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Alkenes and Alkynes I. Properties and Synthesis

6.1 INTRODUCTION

Alkenes are hydrocarbons whose molecules contain the carbon–carbon double bond. An old name for this family of compounds that is still often used is the name *olefins*. Ethene, the simplest olefin (alkene), was called olefiant gas (Latin: *oleum*, oil + *facere*, to make) because gaseous ethene (C_2H_4) reacts with chlorine to form $C_2H_4Cl_2$, a liquid (oil).

Hydrocarbons whose molecules contain the carbon–carbon triple bond are called alkynes. The common name for this family is *acetylenes*, after the first member, $HC{\equiv}CH$.

6.2 NOMENCLATURE OF ALKENES AND CYCLOALKENES

Many older names for alkenes are still in common use. Propene is often called propylene, and 2-methylpropene frequently bears the name isobutylene.

$CH_2{=}CH_2$	$CH_3CH{=}CH_2$	$CH_3{-}\overset{\displaystyle CH_3}{\overset{\vert}{C}}{=}CH_2$
IUPAC: **Ethene or ethylene***	***IUPAC:*** **Propene or propylene***	***IUPAC:*** **2-Methylpropene**
		Common: **Isobutylene**

The IUPAC rules for naming alkenes are similar in many respects to those for naming alkanes:

1. **Determine the base name by selecting the longest chain that contains the double bond and change the ending of the name of the alkane of identical length from ane to ene.** Thus, if the longest chain contains five carbon atoms, the base name for the alkene is *pentene*; if it contains six carbon atoms, the base name is *hexene*, and so on.

2. **Number the chain so as to include both carbon atoms of the double bond, and begin numbering at the end of the chain nearer the double bond. Designate the**

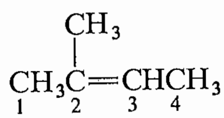
*The IUPAC system also retains the name ethylene and propylene when no substituents are present.

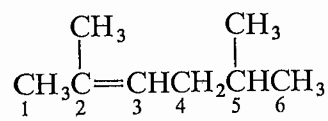
location of the double bond by using the number of the first atom of the double bond as a prefix:

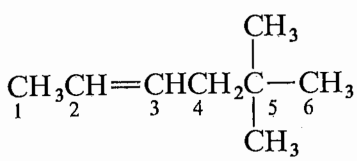
$\overset{1}{C}H_2{=}\overset{2}{C}H\overset{3}{C}H_2\overset{4}{C}H_3$
1-Butene
(*not* 3-butene)

$CH_3CH{=}CHCH_2CH_2CH_3$
2-Hexene
(*not* 4-hexene)

3. Indicate the locations of the substituent groups by the numbers of the carbon atoms to which they are attached.

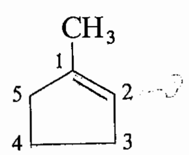

2-Methyl-2-butene
(*not* 3-methyl-2-butene)

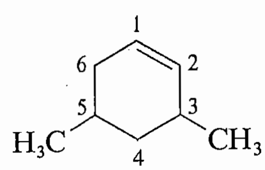

2,5-Dimethyl-2-hexene
(*not* 2,5-dimethyl-4-hexene)


5,5-Dimethyl-2-hexene

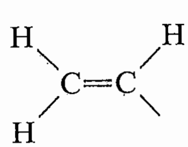
$\overset{4}{C}H_3\overset{3}{C}H{=}\overset{2}{C}H\overset{1}{C}H_2Cl$
1-Chloro-2-butene

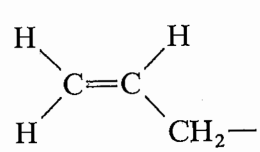
4. **Number substituted cycloalkenes in the way that gives the carbon atoms of the double bond the 1- and 2- positions and that also gives the substituent groups the lower numbers at the first point of difference.** With substituted cycloalkenes it is not necessary to specify the position of the double bond since it will always be on C-1. The two examples listed here illustrate the application of these rules.


1-Methylcyclopentene
(*not* 2-methylcyclopentene)

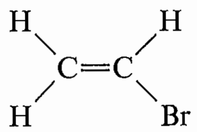

3,5-Dimethylcyclohexene
(*not* 4,6-dimethylcyclohexene)

5. Two frequently encountered alkenyl groups are the *vinyl group* and the *allyl group*.

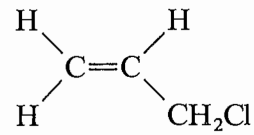

or
$CH_2{=}CH{-}$
The vinyl group


or
$CH_2{=}CHCH_2{-}$
The allyl group

The following examples illustrate how these names are employed:

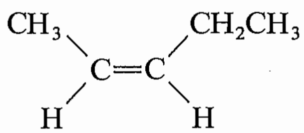


Bromoethene
or
vinyl bromide
(common)

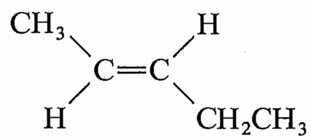


3-Chloropropene
or
allyl chloride
(common)

6. Designate the geometry of a double bond with two identical groups with the prefixes *cis-* and *trans-*. If two identical groups (usually hydrogen atoms) are on the same side of the double bond, it is **cis;** if they are on opposite sides, it is **trans.**



***cis*-2-Pentene**

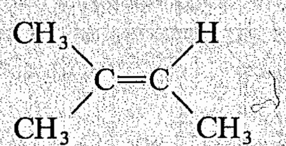


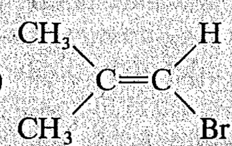
***trans*-2-Pentene**

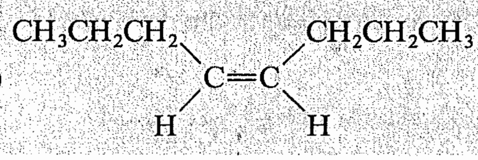
In the next section we shall see another method for designating the geometry of the double bond.

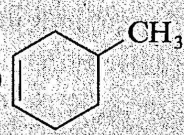
PROBLEM 6.1

Give IUPAC names for the following alkenes:

(a) 

(c) 

(b) 

(d) 

PROBLEM 6.2

Write structural formulas for

(a) *cis*-3-Hexene
(b) *trans*-2-Pentene
(c) 3-Ethylcyclohexene
(d) Vinylcyclohexane
(e) 4,4-Dimethyl-1-hexene
(f) 3-Methylcyclopentene
(g) 3-Chloro-1-octene
(h) 1,2-Dimethylcyclohexene
(i) 1,3-Dimethylcyclopentene
(j) 1,5-Dibromocyclohexene