7.Reaction of hydrogen with acids

Hydrogen does not react with dilute acids.

$H_2(g)$ + dilute $H_2SO_4 \rightarrow$ **No Reaction**

Or dilute HCl

Or dilute HNO_3

8.Reaction of hydrogen with bases

Hydrogen does not react with dilute bases.

$H_2(g)$ + dilute NaOH $\rightarrow$ **No Reaction**

Hydrogen Compounds

We will discuss only a few hydrogen compounds of the nonmetals here.

1.Nitrogen Hydrogen Compounds

Ammonia, NH_3, forms naturally when any nitrogen-containing organic material decomposes in the absence of air. The laboratory preparation of ammonia is by the reaction of an ammonium salt with a strong base such as sodium hydroxide.

$NH_4Cl_{(s)} + NaOH_{(s)} \rightarrow NH_3 + NaCl + H_2O_{(g)}$

Or $NH_4^+{}_{(s)} + {}^-OH_{(s)} \rightarrow NH_3 + NaCl + H_2O_{(g)}$

2.Phosphorus Hydrogen Compounds

The most important of this compound is phosphine, PH_3, a gaseous analog of ammonia in terms of both formula and structure.

3.Sulfur Hydrogen Compounds

Hydrogen sulfide, H2S, is a colorless gas that is responsible for the offensive odor of rotten eggs and of many hot springs. Hydrogen sulfide is as toxic as hydrogen cyanide; therefore, it is necessary to exercise great care in handling it.

4.Halogen Hydrogen Compounds

Binary compounds containing only hydrogen and a halogen are hydrogen halides. At room temperature, the pure hydrogen halides HF, HCl, HBr, and HI are gases.

Hydrogen isotopes

Isotopes are the types of chemical element that have same atomic number but different in atomic mass, because of different in neutron number for example hydrogen isotopes.

Hydrogen has three naturally occurring isotopes, denoted ^{1}H, ^{2}H and ^{3}H. Other, highly unstable nuclei (^{4}H to ^{7}H) have been synthesized in the laboratory but not observed in nature.

- ^{1} **H** is the most common hydrogen isotope with an abundance of more than 99.98%. Because the nucleus of this isotope consists of only a single proton, rarely used formal name *protium*.

- ^{2}**H**, the other stable hydrogen isotope, is known as *deuterium* and contains one proton and one neutron in the nucleus.

- ^{3}**H** is known as *tritium* and contains one proton and two neutrons in its nucleus.

Hybridization

Hybridization : mixing of the pure atomic orbitals to obtain new orbitals (Hybrid orbitals) that are equivalent in shape and energy. The number of the hybrid orbitals is equal to the number of pure orbitals .

Types of Hybridization

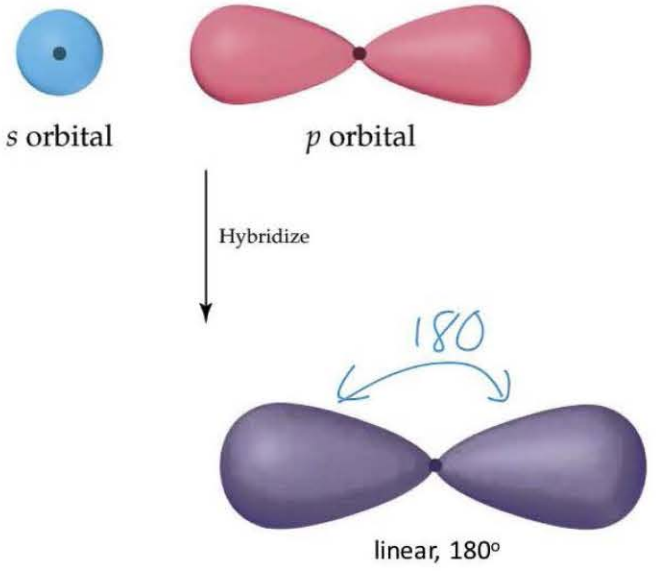
1- sp Hybridization

This type is compose participate of two orbitals one is a **s**, the other type is **p** to form important orbitals of sp located in a straight line at an angle of 180 degrees in order to get less repulsion between the two orbitals.

50% s and 50 % p

s + p ⟶ 2sp

pure orbital pure orbital Hyprid orbitals



sp hybrid orbitals shown together

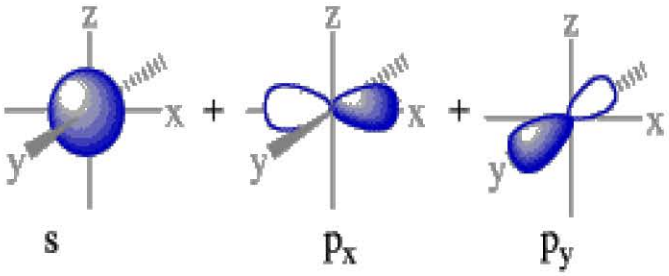
2- sp^2 Hybridization

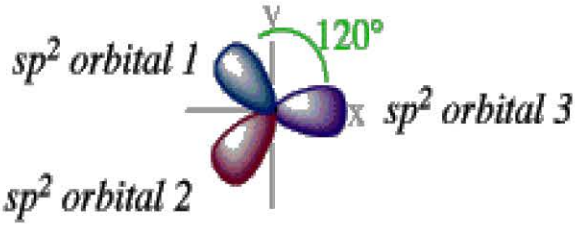
This type consists of one atomic orbital type s, with two orbitals types is p to form important orbitals of sp^2 located in a same level with angle of 120 degrees in order to get less repulsion between the three orbitals.

33% s and 66 % p

$$s + 2p \longrightarrow 3sp^2$$

pure orbital pure orbital Hyprid orbitals





3- sp^3 Hybridization

This type of hybridization produce from one orbital atom type s with three orbital of p and formation four atom hybridization orbitals type sp^3 and take Tetrahedral regular figure with angle of 109.5 degree in order to get less repulsion between the orbitals.

25% s and 75 % p

$$s + 3p \longrightarrow 4sp^3$$

Applications of hybridization

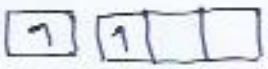
1. Linear molecule

Orbital 1s is internally considered do not participate in hybridization.

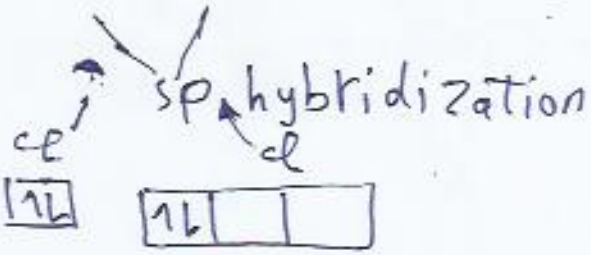
In these orbitals can produce the molecular orbitals with orbital atoms of Cl to produce two covalent bonds between Be and Cl and formation $BeCl_2$ with angle of 180 degree.

$_4Be$ $1s^2$ $2s^2$ $2p$

Be-atom ground state



Be-atom excited state



$BeCl_2$ Linear molecules

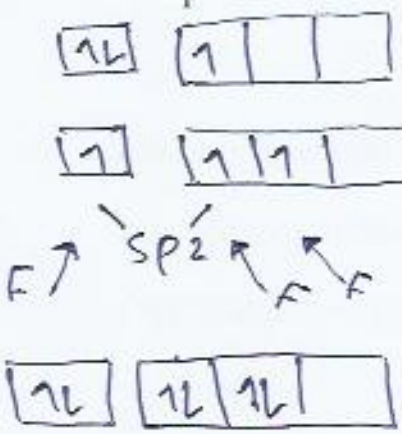
Cl ——— Be ——— Cl =180 degree

صنوبر مثلث

2- Trigonal planar molecules

Example: BF_3

$_5B$ $1s^2$ $2s^2$ $2p^1$



B-atom ground stat

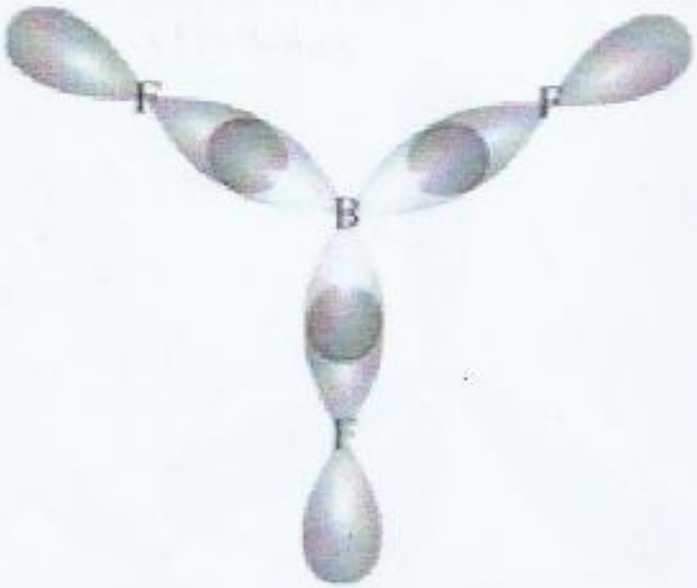
B-atom excited stat

Hyperdization (sp^2)

BF_3 molecules

Trigonal plane

For this of three orbitals can formation three hybrid orbitals molecule with three orbitals of three F atoms to formation BF_3 molecule with angle of 120 degree (Trigonal planar).

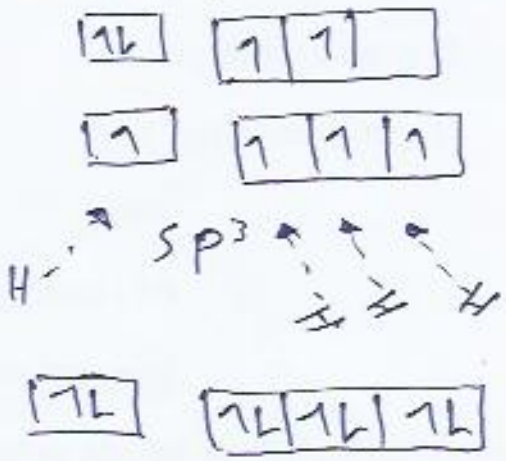


Angle of FBF = 120 degree

3- Tetrahedral molecules

Example: CH_4

$_6C$ $1s^2$ $2s^2$ $2p^2$



C-atom ground stat

C-atom excited stat

Hyperdization (sp^3)

For this of four orbitals can formation four hybrid orbitals molecule with four orbitals of four H atoms to formation CH_4 molecule with angle of 109.5 degree (Tetrahedral).

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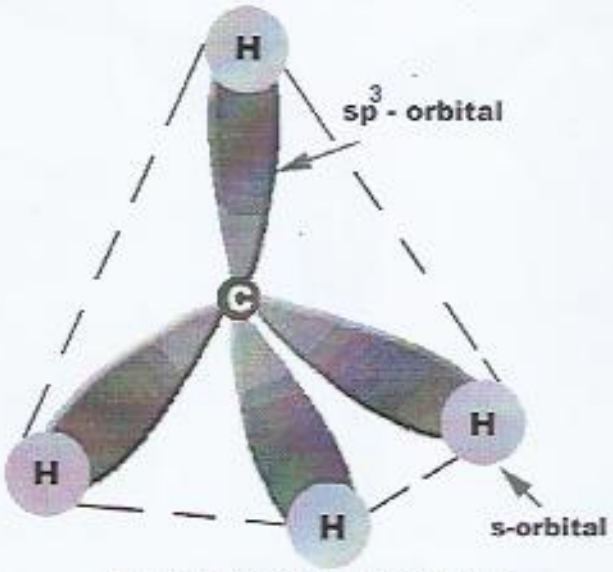

Orbital structure of methane

Angle of HCH = 109.5 degree

Tetrahedral