Distinguish, differentiate, compare and explain what is the Difference between Sigma and Pi Bond in molecules. Comparison and Differences.

Sigma (σ) bonding molecular orbital

A sigma (σ) bond is formed by head on overlap of atomic orbitals. The electron density is concentrated between the nuclei of the bonding atoms. Shared electron density is directly between the bonding atoms, along the bonding axis. A sigma bonds is always the first bond formed between two atoms.

Pi bond (π): bonding molecular orbital

A pi (π) bond is formed by sideways overlap of atomic orbitals. The electron density is concentrated above and below the plane of the nuclei of the bonding atoms. The bonding electron density lies above and below, or in front and in back of the bonding axis, with no electron directly on the bonding axis, since 2p orbitals do not have any electron density at the nucleus. These are always second or third bonds overlapping a sigma bond formed first. The HOMO of a pi system is especially important.

Differences between Sigma and Pi Bond in Molecules

S.No.	Sigma Bond (σ bond)	Pi Bond (π bond)
1	Sigma bond is formed by the end to end overlap of orbitals.	Pi bond is formed by the lateral overlap of orbitals.
2	It has interdependent existence.	It has no interdependent existence.
3	In sigma bond, the orbitals involved in the overlapping are s-s, s-p, or p-p.	Pi bonds are formed by the overlap of p-p orbitals only.
4	It is a strong bond.	It is weak bond.
5	The electron cloud is symmetrical about the line joining the two nuclei.	The electron cloud is not symmetrical.
6	σ bond consists of one electron cloud, which is symmetrical about the inter-nuclear axis.	There are two electron clouds lying above and below the plane of the atomic nuclei.
7	Free rotation about sigma bonds is possible.	Rotation is restricted in case of pi-bonds.
8	These are less reactive.	These are highly reactive.
9	Free rotation of atoms is possible.	Free rotation of atoms is not possible.
10	It is called localized bond.	It is non-localized bond.
11	The lobe participate in the overlapping is stretched and the other lobe is reduced in size.	Both the lobes take part in bonding and remain the same in size.