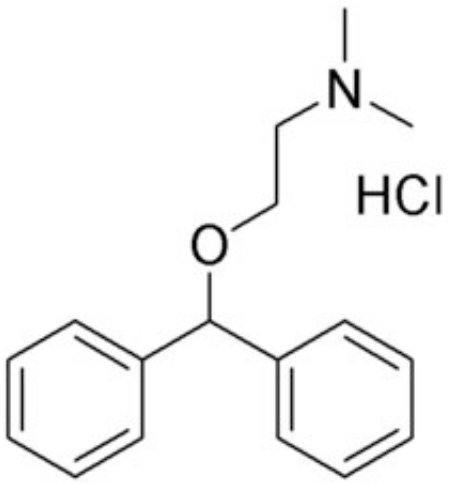
Chemistry 125 First Examination Name _____

September 28, 2007

The exam budgets 50 minutes, but you may have 60 minutes to finish it. Good answers can fit in the space provided. Question values correspond to alloted time. Don't waste too much time on cheap questions.

Read each question carefully to see what it asks for (bold face is used to help highlight questions).
Make sure you are answering the question, not just saying something vaguely relevant to its topic.

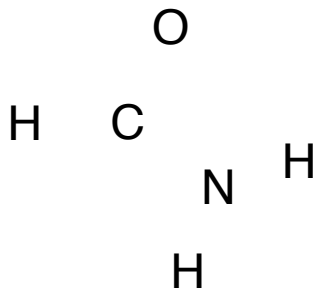
1. The following structure is commonly drawn for the antihistamine Benadryl. This structure is misleading, because the HCl reacts with the organic molecule to form what used to be considered a "*pentavalent*" atom.

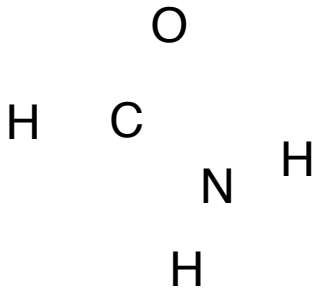


A) (4 min) Scratch out the HCl and redraw its atoms to show a proper Lewis structure with lines for bonds. Write a few words to help explain the "*pentavalence*."

B) (3 min) **Circle** and **name** each **functional group** in your improved structure of Benadryl.

2. (4 min) Draw bond lines and necessary formal charges among the atoms below to show **the two most reasonable "resonance structures"** for formamide. Draw the proper **arrow symbol** between the two structures.





3. (2.5 min) **Who** said "I cannot bear the Thought of being made Master of a Jewell I know not how to wear"?
What did he mean?

4. (2.5 min) Why did J. J. Thomson propose that negative corpuscles (or electrons) were arranged ***INSIDE*** a cloud of positive charge density?

5. (3 minutes) Explain how a discovery by Chladni relates to the idea of "***degenerate***" orbital energies.

6. (5 minutes) **How and Why** does one ***hybridize*** atomic orbitals? Explain using the **example** of an H-like atom in an electric field.

7. (4 minutes) Explain how the average potential energy of a hydrogen-like atom scales with the nuclear charge. That is, if the nuclear charge is doubled, **how much** does the average potential energy change, and **why**?

8. (4 minutes) Which of the following techniques offers the **best** resolution (most detail), and which the **least**? **Explain**.

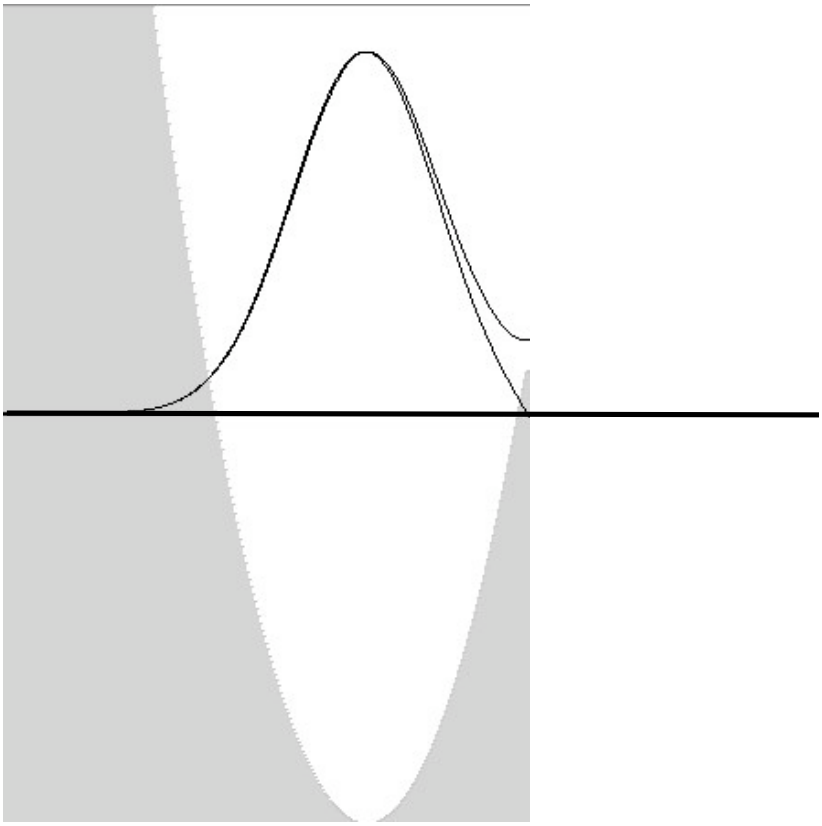
Scanning Tunneling Microscopy

Atomic Force Microscopy

X-ray diffraction

9. (6 min) **How** is an electron **difference (or deformation) density** map prepared? Cite an **example** where it revealed "pathological" bonding. Be as **specific** as you can.

5. The diagram is ***part*** of an "Erwin Meets Goldilocks" plot with two trial wave functions for the potential energy, which is shown in gray.



A) (2 min) **Draw a horizontal line** showing the **TOTAL ENERGY** for the ψ curve that becomes horizontal at the right. Be as accurate as you can.

B) (2 min) Is the total energy for the other trial ψ (the one that has a value of 0 at the right) **higher or lower** than that the one you drew in A?

Explain your thinking.

C) (3 min) Assuming that this is a Hooke's Law single-minimum problem, **draw** in the **correct** lowest-energy **ψ function** (**NOT** its energy), and **extend all three ψ curves** to the right edge of the page.

D) (5 min) Now assume that this potential is in fact the left half of a symmetric double minimum, and the original two ψ traces are part of ***correct*** solutions. **Explain** how one ψ may be considered "bonding", and the other "antibonding".