Problem Set 4

Practice problems:
Do these to learn the material. Check your answers against those in the back of the book or against your friends’ answers, or bring questions to office hours.

9-10, 9-12, 9-15, 9-16, 9-22, 9-40, 9-73, 9-74, 9-81

Discussion problem:
We will discuss this in class (3:30) on Wednesday the 23rd. Be prepared to present answers to and to discuss any of these up at the blackboard.

Like dinitrogen (N\textsubscript{2}), carbon monoxide (CO) has 10 valence electrons, and the two molecules are quite similar when it comes to their bonding.

1. Sketch and fill a molecular orbital diagram for CO; use a homonuclear diagram similar to that used for N\textsubscript{2}.

2. Given the above diagram, what is the bond order of CO? Should it be paramagnetic or diamagnetic?

3. Given the above diagram, should CO have a dipole moment? (Think about both the electrons and the nuclei in your answer.)

4. Do any of the above answers change if the \(\sigma_{2p_z}\) orbital is lower in energy than the \(\pi_{2p_{x,y}}\) orbitals (as it is in O\textsubscript{2})? If so, how and why?

Graded problem:
This should be written up and handed in before class begins on Wednesday the 23rd. This problem may also be discussed in class.

Continuing with molecular orbitals of CO...
1. The 2s and 2p energy levels for an oxygen atom are lower than those for a carbon atom (why?). Redraw the molecular orbital diagram taking this into account. What does the redrawn diagram say about a molecular dipole moment?

2. The molecule BF and the hypothetical molecule BeNe both also have 10 valence electrons, but do not have bonding similar to CO or N₂. Use molecular orbital diagrams to explain what is different, and why.