHCH_3 + 2\,H_2 \xrightarrow[25^\circ C]{\text{Metal catalyst}} CH_3(CH_2)_3CH_3$$

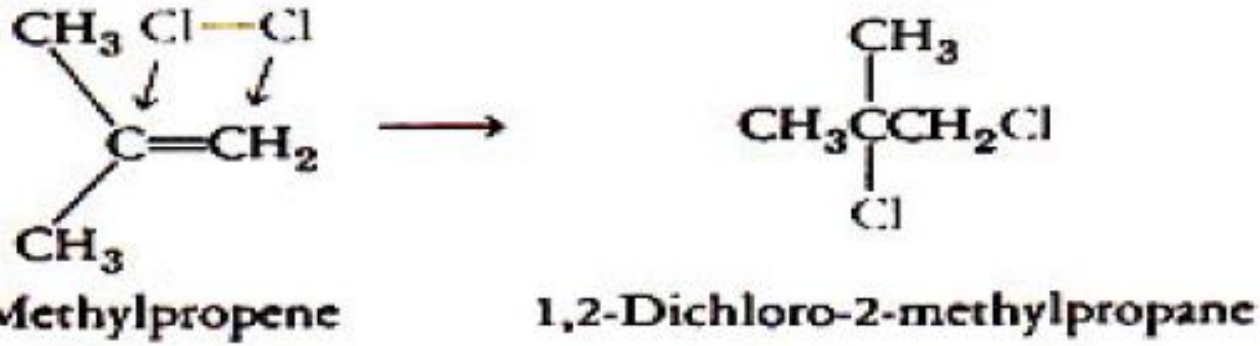
1,3-Pentadiene Pentane

2- Addition of Halogens

The addition of bromine and chlorine to alkenes occurs readily. **Examples**

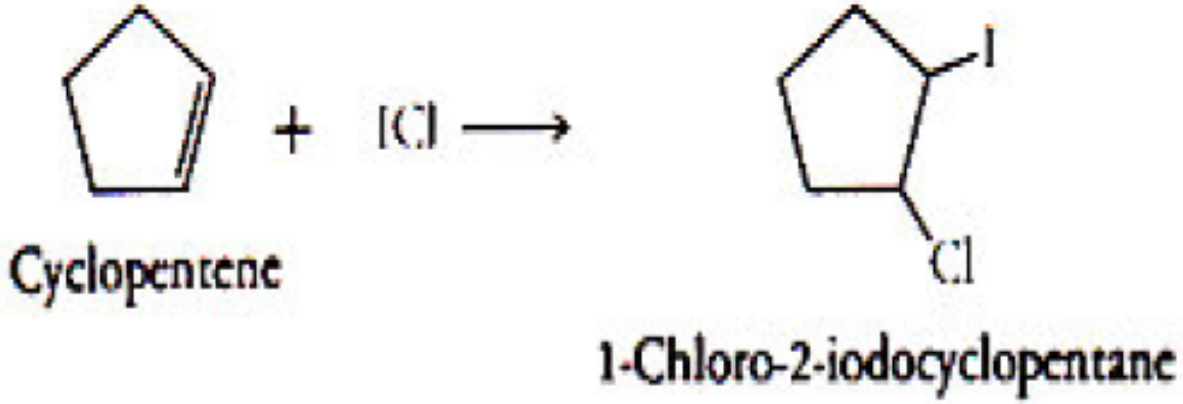


Propene — 1,2-Dibromopropane



Methylpropene — 1,2-Dichloro-2-methylpropane

Iodine usually does not react with alkenes but the interhalogens iodine monochloride (ICl) and iodine mono bromide (IBr) are added readily.

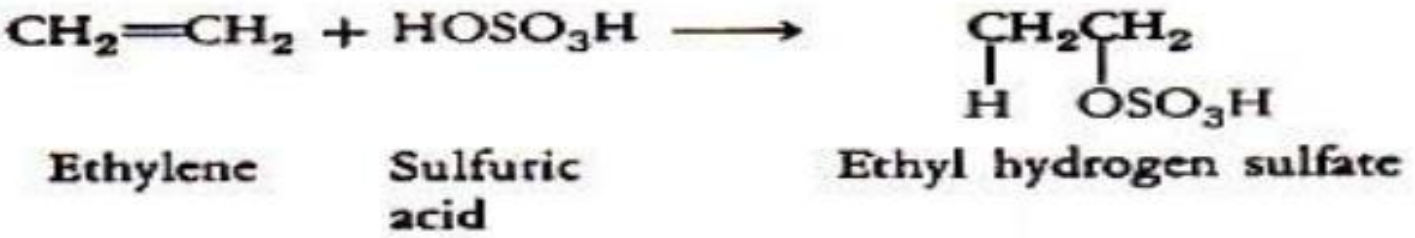


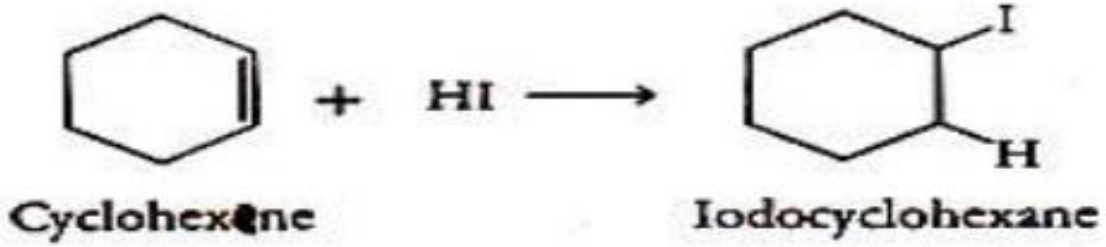
Cyclopentene

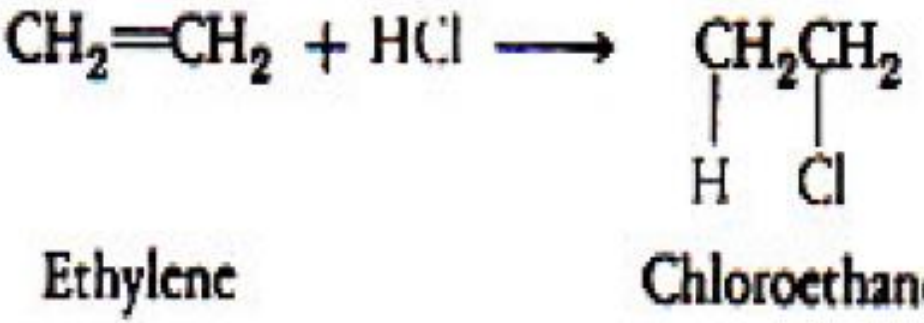
1-Chloro-2-iodocyclopentane

3- Addition of Acids

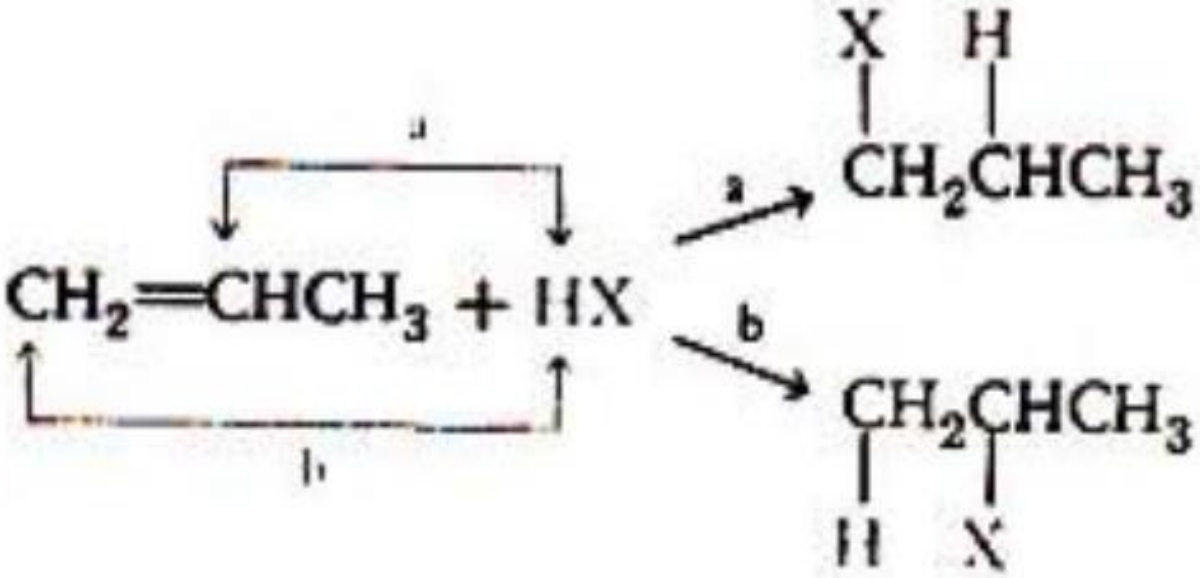
Acids such as sulfuric acid and the hydrogen halides are readily added to alkenes. Examples



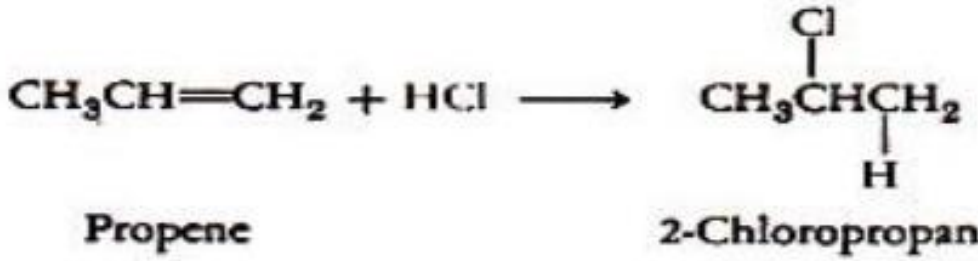




The addition of an unsymmetrical reagent such as HX to an unsymmetrical alkene can form two isometric products:

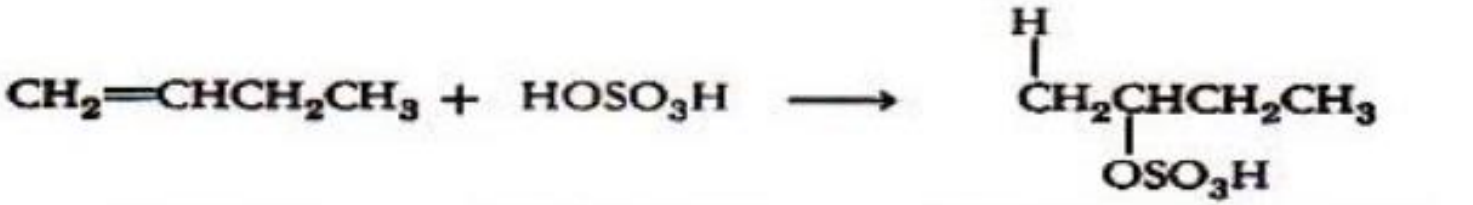


Actually, only one product is obtained, the one formed when the hydrogen of the acid is added to the carbon of the double bond containing the greatest number of hydrogens.This rule is called the Markownikoff rule. Examples



Propene 2-Chloropropane

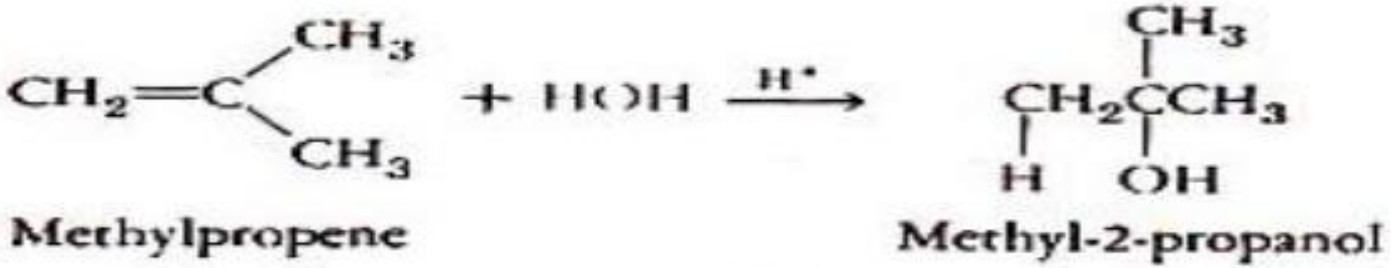
1-Methylcyclohexene 1-Iodo-1-methylcyclohexane



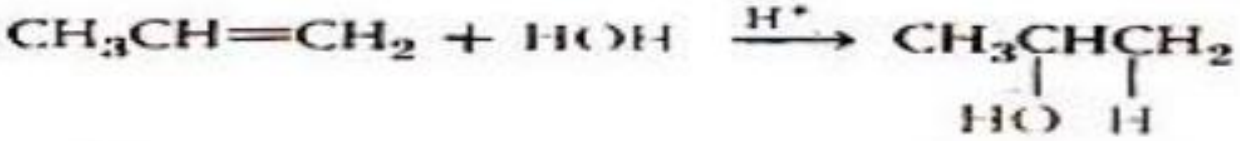
1-Butene Sulfuric acid sec-Butyl hydrogen sulfate

4- Addition of Water

The addition of water to alkenes, called Hydration,riquires the presence of a strong acid catalyst such as sulfuric or phosphoric acid.



Methylpropene — Methyl-2-propanol

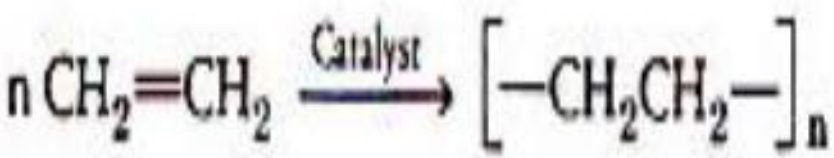


Propene — 2-Propanol

1-Methylcyclohexene — 1-Methylcyclohexanol

Polymerization: One alkene adding to another

Polymer: A huge molecule with a high molecular weight formed by combining a large number of monomers(monomer:one molecule of an alkene),for example, ethylene polymerizes to form polyethylene with the a catalyst.

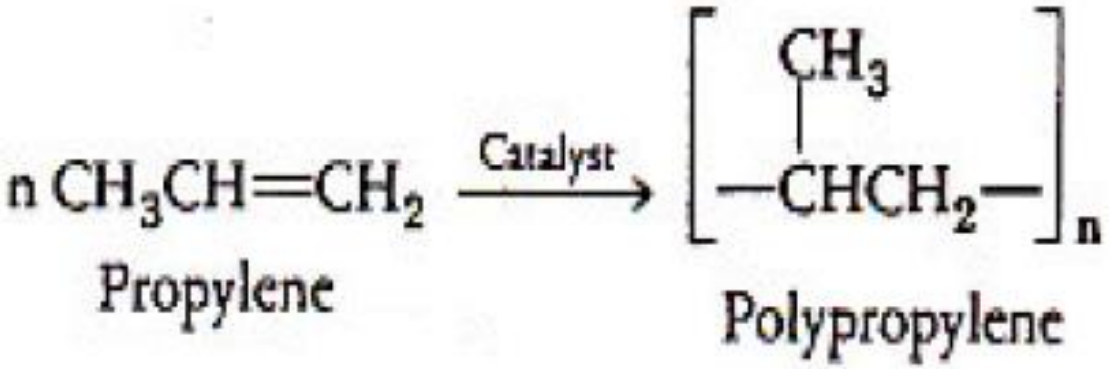


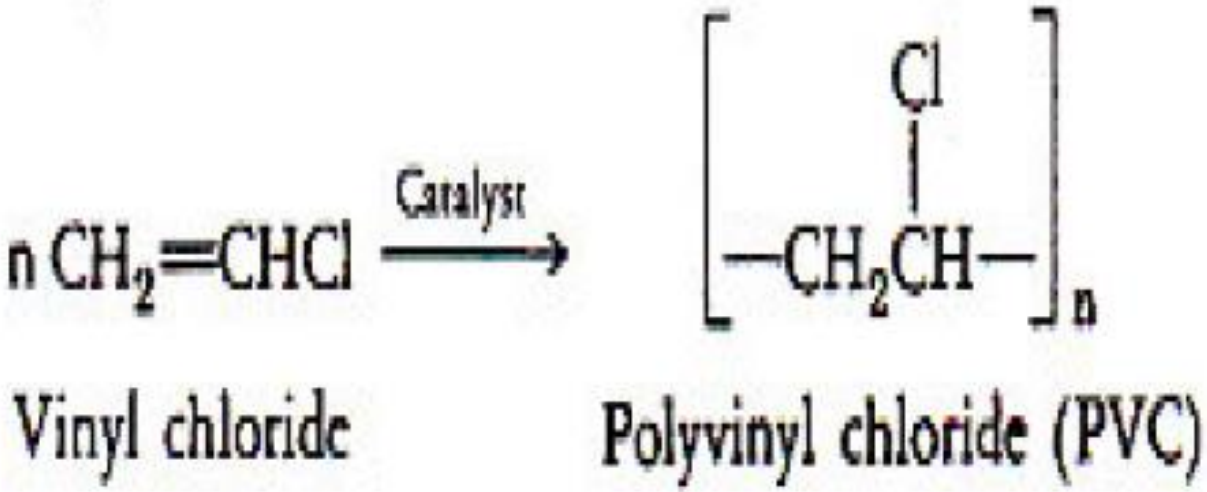
Ethylene (a monomer)

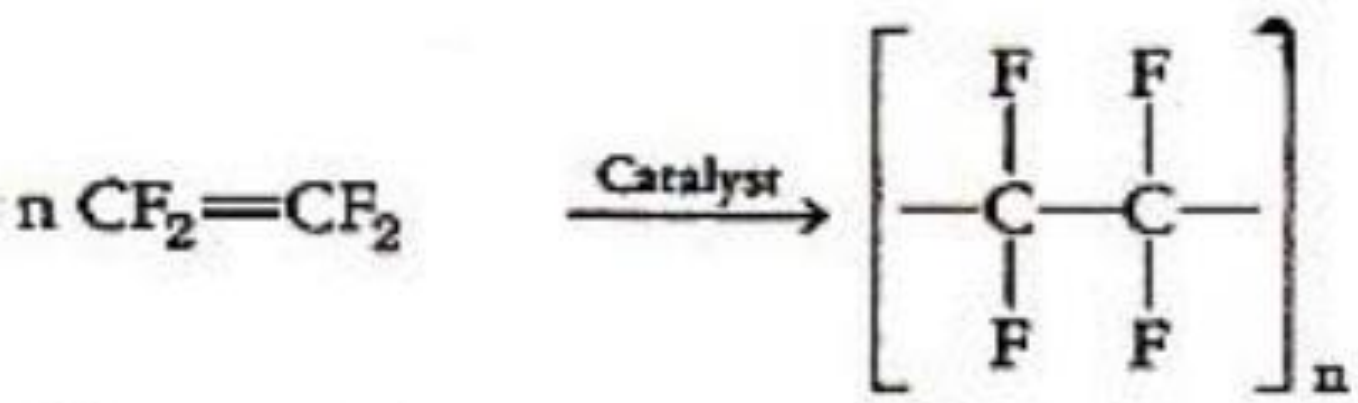
Polyethylene (a polymer)

n is a whole number that varies from several hundred to several thousand

Examples:


n CH3CH=CH2
Catalyst
CH3
CHCH2
n
Propylene
Polypropylene


n CH2=CHCl
Catalyst
Cl
CH2CH
n
Vinyl chloride
Polyvinyl chloride (PVC)



Tetrafluoroethylene

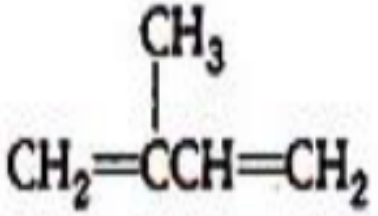
Teflon

1,3-Buradiene

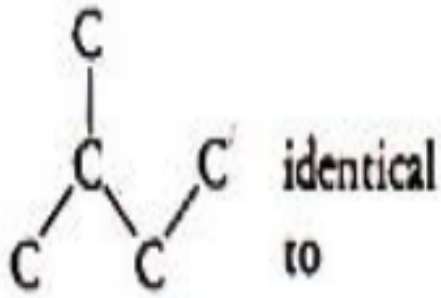
Polyburadiene

Polymers Formed By Living Systems

Polymerization also occurs in living systems. A large number of compounds called terpenes are found in living systems. These compounds are all polymers made of a repeating five-carbon unit that is structurally related to isoprene

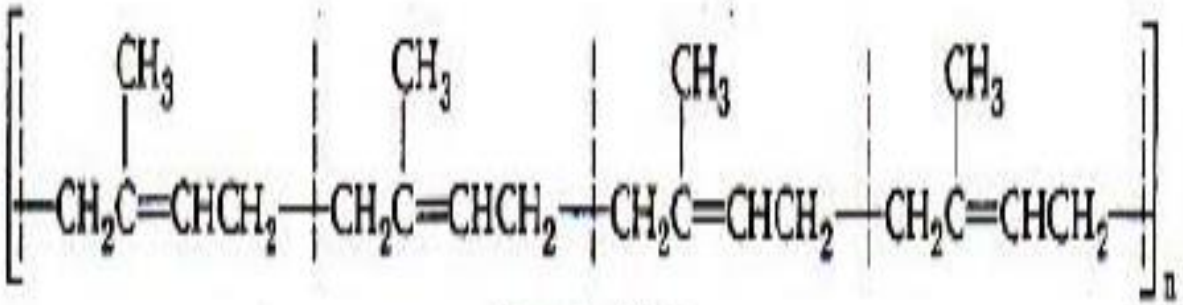


Isoprene



Isoprene unit

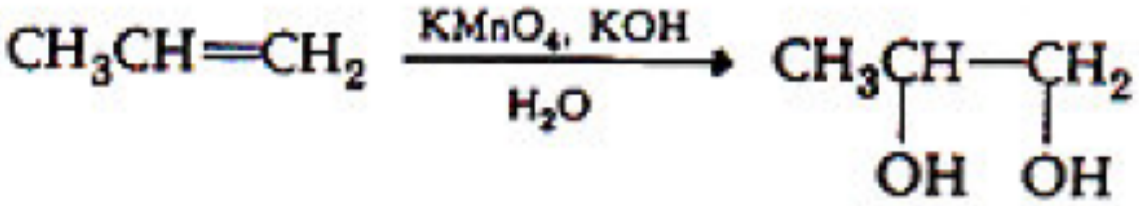
Natural rubber is an example of a polymer made by combining thousands of isoprene unit.

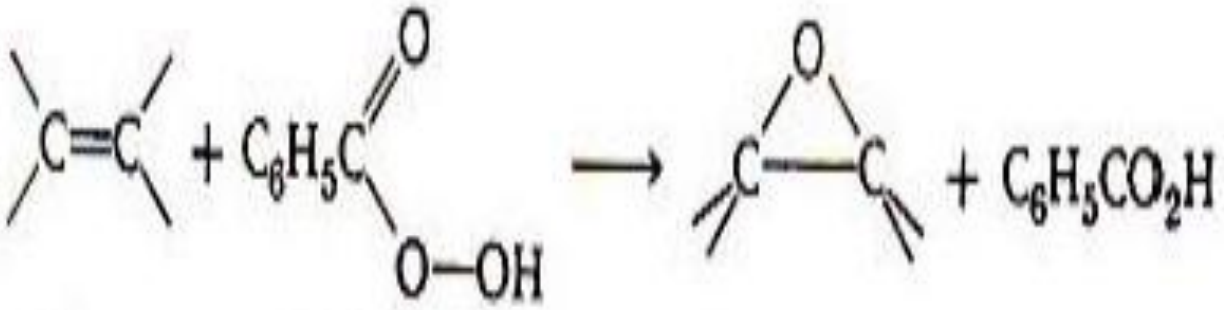


Natural rubber

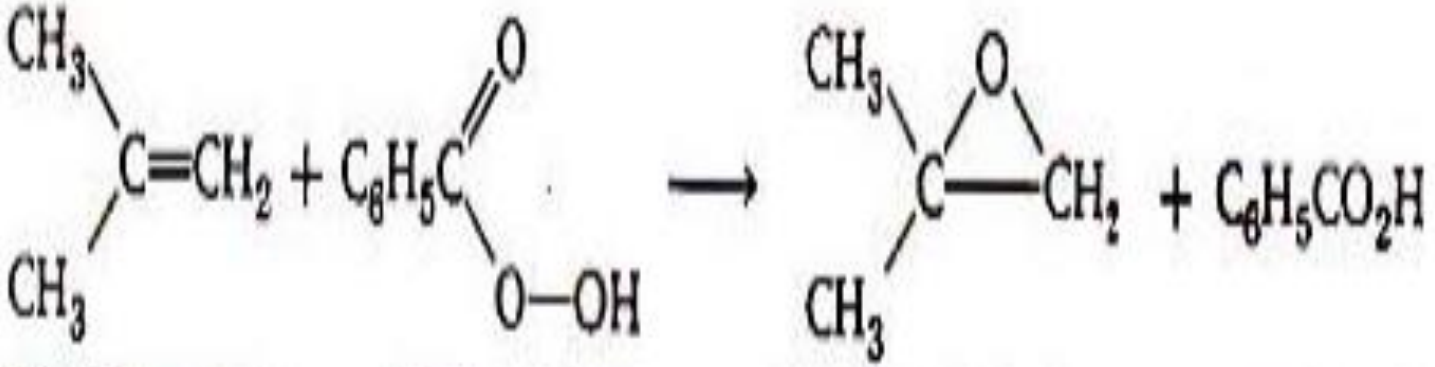
Oxidation of carbon-carbon Double Bonds

The carbon-carbon double bond of an alkene reacts readily with a number of oxidizing reagents such as potassium permanganate, peracids and ozone. The product of the reaction depends on the reagent and the experimental conditions

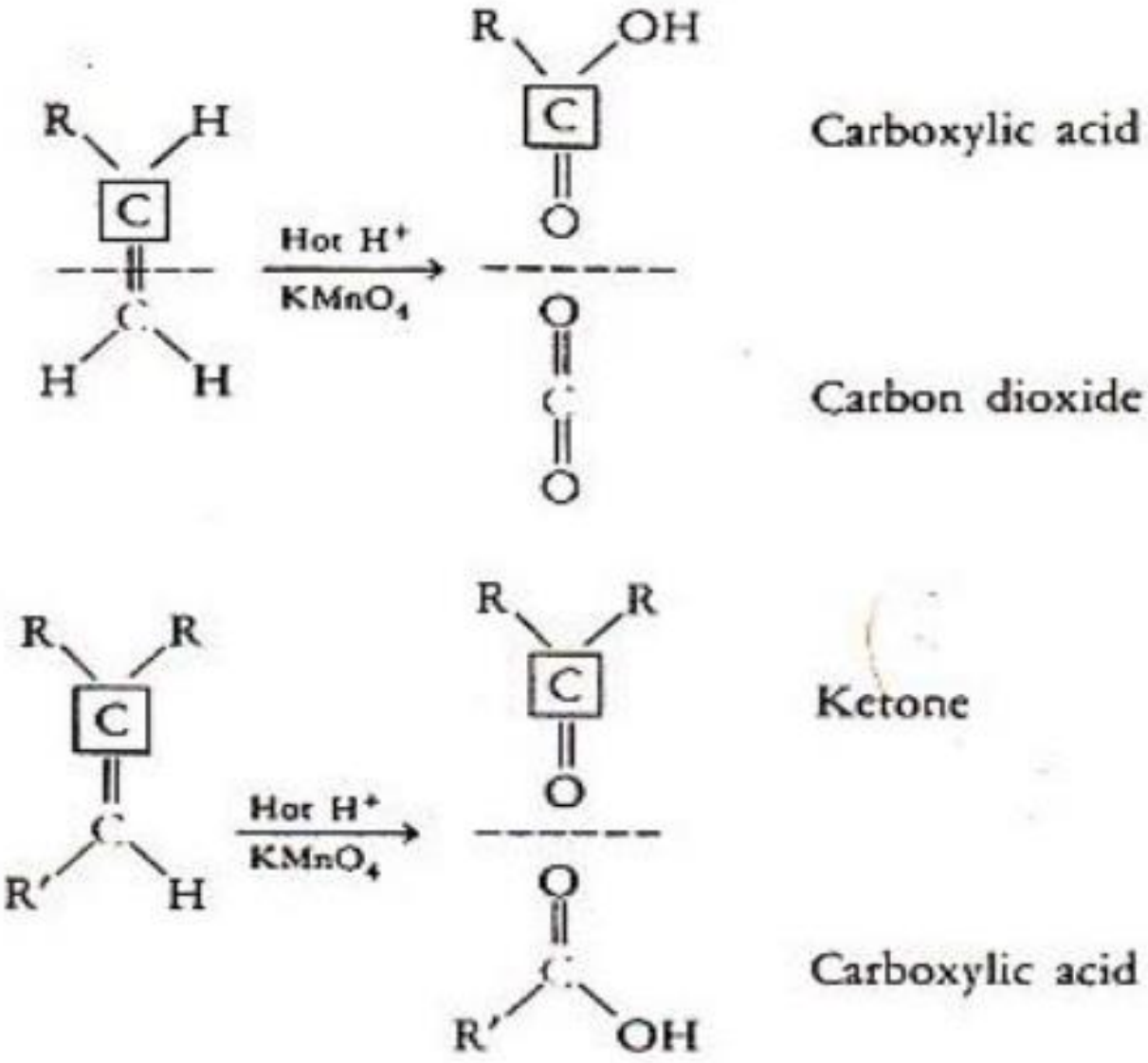




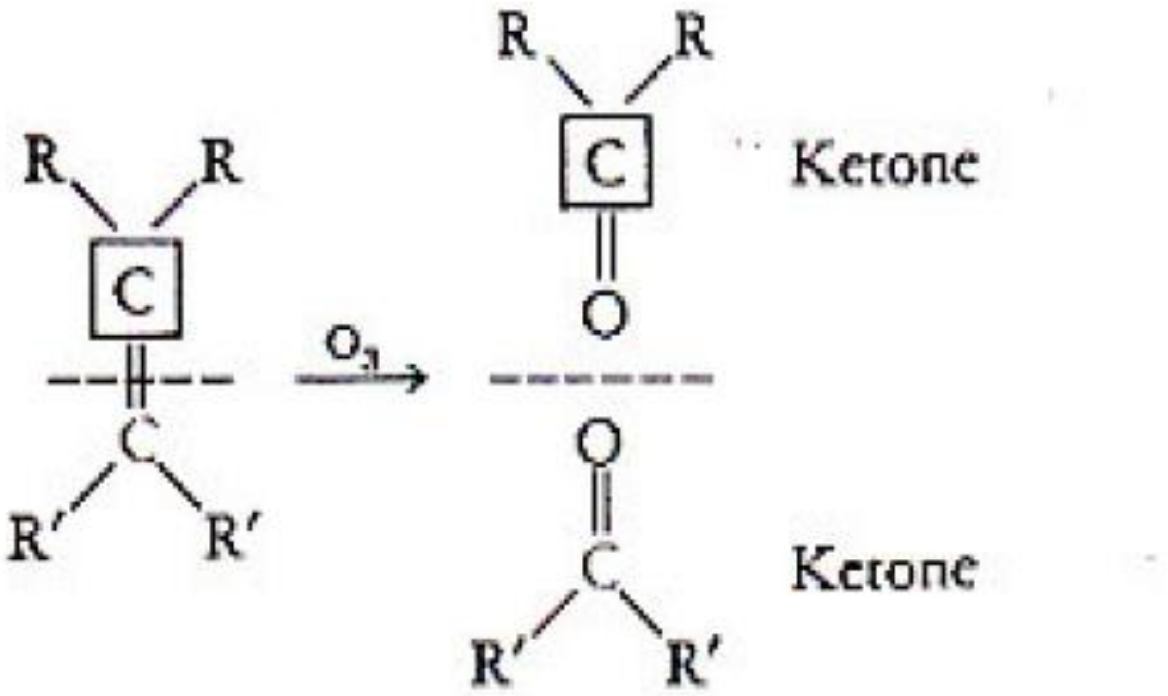
Alkene | Perbenzoic acid | An oxirane (an epoxide) | Benzoic acid



Methylpropene | Perbenzoic acid | 1,1-Dimethyloxirane | Benzoic acid


R
H
C
H
H
Hot H+
KMnO4
R
OH
C
O
O
C
O
Carboxylic acid
Carbon dioxide
R
R
C
R'
H
Hot H+
KMnO4
R
R
C
O
O
R'
OH
Ketone
Carboxylic acid

- The reaction with O_3 called ozonolysis,also breaks the double bond.

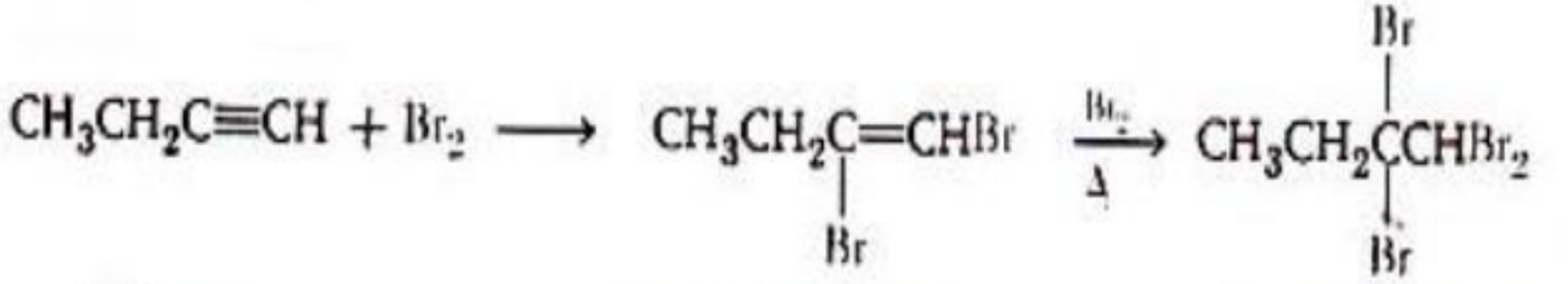


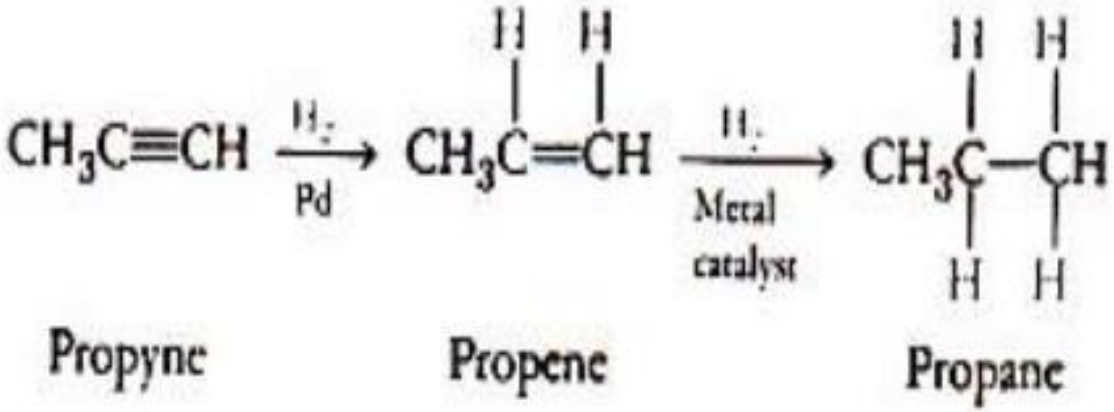
Alkynes

These compounds all contain at least one carbon-carbon triple bond. like acetylene (C_2H_2).

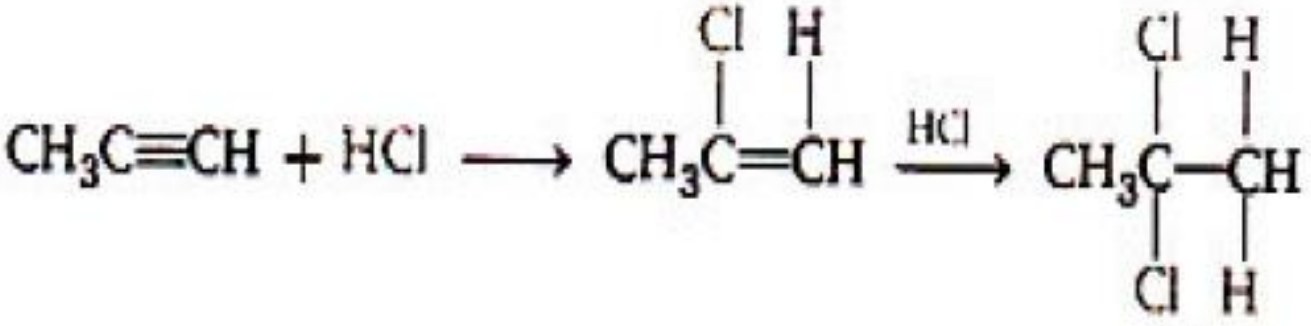
The reactions of alkynes are similar to those of alkenes.

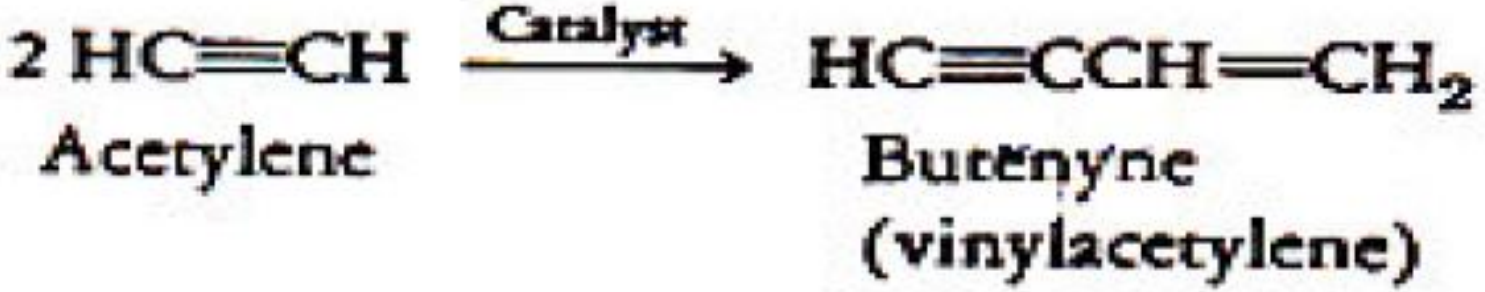
Example:


1-Butyne
1,2-Dibromo-1-butene
1,1,2,2-Tetrabromo-butane


Pd
Metal catalyst
Propyne
Propene
Propane

*




2 HC≡CH
Catalyst
HC≡CCH=CH2
Acetylene
Butenyne
(vinylacetylene)