كلية المعارف الجامعة
AL-MAARIF UNIVERSITY COLLEGE

General Chemistry.1

The title of Lecture: Alkenes and Alkynes

Year One; Semester. 1

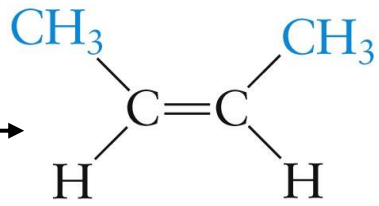
Presented by Dr. Sameer

DEPT. OF MEDICAL LAB. TECHNIQUES
قسم تقنيات المختبرات الطبية
AL-MAARIF UNIVERSITY COLLEGE
EST 2017

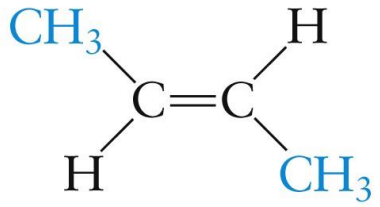
Alkenes (Olefins):

Carbon-hydrogen combination of CnH2n. Alkene family consists of chain molecules that contain double carbon-to-carbon bond and are therefore unsaturated.

- Also known as olefins, aliphatic, unsaturated
- C═C double bonds
- Formula for one double bond = C_nH_{2n}.
- *Cis-trans* isomerism

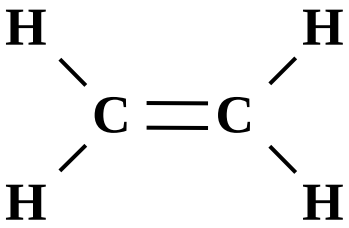


(a)

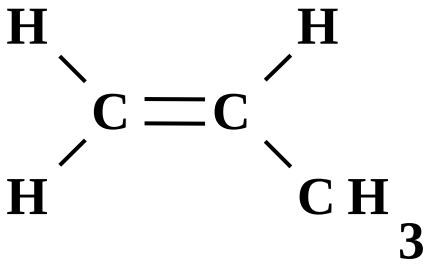


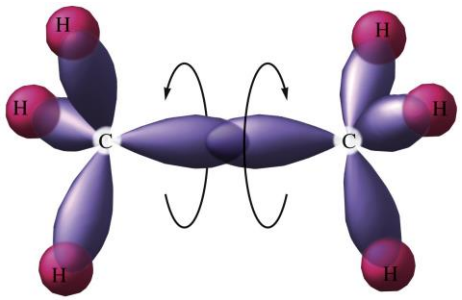
(b)

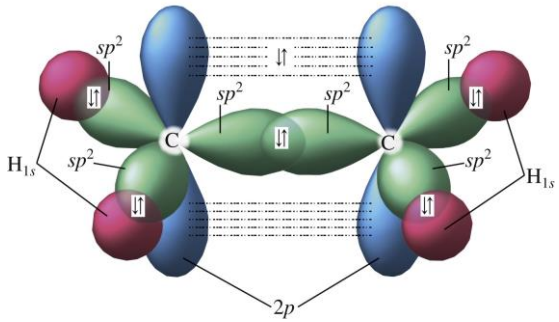
ethene = ethylene



propene = propylene







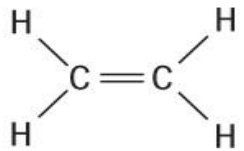
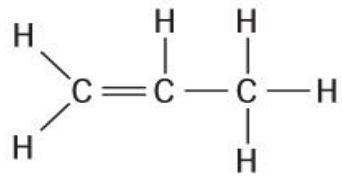
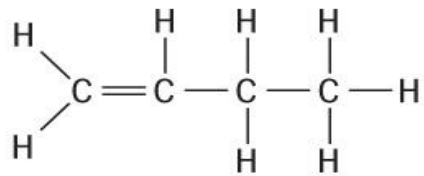
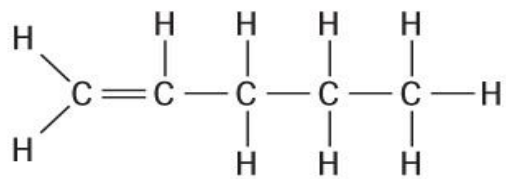
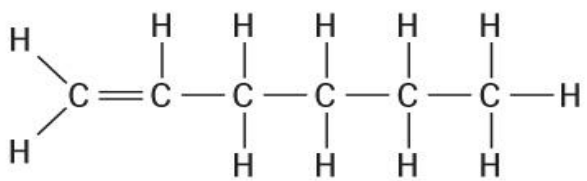
Alkynes

Alkynes: hydrocarbons containing at least one carbon–carbon triple bond.

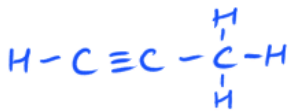
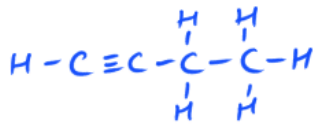
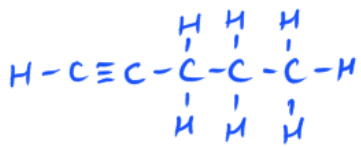
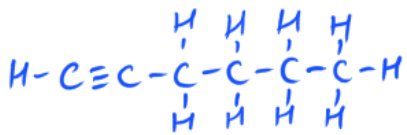
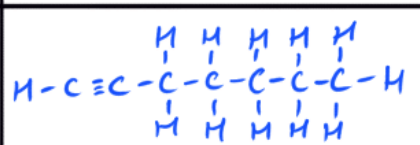
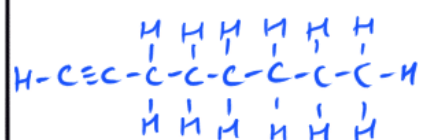
General formula is: CnH2n-2
Begins with ethyne (acetylene) 5. For Example: C2H2 H—C=C—H

1. Identify the parent chain, **which should include the C≡C triple bond**
2. Identify and Name the substituents
3. Assign a locant (and prefix if necessary) to each substituent **giving the C≡C triple bond the lowest number possible**
4. List the numbered substituents before the parent name in alphabetical order. Ignore prefixes (except iso) when ordering alphabetically
5. **The C≡C triple bond locant is placed either just before the parent's name or just before the -yne suffix**

TABLE 20.7 Alkenes

n	Name	Molecular Formula C_nH_{2n}	Structural Formula	Condensed Structural Formula
2	Ethene	C_2H_4		$CH_2=CH_2$
3	Propene	C_3H_6		$CH_2=CHCH_3$
4	1-Butene*	C_4H_8		$CH_2=CHCH_2CH_3$
5	1-Pentene*	C_5H_{10}		$CH_2=CHCH_2CH_2CH_3$
6	1-Hexene*	C_6H_{12}		$CH_2=CHCH_2CH_2CH_2CH_3$

* These alkenes have one or more isomers depending on the position of the double bond. The isomers shown here have the double bond in the 1 position, meaning the first carbon–carbon bond of the chain.

# of Carbons	Prefix	Suffix	Structural Formula	Molecular Formula
2	Eth	yne		C_2H_2
3	Prop	yne		C_3H_4
4	But	yne		C_4H_6
5	Pent	yne		C_5H_8
6	Hex	yne		C_6H_{10}
7	Hept	yne		C_7H_{12}
8	Oct	yne		C_8H_{14}

Physical Properties of Alkenes

- **Physical State**

Alkenes and alkynes occur at room temperature are gases, liquids, and solids.

  - C2 to C4 are gases,
  - C5 to C17 are liquids,
  - C18 and larger alkenes are wax –like solids.

- **Solubility**

  - Alkenes are nonpolar compounds.
  - Alkenes are soluble in the nonpolar solvents; CCl_4 and benzene,
  - Alkenes are insoluble in polar solvents like water.

- **Boiling Points & Melting Points**

  - The boiling points and melting points of normal hydrocarbons increase with increasing molecular weight.

Nomenclature of Alkenes and Alkynes

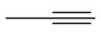
- To name alkenes, select the longest carbon chain which **includes** the carbons of the double bond. Remove the **-ane** suffix from the name of the alkane which corresponds to this chain. Add the suffix **-ene**.

The IUPAC Rules

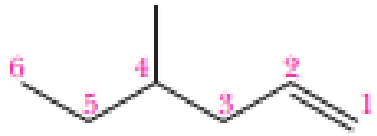
The IUPAC rules for naming alkenes and alkynes are similar to those for alkanes, but a few rules must be added for naming and locating the multiple bonds.

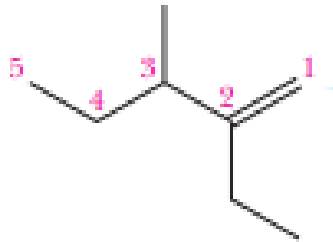
1. The ending *-ene* is used to a carbon–carbon double bond. The ending *-yne* is used for a carbon–carbon triple bond
2. Select the longest chain that includes both carbons of the double or triple bond.
3. Number the chain from the end nearest the double or triple bond so that the carbon atoms in that bond have the lowest possible numbers.

TABLE 12.7 Comparison of Names for Alkanes, Alkenes, and Alkynes

Alkane	Alkene	Alkyne
$CH_3—CH_3$	$H_2C=CH_2$	$HC\equiv CH$
Ethane	Ethene (ethylene)	Ethyne (acetylene)
$CH_3—CH_2—CH_3$	$CH_3—CH=CH_2$	$CH_3—C\equiv CH$
		
Propane	Propene	Propyne

Nomenclature of Alkenes and Alkynes





$CH_3CH_2CH_2CH_2CH{=}CH_2$

1-Hexene

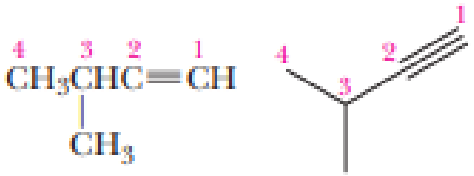
$CH_3CH_2CHCH_2CH{=}CH_2$ (CH$_3$ on C4)

4-Methyl-1-hexene

$CH_3CH_2CHC{=}CH_2$ (CH$_3$ on C3; CH_2CH_3 on C2)

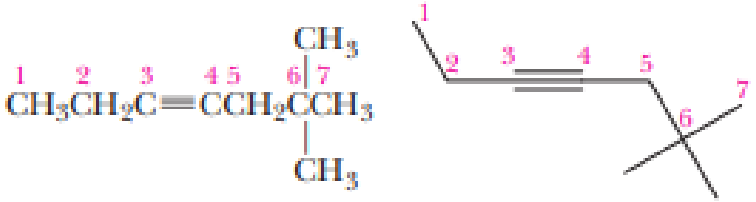
2-Ethyl-3-methyl-1-pentene

in naming alkenes, the parent chain is the longest chain containing the entire C=C bond, even if a different chain that doesn't contain the C=C bond is longer



$CH_3CHC{=}CH$ (CH$_3$ on C3)

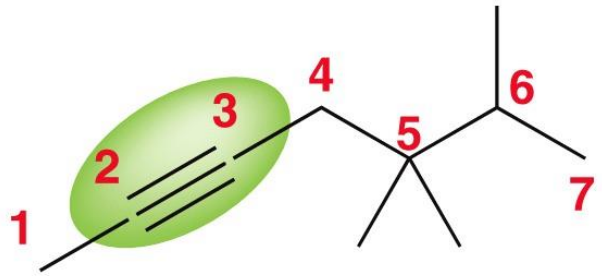
3-Methyl-1-butyne



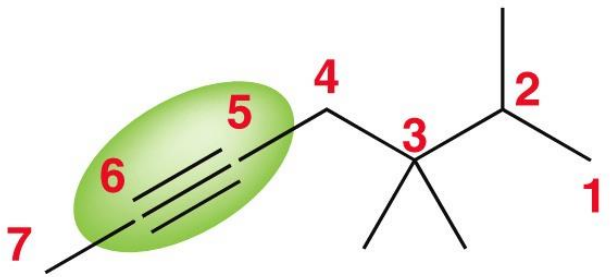
$CH_3CH_2C{=}CCH_2CCH_3$ (CH$_3$ on C6; CH$_3$ on C6)

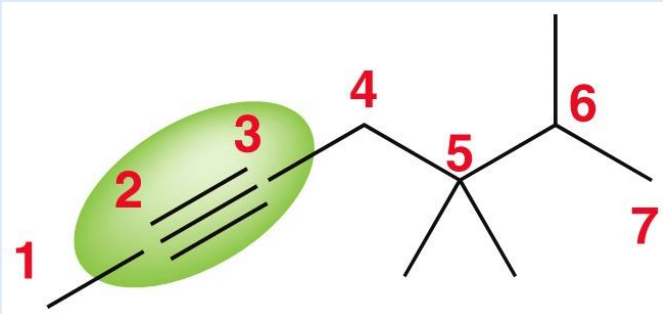
6,6-Dimethyl-3-heptyne

Correct



Incorrect



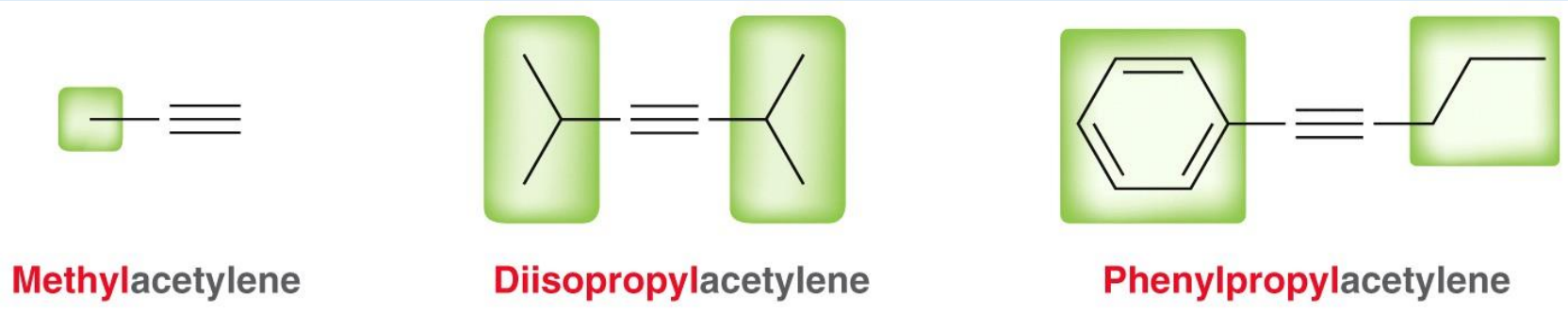


5,5,6-Trimethyl-2-heptyne

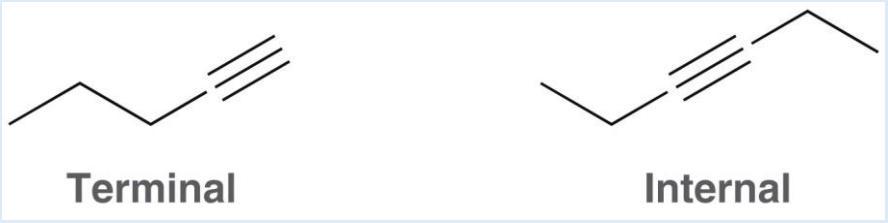
or

5,5,6-Trimethylhept-2-yne

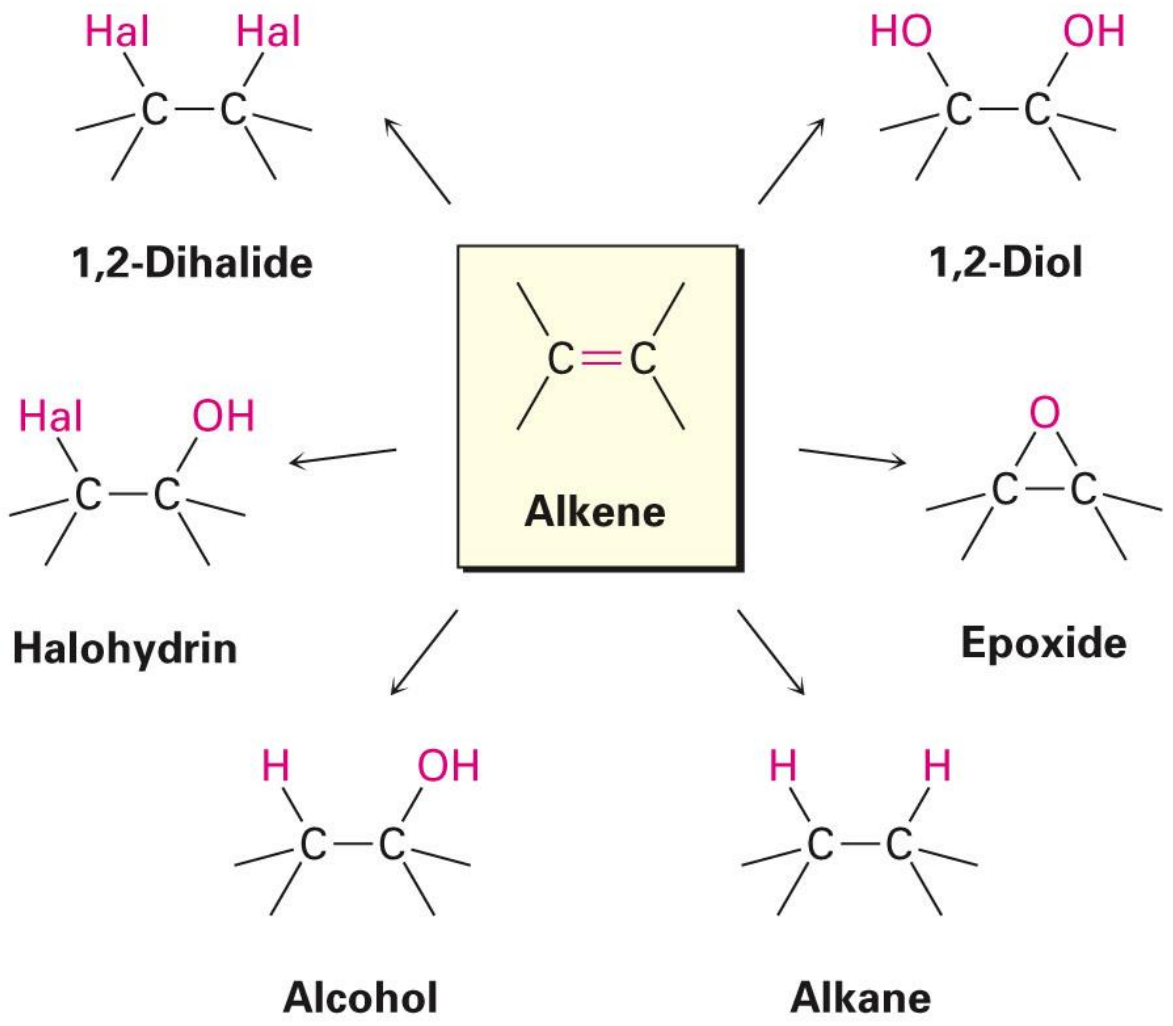
- common names derived from **acetylene** are often used as well



- Alkynes are also classified as **terminal** or **internal**

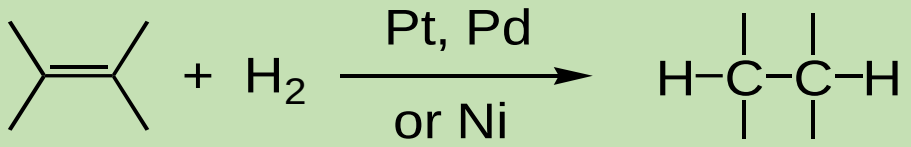


Reactions of Alkenes



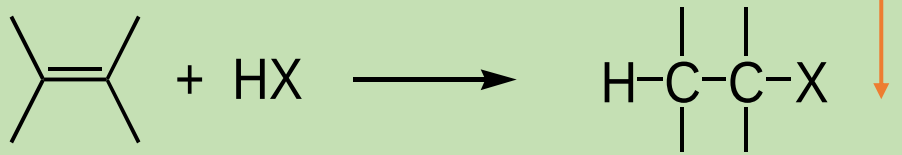
Reactions of alkenes

❑ Heat of hydrogenation



✓ the heat liberated during this reaction. ΔH is ~125 kJ/mol for each double bond in the compound.

❑ Addition of hydrogen halides



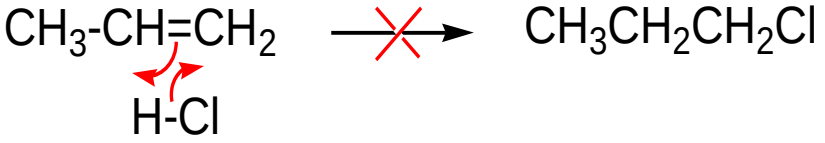
HX = HCl, HBr, HI

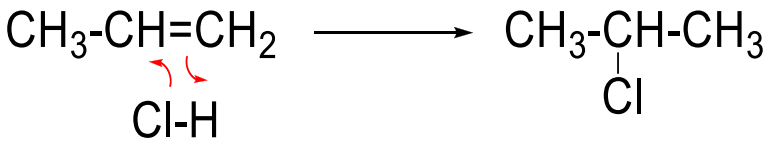
$H_2C{=}CH_2 + HCl \longrightarrow CH_3CH_2Cl$

only one product is possible, chloroethane

but....

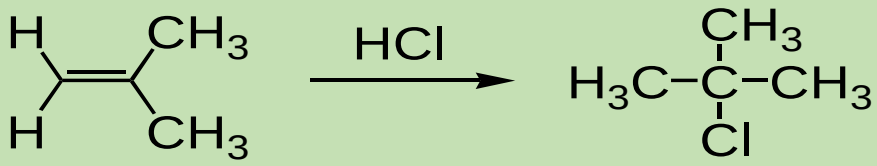
$CH_3\text{-}CH{=}CH_2 \longrightarrow$?





Only 2-chloropropane is formed

Markovnikov's rule



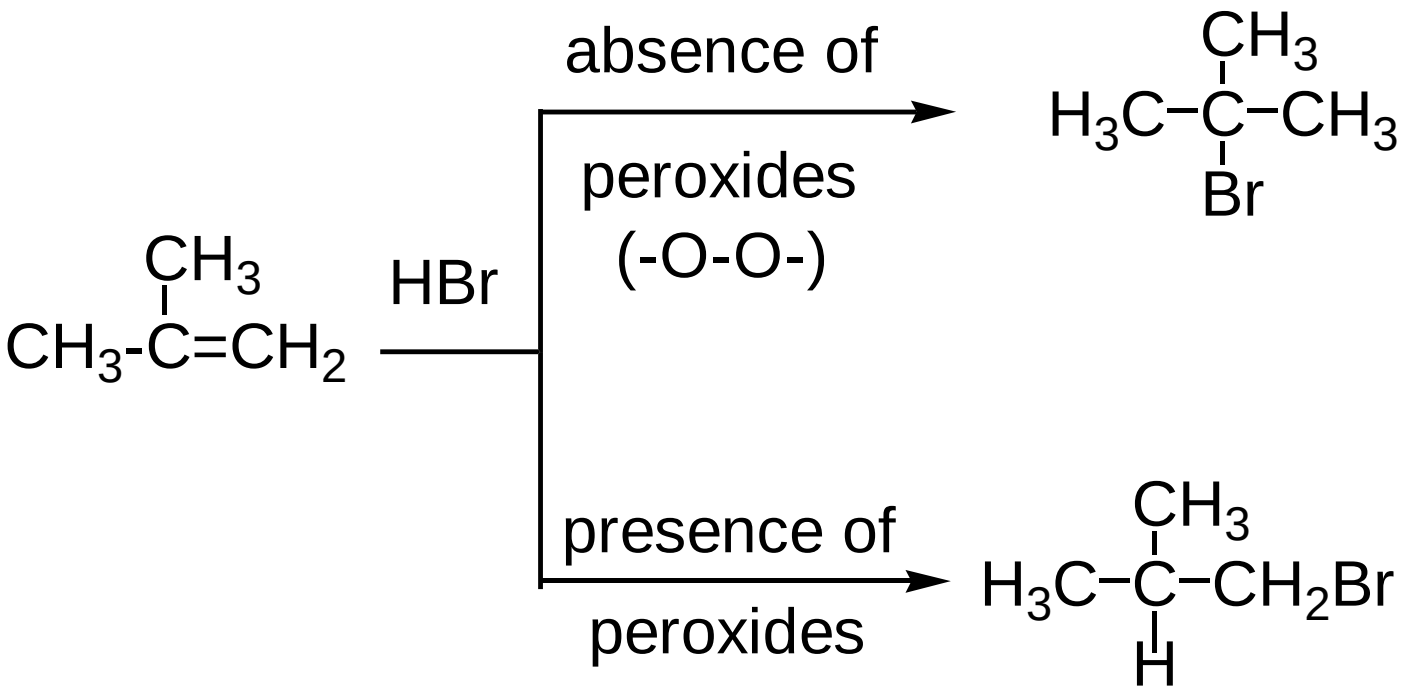
- In 1869, Markovnikov proposed that in the addition of an acid to an alkene, the hydrogen of the acid bonds to the carbon which is already bonded to the greater number of hydrogens.

$$CH_3CH_2CH{=}CHCH_3 + HI \longrightarrow CH_3CH_2CHICH_2CH_3 + CH_3CH_2CH_2CHICH_3$$

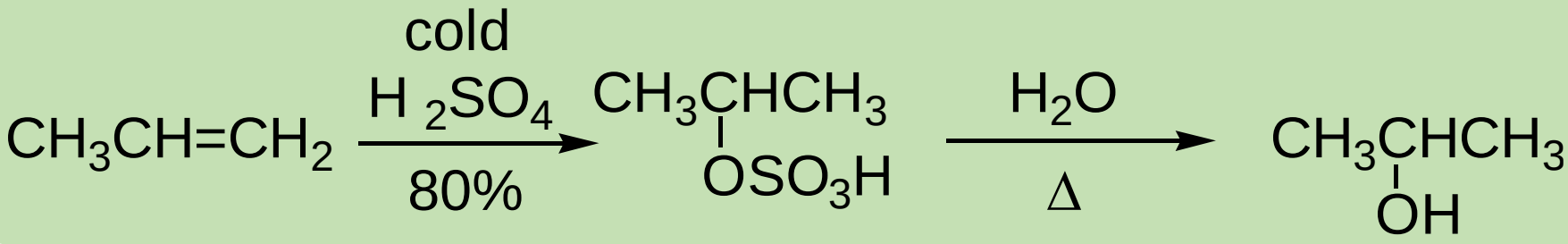
Each carbon of the double bond is bonded to one H therefore both isomers are formed.

HBr - the peroxide effect

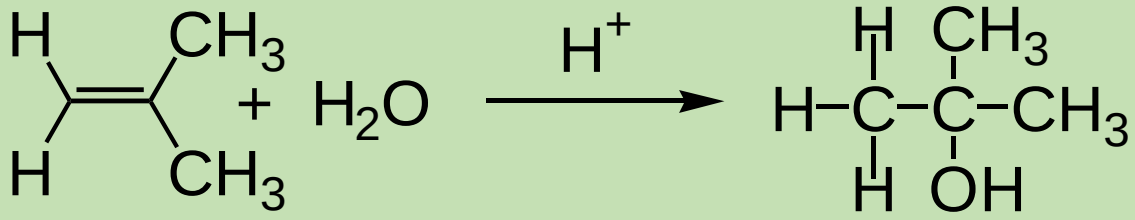
1933, Kharasch and Mayo



Addition of sulfuric acid

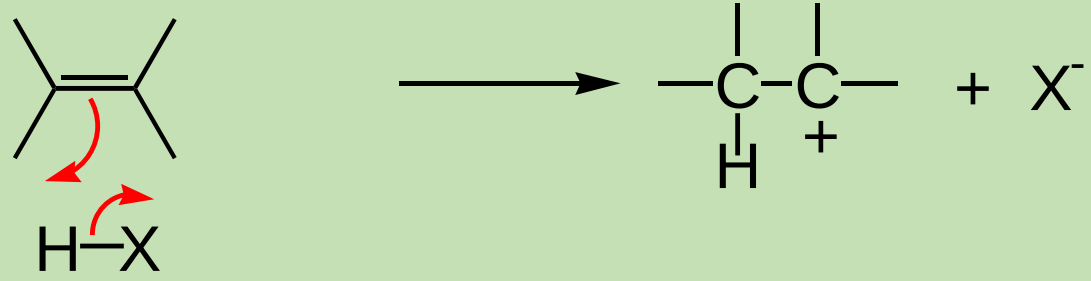


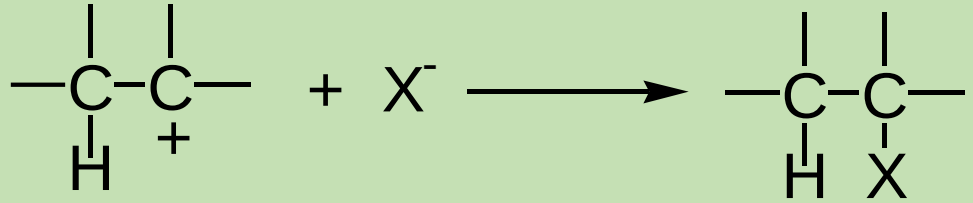
Hydration



a Markovnikov addition

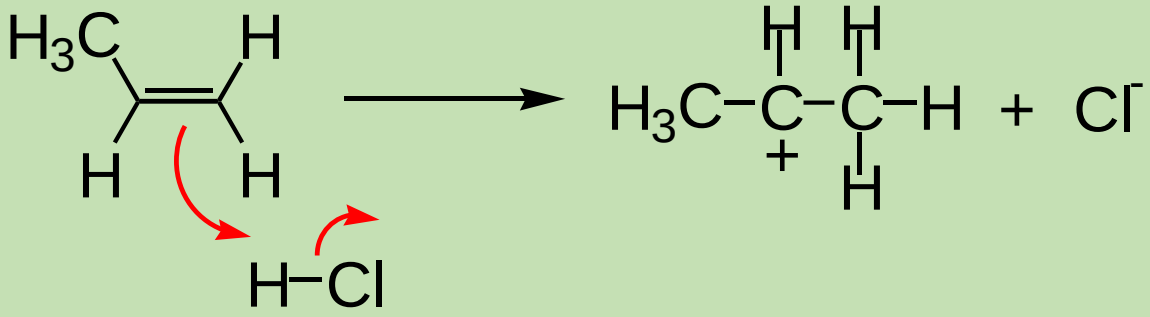
The mechanism of the addition

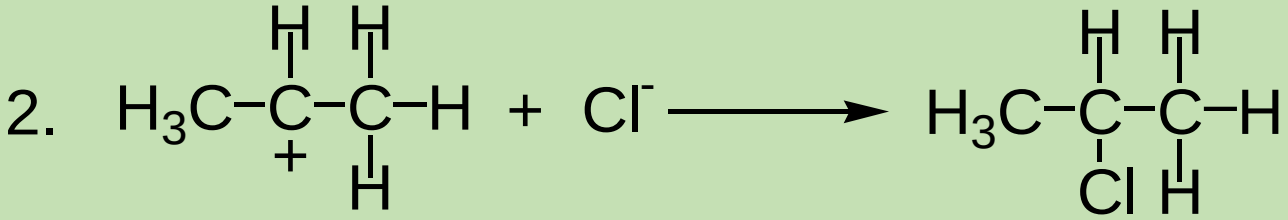
1. 

2. 

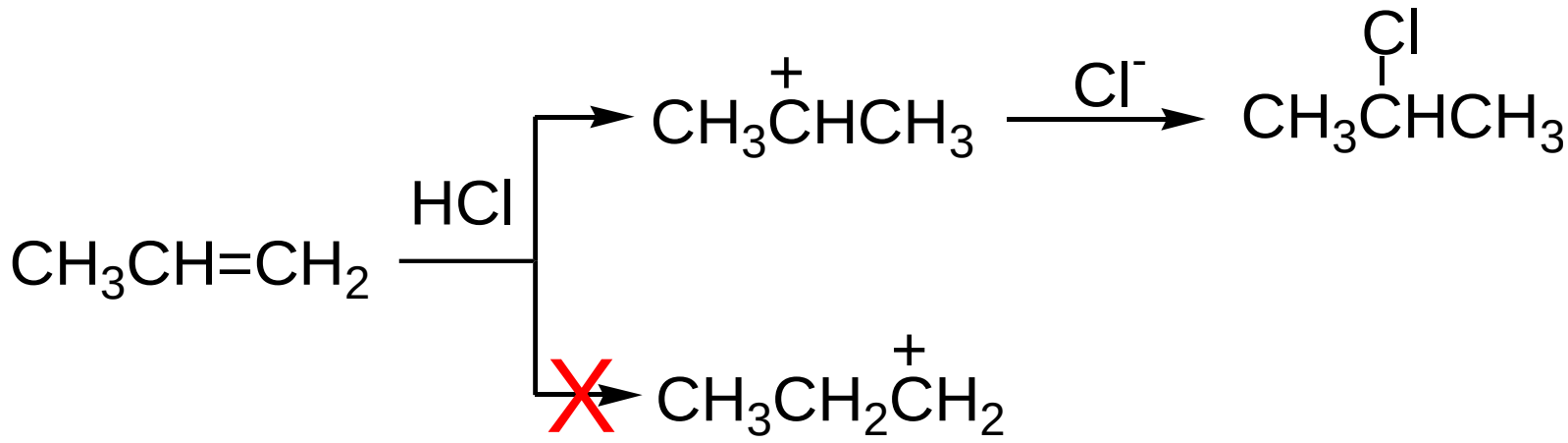
HX = HCl, HBr, HI, H_2SO_4, H_3O^+

An example

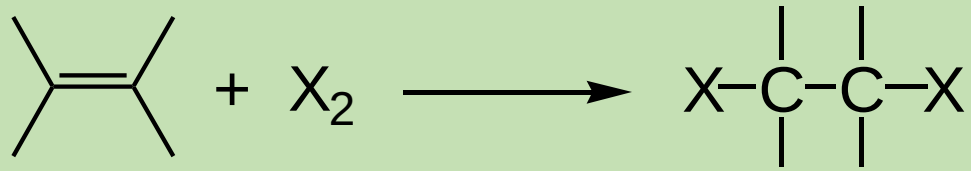
1. 

2. 

Orientation



Addition of halogens

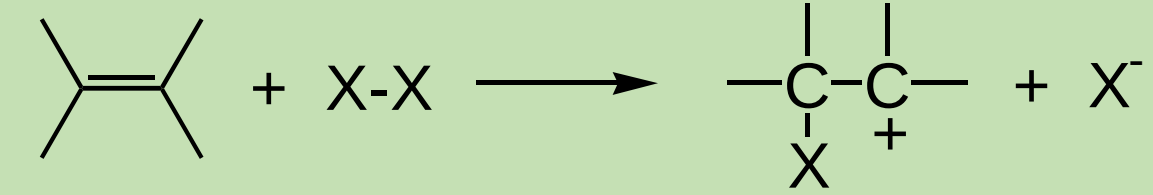


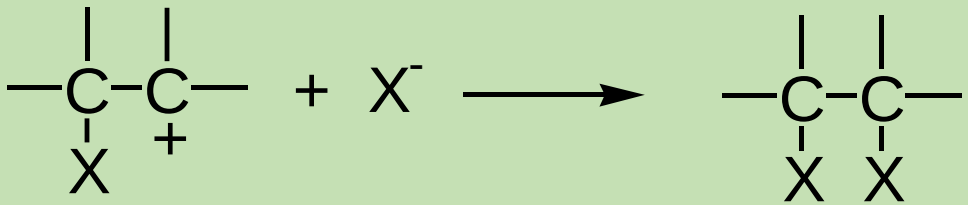
$X_2 = Cl_2, Br_2$ usually iodine does not react

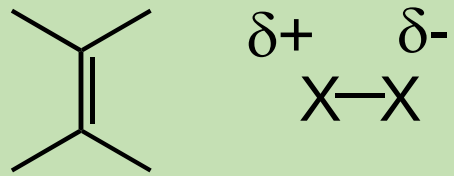
$$CH_3CH{=}CH_2 \xrightarrow[CCl_4]{Br_2 \text{ in}} CH_3CHBrCH_2Br$$

1,2-dibromopropane

Mechanism of X_2 addition



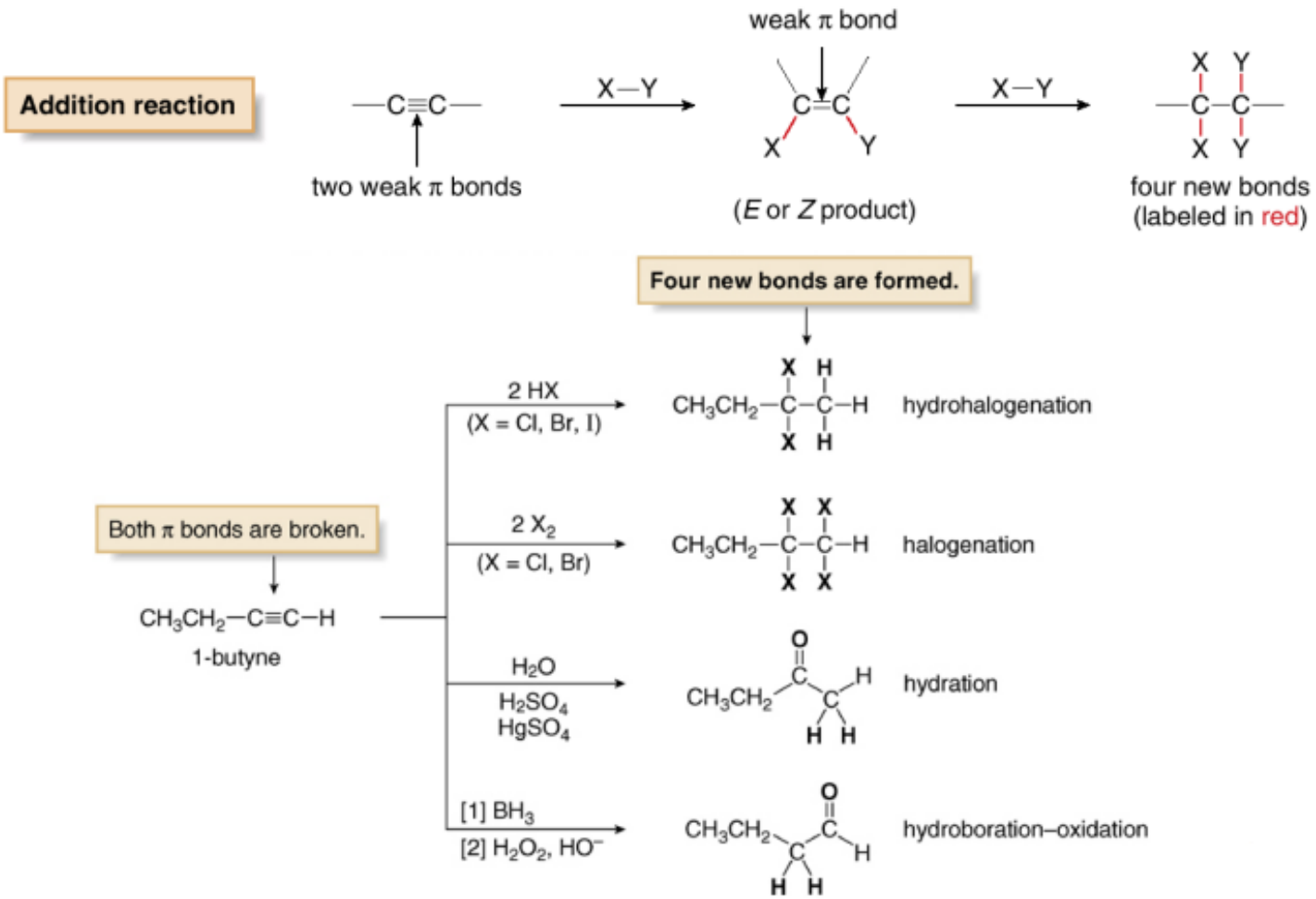




polarisation

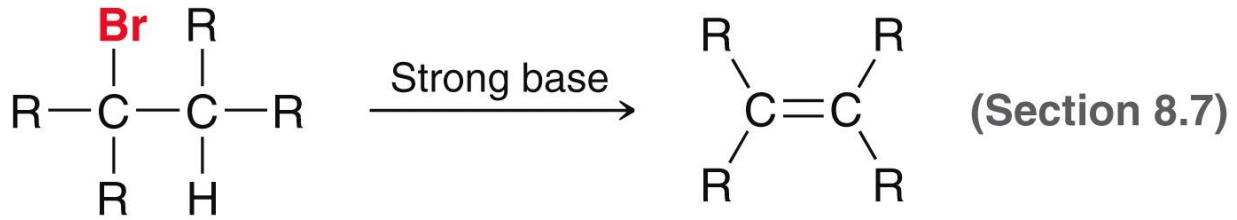
Alkynes Reactions

Alkyne Reactions—Additions

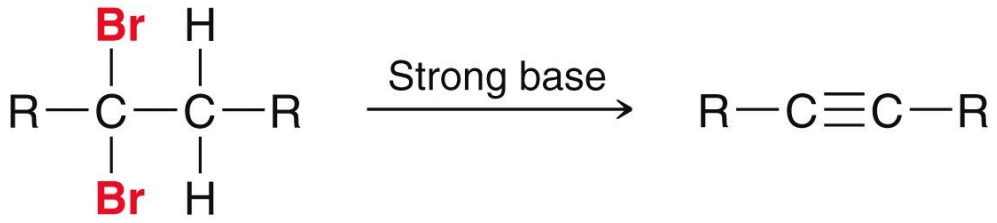


Preparation of Alkynes

- Like alkenes, alkynes can also be prepared by elimination
- Need a **dihalide** to make an alkyne



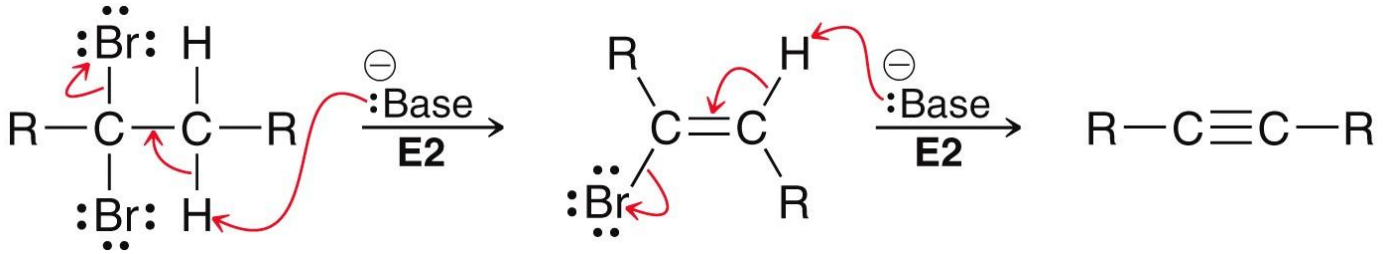
An alkyl halide



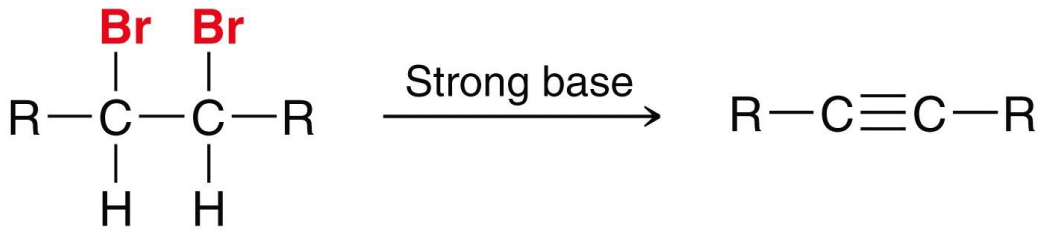
An alkyl dihalide

- Such eliminations usually occur via an E2 mechanism
- **Geminal** or **vicinal dihalides** can be used

Geminal dihalide



Vicinal dihalide



The End of Lecture