

Covalent Bonding

Sigma and Pi Bonds

Types of Bonds

- A **sigma (σ) bond** results when the interacting atomic orbitals point along the axis connecting the two bonding nuclei.
 - Either standard atomic orbitals or hybrids
 - s to s , p to p , hybrid to hybrid, s to hybrid, etc.
- A **pi (π) bond** results when the bonding atomic orbitals are parallel to each other and perpendicular to the axis connecting the two bonding nuclei.
 - Between unhybridized parallel p orbitals
- The interaction between parallel orbitals is not as strong as between orbitals that point at each other; therefore, **σ bonds are stronger than π bonds.**

Sigma and Pi Bonds

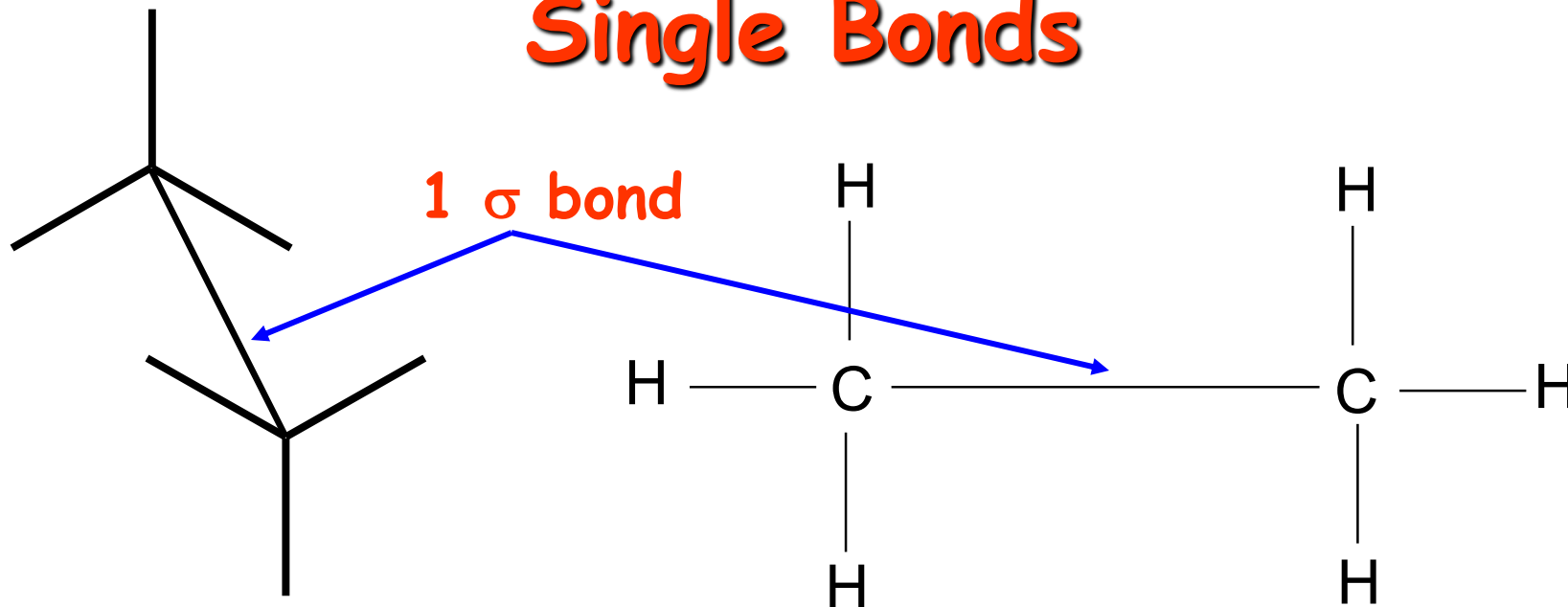
Sigma (σ) bonds exist in the region directly between two bonded atoms.

Pi (π) bonds exist in the region above and below a line drawn between two bonded atoms.

Single bond	1 sigma bond
Double Bond	1 sigma, 1 pi bond
Triple Bond	1 sigma, 2 pi bonds

Sigma and Pi Bonds

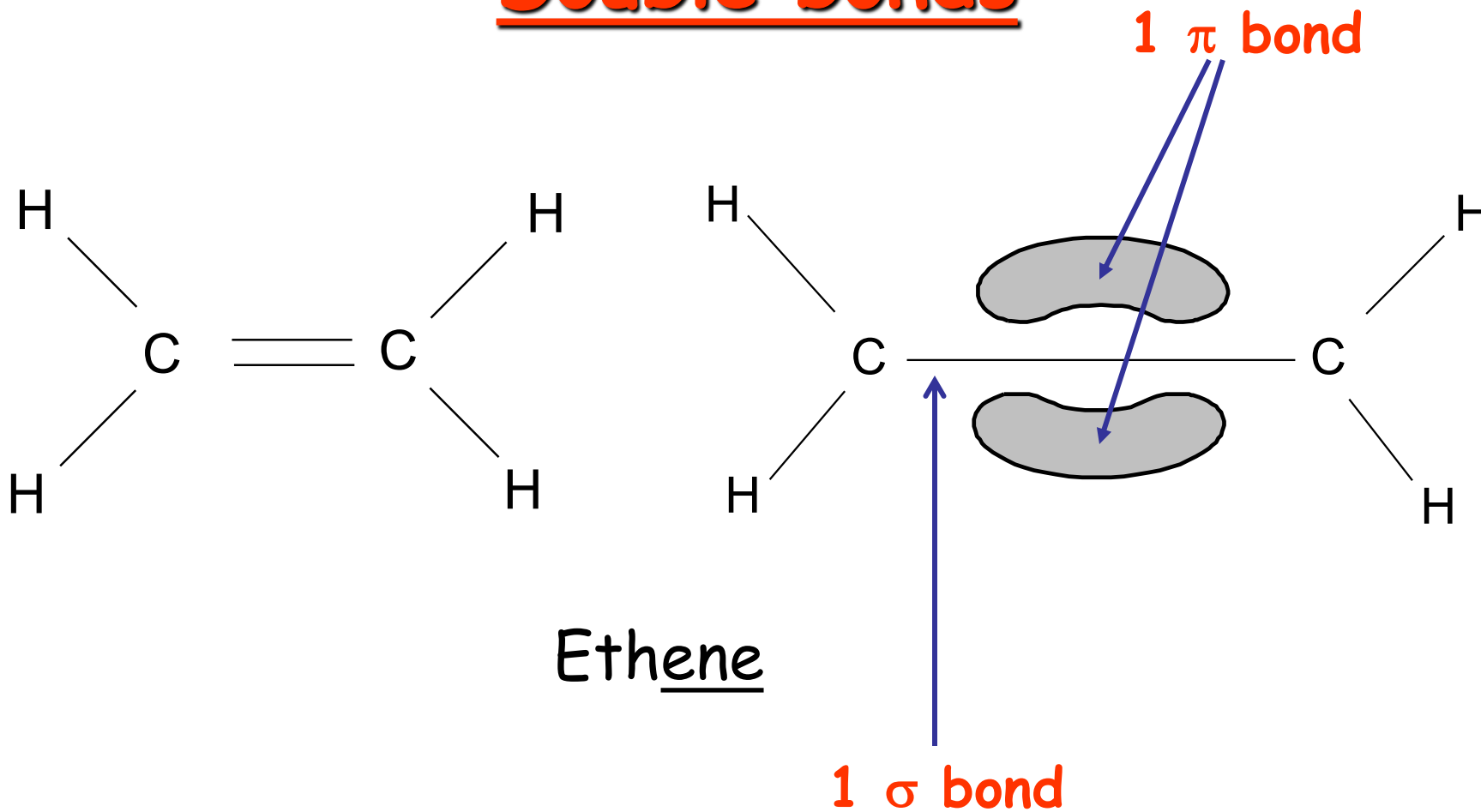
Single Bonds



Ethane

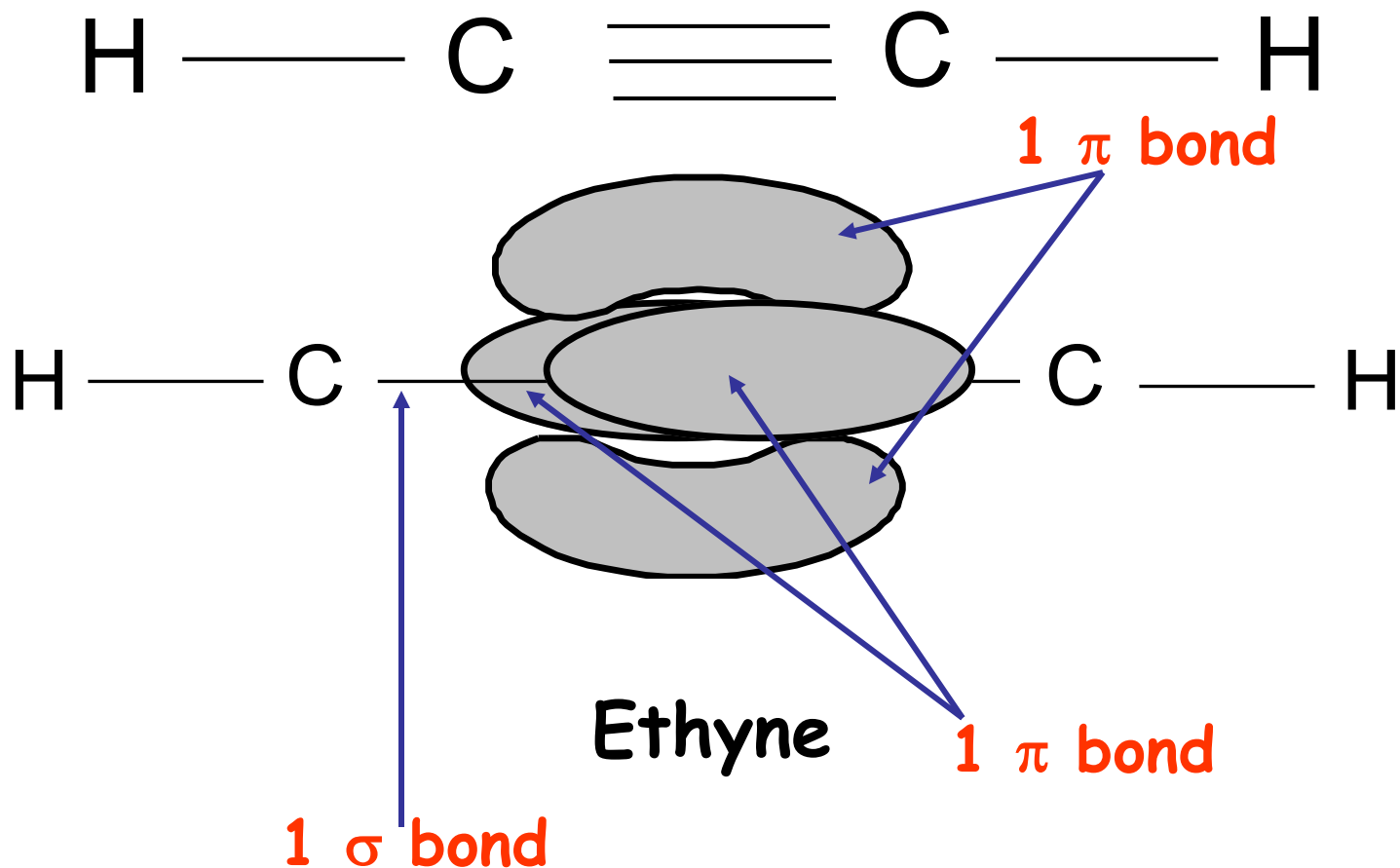
Sigma and Pi Bonds:

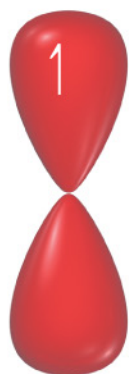
Double bonds



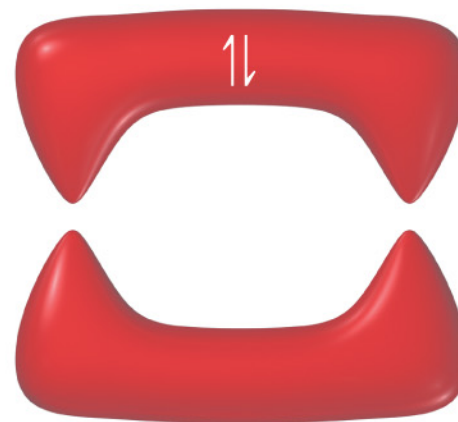
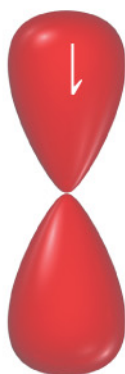
Sigma and Pi Bonds

Triple Bonds





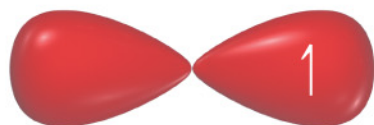
+



Half-filled
 p_y or p_z orbital

Half-filled
 p_y or p_z orbital

π bond



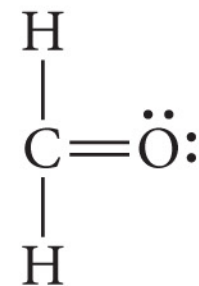
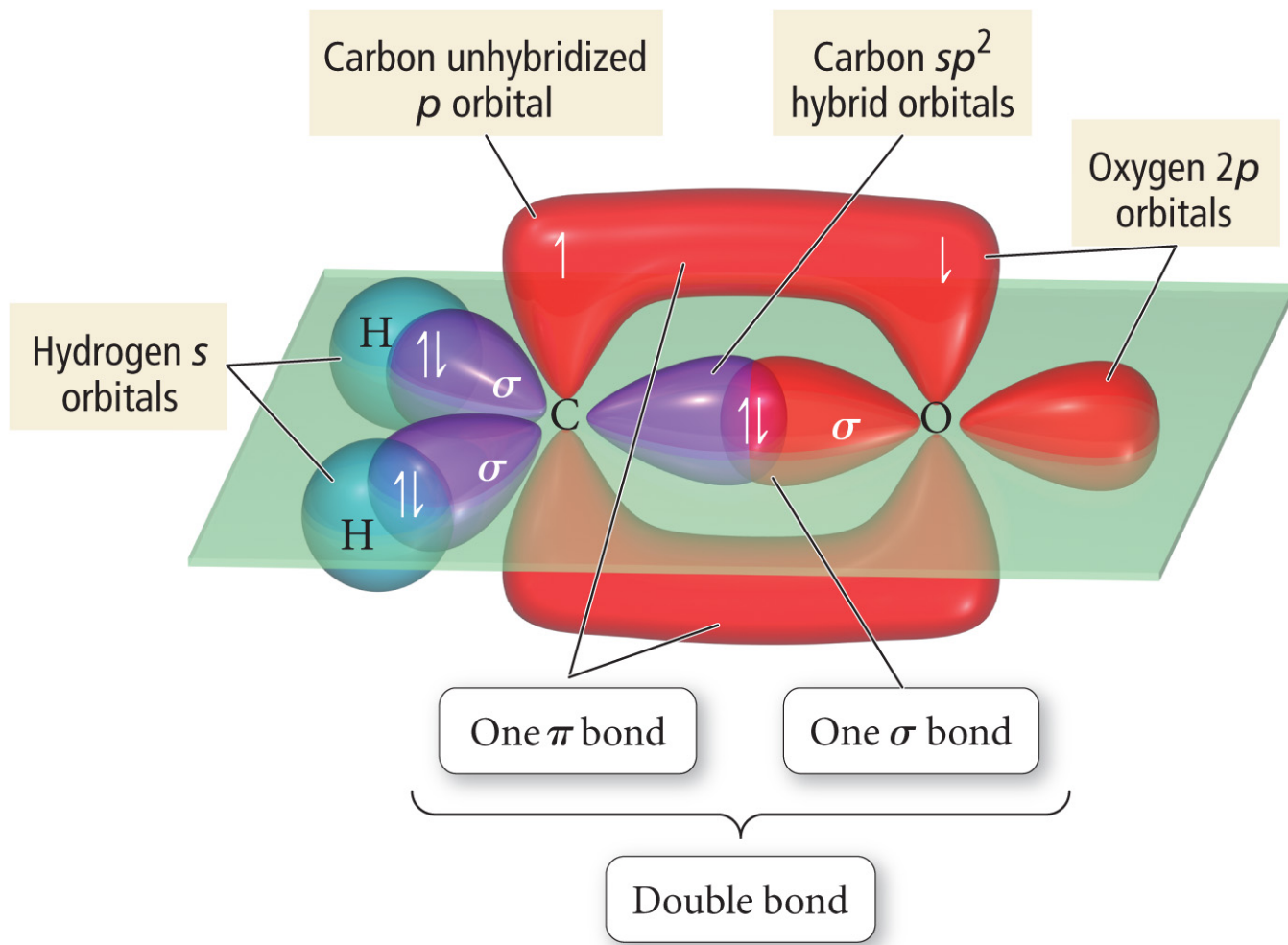
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Half-filled
 p_x orbital

Half-filled
 p_x orbital

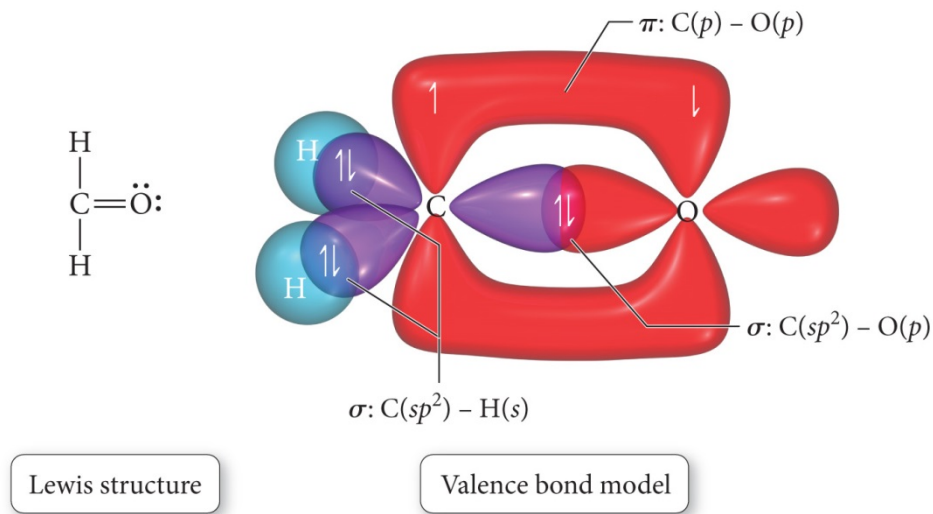
σ bond



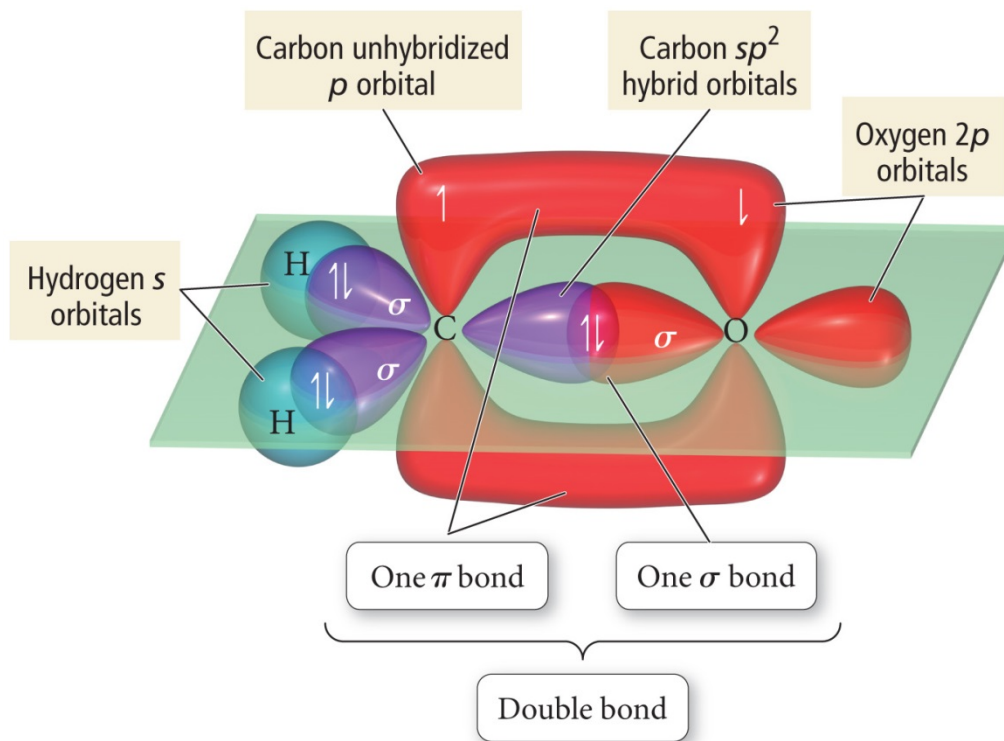
Lewis structure

Orbital Diagrams of Bonding

- “Overlap” between a hybrid orbital on one atom with a hybrid or nonhybridized orbital on another atom results in a σ bond.
- “Overlap” between unhybridized p orbitals on bonded atoms results in a π bond.



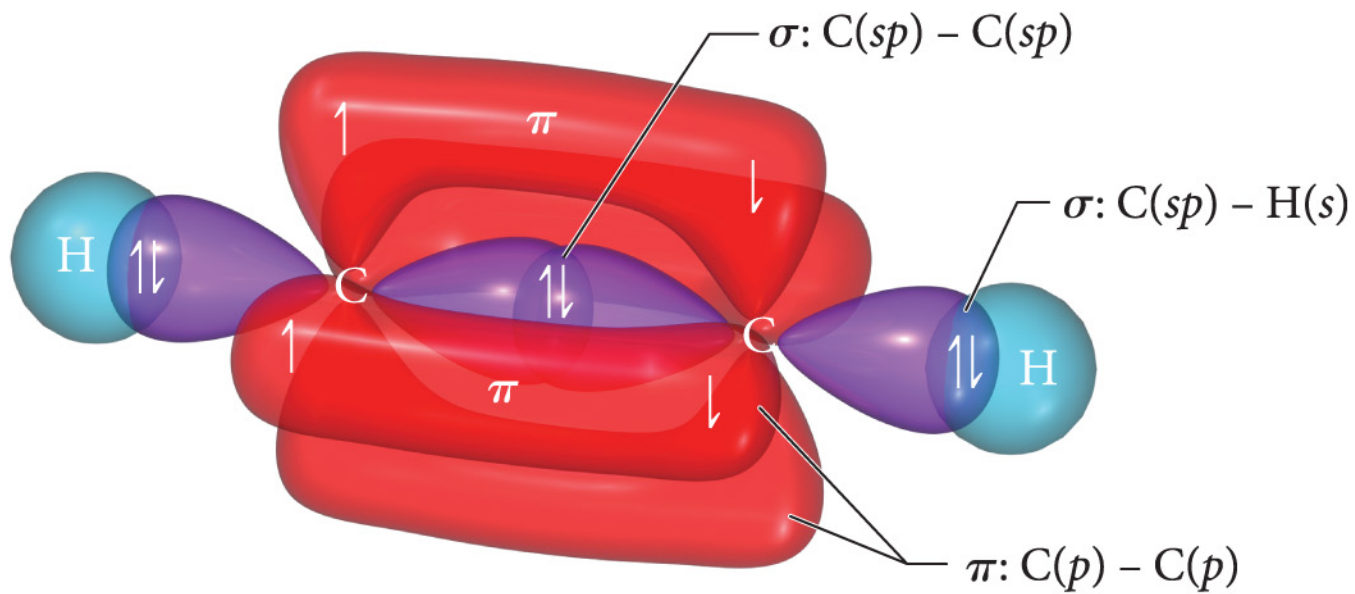
Orbital Diagrams of Bonding cont.



Hybrid orbitals overlap to form a σ bond. Unhybridized p orbitals overlap to form a π bond.



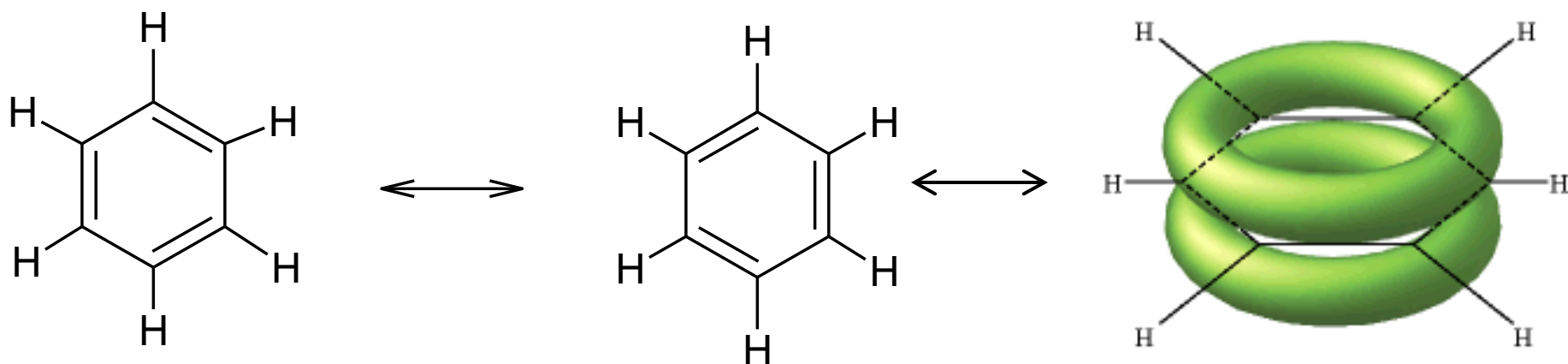
Lewis structure



Valence bond model

The De-Localized Electron Model

Pi bonds (π) contribute to the delocalized model of electrons in bonding, and help explain resonance



Electron density from π bonds can be distributed symmetrically all around the ring, above and below the plane.