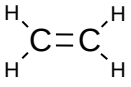
Multiple Bonds

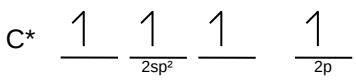
HYBRIDIZATION IN ETHENE, an Example of a Double Bond



ethene, C_2H_4

The valence shell of carbon is:

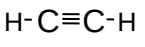
In order for the carbon atoms to form three bonds (one with the other carbon atom, and two with two hydrogen atoms), each carbon uses a set of sp^2 hybrids:



(Note: the last p orbital is unhybridized.)

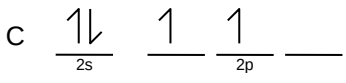
Two of the three sp^2 orbitals overlap with the 1s orbitals from the hydrogen atoms. The third sp^2 orbital overlaps with a similar sp^2 orbital from the other carbon to form σ bond. This only accounts for one of the electron pairs shared between the two carbons. Since each carbon atom has an unhybridized p orbital perpendicular to the plane of the sp^2 orbital, a second bond (a π bond) is formed when these p orbitals approach each other sideways. Thus the double bond consists of one σ bond and one π bond.

HYBRIDIZATION IN ETHYNE, an Example of a Triple Bond

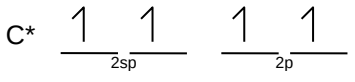


ethyne, C_2H_2

The valence shell of carbon is:



In order for the carbon atoms to form two bonds (one with the other carbon atom, and one with a hydrogen atom), each carbon uses a set of sp hybrids:



(Note: the last two p orbitals are unhybridized.)

The two unhybridized p orbitals on each carbon atom are perpendicular to each other, as well as being perpendicular to the sp hybrids. When the two carbon atoms overlap their sp hybrid orbitals to form a σ bond, the other two p orbitals overlap to form two π bonds. Thus a triple bond consists of one σ bond and two π bonds.

SUMMARY

single bond	one σ bond
double bond	one σ bond and one π bond
triple bond	one σ bond and two π bonds

Authored by Gordon Wong