INTRODUCTION TO ORGANIC CHEMISTRY

BY

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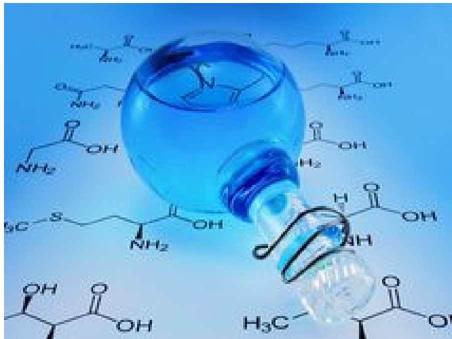
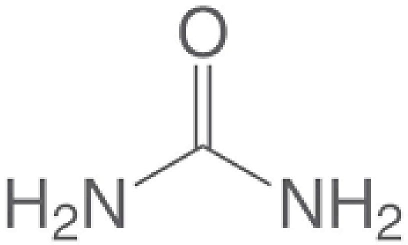
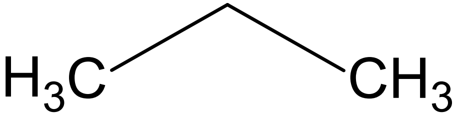


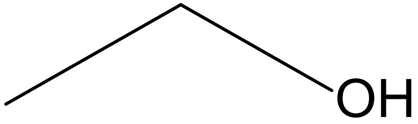
ORGANIC CHEMISTRY

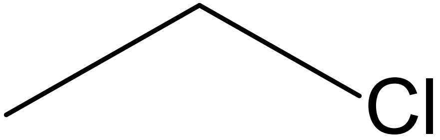
FRIEDRICH WOHLER AND THE UREA



Study of hydrocarbons and their functional derivatives



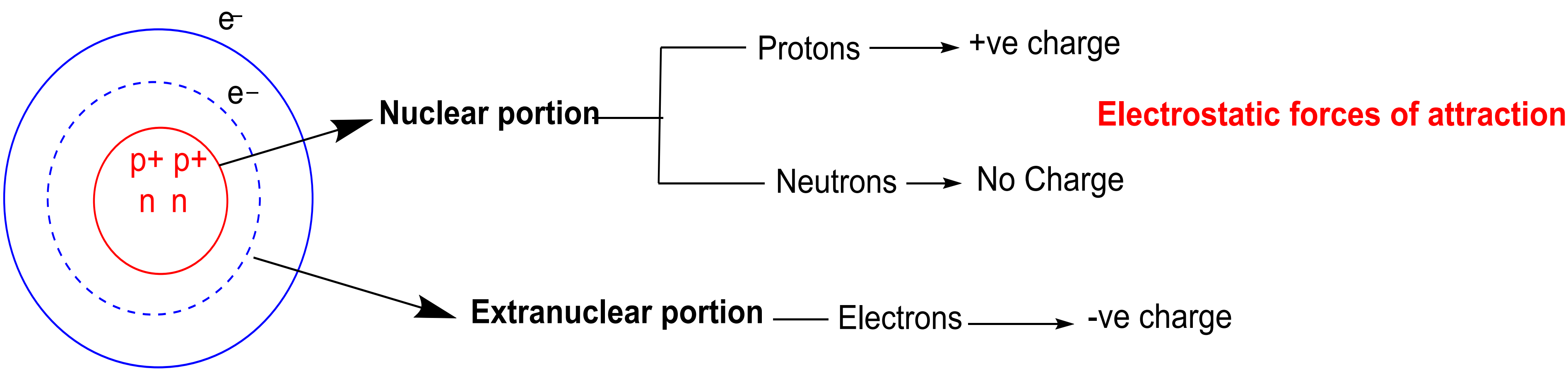




ATOM

Atom, a basic unit of matter

Greek word: Atomos; Atomos = Undivided/indivisible.



STRUCTURE OF ATOM

In an atom number of protons and electrons are equal.

1. Electrons revolve around nucleus the and due to opposite charges between electrons and protons, they are held together by **electrostatic forces of attraction/columbic force**.
2. Neutrons have no charge and **nuclear force** held neutrons and protons together.
3. The number of electrons in the atoms is not constant
4. Atom either looses or gain an electron and participate in a chemical reaction to gain stability.
5. If an atom looses an electron it will gain positive charge and when an atom gain an electron it will have negative charge.

6. The place where the electron is located is called as orbital.

7. An orbital can accommodate a maximum of 2 electrons.

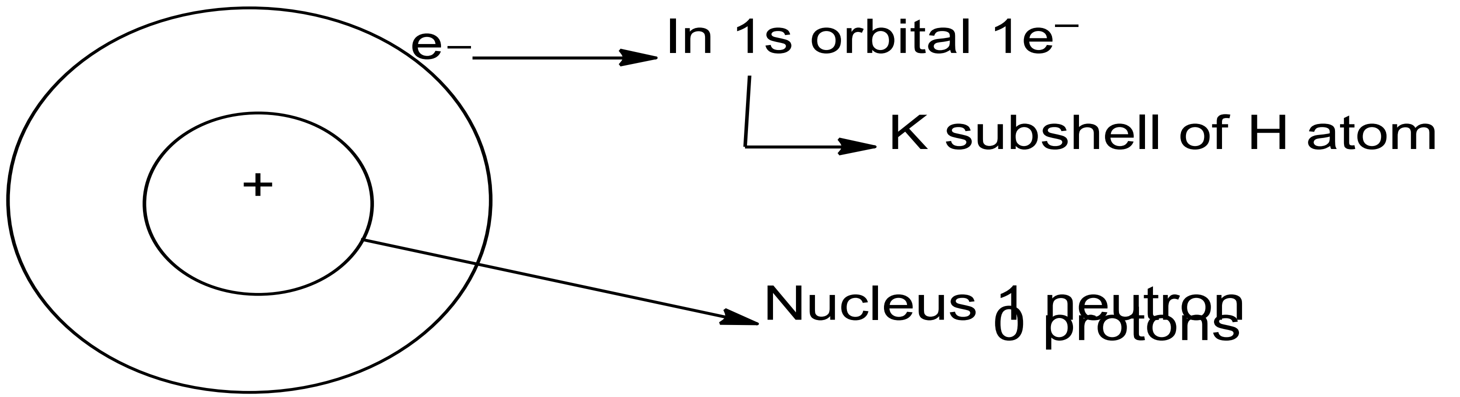
8. Orbitals also called as subshells and a group of orbital's are called as orbits or shells.

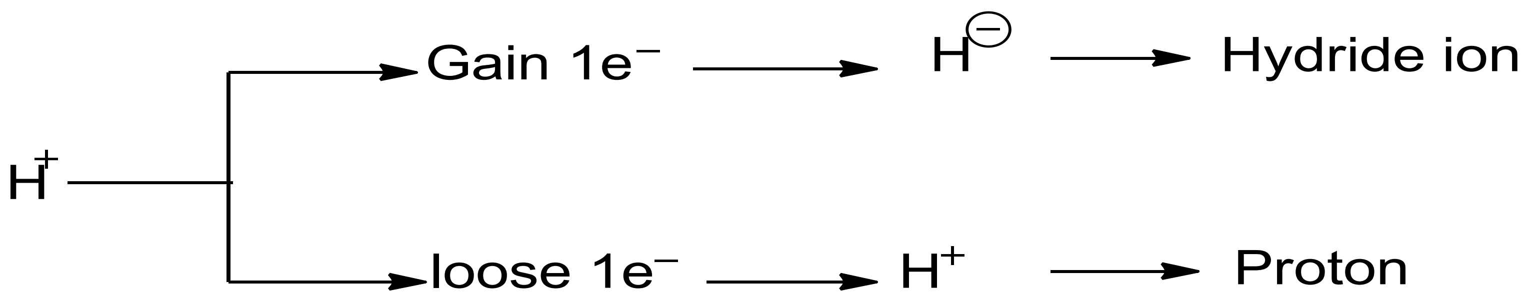
9. Different types of orbital's are ***s, p, d, f*** and **orbits/ shells** include ***K, L, M, N***.

10. According to octets rule configuration the outermost shell should contain 8 electrons.

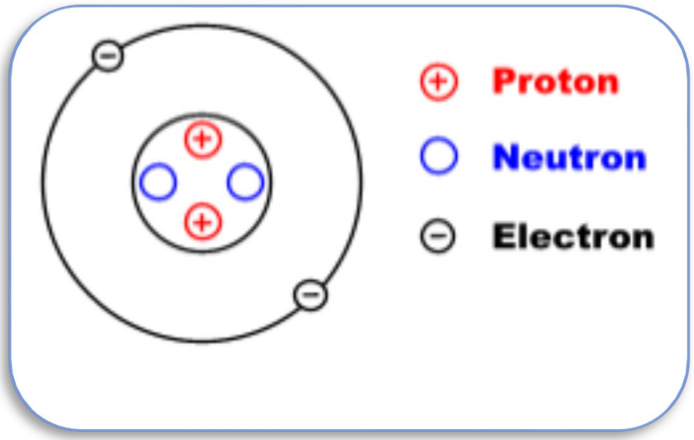
11. If the atom does not contain 8 electrons it will either gain or loose electrons and see that the outermost shell contain 8 electrons in order to get stabilized.

Hydrogen atom:





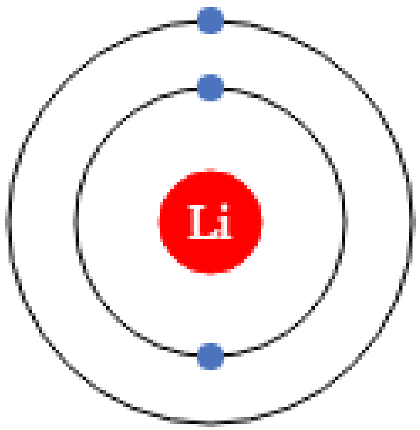
Helium-A neutral atom



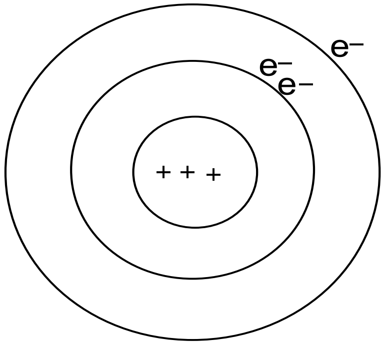
It contain 2 electrons in its only 1s orbital. It cannot gain or loose electron as the 1s orbital is completely filled with two electrons. So it is **inert**.

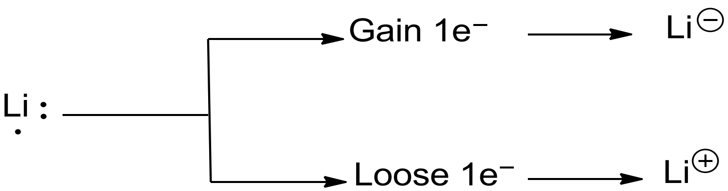
Helium is used as a mobile phase in gas chromatography, where the detector used when Helium as the mobile phase is thermal conductivity detector as Helium has high thermal conductivity.

Lithium-An electropositive element



[He] 2s1 [2, 1]





Electro positive atoms will lose electron and gain stability where as the electronegative atom will gain electron and get stabilized.

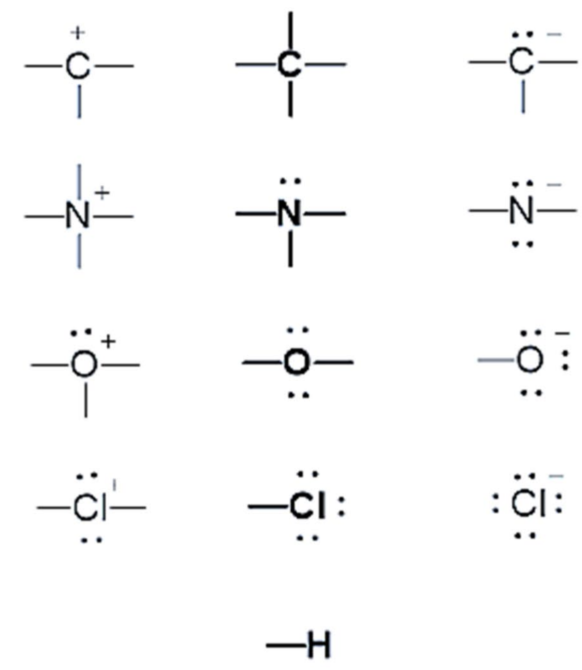
VALENCY:

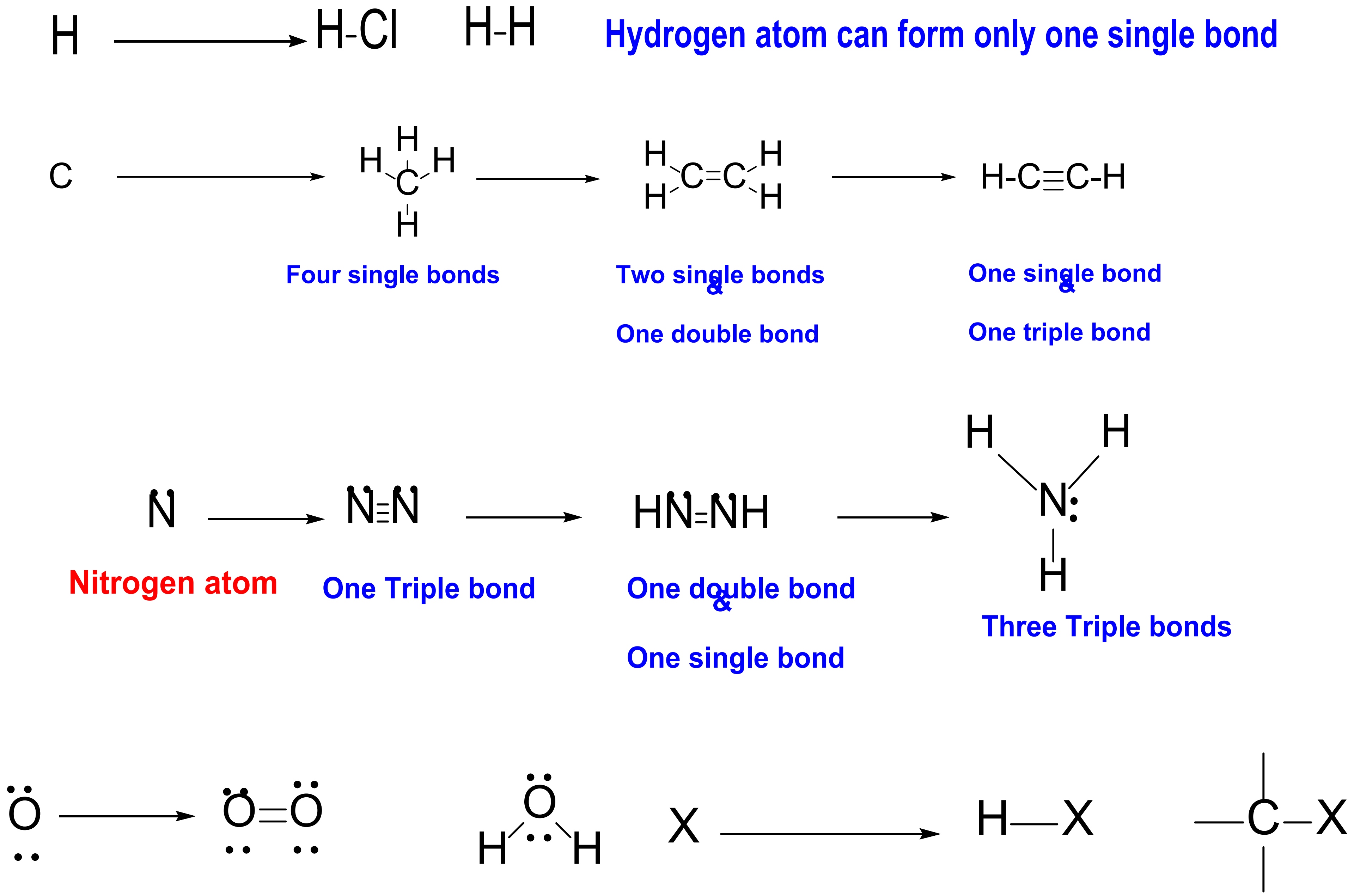
- The combining capacity of an atom is known as its **valency.** In other words Valency is simply the ability of an atom to form number of bonds.

Element (valence electrons)	The Number Each Element Likes (No Formal Charge)	
	Bonds	Lone Pairs
C (4)	4	0
N (5)	3	1
O (6)	2	2
X (7)	1	3
H (1)	1	0

Formal Charge

+1 0 -1




H
H-Cl
H-H
Hydrogen atom can form only one single bond
C
Four single bonds
Two single bonds
&
One double bond
One single bond
&
One triple bond
N
Nitrogen atom
One Triple bond
HN=NH
One double bond
&
One single bond
Three Triple bonds
O
X
H—X

ATOMIC NUMBER /PROTON NUMBER (*Z*)

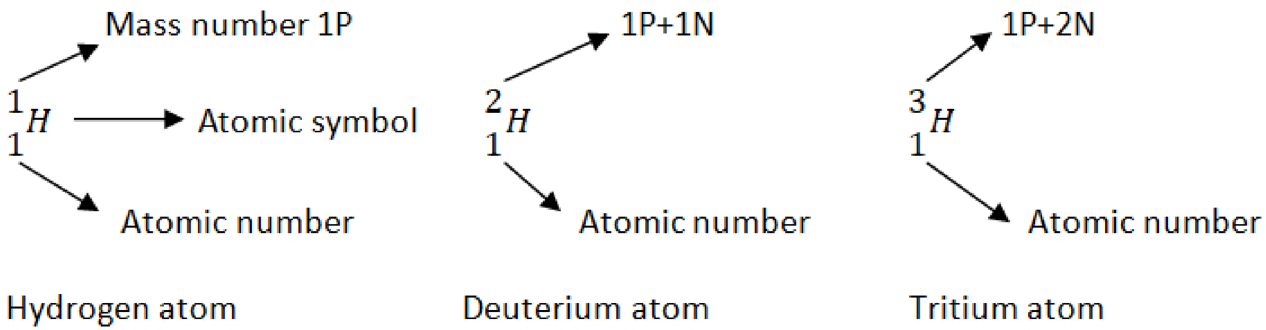
Number of protons in an atom.

MASS NUMBER (*A*)

Total number of protons and neutrons.

$$A = Z + N$$

ISOTOPES



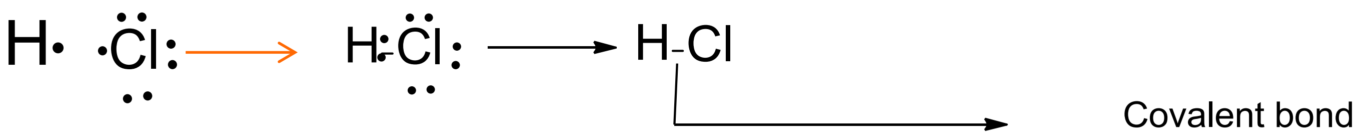
1. Isotopes posses some atomic number but different mass number.
2. All isotopes have some chemical properties due to same number of electrons.
3. Isotopes posses different physical properties.

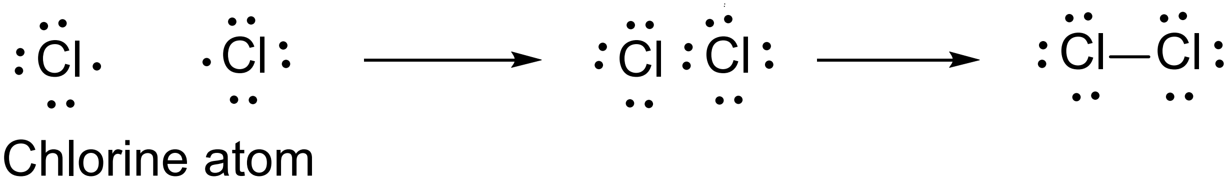
TYPES OF CHEMICAL BONDS

1. Covalent bond
2. Ionic bond
3. Co-ordinate covalent bond/dative bond

Covalent bond:

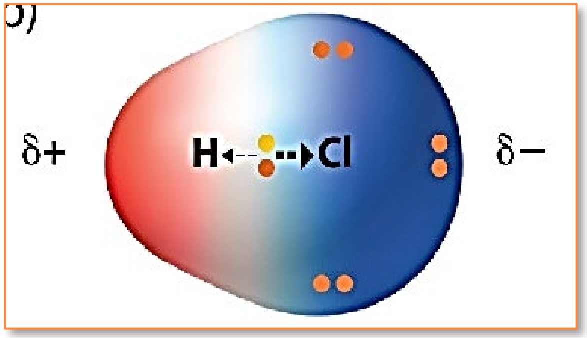
Covalent bond formation involves sharing of electrons by two atoms in order to satisfy their valencies.



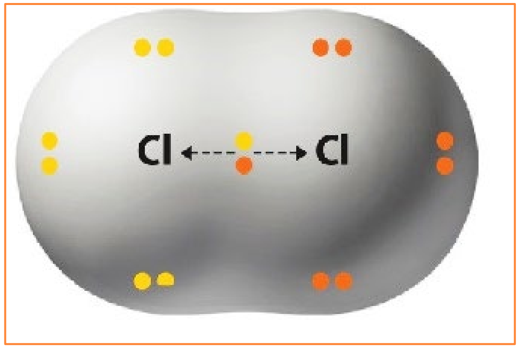


Covalent bond two types

1.Polar covalent bond



2.Non polar covalent bonds:



Polar molecule have dipole moment.

Dipole moment is given by

$$\mu = e \text{ x } d$$

where μ=dipole moment

e=charge

d=distance

Units of μ is Debye

Dipole moment can be determined by **Oscillometry**.

Molecules which have polar covalent bond are soluble in polar solvent and non polar molecule in non polar solvent. i.e. Like dissolves like.

HOW THE COVALENT BOND IS FORMED?

THE CONCEPT OF HYBRIDIZATION

HYBRIDIZATION: Intermixing of atomic orbitals of the same atom to from hybridized orbital.

Atomic orbitals → hybridized orbitals

↓ ↓

Hybridizing orbital — will have same energies

↓

Will have different chemical energies

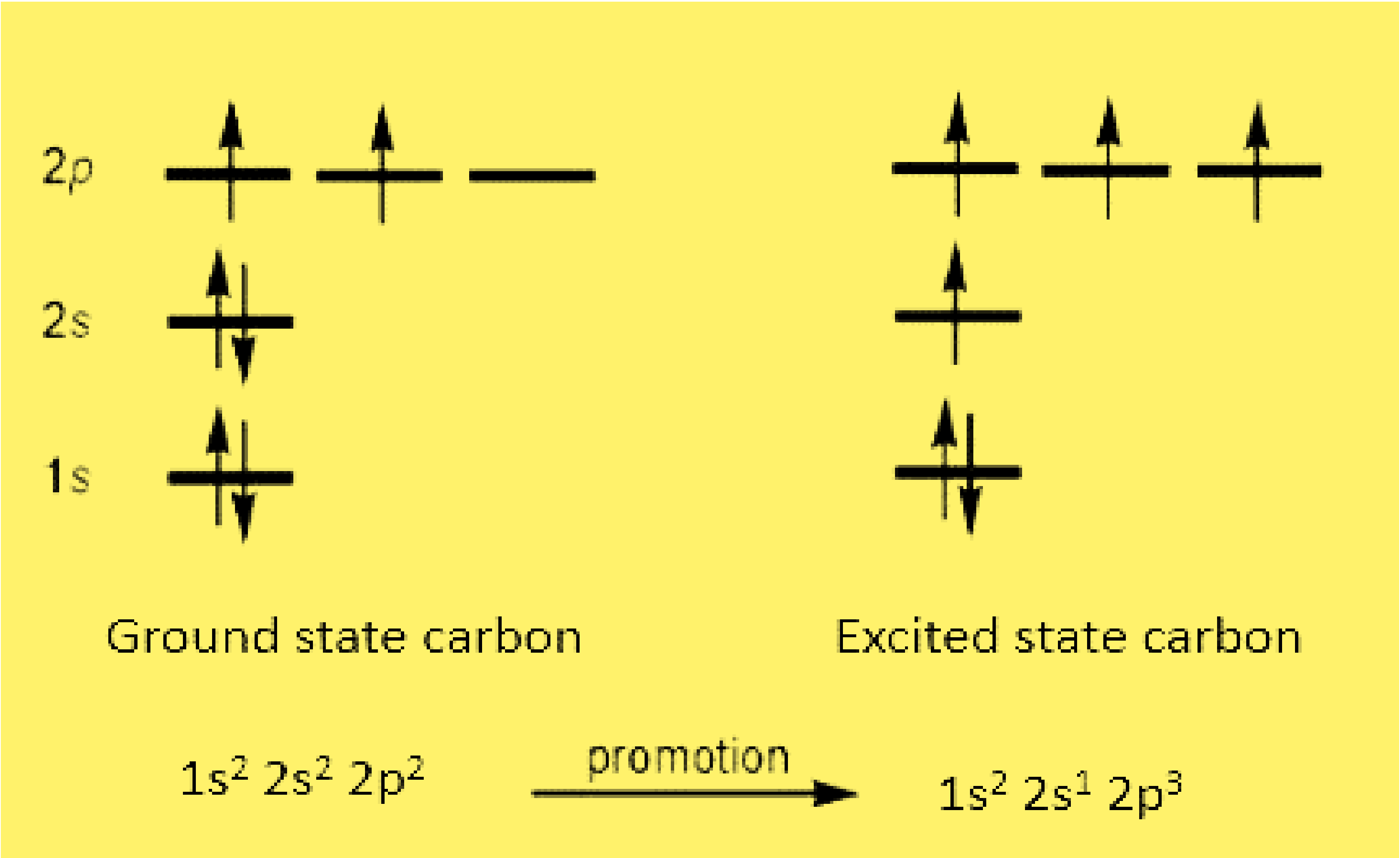
Number of hybridizing orbital =Number of hybridised orbital

Carbon atom form 4 covalent bonds and can have 3 states of hybridization

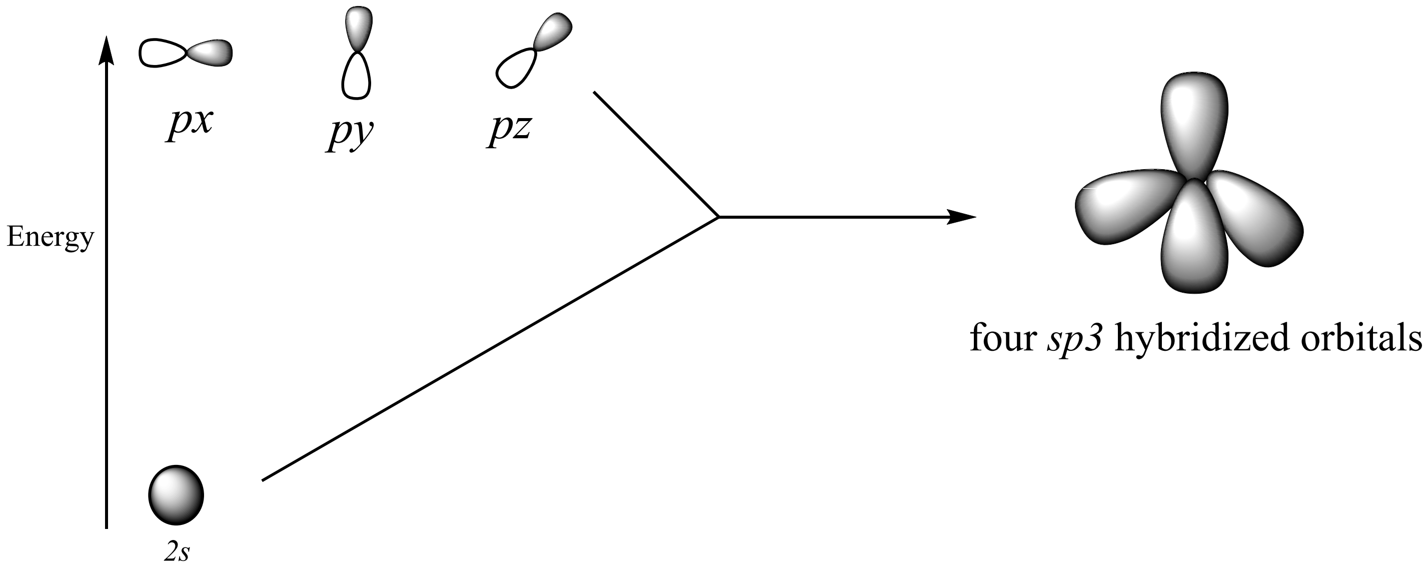
sp³ **Tetrahedral Hybridization**

sp² **Trigonal Hybridization**

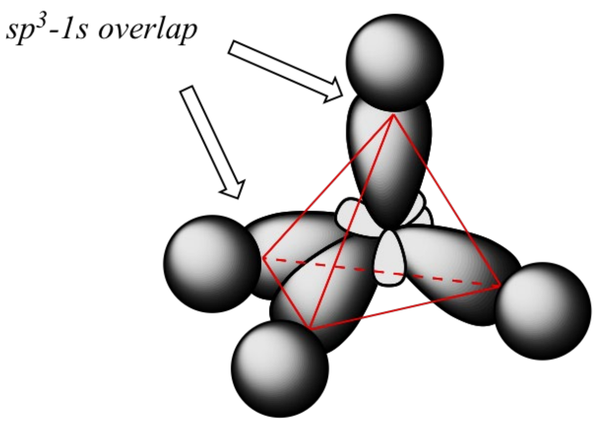
sp **Linear Hybridization**

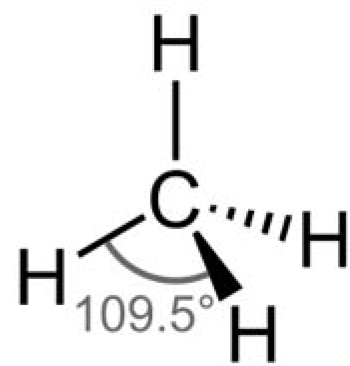


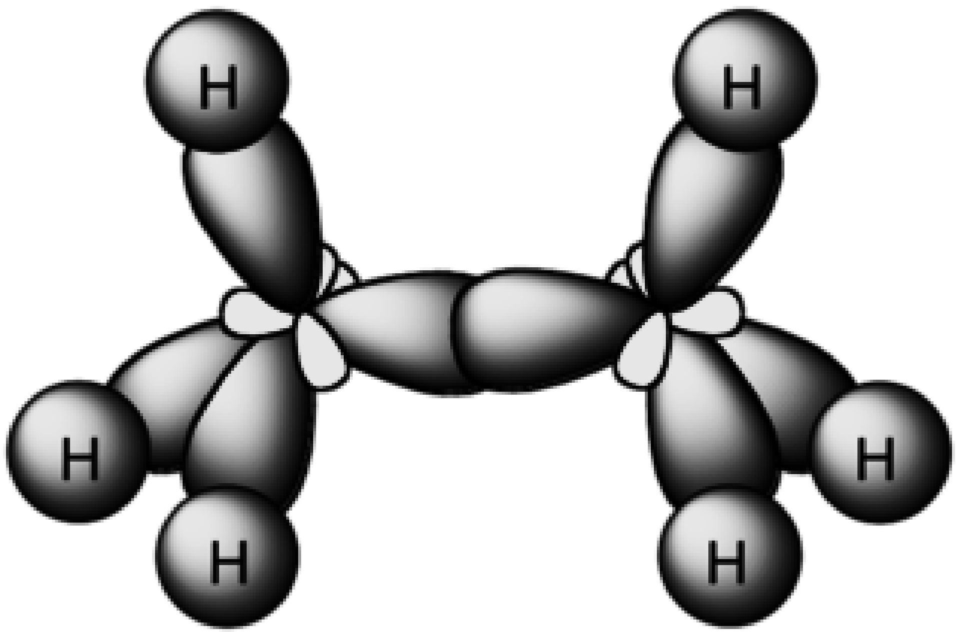
sp^3 **hybridization** : one *s*-orbital and three *p*-orbitals

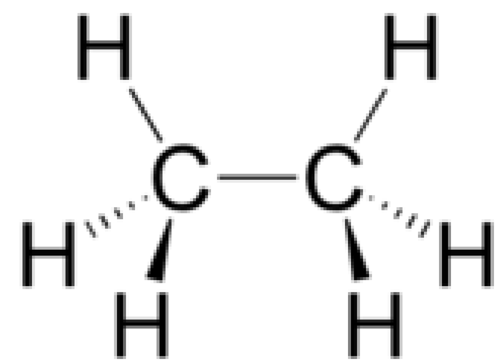


Carbon atom of alkanes will have *sp*^{3} hybridization

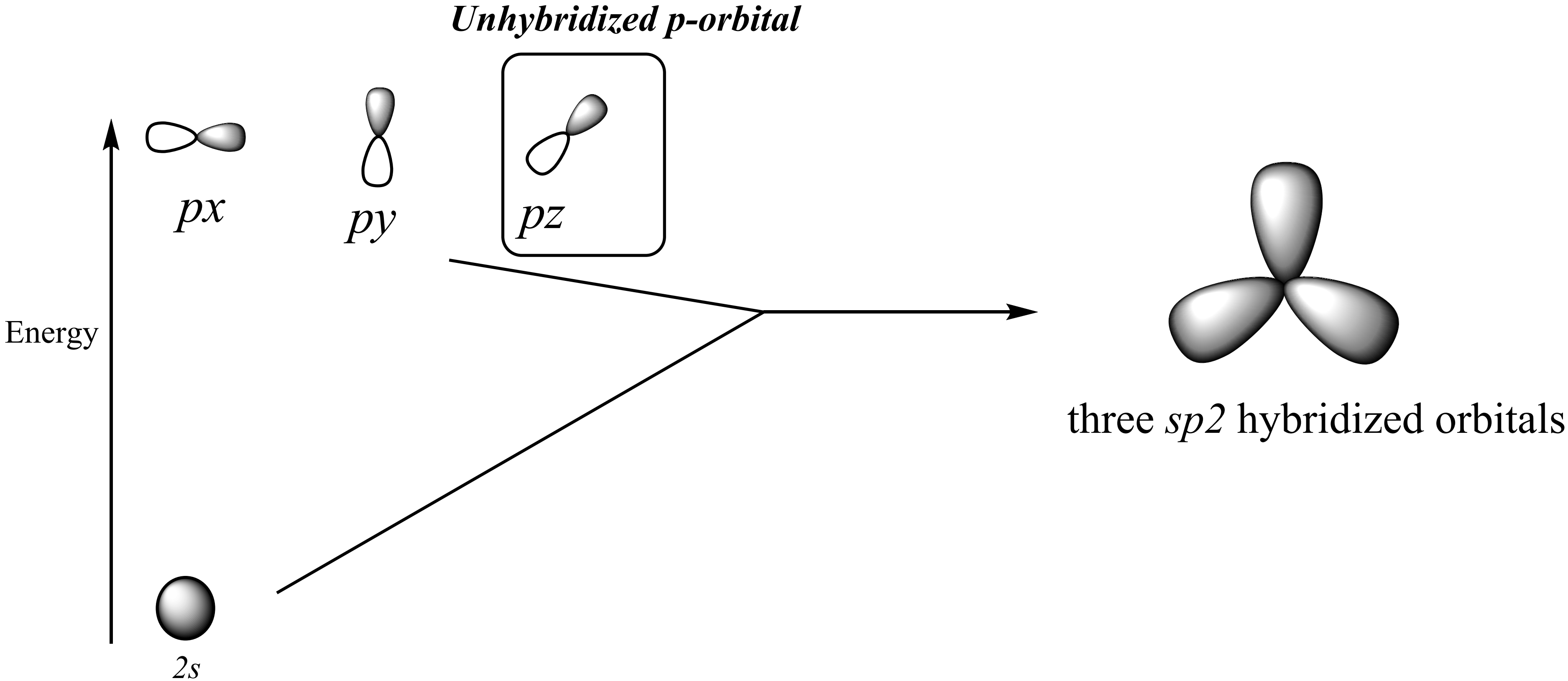




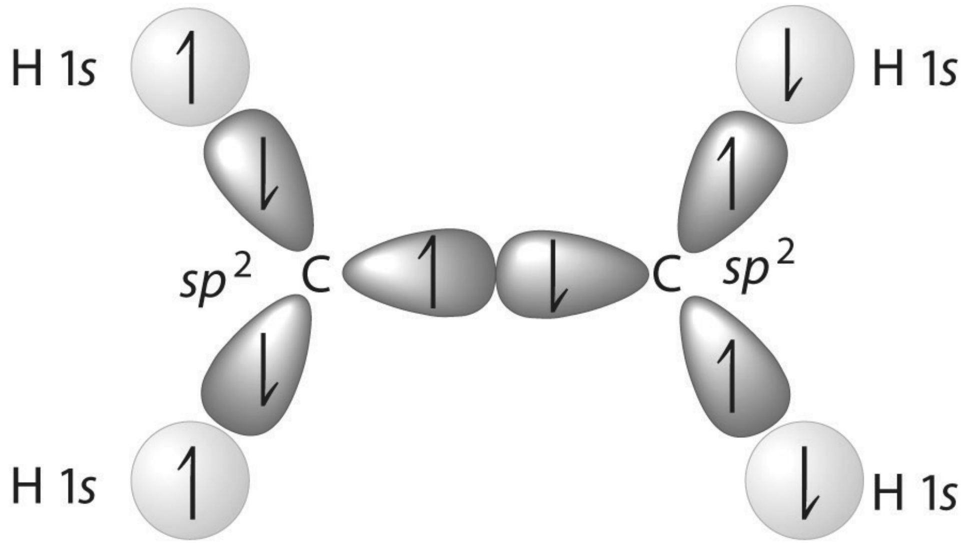


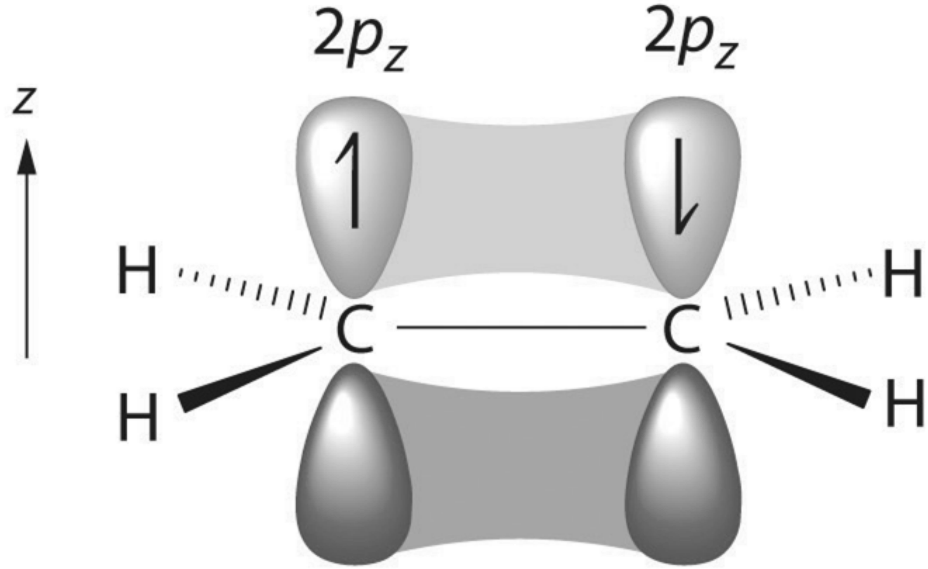


sp^2 **hybridization** : one *s*-orbital and two *p*-orbitals

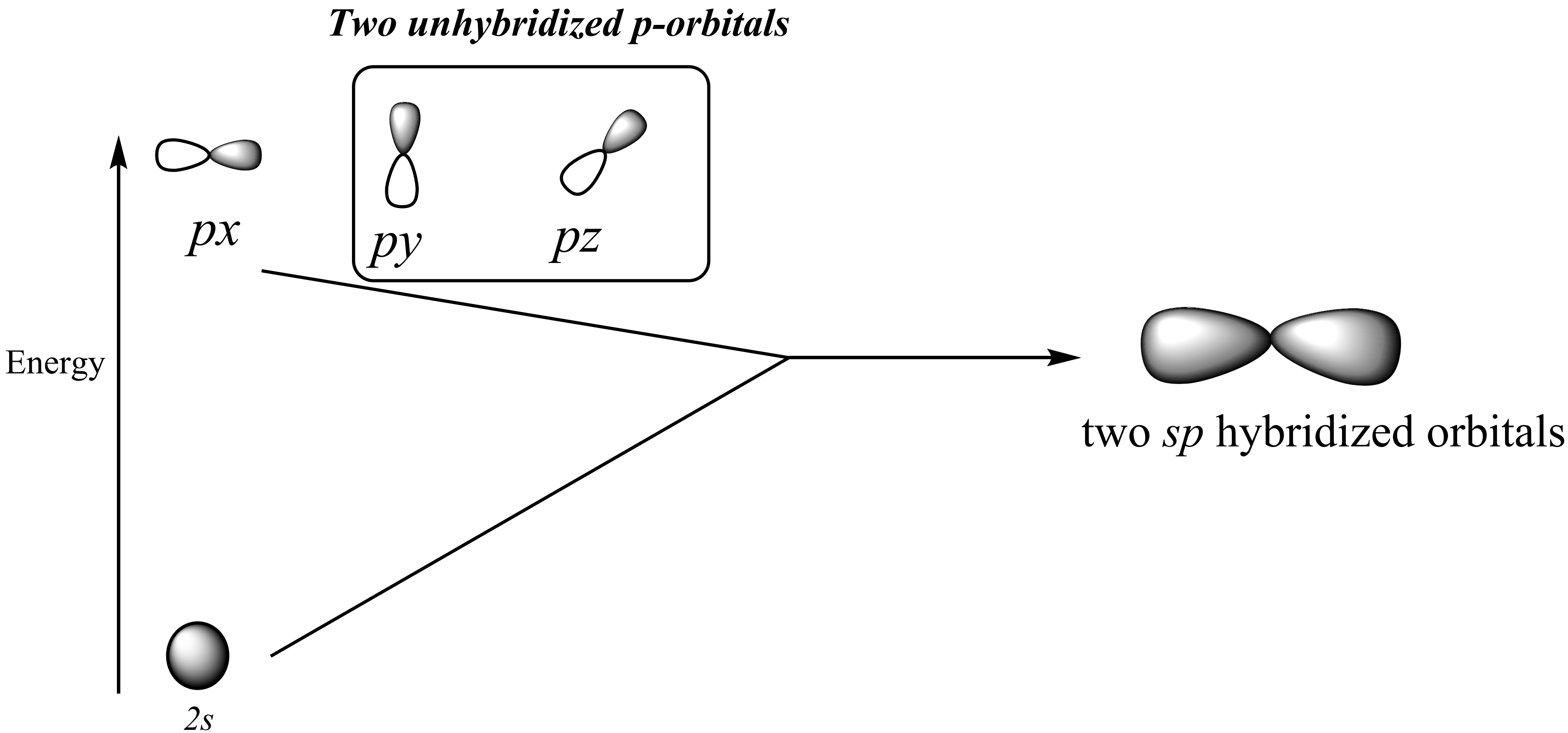


Carbon atom of alkenes and aromatic compounds will have *sp^2* hybridization

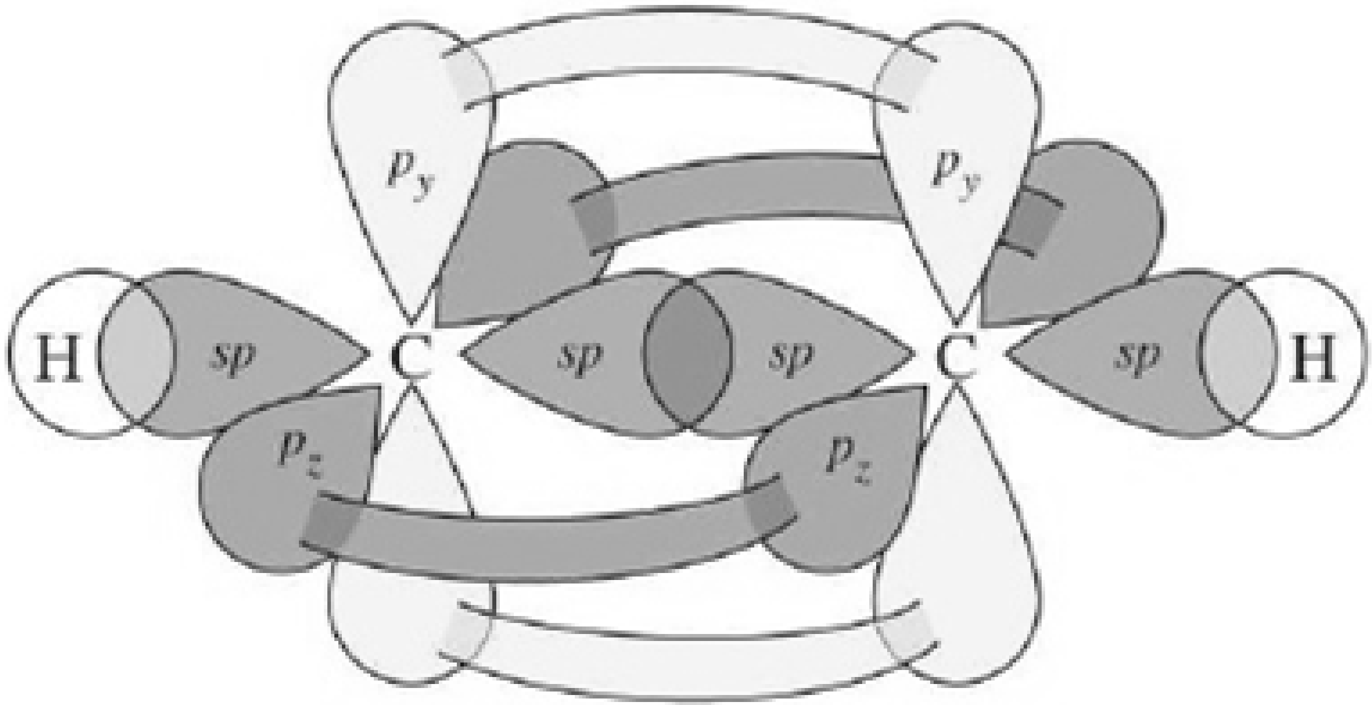

H 1s
H 1s
sp2
C
C
sp2
H 1s
H 1s


2pz
2pz
z
H
H
C
C
H
H

sp **hybridization** : one *s*-orbital and one *p*-orbital



Carbon atom of alkynes will have *sp* hybridization



acetylene

Ionic bond:

Ionic bond is a force of attraction between two opposite charged ions.

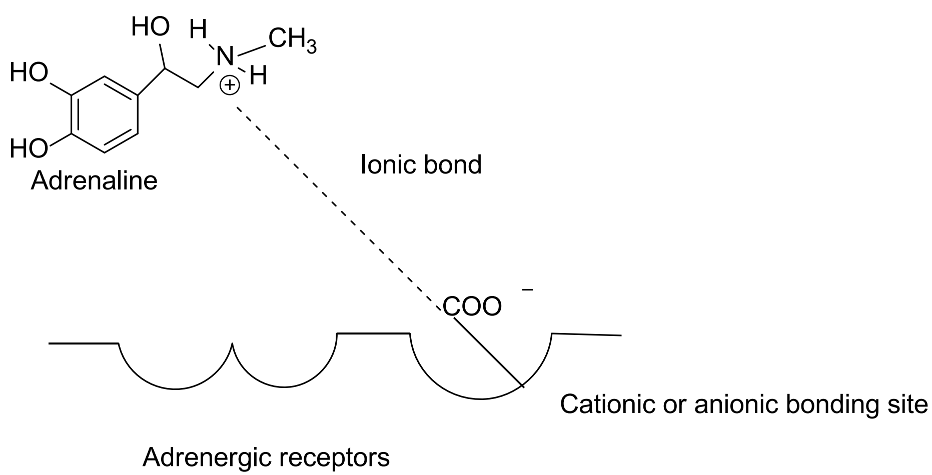
Eg:

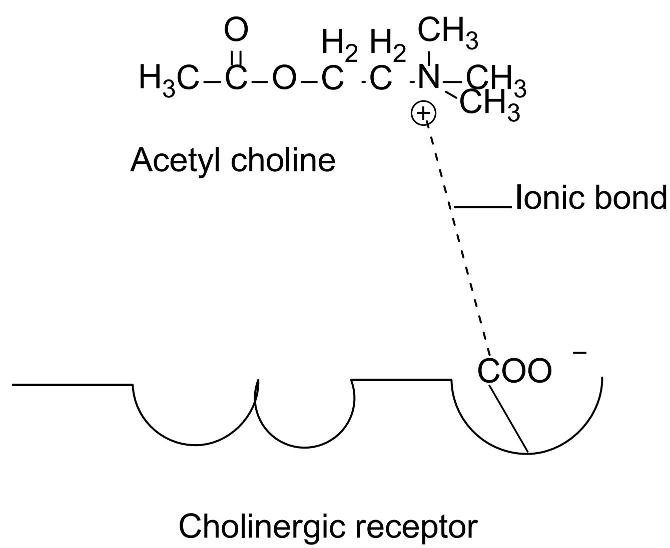
Na^{+}-----Cl^{-}

Ionic bond/electrostatic bond/columbic bond

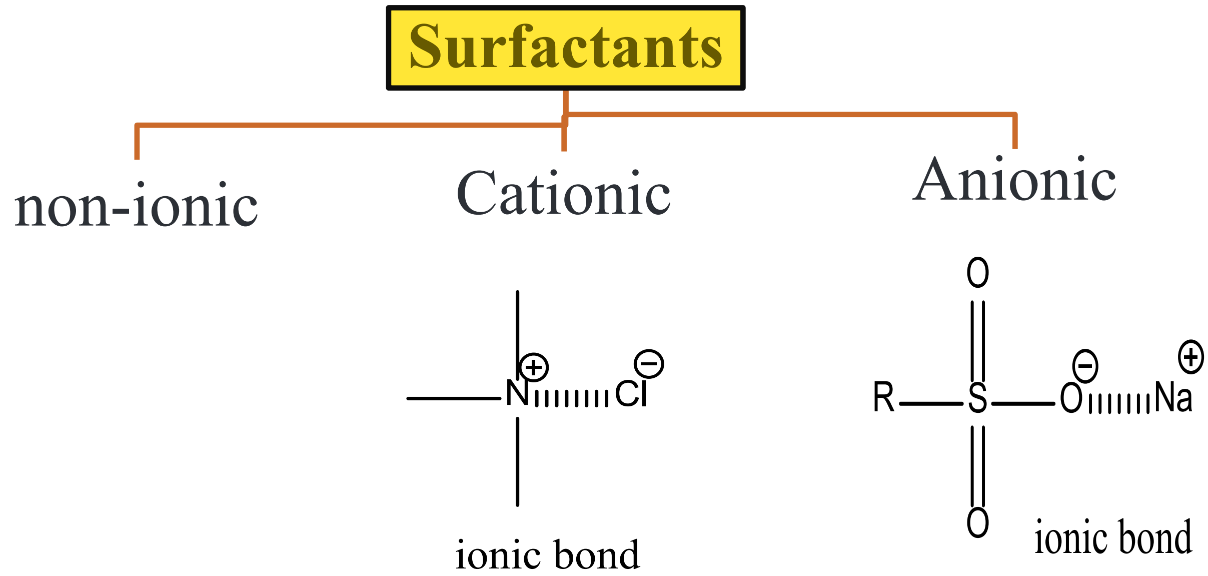
Most of the molecules will show their action by interacting with receptor through ionic bond.

Eg:



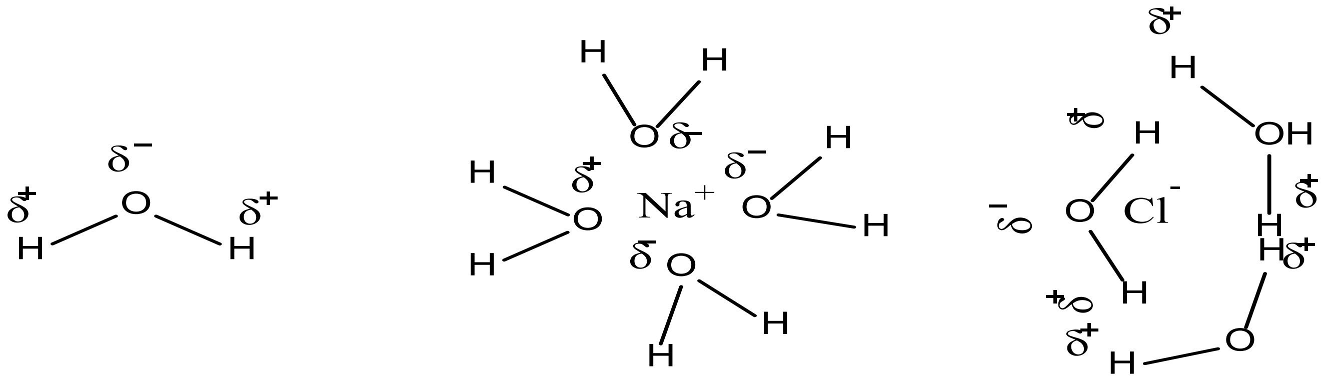


Surfactants:

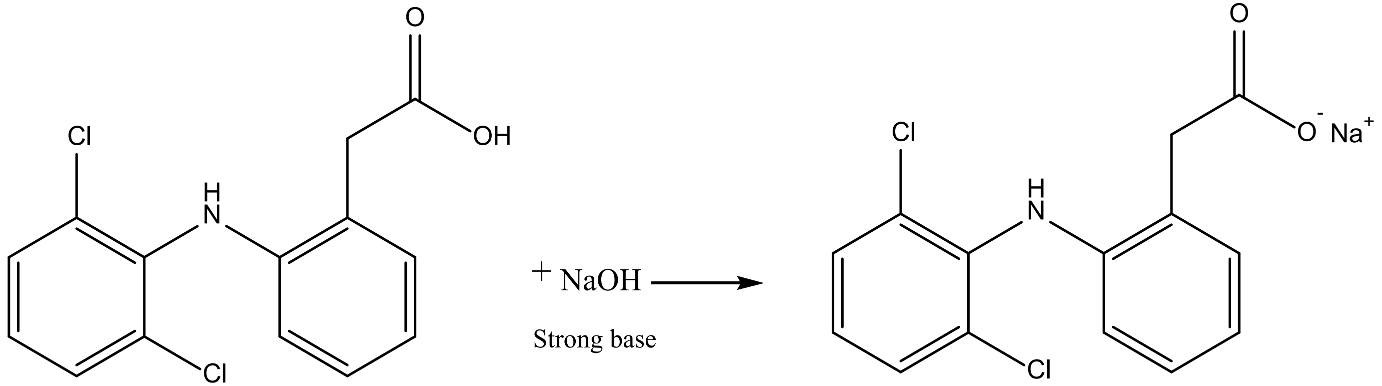


- The concentration of ions in an ionic solution can be determined by conductometry because ions has capacity of conducting electricity.
- In ion exchange chromatography usually conductivity detector is used.
- Ionic compounds are soluble in polar solvents like water.

•NaCl is soluble in water due ion-dipole force. This process is called **ion solvation.**



•Diclofenac-NSAID is having less water solubility , hence it is converted into its sodium salt diclofenac sodium which has better water solubility.



Diclofenac
(Less water solubility)

Diclofenac sodium
(More water soluble)

Co-ordinate covalent bond/ dative bond:

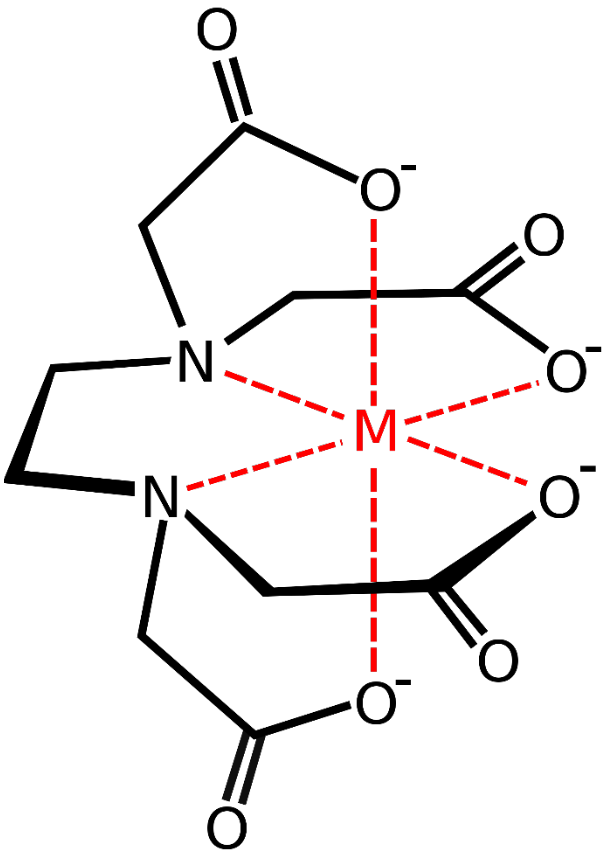
Two chemical species

Electro rich species

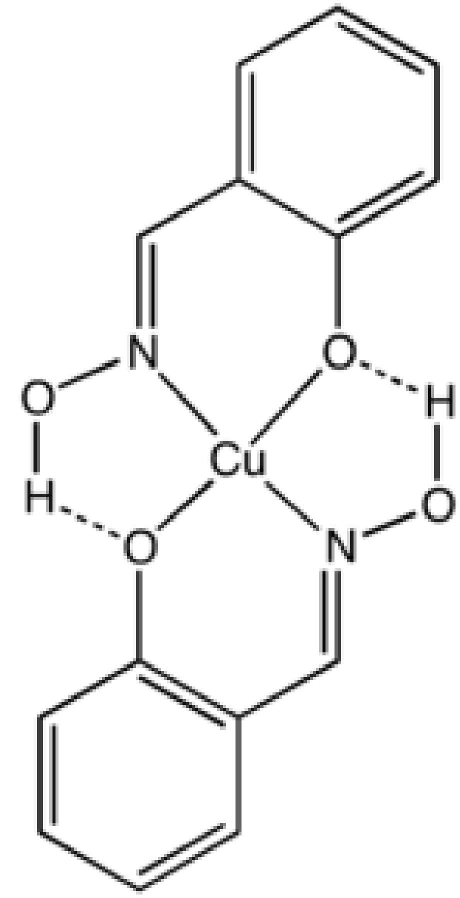
$-\ddot{N}H_2$ $-\ddot{\underset{\cdot\cdot}{O}}H$ $-\ddot{\underset{\cdot\cdot}{S}}H$

Electro deficient species

Metal cations



Sequestering agent: Disodium EDTA



Chelating agent: Salicylaldoxime

Electron rich species + M+

↓

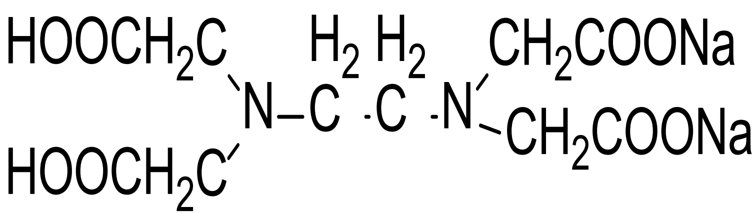
ESR-M+ complex

•Water soluble ESR

↓

sequestering agent

Eg: disodium EDTA



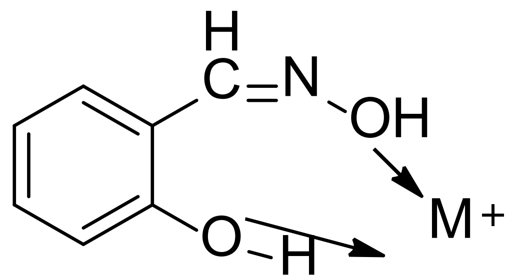
•Water soluble ESR form water soluble complex

Electron deficient spices

• water insoluble ESR

chelating agent

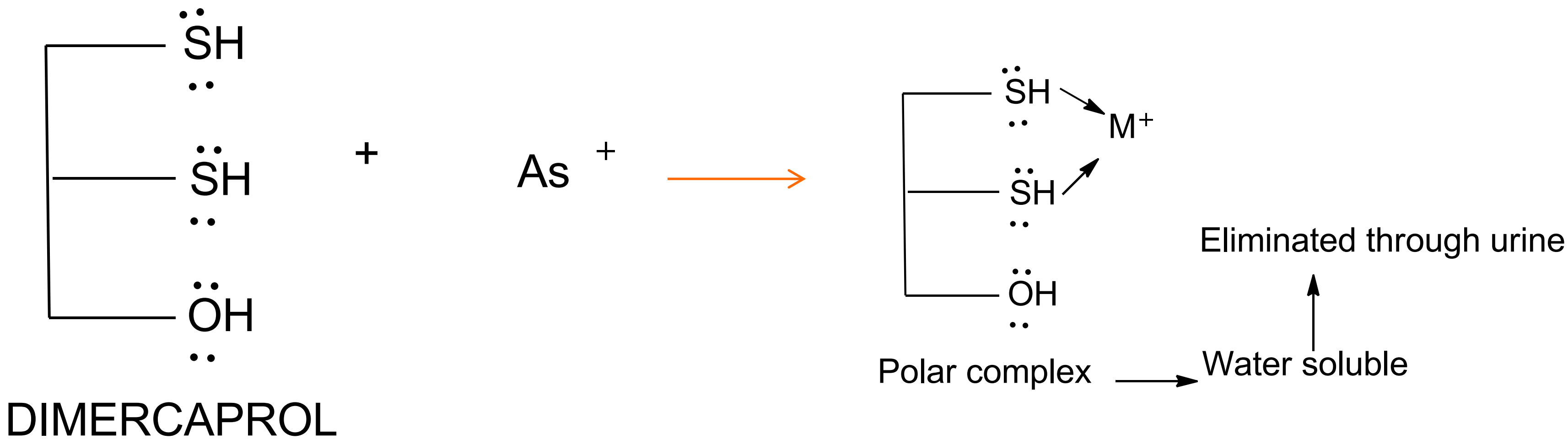
Eg: salicyl aldoxime



• water insoluble complex

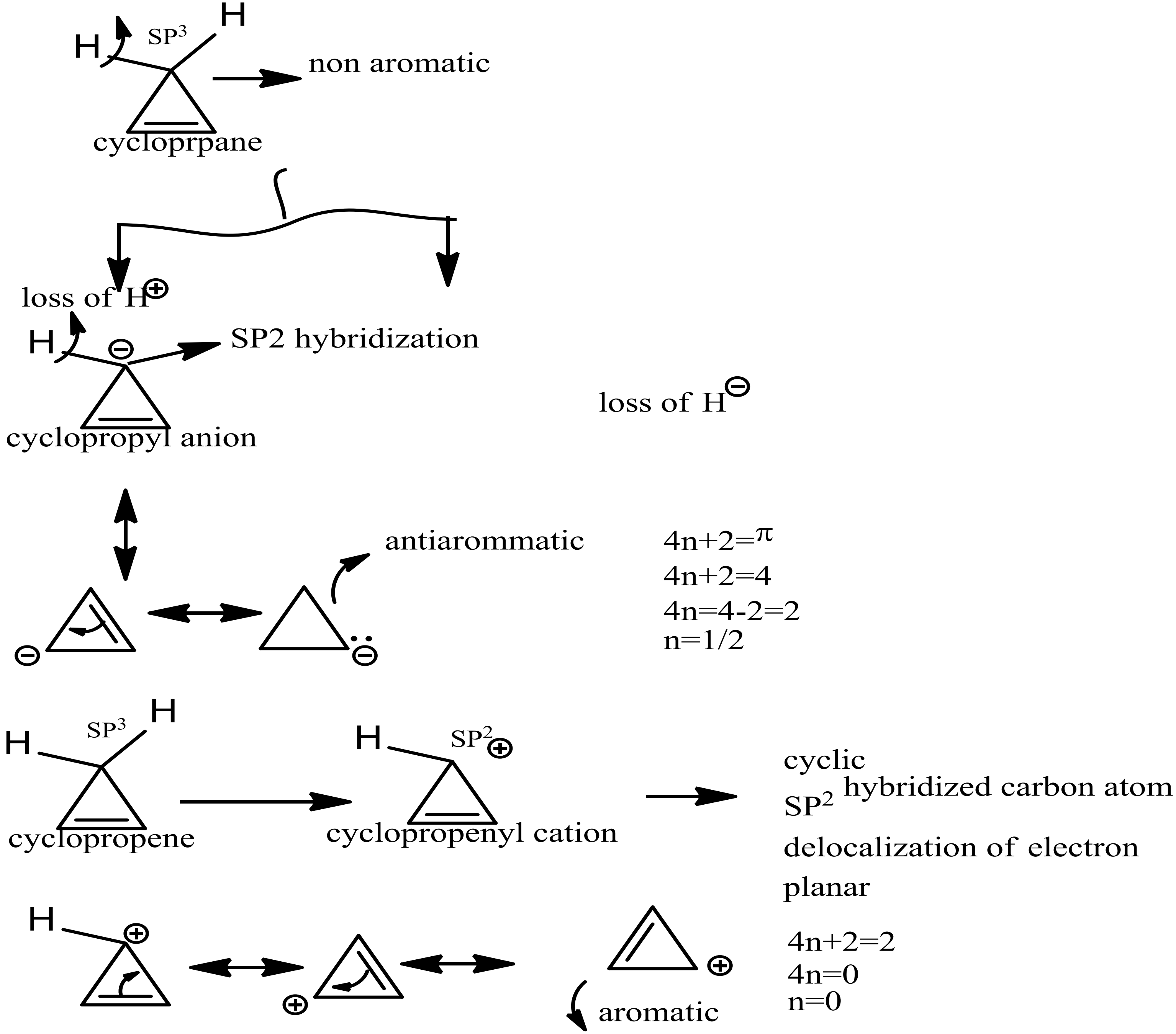
Dimercaprol (British antilewisite (BAL): Sequestering agent used as antidote for Arsenic and mercury poisoning

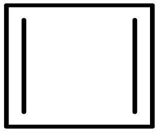
Lewisite is an arsenic poison



AROMATICITY

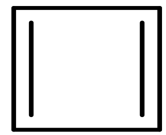
Aromatic	Antiaromatic	Non-aromatic
Cyclic	cyclic	Cyclic/acyclic
Have SP^3 hybridized atom	Have SP^2 hybridized atom	SP^3/SP^2 hybridized atom
Delocalization of electron	Delocalization of electron planar	No delocalization of electron
planar	Planar	Non planar
Obey huckel's rule ($4n+2=\pi\ e^-$)	Obey 4n rule	Doesn't obey 4n+2 (or) 4n rule
Highly stable	Highly unstable	Intermediate stability

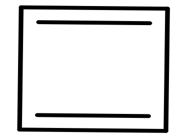

H
SP3
H
non aromatic
cycloprpane
loss of H⊕
H
SP2 hybridization
cyclopropyl anion
loss of H⊖
antiarommatic
4n+2=π
4n+2=4
4n=4-2=2
n=1/2
H
SP3
H
cyclopropene
H
SP2
cyclopropenyl cation
cyclic
SP2 hybridized carbon atom
delocalization of electron
planar
H
aromatic
4n+2=2
4n=0
n=0



→ cyclobutadiene → anti-aromatic

* cyclic
* SP_2 hybridization
* delocalization
* planar





$4n+2=\pi e^-$

$4n+2=4$

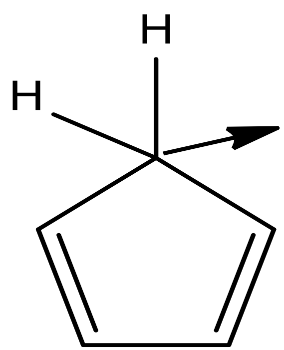
$4n=2$

$n=1/2$

$4n=4$

$n=1$

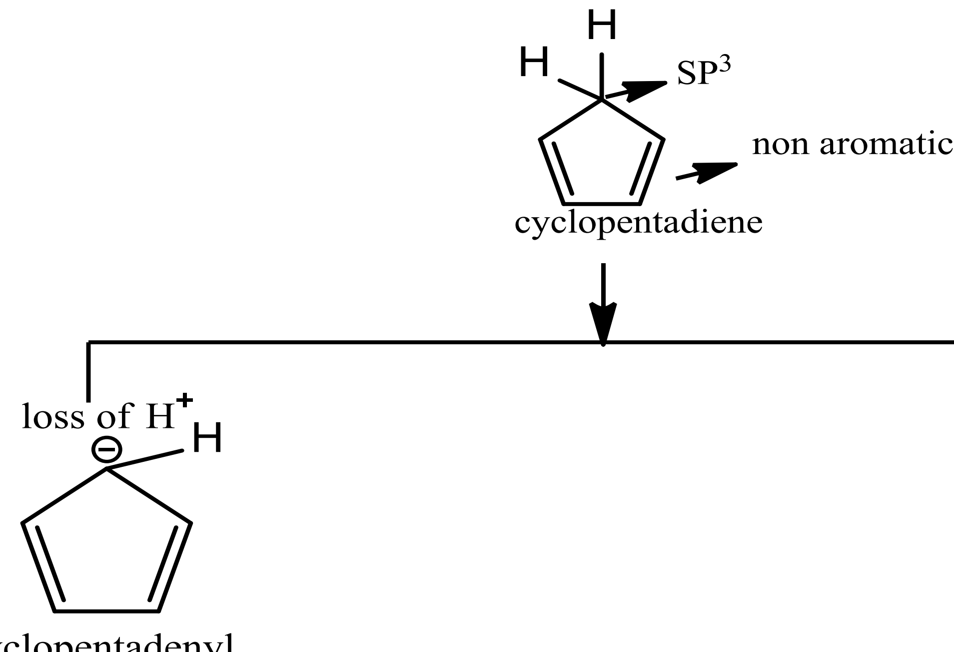
obeys 4n rule



→ SP^3

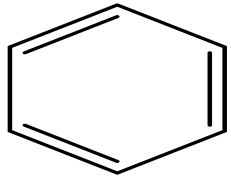
→ non aromatic

cyclopentadiene



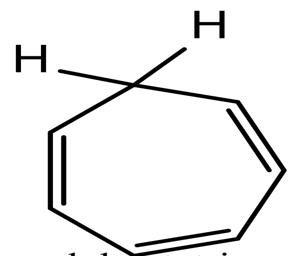
cyclopentadenyl
anion-aromatic
cyclic
SP^2 hybridization
delocalization
planar
4n+2=6
n=1

cyclopentadenyl-aromatic
cyclic
SP^2 hybridization
delocalization
planar
4n+2=4
n=1/2
4n=4
n=1



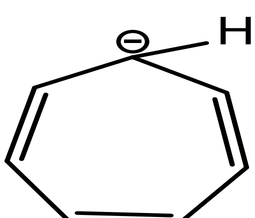
Benzene → Aromatic →

cyclic
SP^2 hybridization
delocalozation
planar
$4n+2=\pi e^-$
$4n+2=6$
$n=1$



cycloheptatriene → Non-aromatic

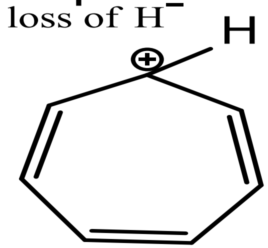
loss of H^+



cyclopentatriene
Anion--anti-armatic
cyclic
delocalization
SP^2 hybridization
planar

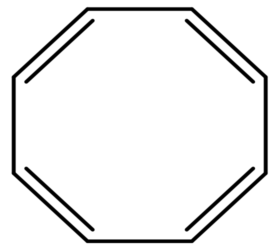
$4n+2=8$
$4n=8$
$n=2$

loss of H^-

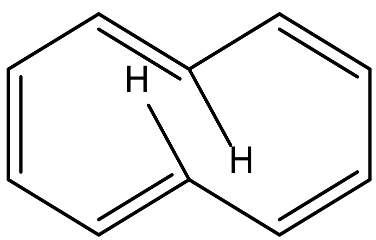


cycloheptatriene
cation - aromatic
Tropyllium ion
$4n+2=6$
$4n=4$
$n=1$

cyclo-octatetraene → tub shape → identified by x-ray spectroscopy
-non aromatic



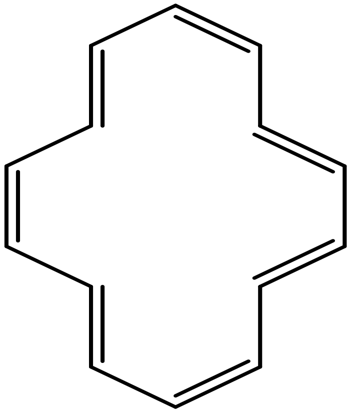
Annulenes



It seems to be aromatic but actually is non-aromatic

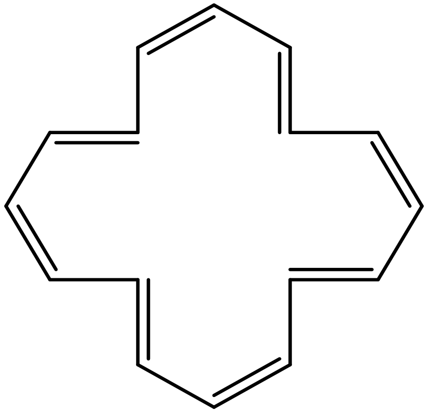
Annulenes are monocyclic ring with unsaturation and delocalization

- Cyclic
- SP^2 hybridization
- Delocalization -retarded



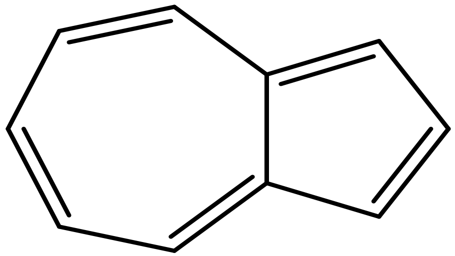
(14) Annulenes – aromatic
4n+2=4
4n=12
n=3 ----- Aromatic

(16) Annulenes - antiaromatic



Cyclic
SP² hybridization
Delocalzation
Planar
4n=16
N=4----- Antiaromatic

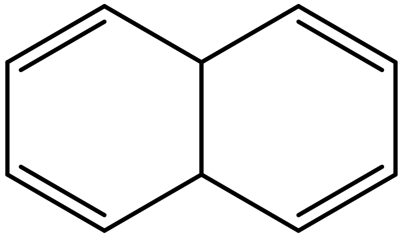
1. Aromaticity in fused rings:



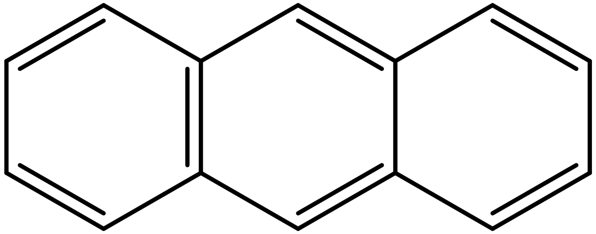
Azulene

Aromatic

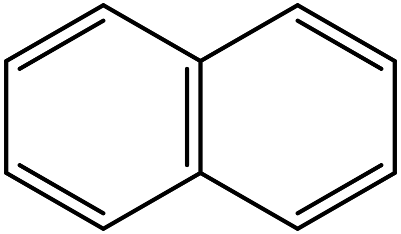
Cyclic
SP ^{2} hybridization
Delocalization
Planarity
4n+2=10
N=8
N=2



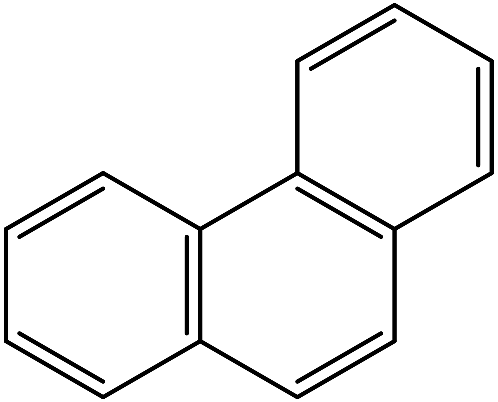
Non - aromatic



Anthracene
aromatic



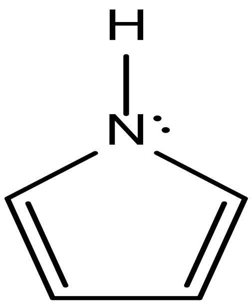
Napthalene



phenanthrene
aromatic

Hetrocyclic rings :

1) Pyrrol ---- Aromatic

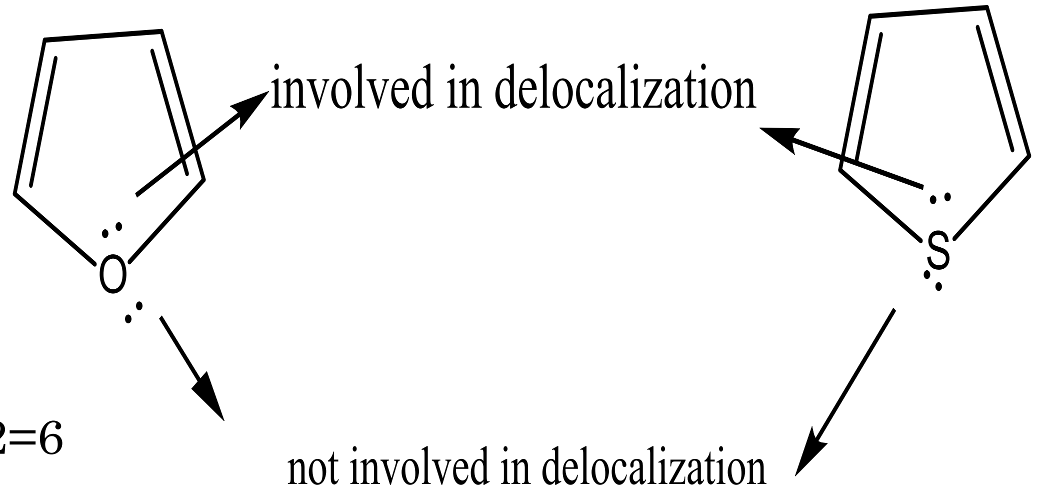


Cyclic
SP^2 hybridization
Delocalization
Planar
4n+2=6 (N lone pair is involved)
4n=4
N=1

2) Pyridine ---- Aromatic

Cyclic
SP^2 hybridization
Delocalization
4n+2=6
4n=4
n=1

3) Furan ---- Aromatic ← 4) Thiophene



4n+2=6
N=1

5) Imidazolopyridine ---- Non aromatic