Name: _____
Date: _____ Score ___ / 5

AP Chemistry: *Molecular Orbitals*

For each problem below, write the equation and show your work. Always use units and box in your final answer.

1.
   a. What are the similarities and differences between atomic orbitals and molecular orbitals?

   b. Why is the bonding molecular orbital of H_2 at lower energy than the electron in a hydrogen atom?

   c. How many electrons can be placed into each MO of a molecule?

2. Consider the H_2^+ ion.
   a. Sketch the molecular orbitals of the ion, and draw its energy-level diagram.

   b. How many electrons are there in the H_2^+ ion? _____ Can you write a Lewis structure for the ion? _____ Explain

   c. Write the electron configuration of the ion in terms of its MOs.

   d. What is the bond order in H_2^+?

   e. Suppose that the ion is excited by light so that an electron moves from a lower-energy to a higher-energy molecular orbital. Would you expect the excited-state H_2^+ ion to fall apart? Explain.

3.

a. Sketch the σ and σ^* molecular orbitals that can result from the combination of two $2p_z$ atomic orbitals.

b. Sketch the π and π^* MOs that result from the combination of two $2p_x$ atomic orbitals.

c. Place the MOs from parts (a) and (b) in order of increasing energy, assuming no mixing of 2*s* and 2*p* orbitals.

4. Provide explanations for the following:

a. in Li_2 the energy separation between the σ_{1s} and σ^*_{1s} MOs is much less than that between the σ_{2s} and σ^*_{2s} MOs.

b. The *peroxide* ion, O_2^{2-}, has a longer bond than does the *superoxide* ion, O_2^{1-}.

c. The π_{2p} MOs of B_2 are lower in energy than the σ_{2p} MO.

5. Using Figures 9.34 and 9.39 as guides, give the molecular orbital electron configuration for each of the following cations:

a. B_2^+ b. Li_2^+ c. N_2^+ d. Ne_2^{2+}

In each case indicate whether the addition of an electron would increase or decrease the bond order of the species.