Organic Chemistry

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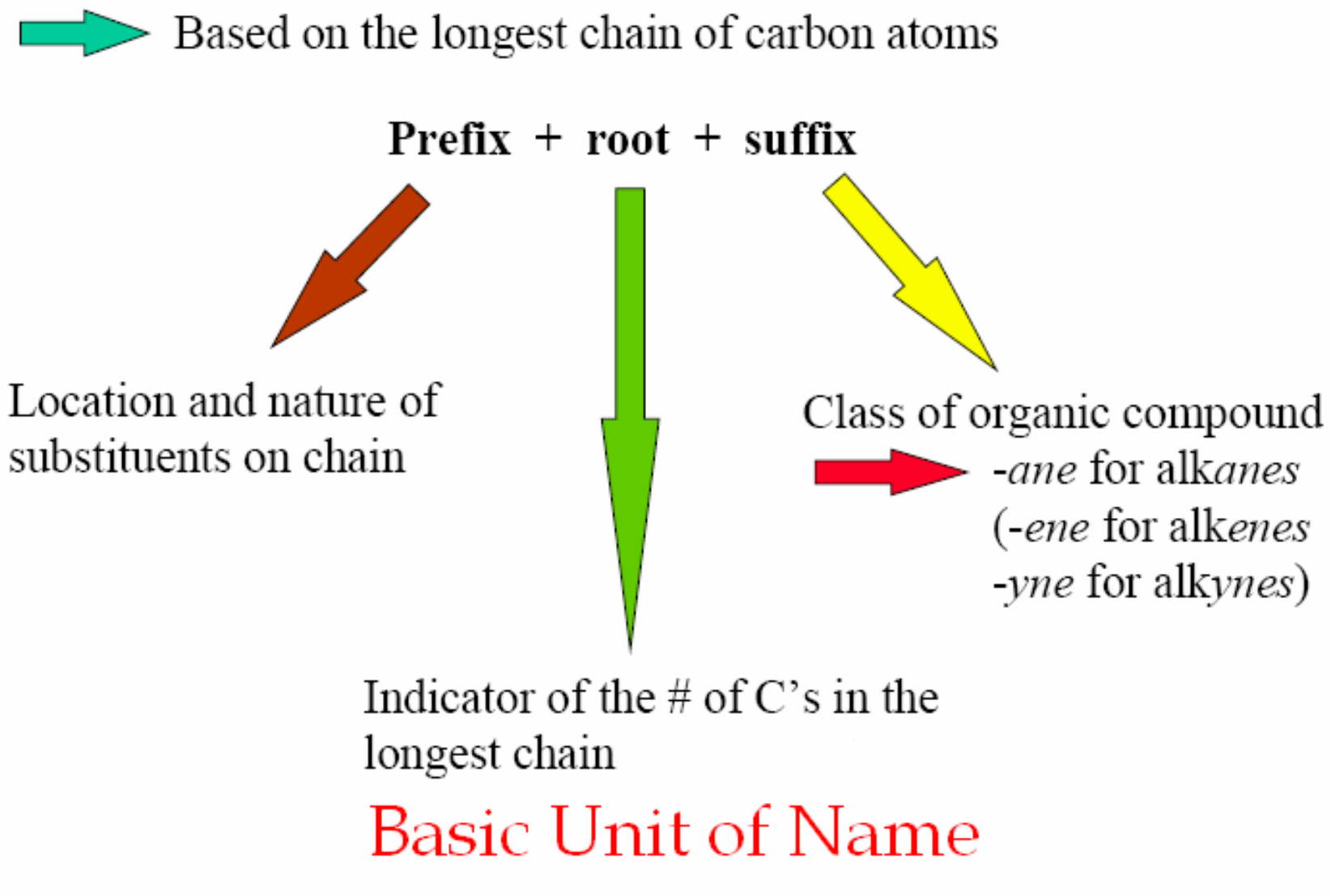
Naming Hydrocarbons



Numerical Roots for Carbon Chains and Branches

Root	Number of Carbon Atoms
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6
hepta-	7
oct-	8
non-	9
dec-	10

Alkanes

- **Methane** CH_4
- **Ethane** C_2H_6 CH_3CH_3
- **Propane** C_3H_8 $CH_3CH_2CH_3$
- **Butane** C_4H_{10} $CH_3CH_2CH_2CH_3$
- **Pentane** C_5H_{12} $CH_3CH_2CH_2CH_2CH_3$
- **Hexane** C_6H_{14} $CH_3CH_2CH_2CH_2CH_2CH_3$
- **Heptane** C_7H_{16} $CH_3\text{-}(CH_2)_5\text{-}CH_3$
- **Octane** C_8H_{18} $CH_3\text{-}(CH_2)_6\text{-}CH_3$
- **Nonane** C_9H_{20} $CH_3\text{-}(CH_2)_7\text{-}CH_3$
- **Decane** $C_{10}H_{22}$ $CH_3\text{-}(CH_2)_8\text{-}CH_3$

Important Prefixes

Substituent	Prefix	Substituent	Prefix
$-CH_3$	Methyl	$-C_2H_5$	Ethyl
C_3H_7	Propyl	$-CH(CH_3)_2$	Iso-propyl
$-C_6H_5$	Phenyl	-F	Fluoro
$-NO_2$	Nitro	-NO	Nitroso
$-OCH_3$	Methoxy	-OH	Hydroxy

Suffix

Primary Suffix

Added to the word root to indicate saturation or unsaturation in the carbon chain

Secondary Suffix

Secondary suffix is added to primary suffix to indicate the nature of the functional group

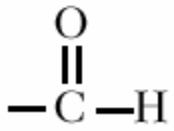
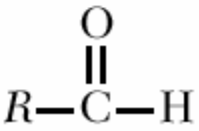
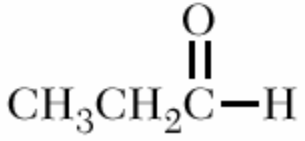
Organic Compound	Word Root	Primary Suffix	IUPAC Name
$CH_3CH_2CH_2CH_3$	But	ane	Butane
$CH_3CH{=}CH_2$	Prop	ene	Propene
$HC{\equiv}CH$	Eth	yne	Ethyne

Secondary Suffix

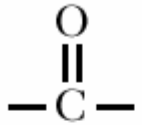
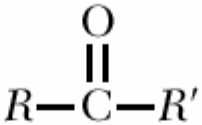
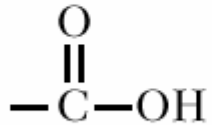
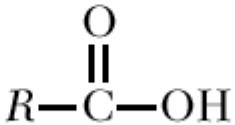
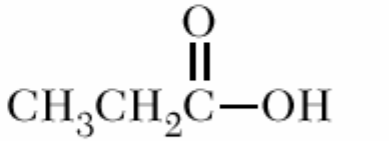
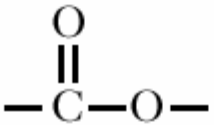
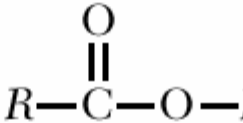
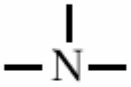
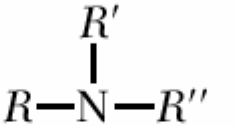
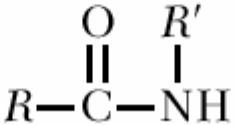
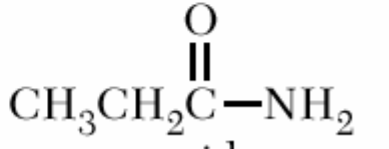
Class	Functional Group	Secondary Suffix
Alcohol	-OH	-ol
Aldehyde	-CHO	-al
Ketones	>C=O	-one
Carboxylic acids	-COOH	-oic acid
Acid amide	$-CONH_2$	-amide
Esters	-COOR	Alkyl oate
Nitriles	-CN	-nitrile
Amines	$-NH_2$	-amine
Thiol	-SH	-thiol

Organic compound	Word root	Primary suffix	Secondary suffix	IUPAC Name
CH_3CH_2OH	Eth	an(e)	-ol	Ethanol
$CH_3CH_2CH_2NH_2$	Prop	an(e)	-amine	Propanamine
$CH_3CH_2CH_2COOH$	But	an(e)	oic acid	Butanoic acid
CH_3CH_2CN	Prop	ane	nitrile	Propanenitrile

List of the functional groups

Class of Compound	Functional Group	General Formula	Example
halide (halocarbon)	—F (fluoro-) —Cl (chloro-) —Br (bromo-) —I (iodo-)	*R*—*X* (*X* represents any halogen)	$CH_3CHClCH_3$ 2-chloropropane
alcohol	—OH	*R*—OH	$CH_3CH_2CH_2OH$ 1-propanol
ether	—O—	*R*—O—*R*′	$CH_3OCH_2CH_3$ methyl ethyl ether
aldehyde			 propanal

List of the functional groups

ketone			 2-pentanone
organic acid			 propanoic acid
ester			 methyl propanoate
amine			$CH_3CH_2CH_2NH_2$ 1-propanamine
amide			 propanamide

Isomerism

A. Structural Isomerism

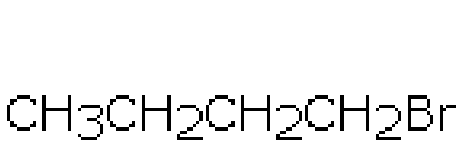
1. Chain
2. Position
3. Functional
4. Metamerism
5. Tautomerism

B. Stereomerism

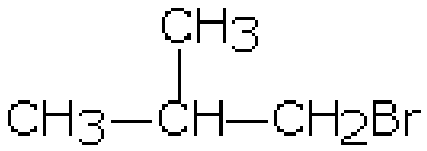
1. Conformations
2. Geometrical
3. Optical

Structural Isomerism

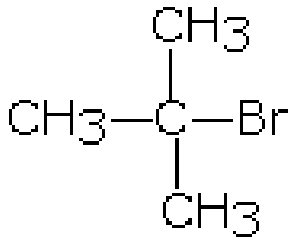
Skeletal or chain Isomerism:- The compounds having same molecular formula but different arrangement of carbon chain within the molecule are called chain isomer.



1-Bromobutane



1-Bromo-2-methylpropane



2-Bromo-2-methylpropane

Position isomerism :- The compound which have same molecular formula but differ in the position of the functional group, carbon-carbon multiple bond or substituent group are called position isomer.

$CH_3 - CH_2 - CH = CH_2$ But – 1 – ene

$CH_3 - CH = CH - CH_3$ But 2 ene

Functional isomerism :- The compound having same molecule formula, but different functional groups in the molecule are called functional isomer.

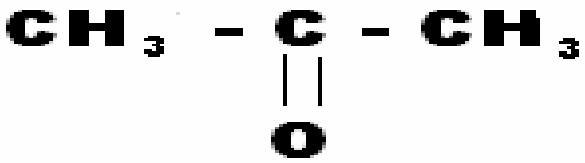
$CH_3 - CH_2$ OH
Ethanol

$CH_3 - O - CH_3$
Methoxy methane

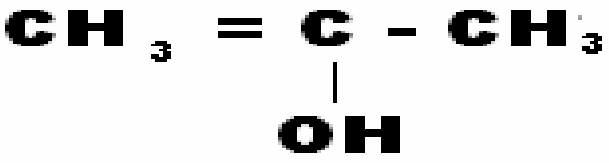
Metamerism :- The compound having same molecular formula but different number of carbon atoms on either side of functional group are called metamers.

$CH_3\ CH_2\ COO\ CH_2\ CH_3$ $CH_3\ COO\ CH_2\ CH_2\ CH_3$

Tautomerism :- This is a special type of functional isomerism in which the isomers differ in the arrangement of atoms but they exist in dynamic equilibrium with each other.

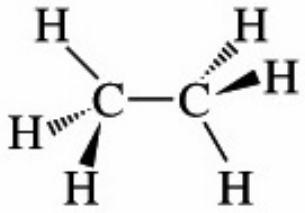
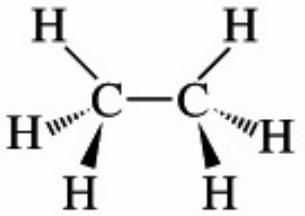
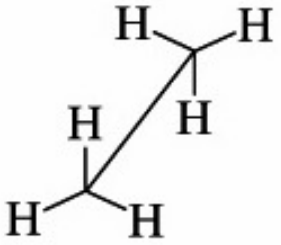
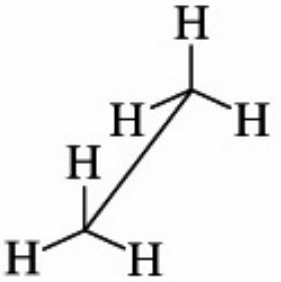
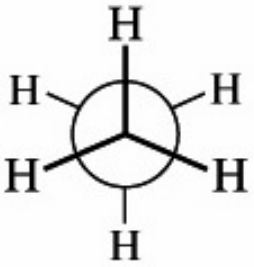
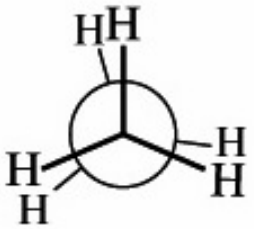


Propanone

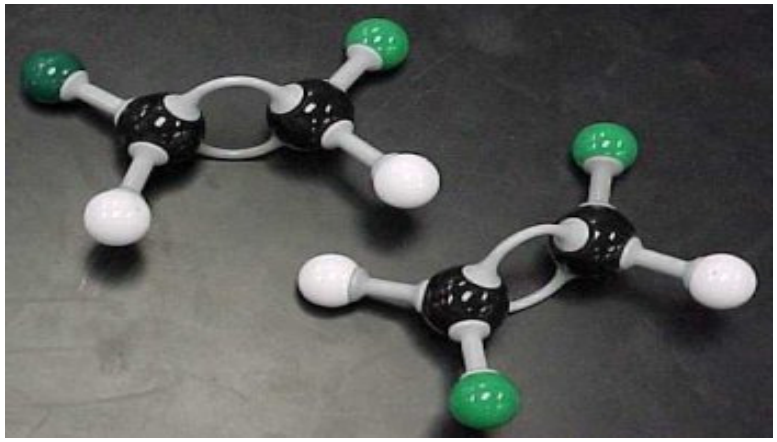


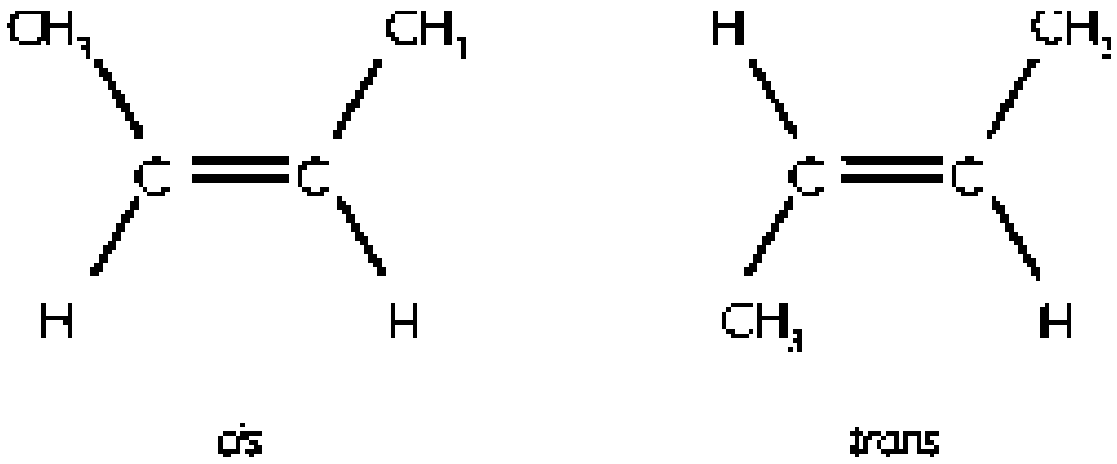
Prop – 1 – en – 2 – ol

Conformations of Alkanes: Rotation About C-C Single Bonds

	staggered conformation for rotation about the carbon–carbon bond in ethane		eclipsed conformation for rotation about the carbon–carbon bond in ethane
perspective formulas		60°	
sawhorse projections		60°	
Newman projections		60°	

Stereoisomerism :- The compounds which have the same structural formula but differ in the spatial arrangement of atoms or groups of atoms about the double bond.

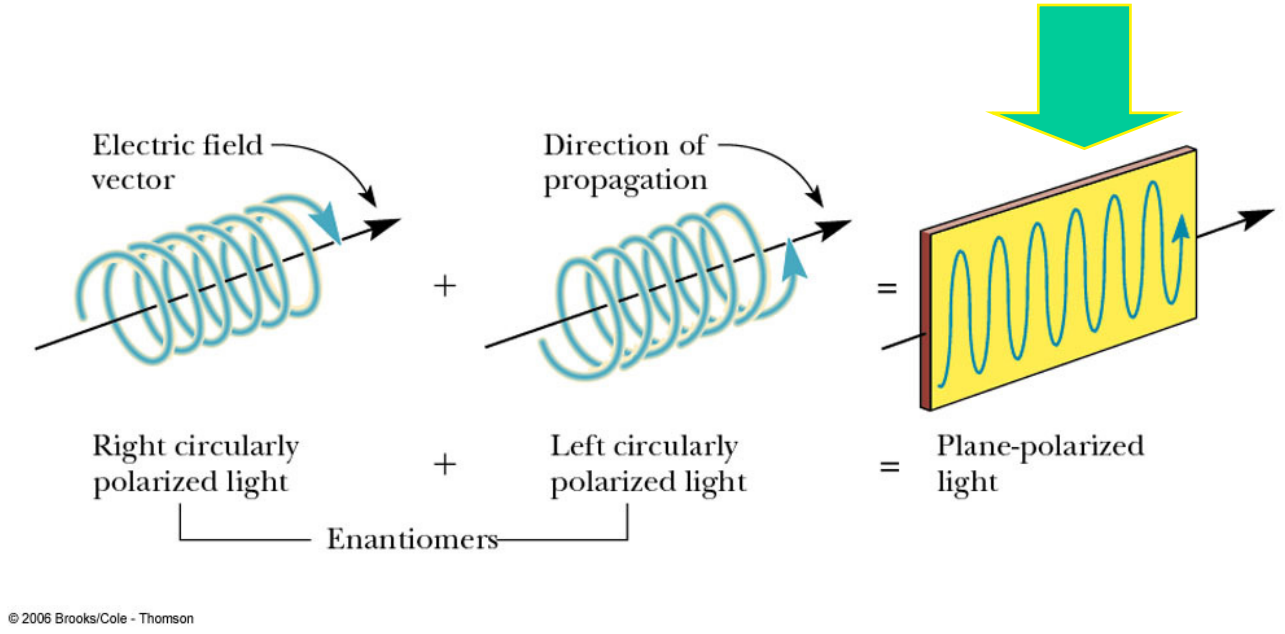




Plane-Polarized Light

Light **vibrating in all planes ⊥ to direction of propagation**

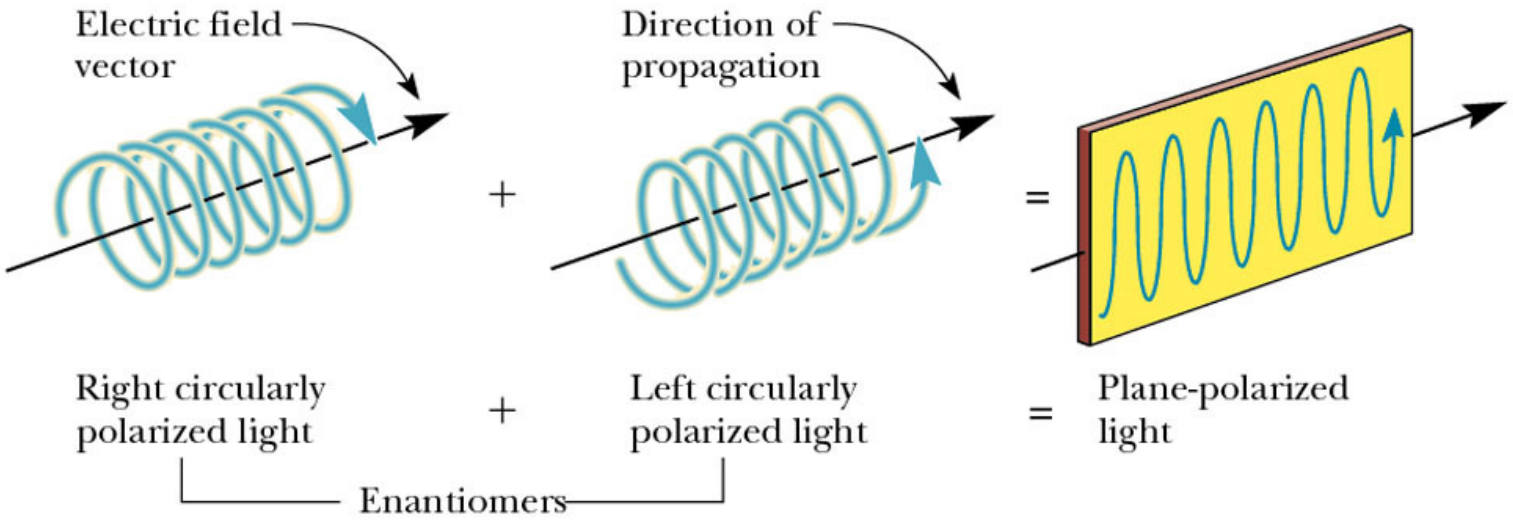
Plane-polarized light: **light vibrating only in parallel planes**



Plane-polarized light the vector sum of left and right circularly polarized light

Optically Activity

Enantiomers (chiral) interact with circularly polarized light rotating the plane one way with *R* center and opposite way with S



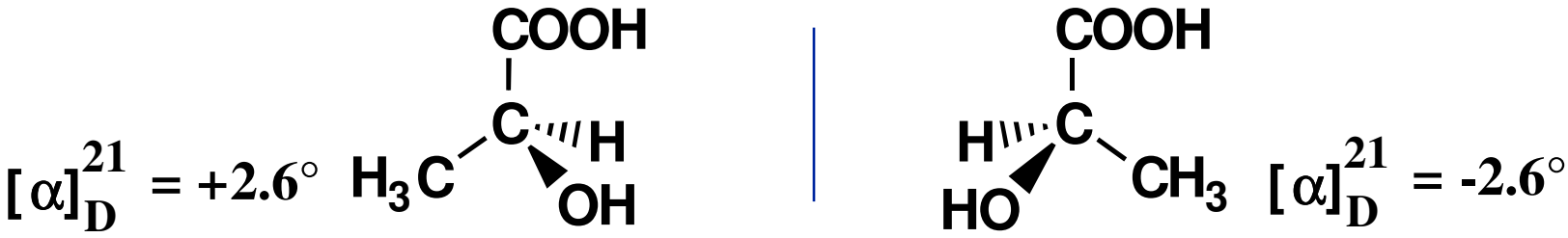
Result: rotation of plane-polarized light clockwise (+)

or counterclockwise (-)

Optical Activity

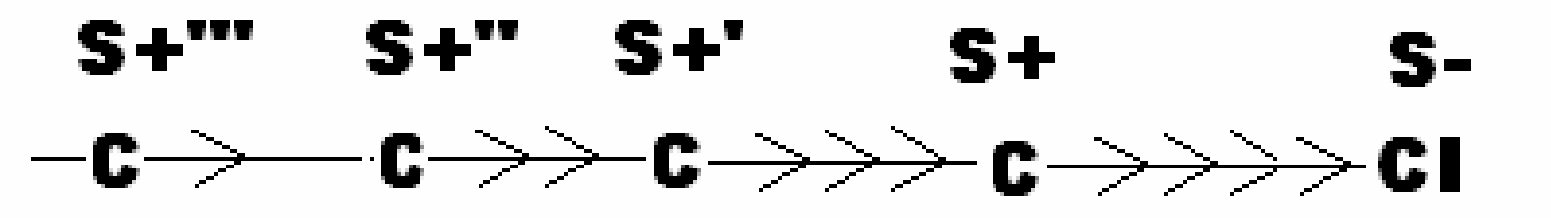
Observed rotation: α, **degrees a compound rotates polarized light - dextrorotatory (+) right - levorotatory (-) left**

$$\text{specific rotation } [\alpha]_D^T = \frac{\alpha \text{ (observed, deg.)}}{l(\text{dm})\ [\text{g/ mL}]}$$



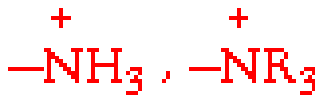
(S)-(+)-lactic acid **(R)-(-)-lactic acid**

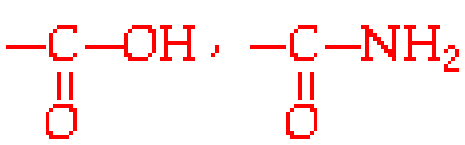
Inductive effect :- It is a process of electron displacement of electrons along the chain of carbon atoms due to the presence of polar covalent bond at one end of the chain is called inductive effect.

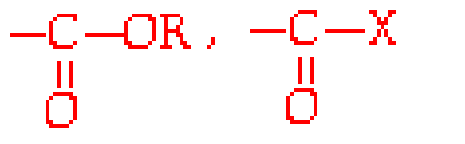


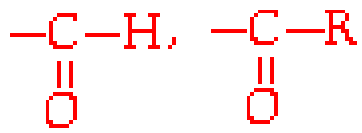
Atoms or groups of atoms having electron attracting capacity more than hydrogen are referred to as having – 1 effect.

-I (electron withdrawing)

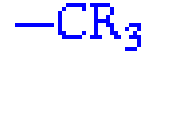


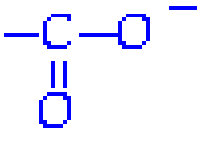




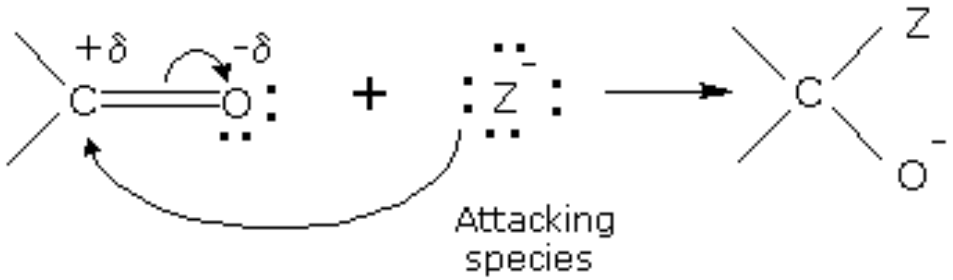


+I (electron donating)

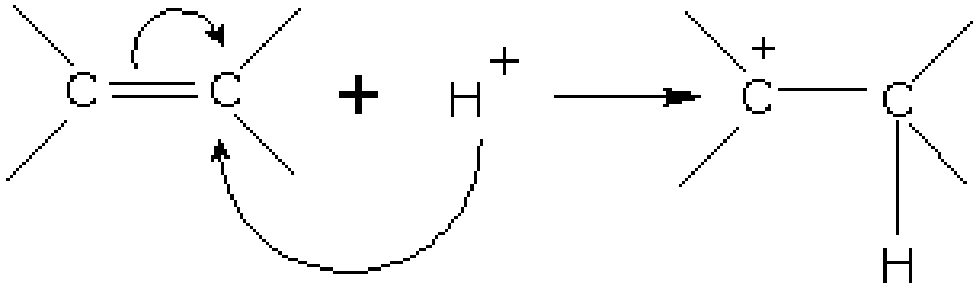




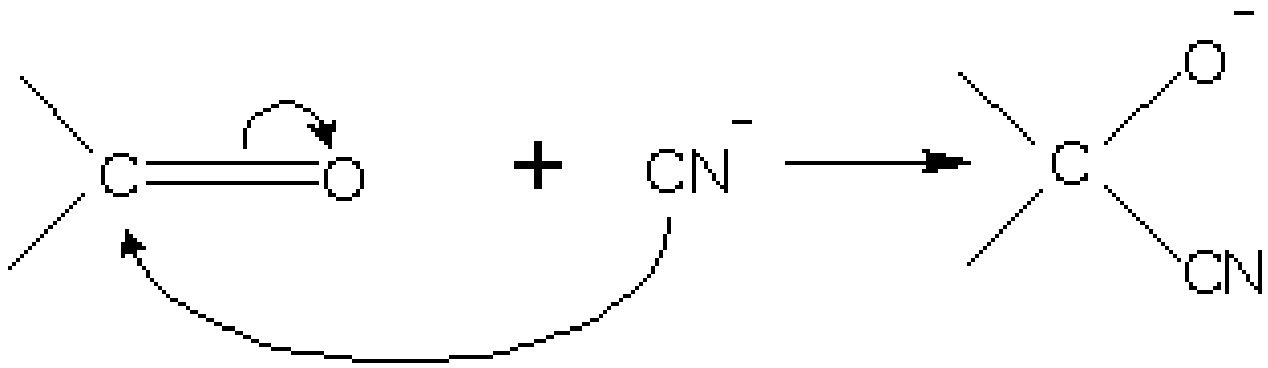
Electrometric effect :- **The phenomenon of movement of electrons from one atom to another in multibonded atoms at the demand of attacking reagent is called electrometric effect.**



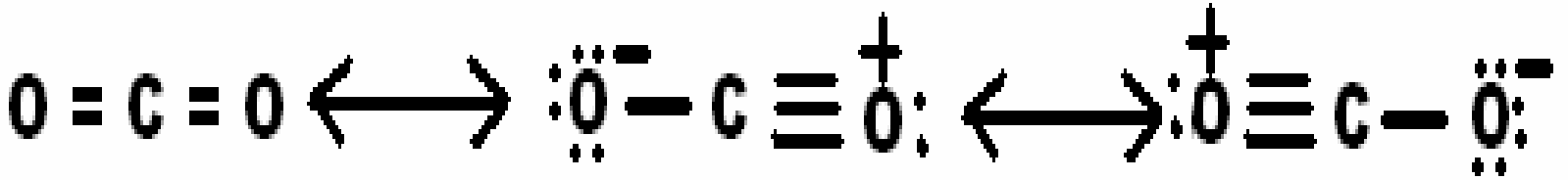
1. When transfer of electrons takes place toward the attacking reagent. (+ E)

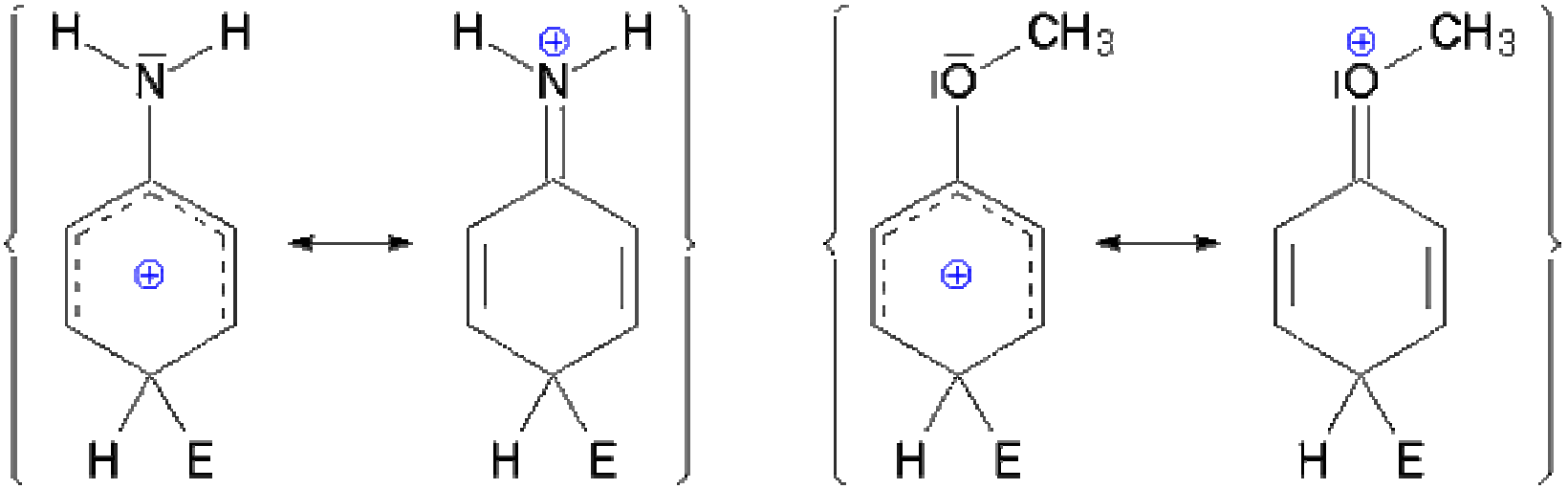


1. When transfer of electrons takes away from the attacking reagent.(-E)

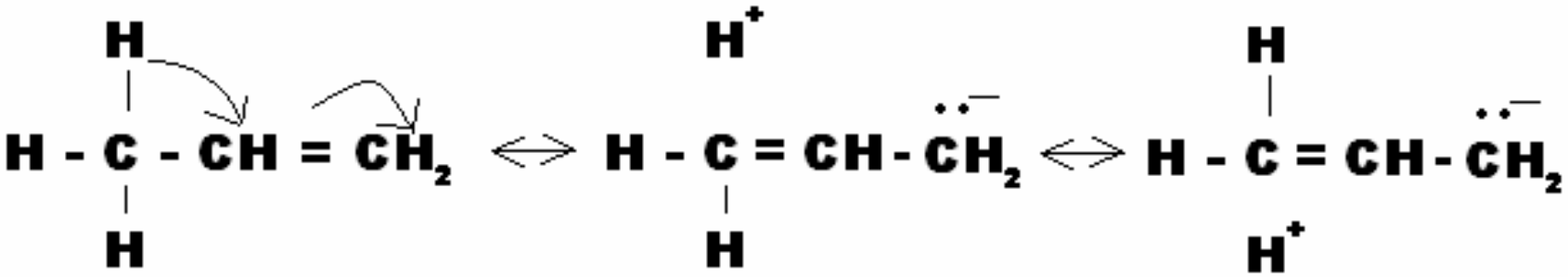


Resonance or Mesomeric effect :- If a molecule can be assigned two or more structure none of which is capable of describing all the known properties of compound, then the actual structure is in intermediate of these structure.



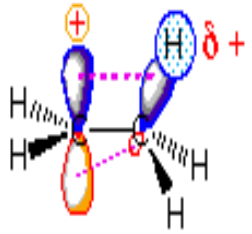


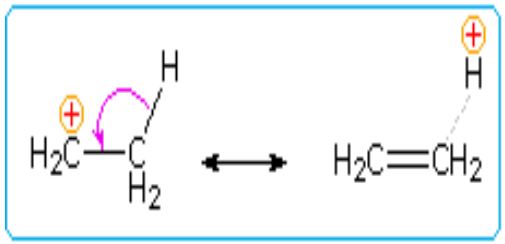
Hyperconjugation :- The interaction between the electrons of system and the adjacent bond of the substituent groups in organic compounds is called hyperconjugation.



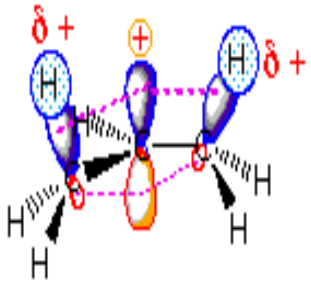
Stabilization of Carbocations by Hyperconjugation

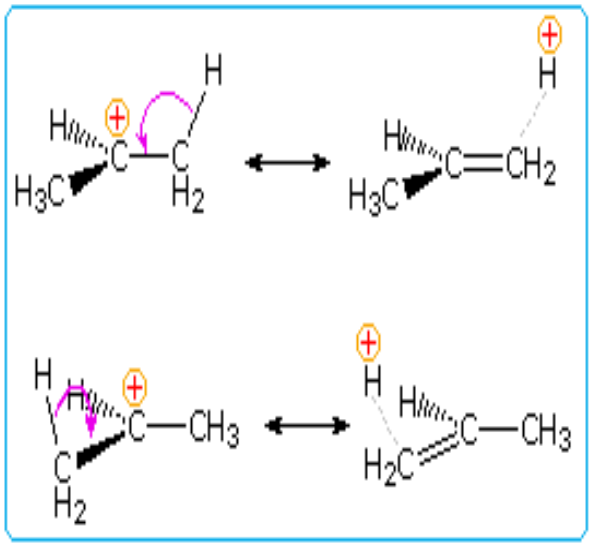
Ethyl



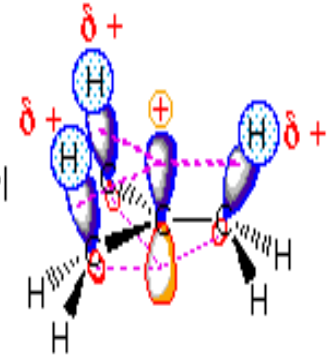


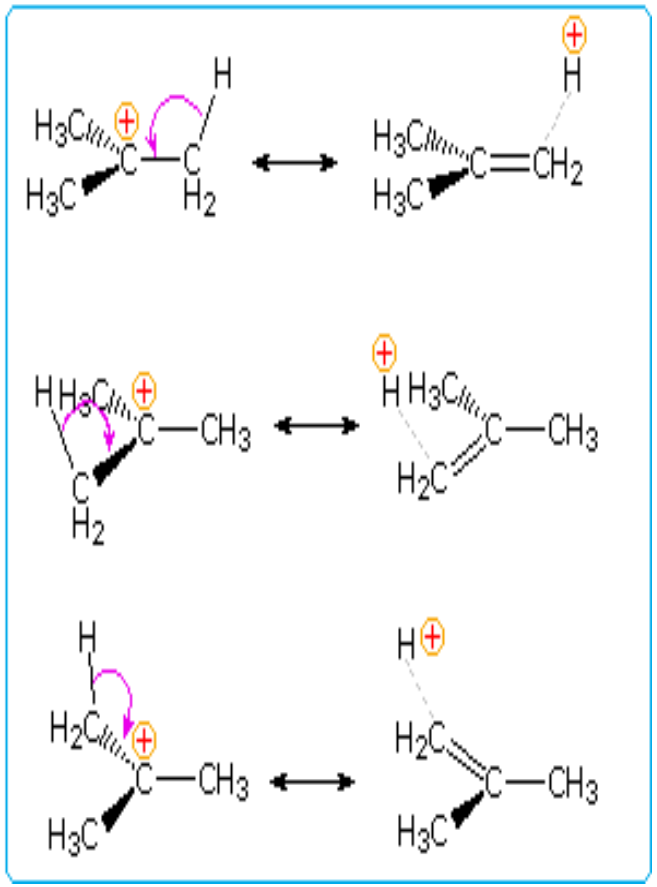
2-Propyl





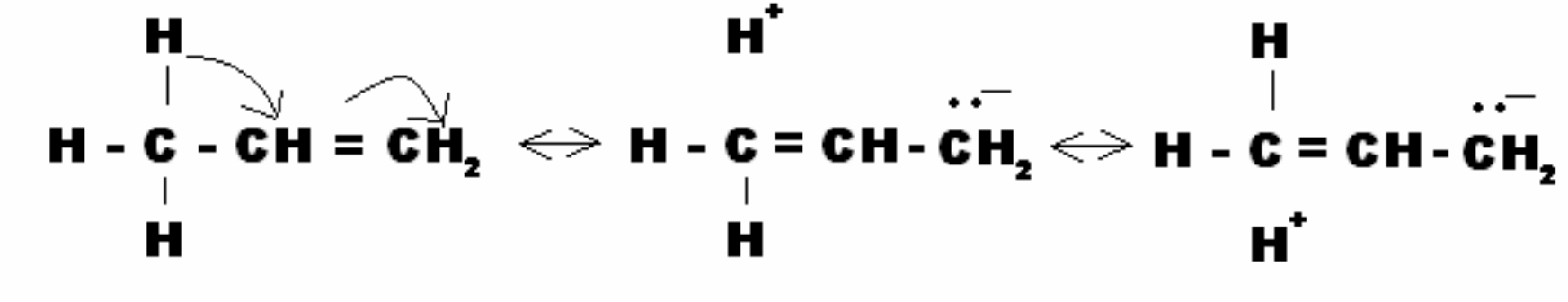
tert-Butyl



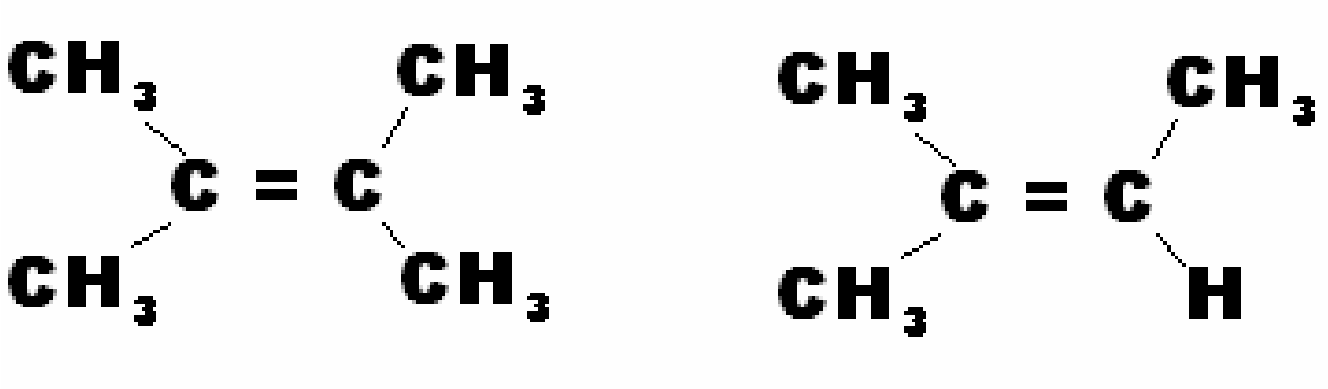


Application of Hyper conjugation

1. shortening of carbon – carbon single bonds adjacent to multiple bonds.



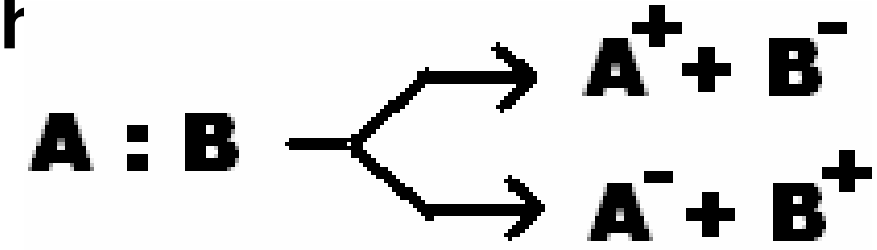
2. Stability of methylated alkenes.



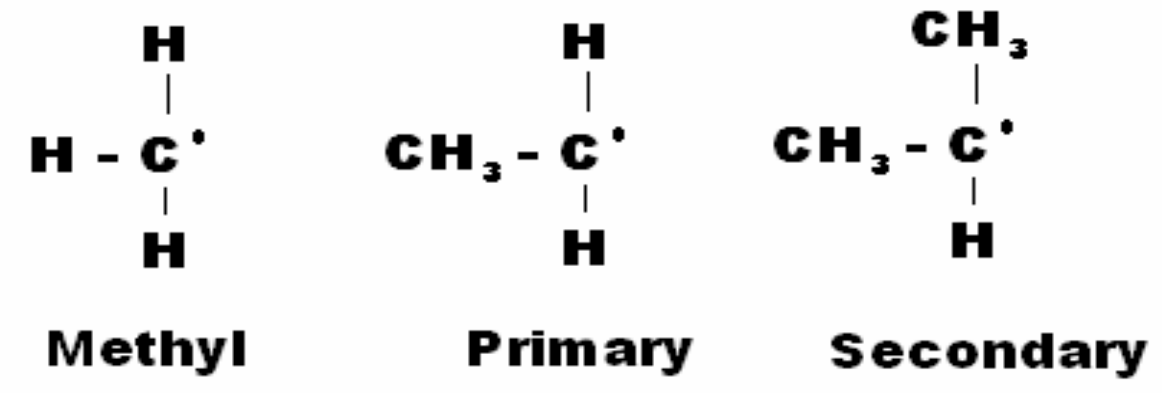
Bond Cleavage

Homolytic fission :- The cleavage of covalent bond between two atoms takes place in such a way that each atom retain one electron of the shared pair.

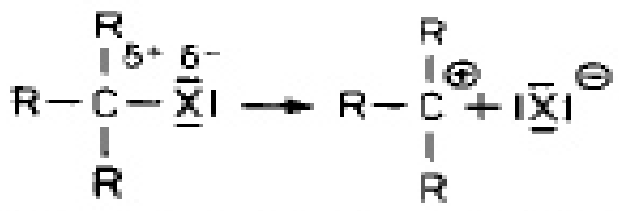
Heterolytic fission :- Heterolytic fission is unsymmetrical so that one of the fragments takes both the electrons of the shared pair leaving none on oth



Free Radical :- A free radical may be defined as an atom or group of atoms having an unpaired electron.

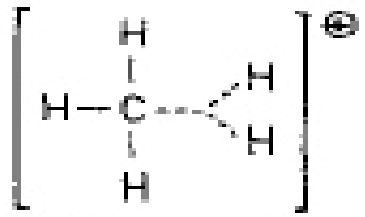


Carbonium ion:- **It is defined as a groups of atoms which contain positively charged carbon having only six electrons.**



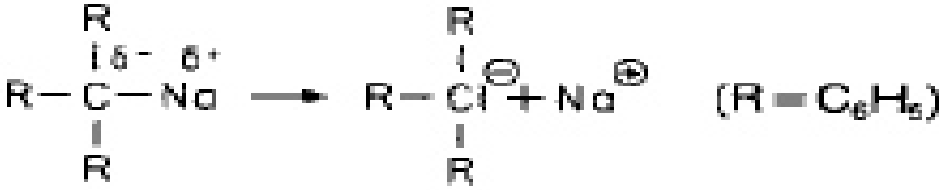
(R = H oder organischer Rest, X = Halogen)

Carbenium-Ion



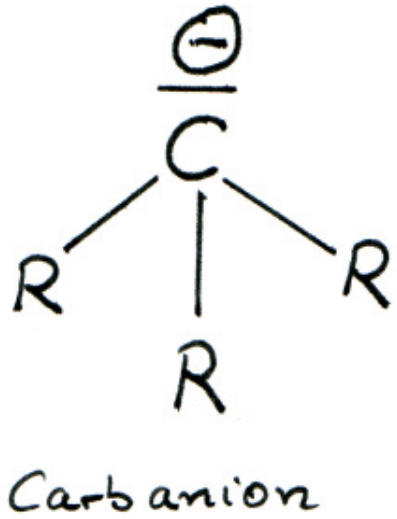
Methonium-Ion

Carbonium-Ion

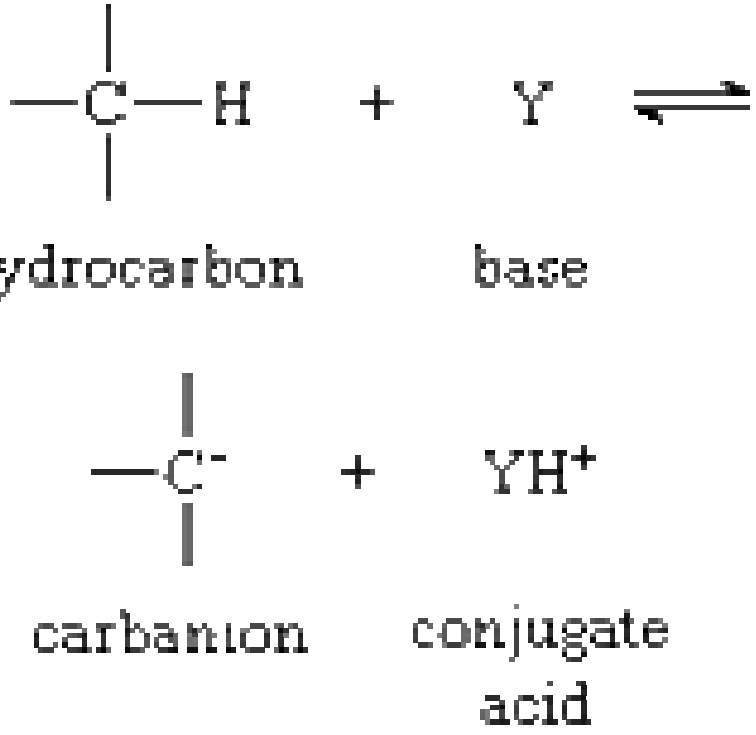


Carbanion

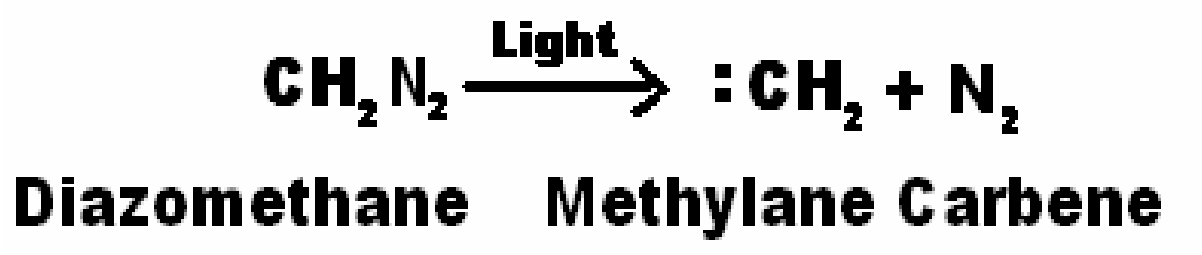
Carbanion :- A carbanion may be defined as a species containing a carbon atom carrying a negative charge.



Carbanion

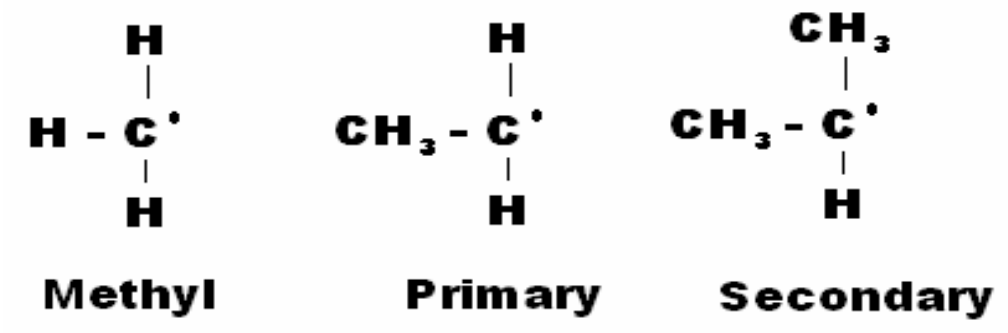


Carbene:- **The carbene are reactive neutral species in which the carbon atom has six electrons in their valence shell out of which two are shared.**



Stability of free radical, carbonium ion and carbanion.

For Free Radical



For Cabocation $CH_3^+ < 1^0 < 2^0 < 3^0$

For carbanion $CH_3^- > 1^0 > 2^0 > 3^0$

Electrophiles:- A positively charged or neutral species which are deficient of electrons and can accept a pair of electrons are called electrophiles.

H^+, H_3O^+, Cl^+ $AlCl_3$, BF_3, SO_3

Nucleophiles :- A nuclophile is a reagent containing an atom having lone pair of electrons.

X^-, OH^-, CN^-, $RCOO^-$ (Negatively Charged)

$\ddot{N}H_3$ $H_2\ddot{O}$: (Neutral Molecule)