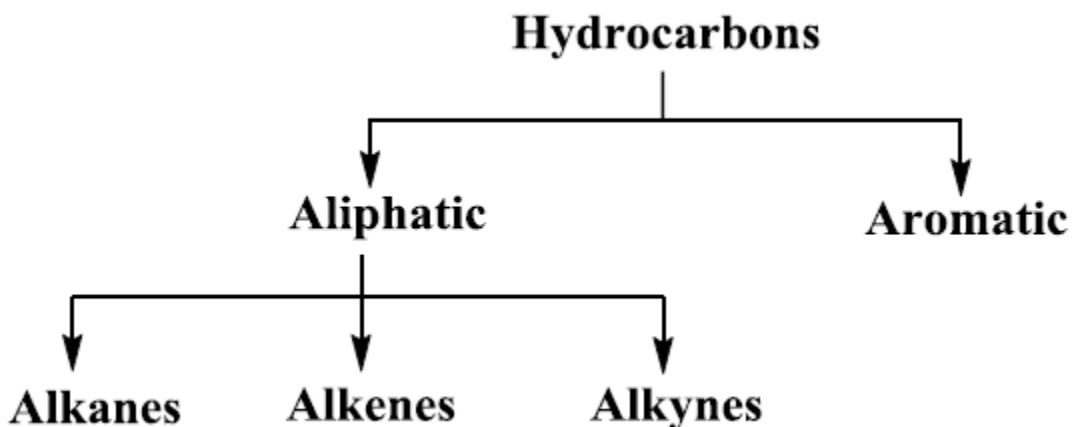


Organic Chemistry

Hydrocarbons: are Compounds that contain only carbon and hydrogen atoms.

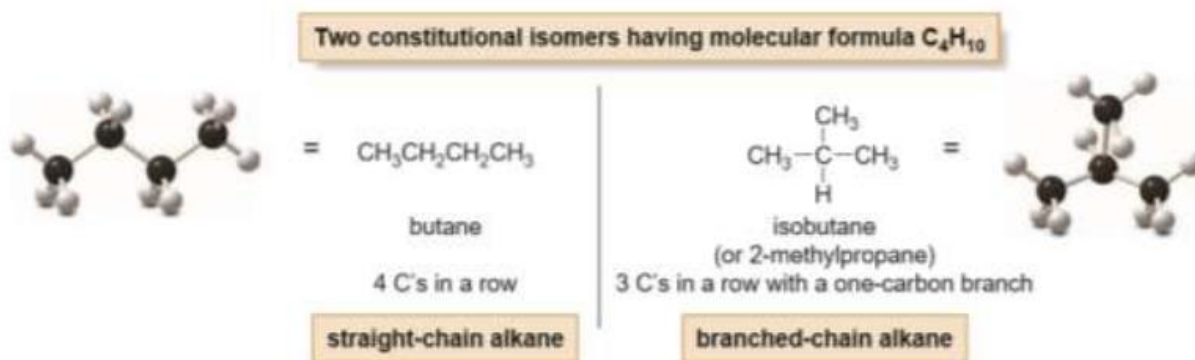


Alkanes

Alkanes: are aliphatic hydrocarbons having only **C–C** and **C–H** σ bonds.

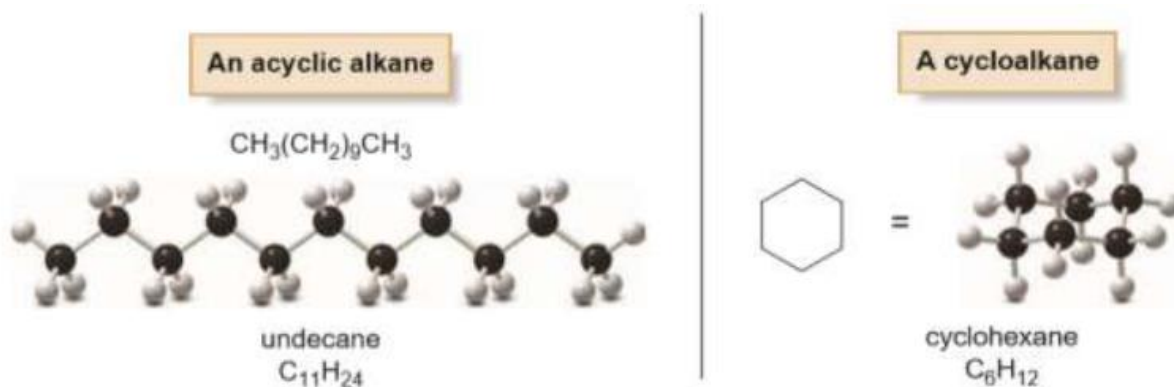
Alkanes can be subdivided into the following two groups:

- **A cyclic alkanes** have the molecular formula **$C_nH_{2n} + 2$** and contain only linear and branched chains of carbon atoms. They are also called saturated hydrocarbons because they have the maximum number of hydrogen atoms per carbon.



- **Cycloalkanes** contain carbons joined in one or more rings, the general formula is **C_nH_{2n}**, they have two fewer H atoms than an acyclic alkane with the same number of carbons.

Alkanes are the simplest and least reactive hydrocarbon species containing only carbons and lack any other functional groups.

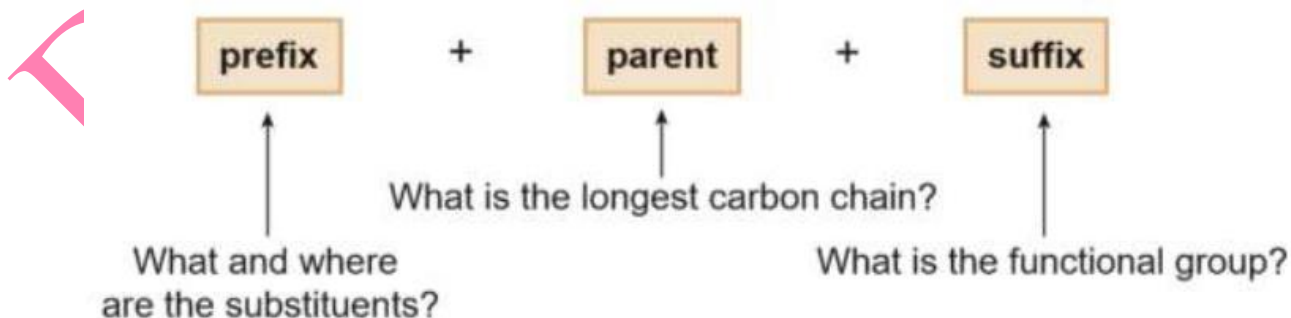


Nomenclature

A systematic method of naming compounds was developed by the International Union of Pure and Applied Chemistry. It is referred to as the **IUPAC** system of nomenclature.

The name of every organic molecule has three parts.

- The **parent** name indicates the number of carbons in the longest continuous carbon chain in the molecule.
- The **suffix** indicates what functional group is present.
- The **prefix** reveals the identity, location, and number of substituents attached to the carbon chain.

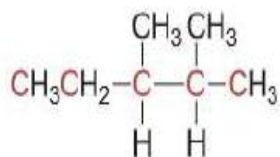


Number of C atoms	Molecular formula	Name (<i>n</i> -alkane)	Number of constitutional isomers
1	CH ₄	methane	—
2	C ₂ H ₆	ethane	—
3	C ₃ H ₈	propane	—
4	C ₄ H ₁₀	butane	2
5	C ₅ H ₁₂	pentane	3
6	C ₆ H ₁₄	hexane	5
7	C ₇ H ₁₆	heptane	9
8	C ₈ H ₁₈	octane	18
9	C ₉ H ₂₀	nonane	35
10	C ₁₀ H ₂₂	decane	75
20	C ₂₀ H ₄₂	eicosane	366,319

The simple **n-alkanes** consist of the **parent** name, which indicates the number of carbon atoms in the longest carbon chain, and the **suffix** -ane, which indicates that the compounds are **alkanes**. The name for one carbon is meth-, for two carbons is eth-, and so on.

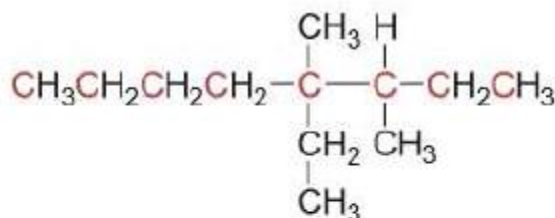
Prefix, name the carbon groups (called alkyl groups) or substituents that are bonded to the longest carbon chain.

• **An alkyl group** is formed by removing one hydrogen from an alkane, to name an alkyl group, change the **-ane** ending of the parent alkane to **-yl**. Thus, methane (CH₄) becomes methyl (CH₃-) and ethane (CH₃CH₃) becomes ethyl (CH₃CH₂-).



2,3-dimethylpentane

[Number to give the 1st methyl group the lower number.]



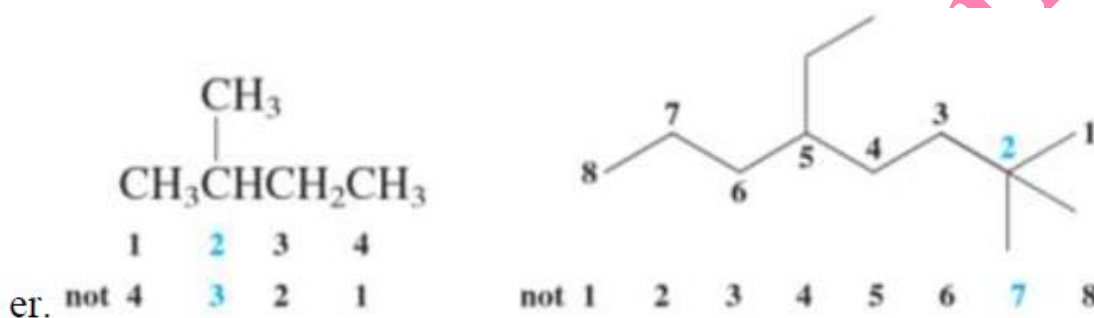
4-ethyl-3,4-dimethyloctane

[Alphabetize the **e** of ethyl before the **m** of methyl.]

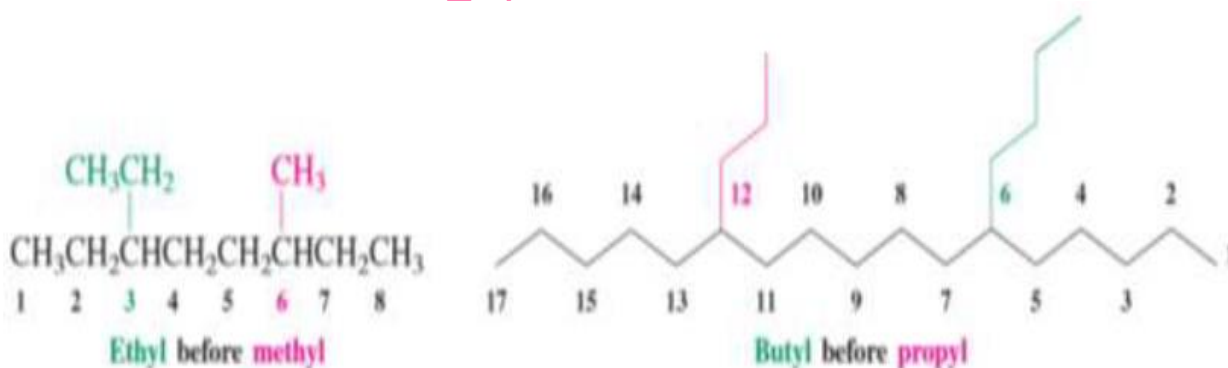
IN SUMMARY

Steps for naming branched alkanes:

- (1) Find the longest chain;
- (2) find the names of all the alkyl groups, attached to the chain;
- (3) number the chain;
- (4) name the alkane, with substituent names in alphabetical order. Haloalkanes are named in accord with the rules that apply to naming the alkanes, the halo substituent being the same as alkyl groups.



If there are two substituents at equal distances from the two ends of the chain, use the alphabet to decide how to number. The substituent to come first in alphabetical order is attached to the carbon with the lower number.



Cycloalkanes: are named by adding the prefix cyclo- to the name of the acyclic alkanes have the same number of carbons.

cyclopropane



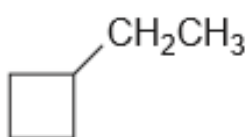
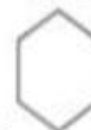
cyclobutane



cyclopentane

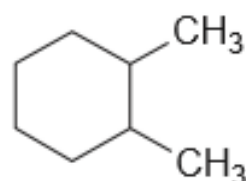


cyclohexane



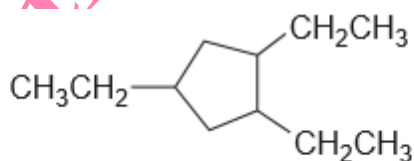
ethylcyclobutane

[No number is needed
with only one substituent.]



1,2-dimethylcyclohexane

[Number to give the 2nd CH₃ group
the lower number: 1,2- not 1,6-.]

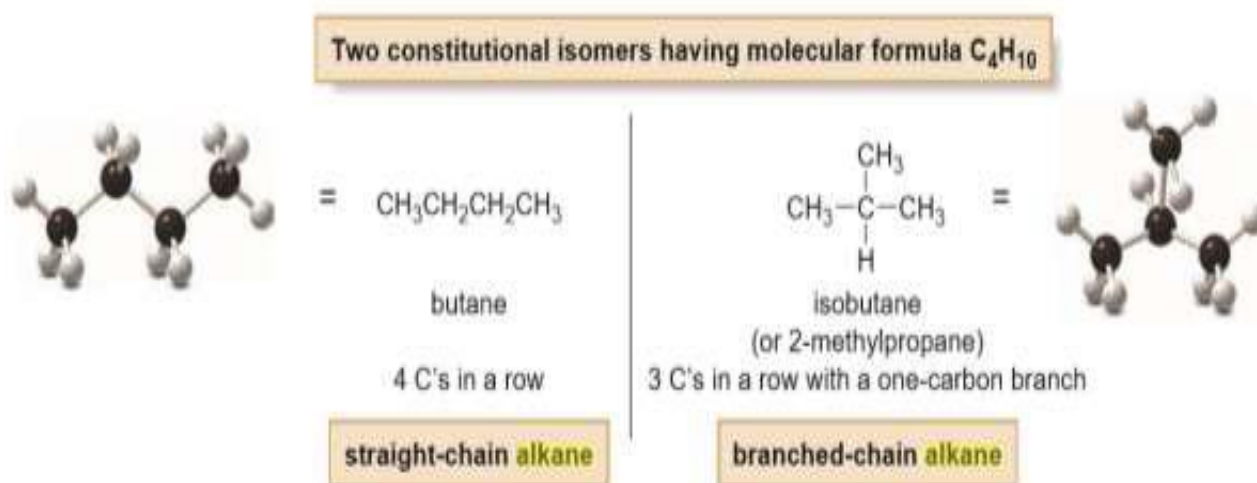


1,2,4-triethylcyclopentane

[Number to give the 2nd CH₃CH₂ group the
lower number: 1,2,4- not 1,3,4- or 1,3,5-.]

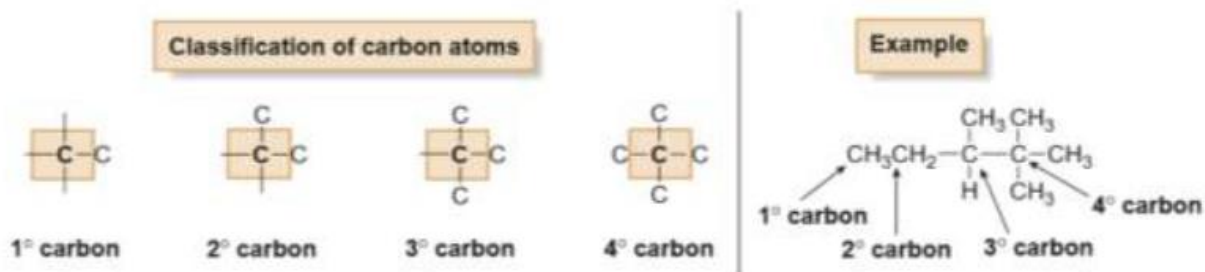
Structural isomers:

There are two different ways to arrange four carbons, giving two compounds with molecular formula **C₄H₁₀**, named butane and isobutane.



Carbon atoms in alkanes and other organic compounds are classified by the number of other carbons directly bonded to them.

- A **primary carbon** (1° carbon) is bonded to one other C atom.
- A **secondary carbon** (2° carbon) is bonded to two other C atoms.
- A **tertiary carbon** (3° carbon) is bonded to three other C atoms.
- A **quaternary carbon** (4° carbon) is bonded to four other C atoms.

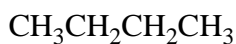


Hydrogen atoms are classified as primary (1°), secondary (2°), or tertiary (3°) depending on the type of carbon atom to which they are bonded.

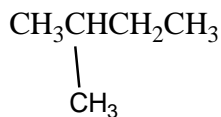
Name of alkanes:

1. Select the longest continuous chain.
2. The branched have the lowest number.

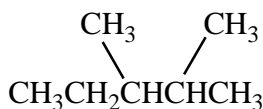
For example:



n-butane



2-methyl butane



2,3-dimethyl pentane



2-chloro-3-methyl-pentane

Physical Properties:

- 1- Non-polar compounds.
- 2- Dissolve in non-polar solvent (Like dissolve Like).
- 3- Have low b.p. and the b.p. increased with molecular weight (M.Wt.).

Conformation of alkanes:

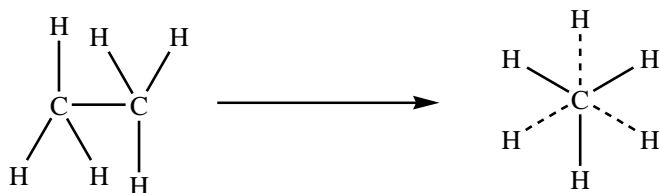
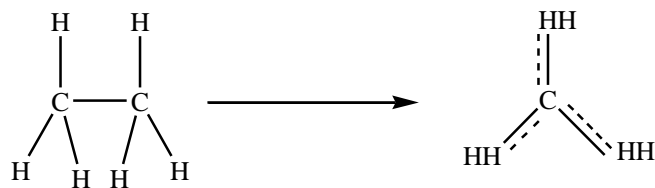
Conformation: different arrangement of atoms results from rotation around (C-C) single bond.

For example:

Ethane, have two conformations:

First, staggered conformation.

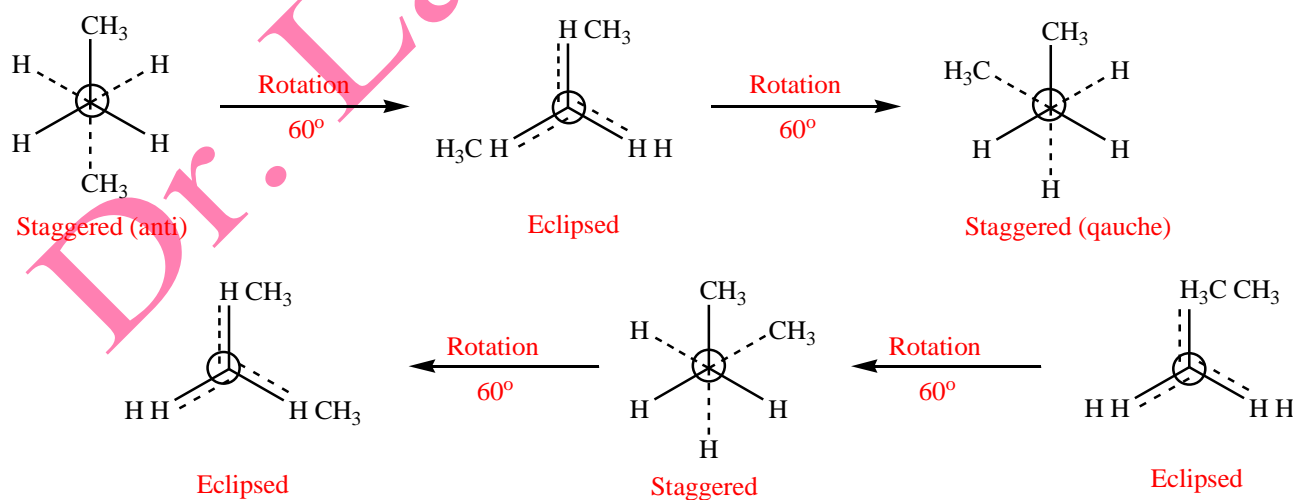
Second, eclipsed conformation.



The staggered conformation is more stable than the eclipsed conformation because all atoms in the staggered are far away from each other, while in the eclipsed, all the atoms are close to each other.

H.W.: Draw staggered and eclipsed conformation of propane and $(\text{CH}_3\text{CH}_2\text{Br})$.

Conformation of butane ($\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$) has six different conformations:



Alkenes

Alkenes are compounds that contain a carbon double bond.

The double bond of alkenes consists of (σ) bond and (π) bond.

Each carbon is sp^2 hybridized and triangle planer and all bond angles are approximately (120°).

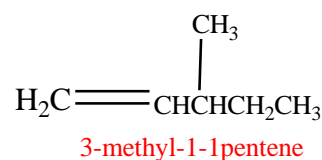
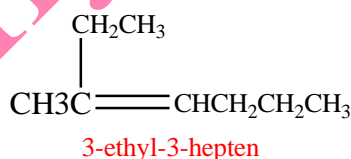
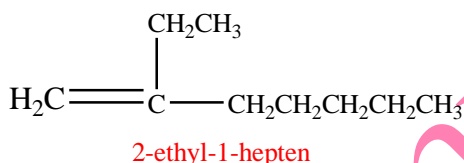
The rotation around the ($C=C$) double bond, is restricted.

The rotation only occurs if the (π) bond break.

Name of the alkenes (IUPAC):

- 1- Is the same as for alkane except for replacing the suffix **ane** to **ene**.
- 2- The double bond has a smaller number.

For example:

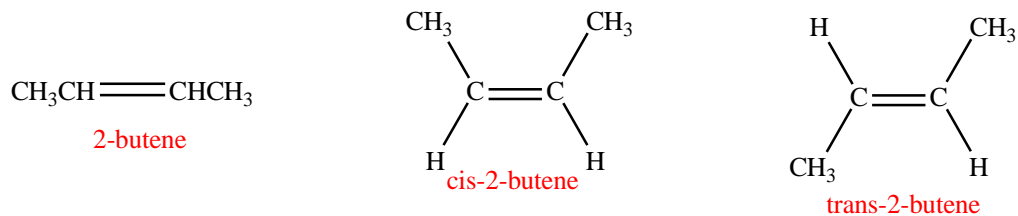


Using (cis) and (trans) as prefixes.

If the two groups are on the same side of the double bond, the compound is (cis).

If the two groups are on the different sides of the double bond, the compound is (trans).

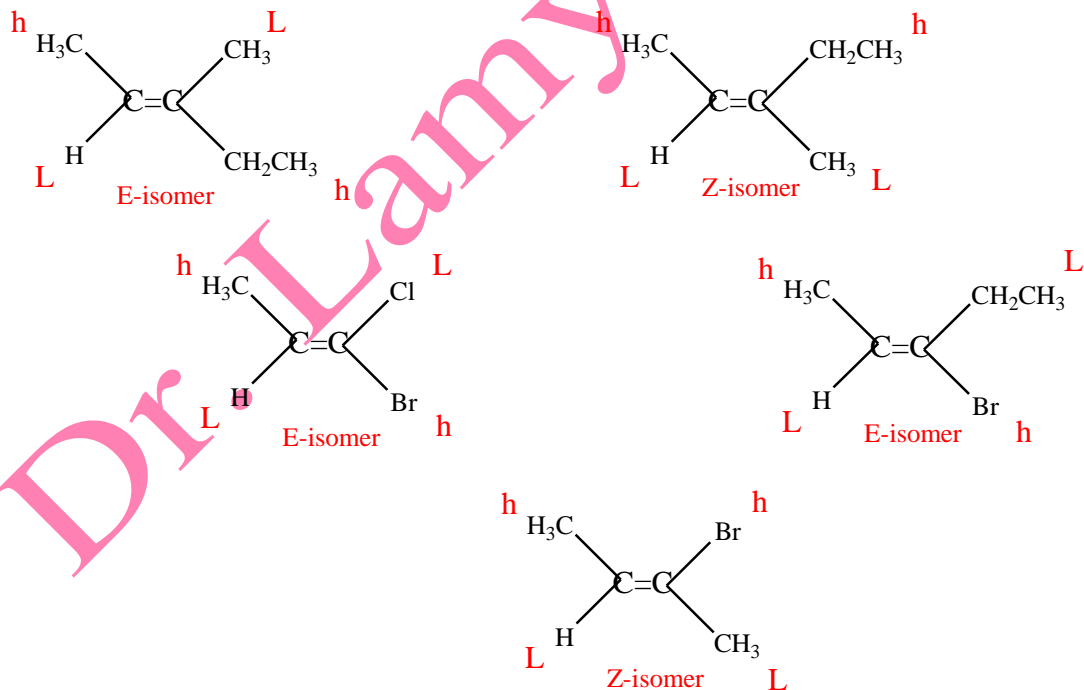
For example:



Assign the prefixes (E) and (Z) to alkene:

Divide the double bond in half and assign the numbers (1) and (2) to indicate the relative priority of the two groups on each the higher priority.

For example:

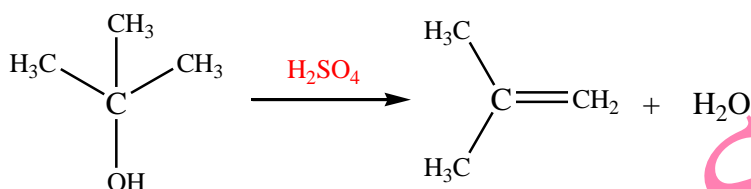


Physical Properties:

- 1- Alkenes have low (m.p.) and (b.p.).
- 2- (m.p.) and (b.p.) increase as the number of carbon atoms increases.
- 3- Alkenes are soluble in organic solvents and insoluble in water.
- 4- Cis-2-butene has higher (b.p.) than trans isomer because the cis-isomer is slightly polar.

Preparation of alkenes:

1. Dehydration of alcohols:

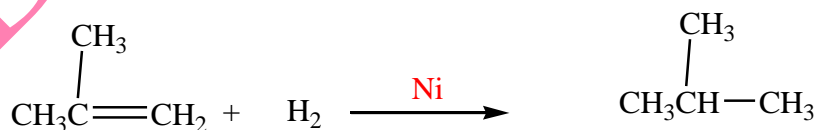
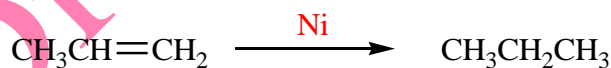
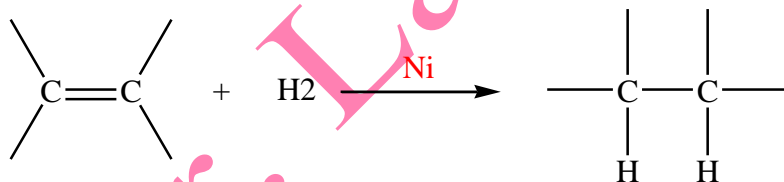


2.

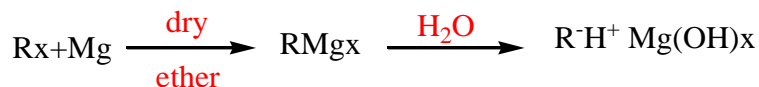


Preparation:

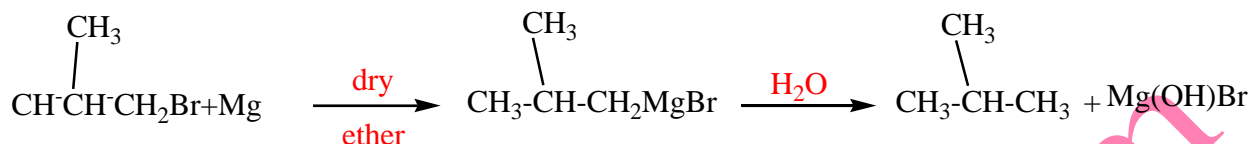
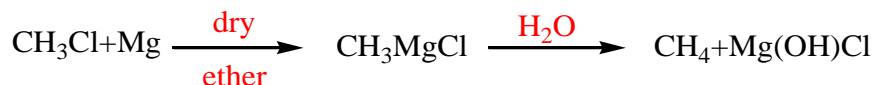
1. Addition of hydrogen to alkenes:



1- From Grignard reagent:



For example:



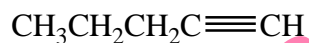
H.W.: How can you prepare butane from Butyl chloride?

Alkynes

Alkyne contains a carbon-carbon triple bond.

A terminal alkyne has triple bonds at the end of the carbon chain so that a hydrogen atom is directly bonded to the carbon of the triple bond.

Internal alkyne has a carbon atom bonded to each carbon atom of the triple bond.



terminal alkyne

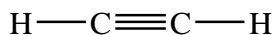


internal alkyne

An alkyne has general molecular formula ($\text{C}_n\text{H}_{2n-2}$).

The triple bond consists of one (σ bond) and two (π bond) and has (SP) hybridized and linear and the bond angle is 180° .

180°



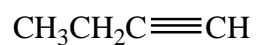
SP hybridized

Physical Properties:

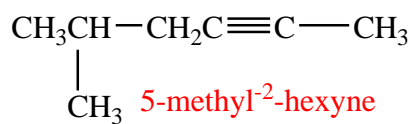
- 1- Alkynes have low (m.p.) and (b.p.).
- 2- (m.p.) and (b.p.) increase as number of carbon atom increase.
- 3- Alkynes are soluble in organic solvents and insoluble in water.

Name of alkyne:

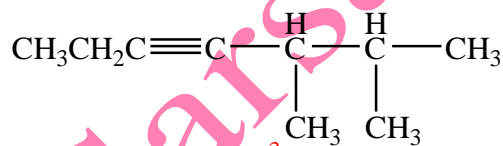
As the same as for alkenes except for the replacement of the ene by yne.



1-butyne



5-methyl²-hexyne

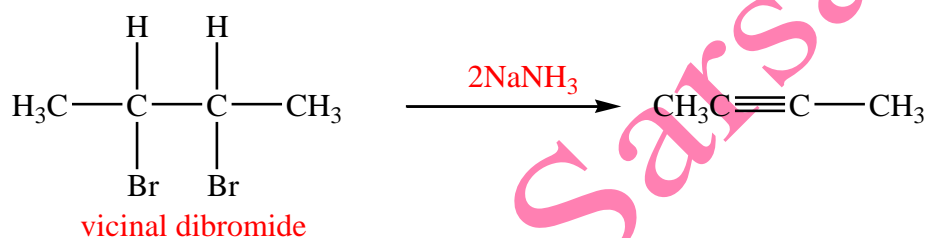
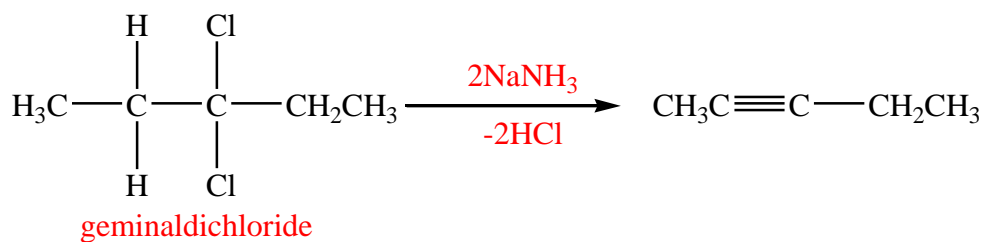


5,6-dimethyl³-heptyne

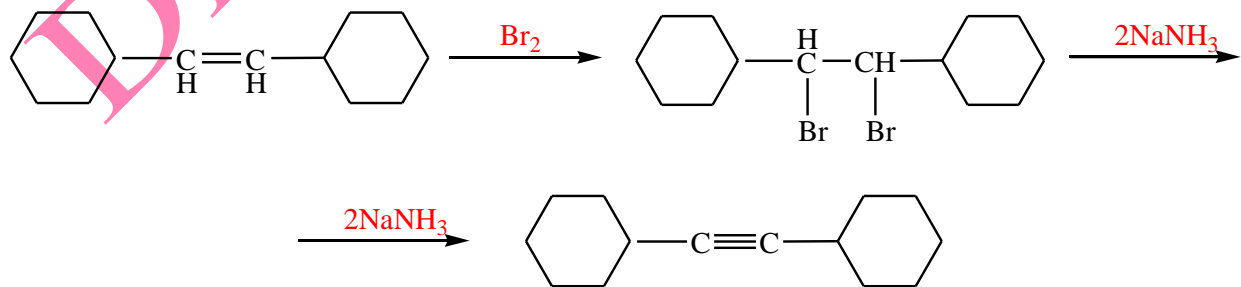
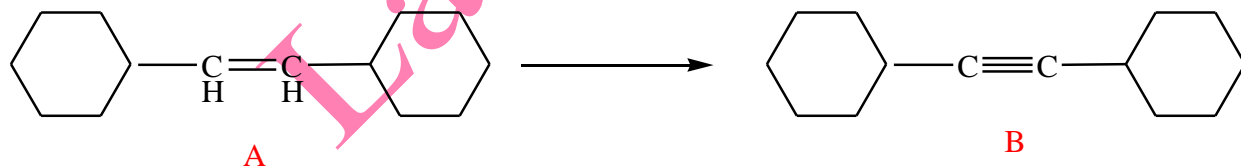
Preparation:

Elimination reaction:

A strong base removes two equivalents of HX from vicinal or geminal dihalide.



Example: Convert alkene A into alkyne B:



Dr. Lamya Sarsam