# Chemistry 125   Second Examination
October 21, 2002

1. (6 min) **Explain** the following apparent paradoxes:

   a) BH_3 is both an acid and a base

   b) HF is properly called an acid even though its H-F bond is much stronger than a typical C-H bond

2. (6 min) Cite and interpret **experimental** evidence relevant to the favored H-X-H bond angles in BH_3 and NH_3.
                                 (**Don't** worry about the orbital explanation of why they have these angles.)

3. (6 minutes), Name the **three factors** that could result in unusually high-energy HOMOs, and give an example for each. (Give three examples in all).

4. (8 min) Describe the attack of OH^- on a carbonyl group both from the point of view of **HOMO/LUMO** mixing and with a **curved arrow** diagram showing the bonding change.

5. (4 minutes) Describe atomic-orbital hybridization in the H_2 molecule. Explain what factors determine its extent.

6. (9 minutes) This one-dimensional wave function (from the first hour exam) is in some ways analogous to an interesting molecular orbital of HF.

   a) **Name** the MO of HF.

   b) **Explain** the analogy.

   c) **Explain** how you would adjust the **potential-energy graph** that gave this wave function in order to make the wave function a better analogue of the MO of HF.
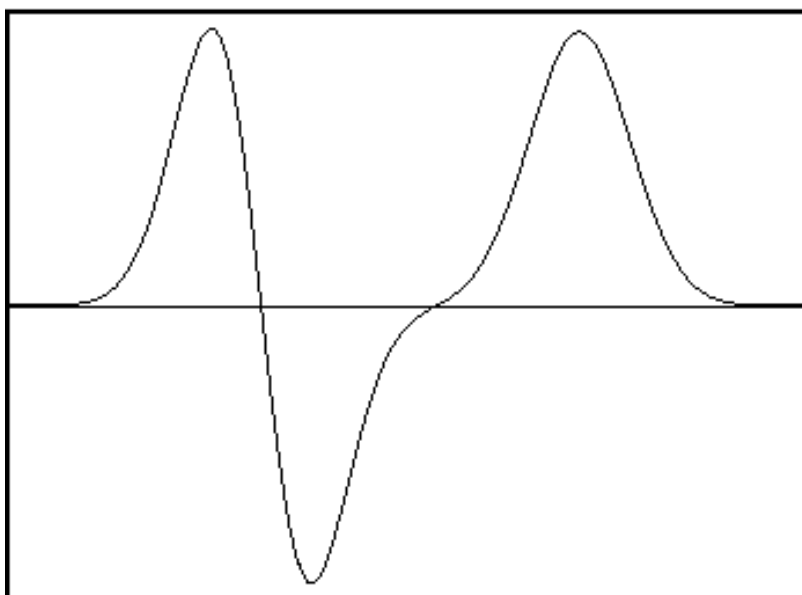
7. (10 min) Consider the group $H_2N-CH=NH$ (which could be a model for the circled portion of the adenine bases of DNA).

   Explain why the three bonds to the top nitrogen of this group might prefer all to lie in the same plane, that is, **why the N might be flat** rather than pyramidal like a normal amine.

   Incorporate the following concepts in your answer: atomic orbital energy, orbital hybridization, hybrid-orbital overlap, MO energy, resonance stabilization, curved arrows

etc
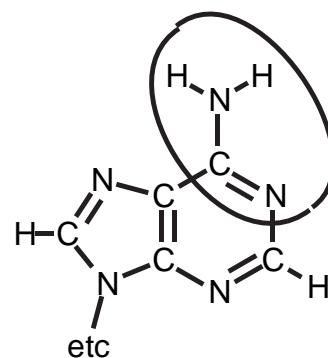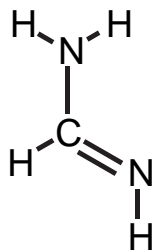
8. (1 min – **SMALL CREDIT** answer only after completing the rest of the exam)

   Rank the following functional groups in order of the expected ease of adding OH^- to the carbonyl group. (Use 1 for most reactive, 4 for least reactive). Explain your thinking on the back of this page.