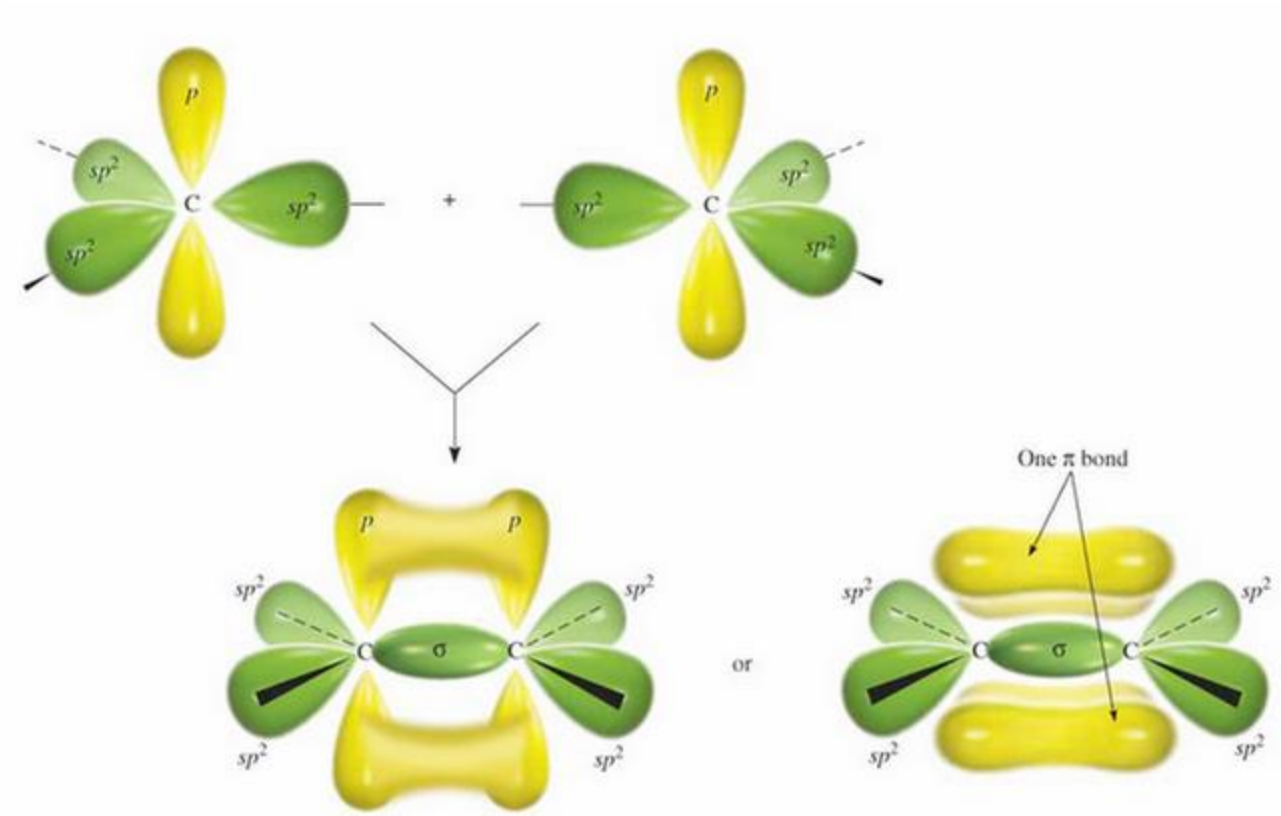
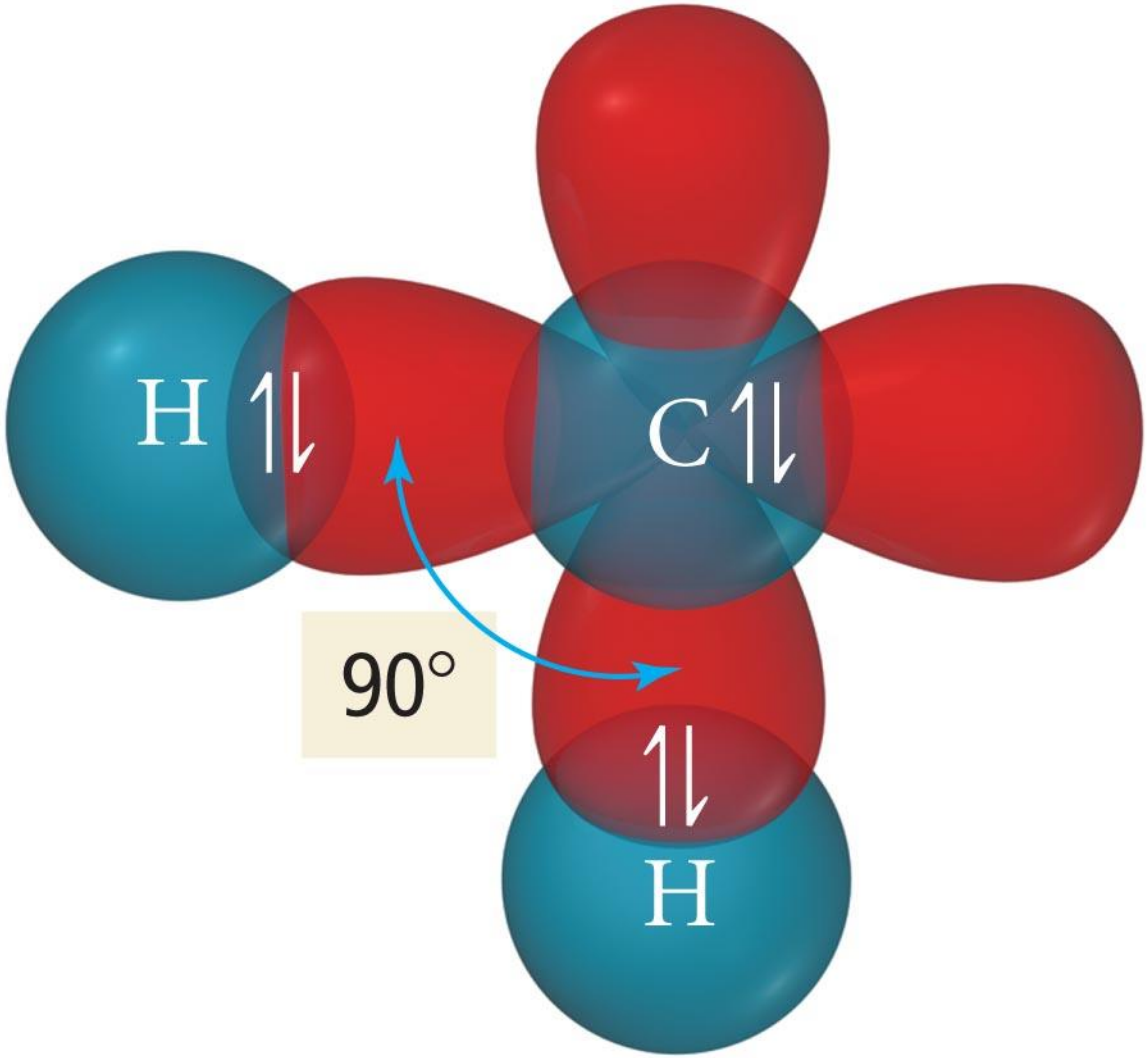
Pi Bond



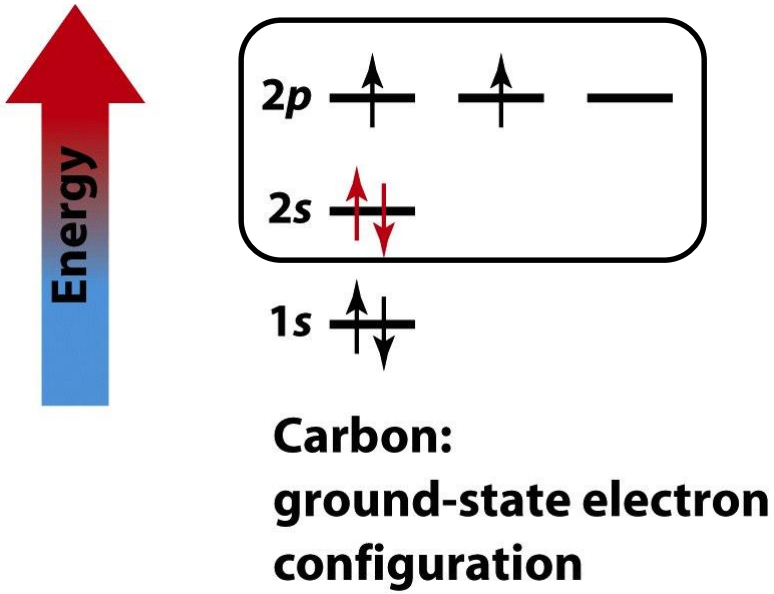


Theoretical prediction

Hybridization and sp^3 Hybrid Orbitals

How can the bonding in CH_4 be explained?

4 valence electrons
2 unpaired electrons



Carbon: ground-state electron configuration

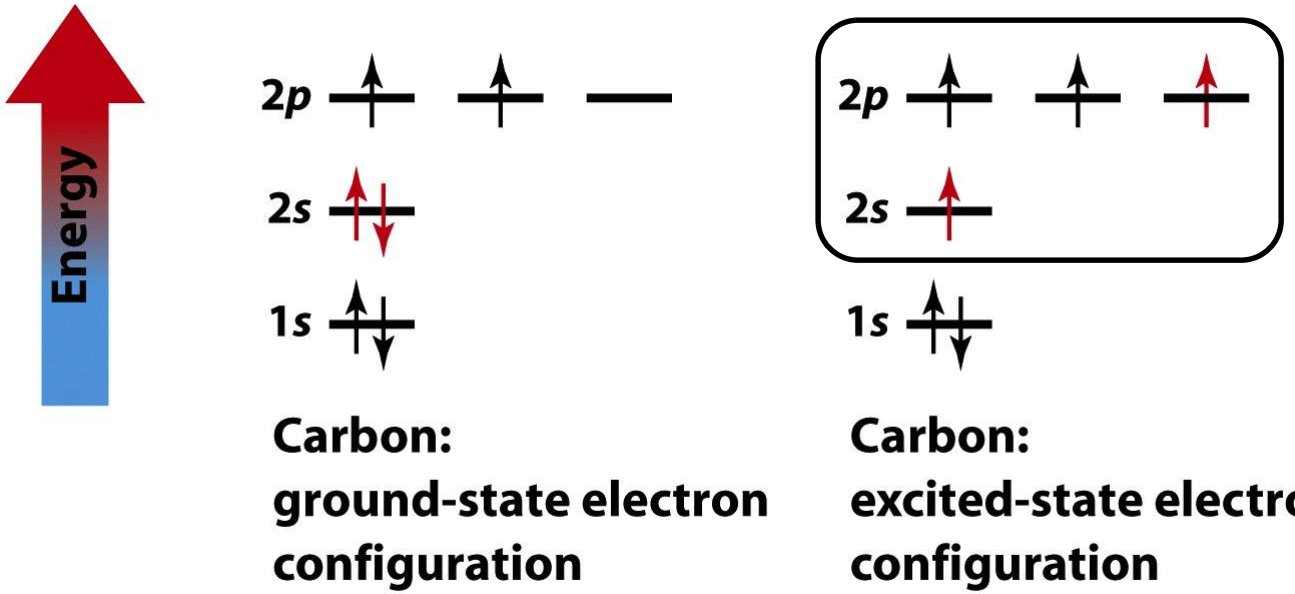
Unnumbered 7 p251a Chemistry, 5/e

Hybridization and sp^3 Hybrid Orbitals

How can the bonding in CH_4 be explained?

PROMOTION

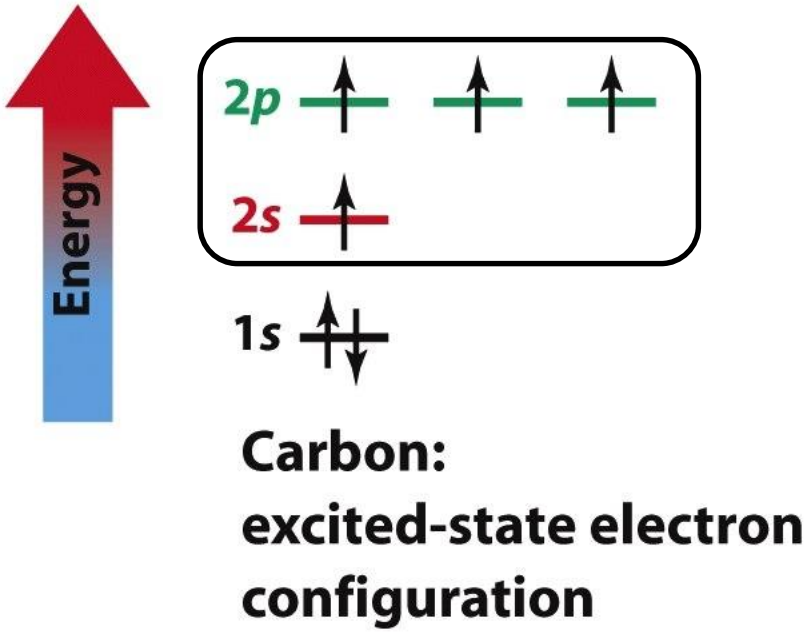
4 valence electrons
4 unpaired electrons



Hybridization and sp^3 Hybrid Orbitals

How can the bonding in CH_4 be explained?

4 **nonequivalent** orbitals

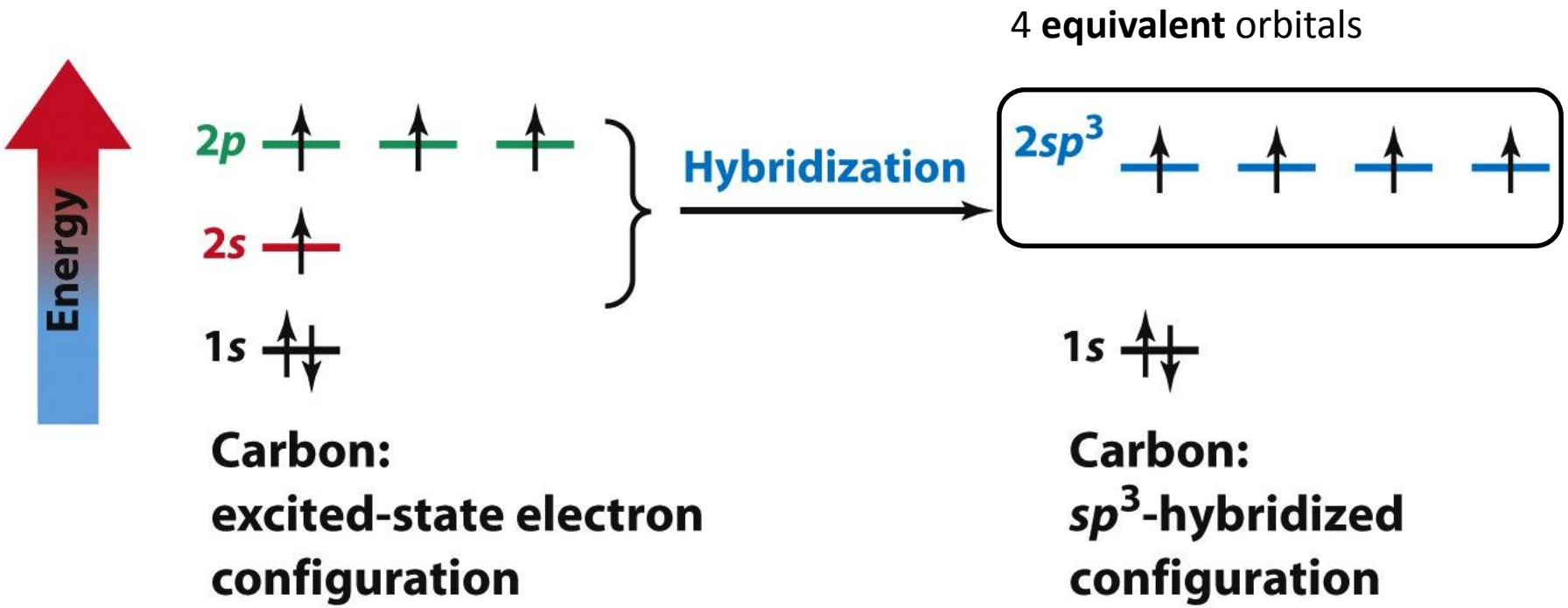


Carbon: excited-state electron configuration

Unnumbered 7 p251b Chemistry, 5/e

Hybridization and sp^3 Hybrid Orbitals

How can the bonding in CH_4 be explained?



Hybridization and sp^3 Hybrid Orbitals

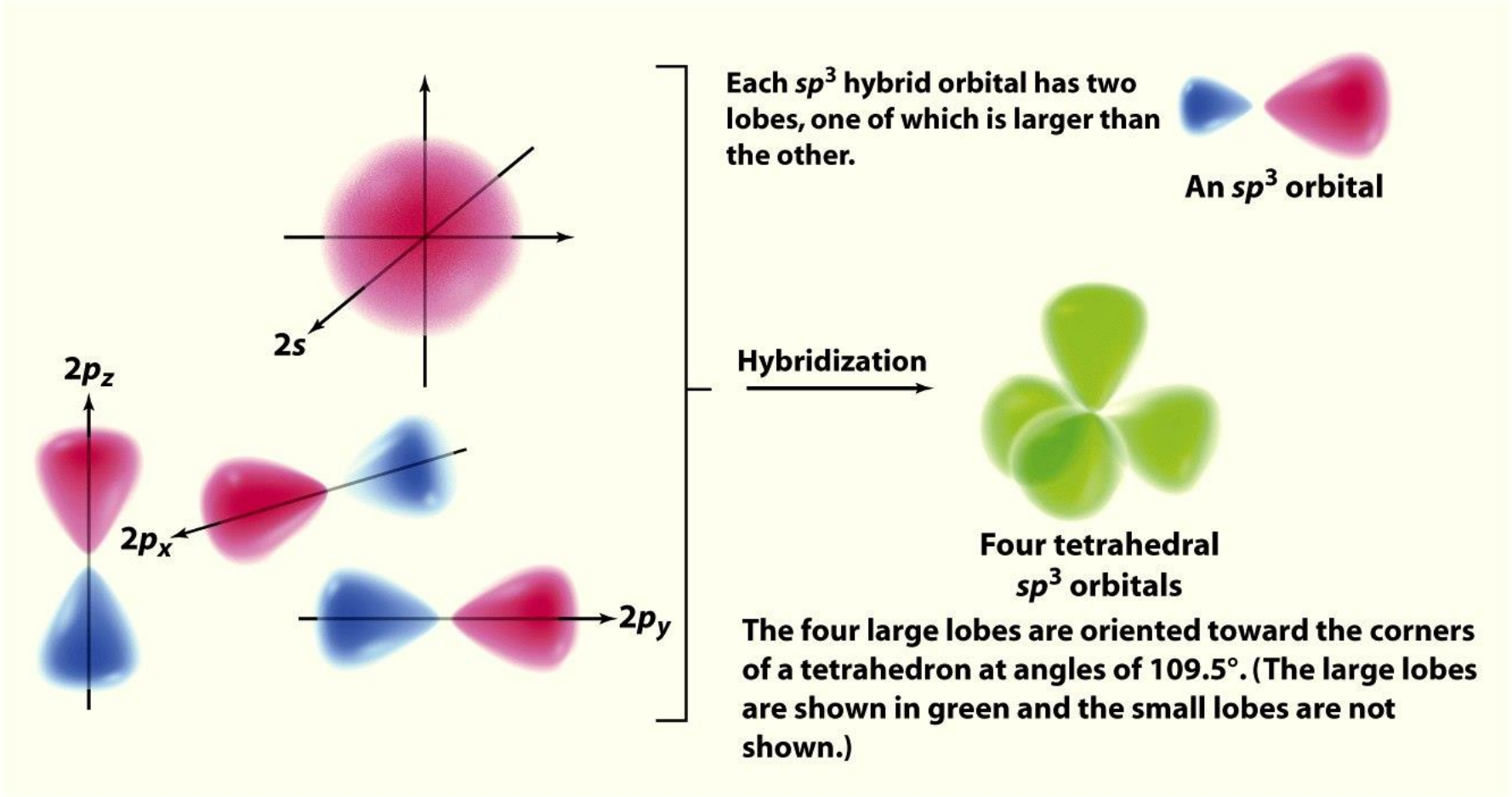
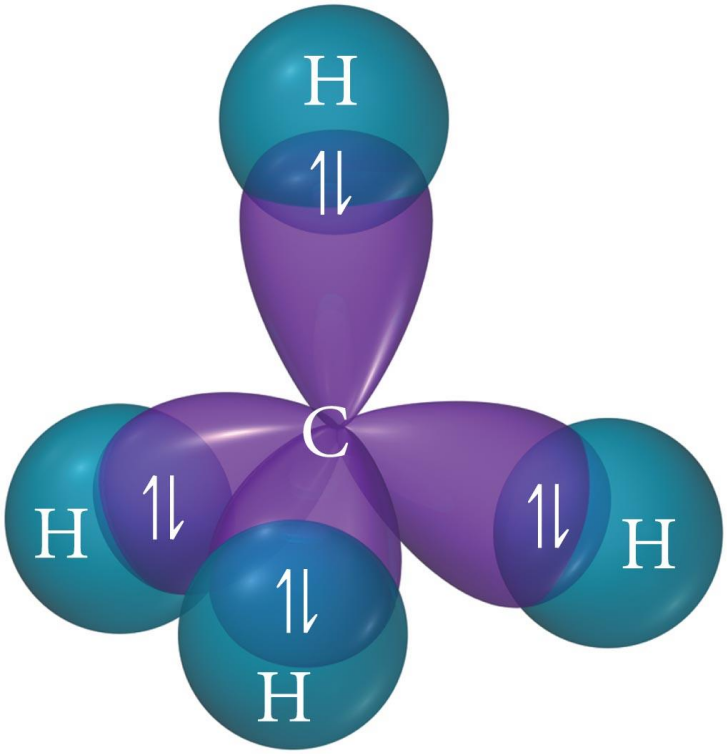
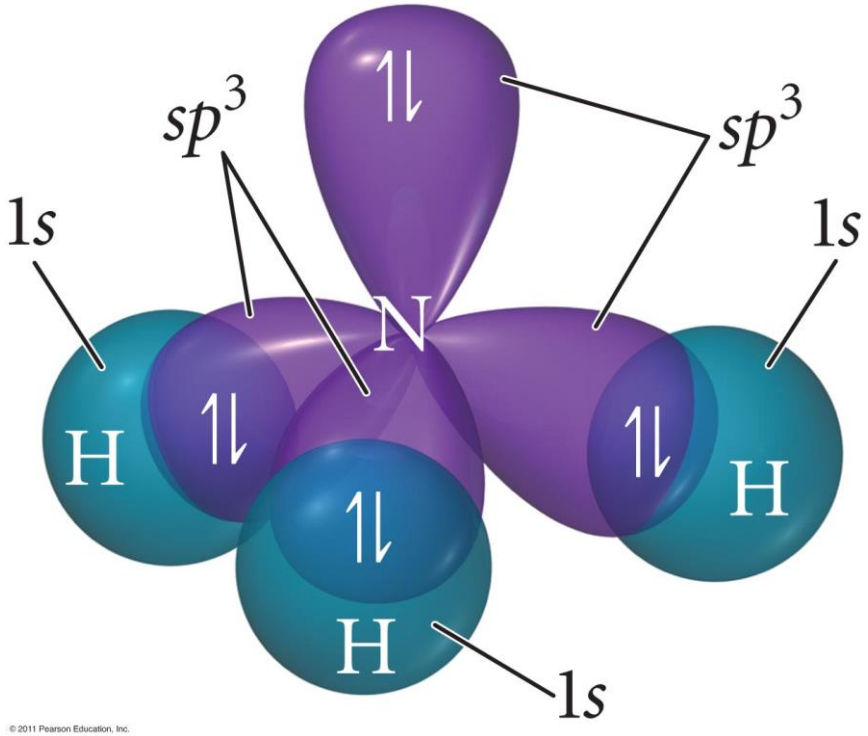
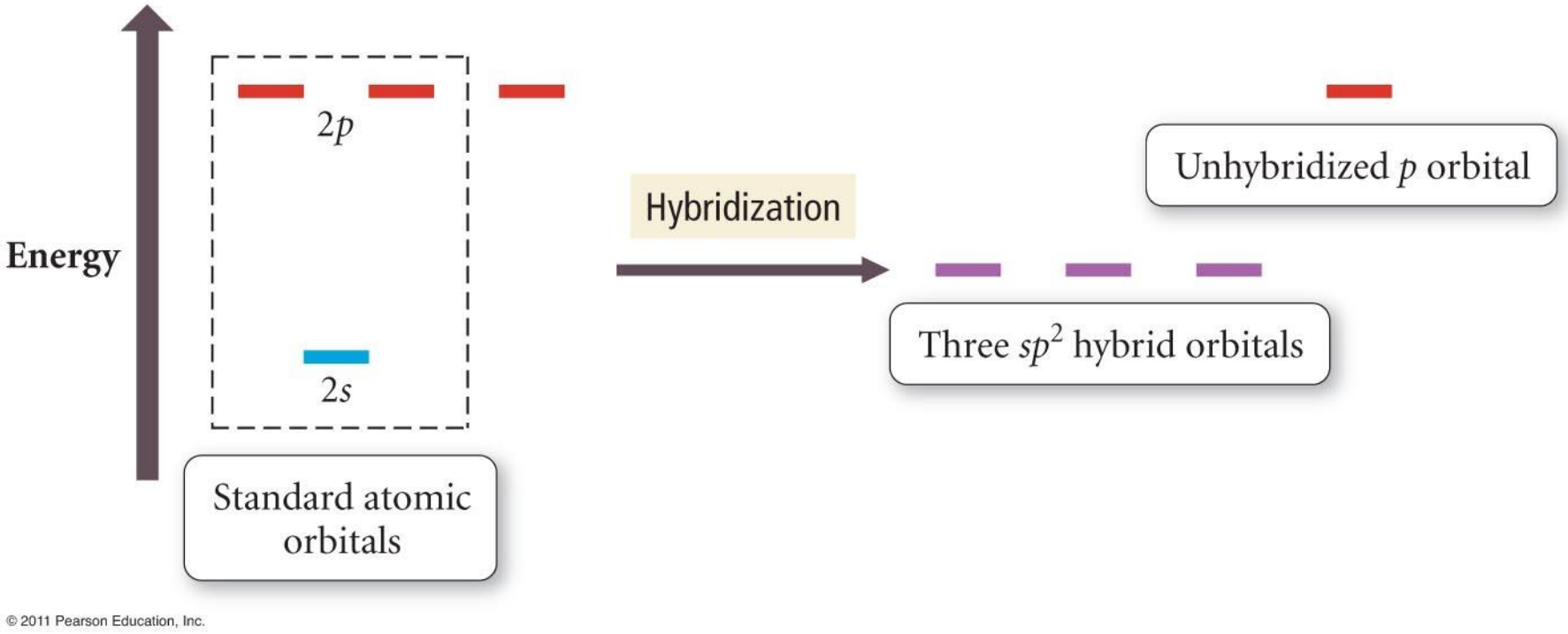


Figure 7-6 Chemistry, 5/e



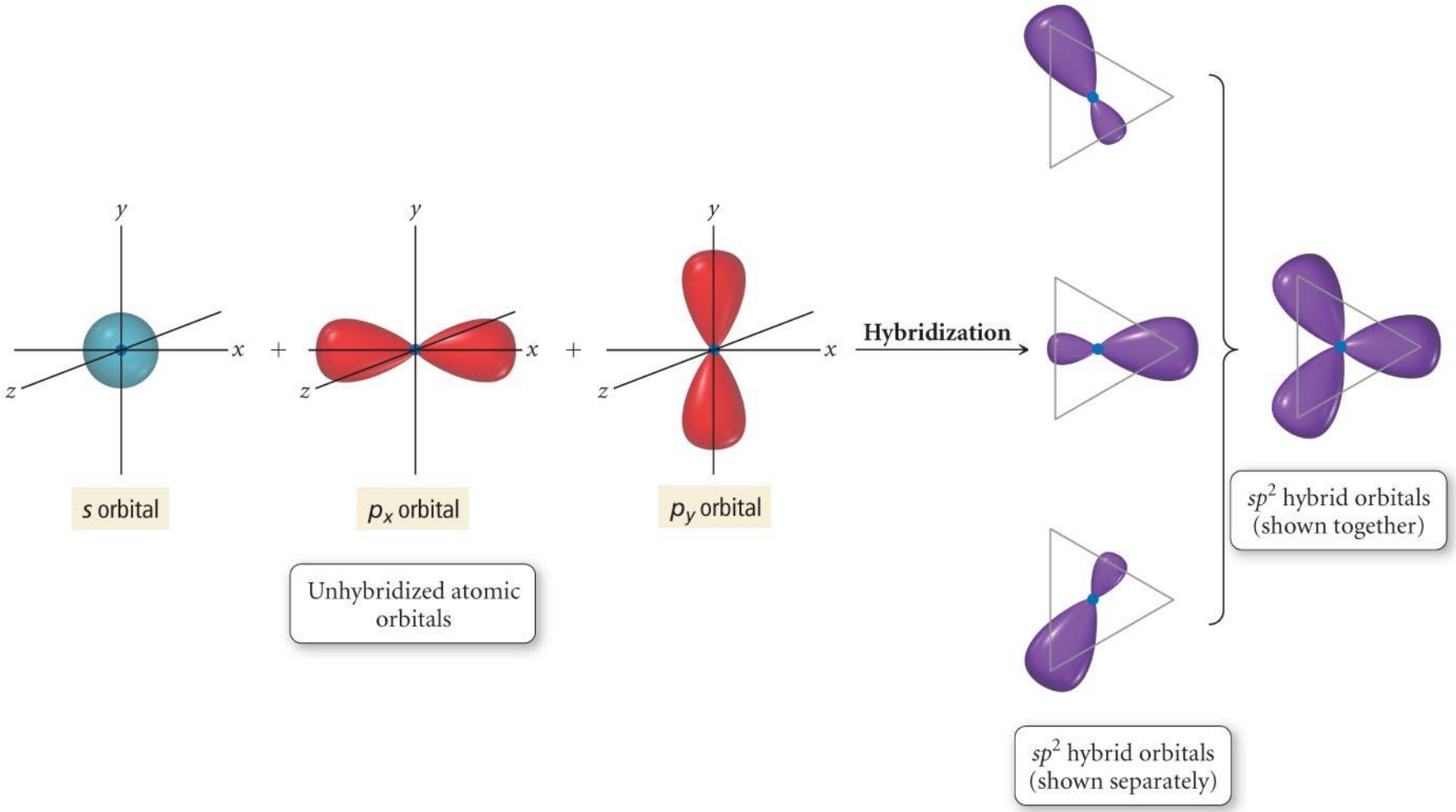


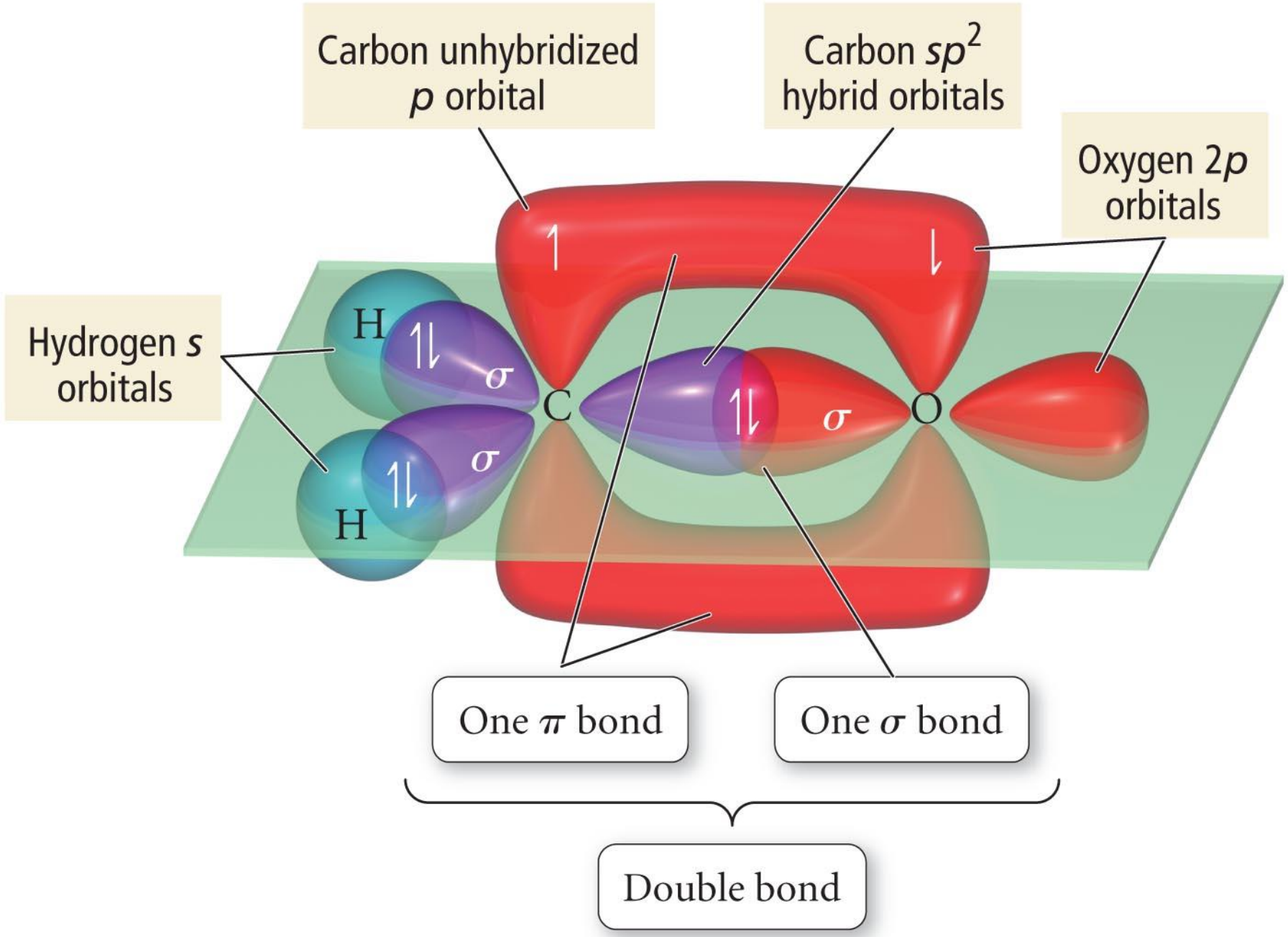
sp^2 Hybridization

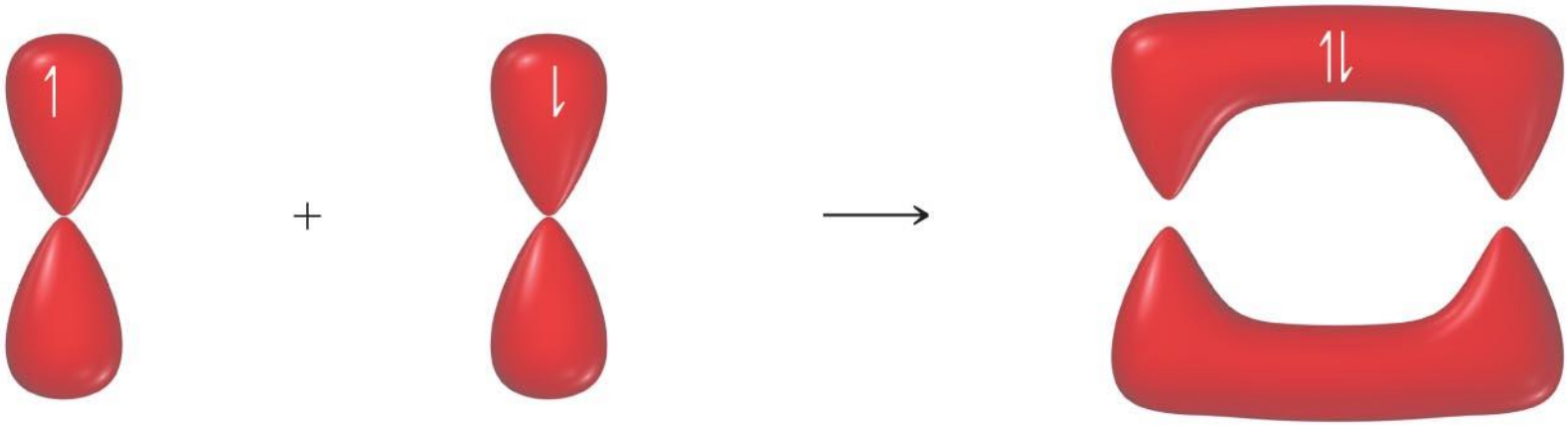


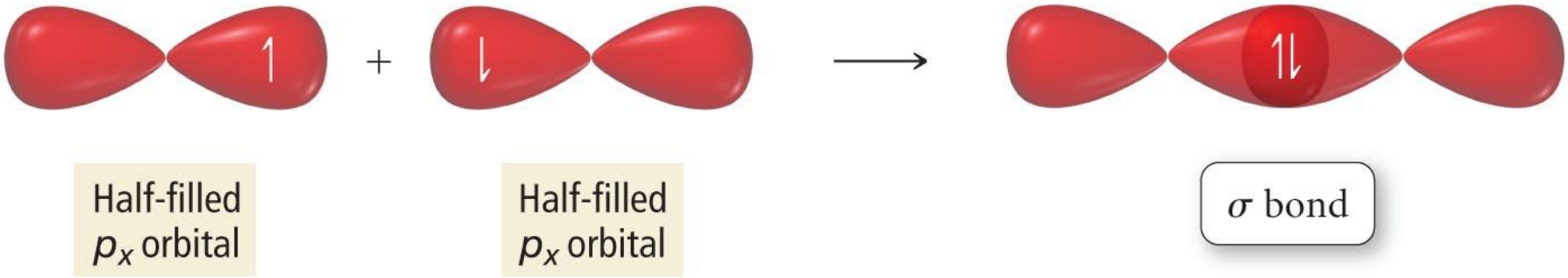
Formation of sp^2 Hybrid Orbitals

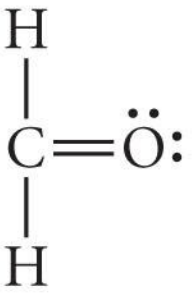
One *s* orbital and two *p* orbitals combine to form three sp^2 orbitals.

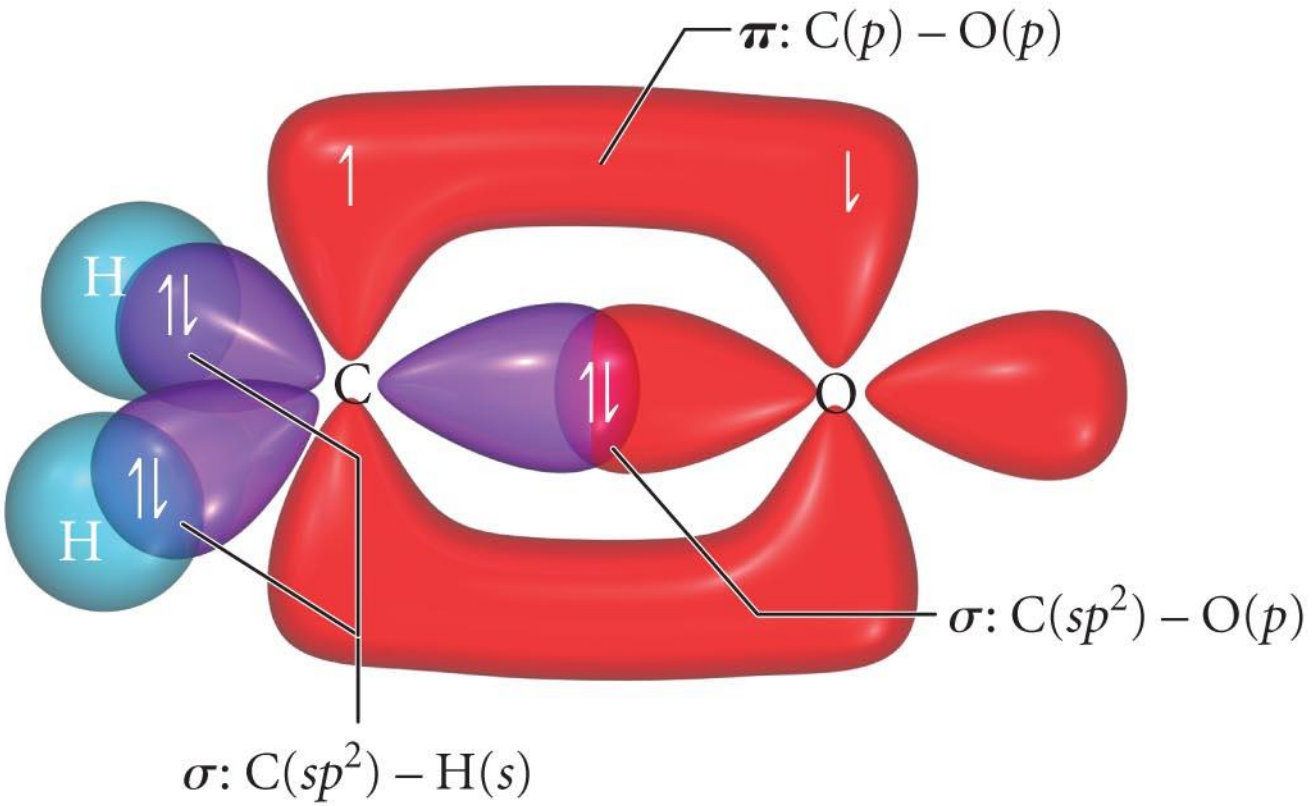












Lewis structure

Valence bond model

Other Kinds of Hybrid Orbitals

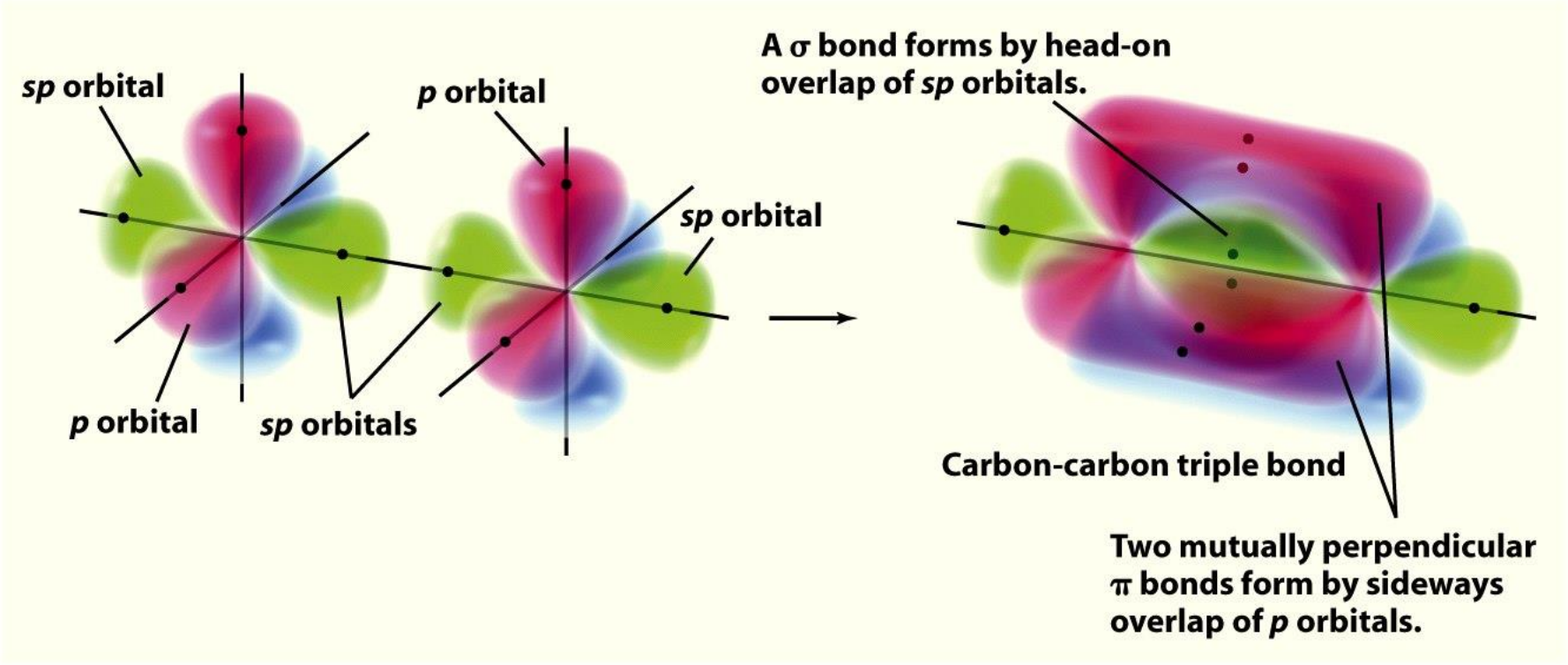
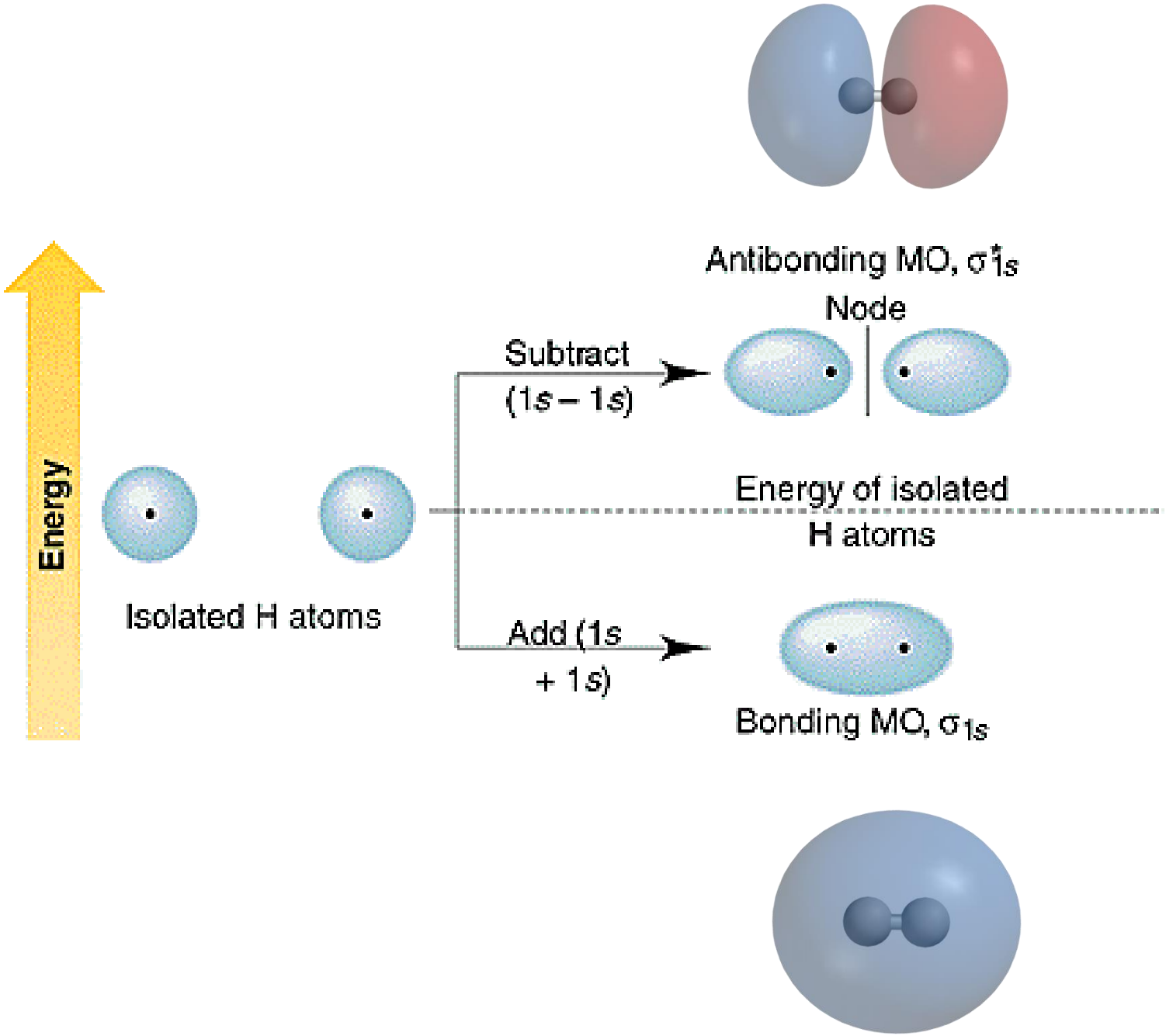
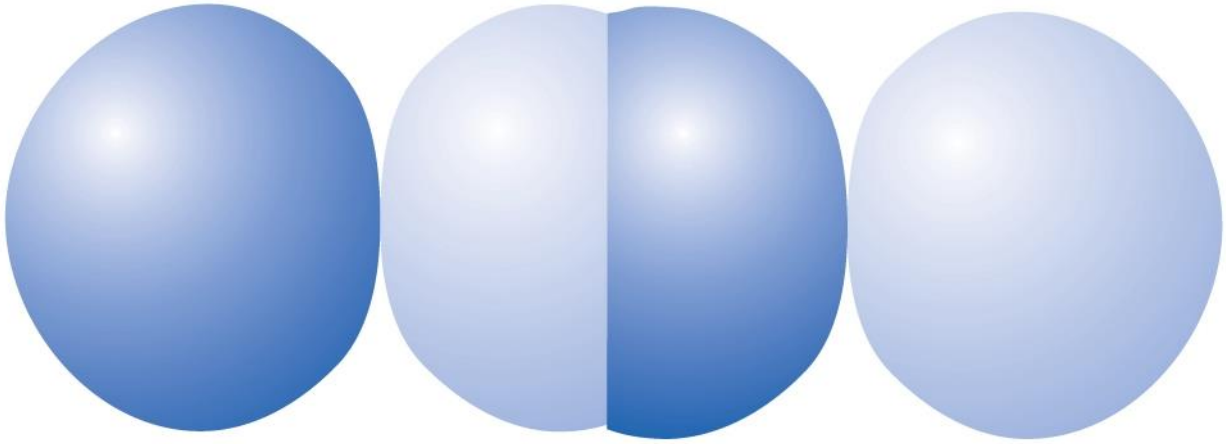
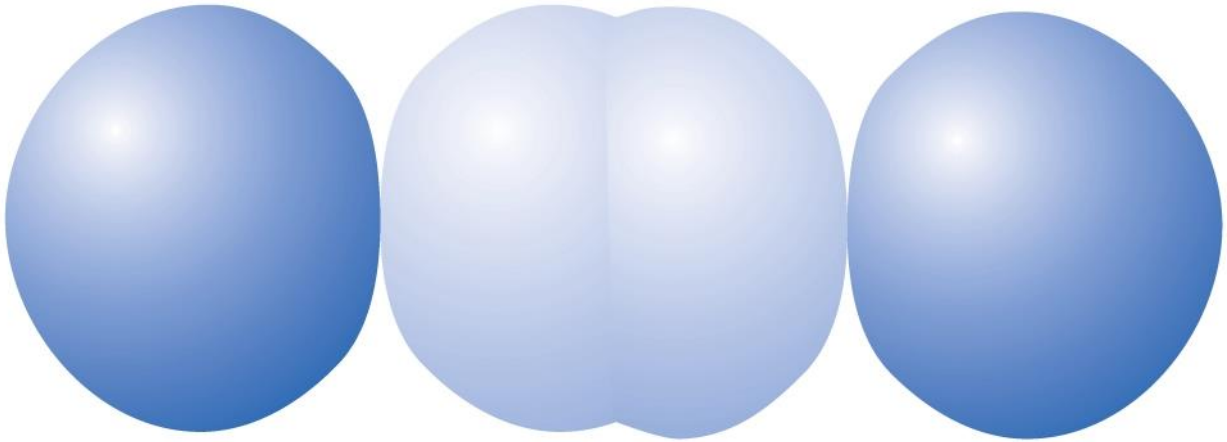


Figure 7-11 Chemistry, 5/e

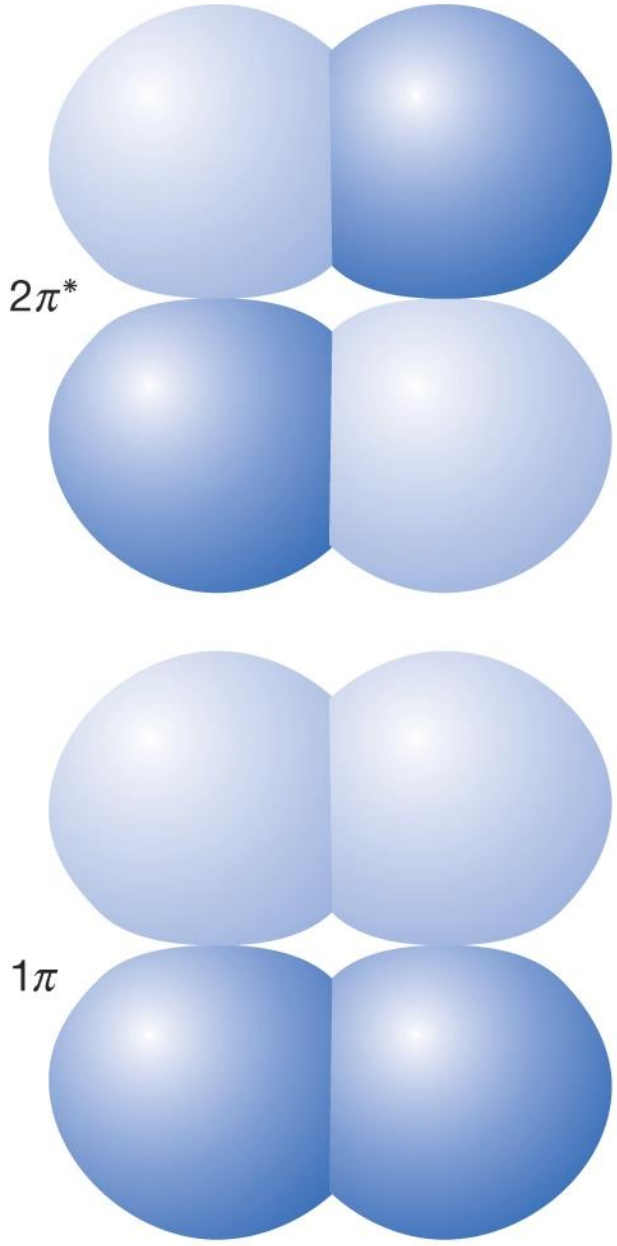

Antibonding MO, σ^*_{1s}
Node
Subtract
(1s – 1s)
Energy
Energy of isolated
H atoms
Isolated H atoms
Add (1s
+ 1s)
Bonding MO, σ_{1s}



$4\sigma^*$



3σ


$2\pi^*$
1π

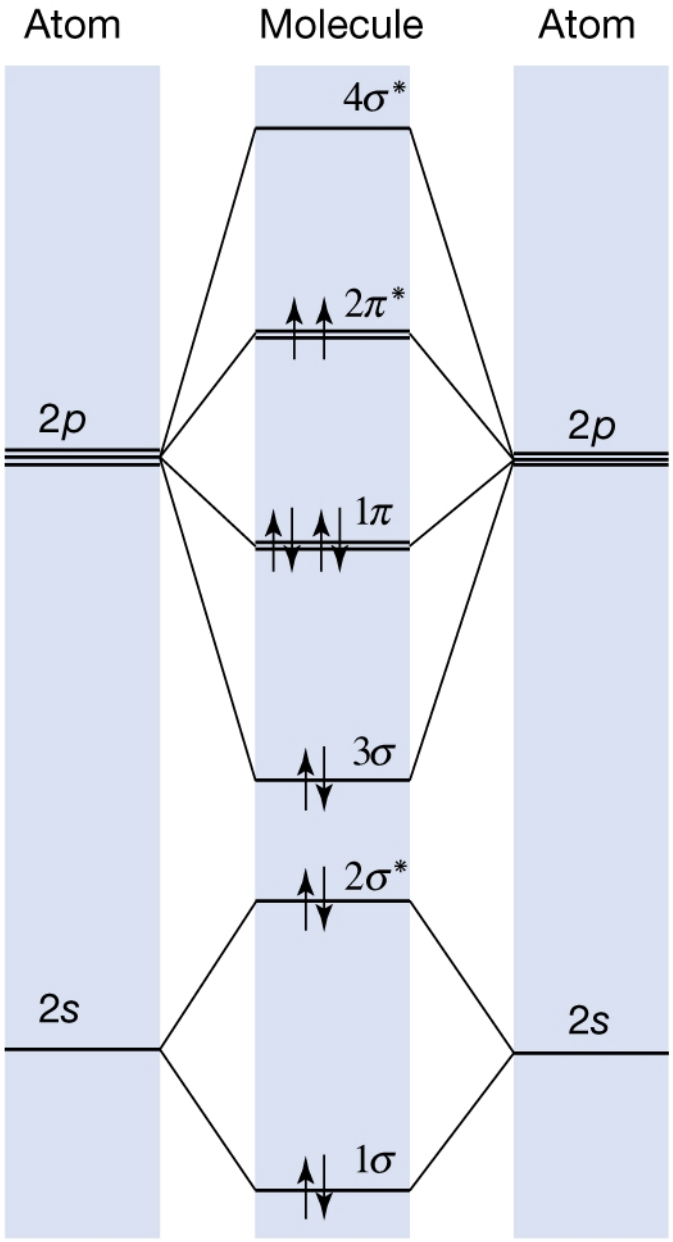
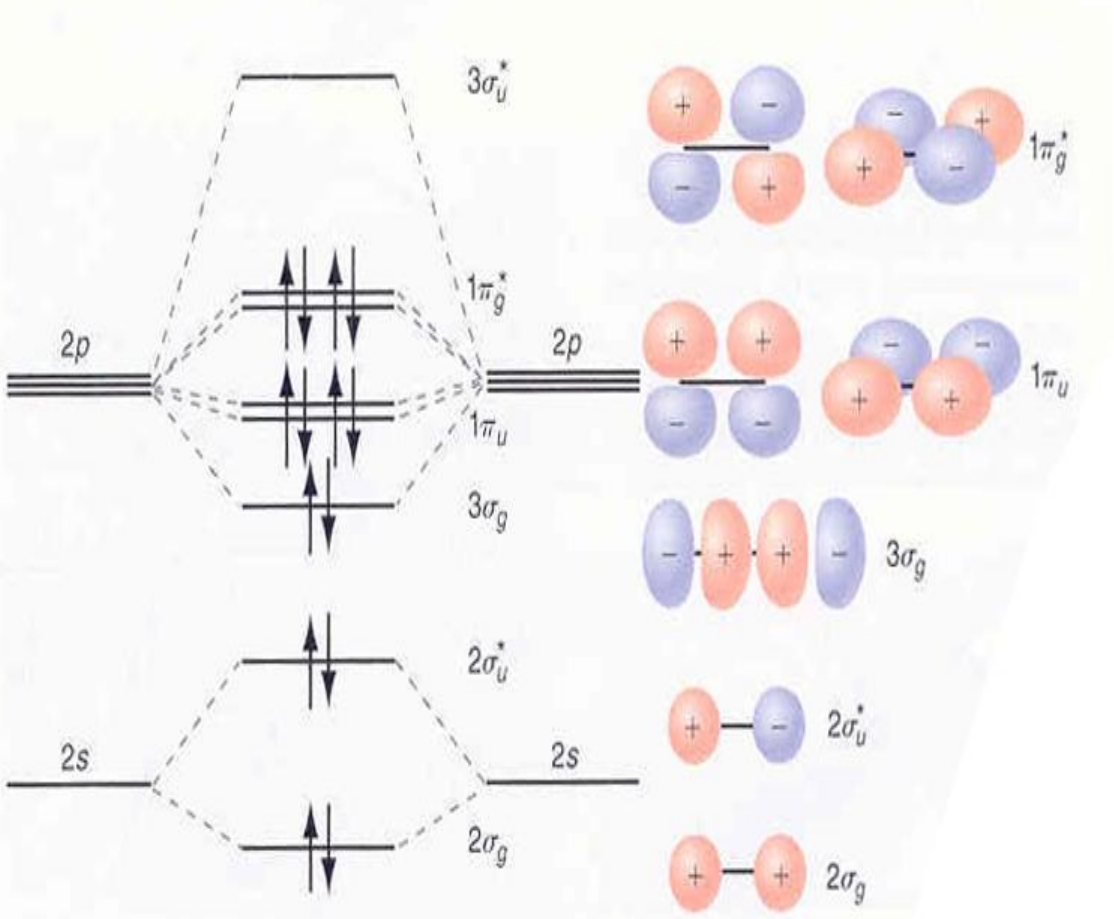

Atom
Molecule
Atom
4σ*
2π*
2p
2p
1π
3σ
2σ*
2s
2s
1σ

FIGURE 13.8

Schematic MO energy diagram for the valence electrons in F_2. The degenerate p and π orbitals are shown slightly offset in energy. The dominant atomic orbital contributions to the MOs are shown as solid lines. Minor contributions due to s–p mixing have been neglected. The MOs are schematically depicted to the right of the figure. The $1\sigma_s$ and $1\sigma_u^*$ MOs are not shown.



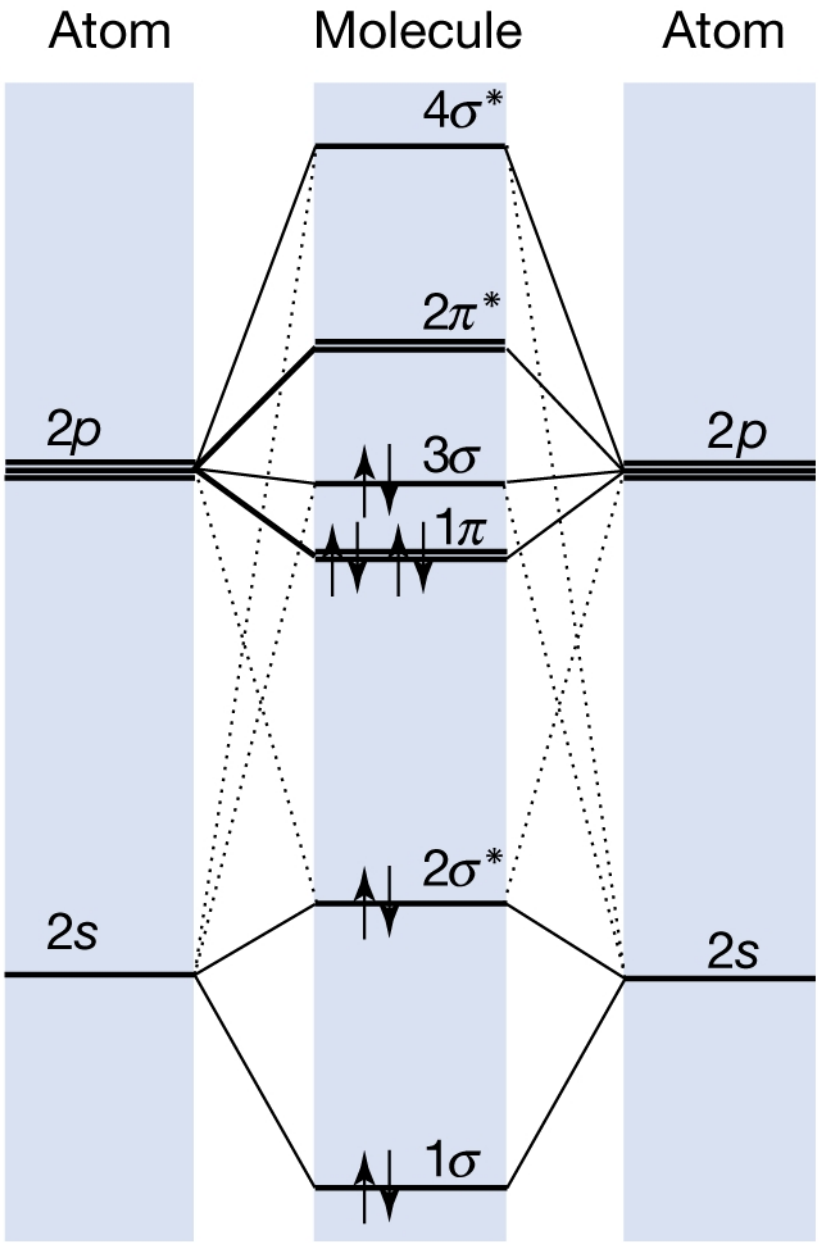
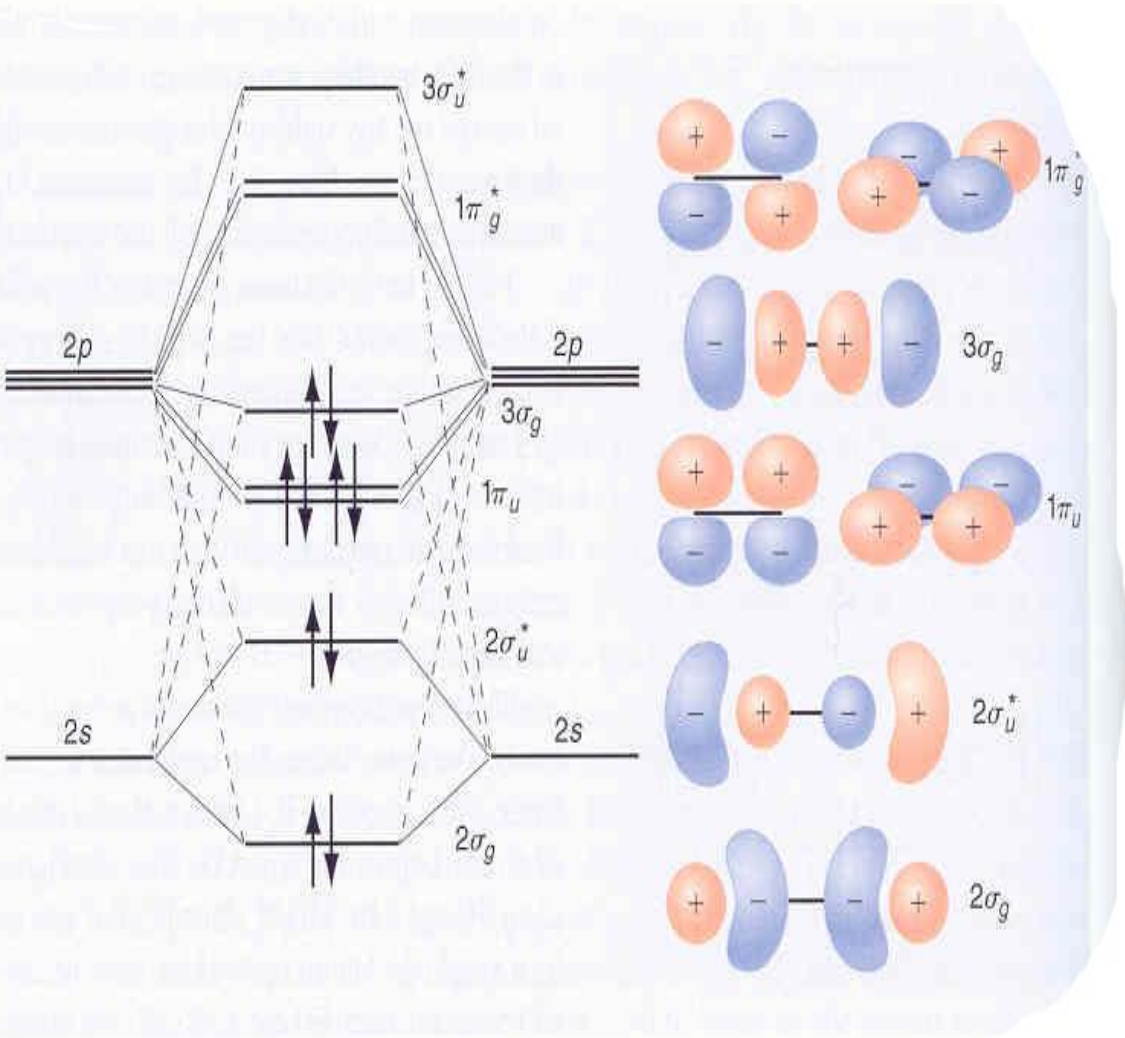

Atom
Molecule
Atom
4σ*
2π*
2p
3σ
1π
2p
2σ*
2s
2s
1σ

FIGURE 13.9

Schematic MO energy diagram for the valence electrons in N_2. The degenerate p and π orbitals are shown slightly offset in energy. The dominant AO contributions to the MOs are shown as solid lines. Lesser contributions arising from s–p mixing are shown as dashed lines. The MOs are schematically depicted to the right of the figure. The $1\sigma_g$ and $1\sigma_u^*$ MOs are not shown.



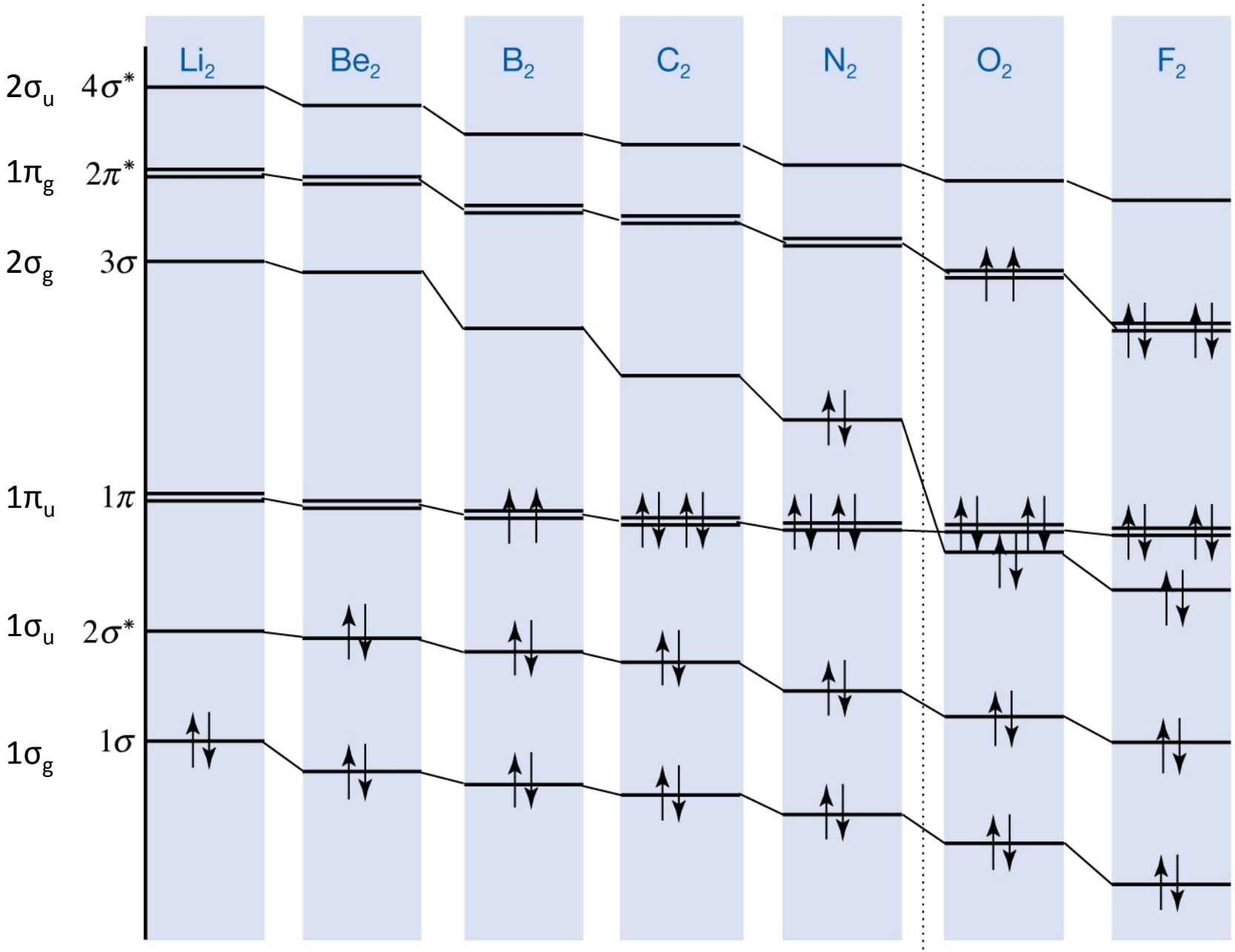

Li2
Be2
B2
C2
N2
O2
F2
2σu
4σ*
1πg
2π*
2σg
3σ
1πu
1π
1σu
2σ*
1σg
1σ

FIGURE 13.2

Molecular orbital energy diagram for a qualitative description of bonding in H_2 and HF. The atomic orbitals are shown to the left and right, and the molecular orbitals are shown in the middle. Dashed lines connect the MO with the AOs from which it was constructed. Shaded circles have a diameter proportional to the coefficients c_{ij}. Red and blue shading signifies positive and negative signs of the AO coefficients, respectively.

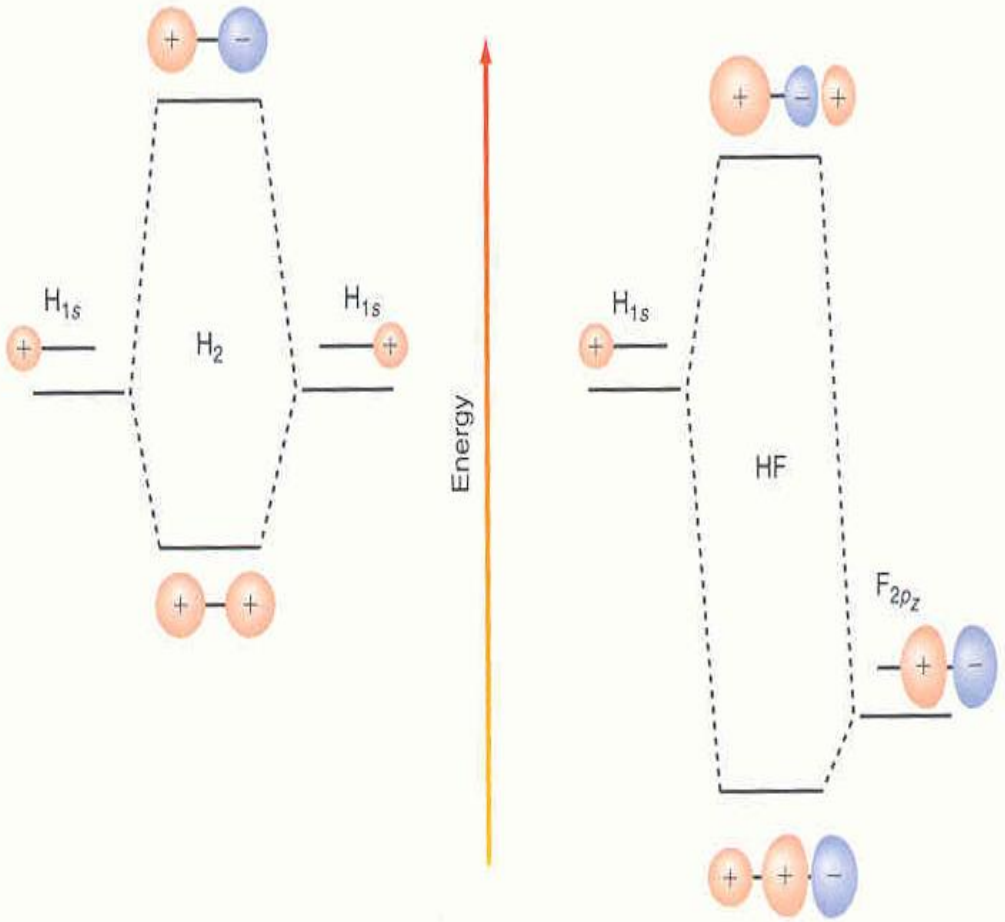


FIGURE 13.12

Schematic energy diagram showing the relationship between the atomic and molecular orbital energy levels for the valence electrons in HF. The degenerate p and π orbitals are shown slightly offset in energy. The dominant atomic orbital contributions to the MOs are shown as solid lines. Lesser contributions are shown as dashed lines. The MOs are depicted to the right of the figure.