Chemistry 125 First Examination Name _____

September 21, 2005

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.

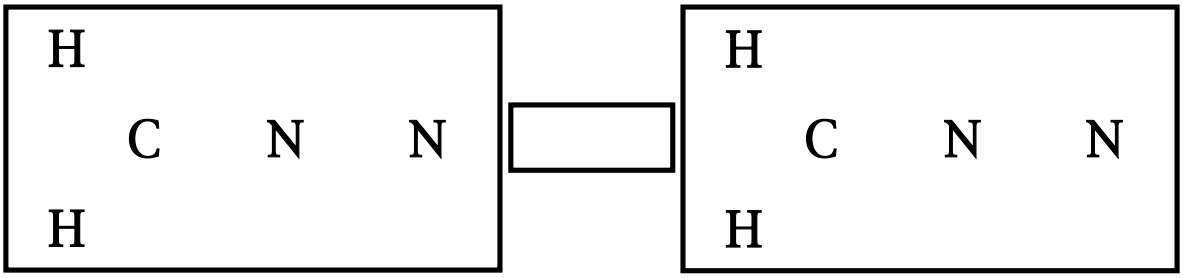
Read each question carefully to see what it asks for (bold face is used to help highlight questions).
Make sure you are answering the question, not just saying something vaguely relevant to its topic.

1. (7.5 minutes).

A) Add dots to the following diagrams to complete **two reasonable Lewis structures** for H_2CNN.

B) Show their relationship by drawing the appropriate **arrow symbol** in the box **between** your two structures.

C) Mention **a strength and a weakness** for **each** way of drawing the structure (2 strengths, 2 weaknesses).



Strength:

Strength:

Weakness:

Weakness:

2. (5 min) Choose a scientific discovery that occurred within 75 years of the founding of Yale College and is relevant to the subject matter of the course thus far. **Describe** in a sentence or two the experiment on which the discovery was based and **name** the discoverer.

3. (3 minutes) Give approximate values for the following (with units):

A) the diameter of a human hair:

B) the width of the tip of an AFM probe where it touches the sample:

C) the diameter of an atomic nucleus:

4. (3 minutes) For one-dimensional quantum mechanics

A) Name a potential for which all energies are quantized:

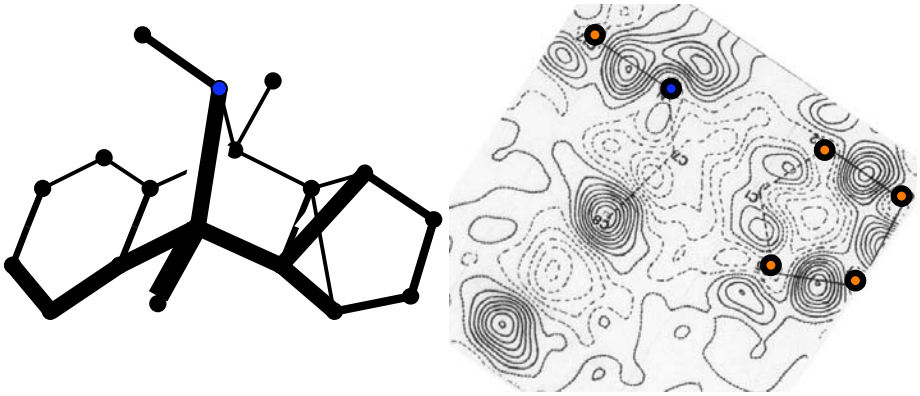
B) Name a potential for which no energies are quantized:

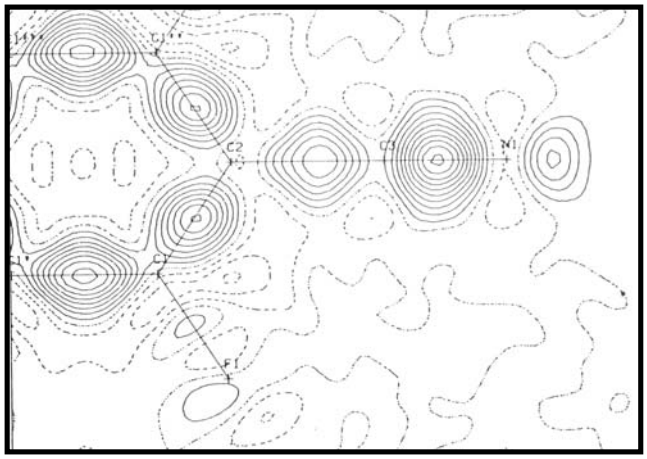
C) Name a potential for which some energies are quantized, and some non-quantized:

5. (6 minutes) **Explain** how it is that STM can show ***individual*** molecules, but not bonds, while X-ray diffraction can show bonds, but not ***individual*** molecules.

6. (3.5 minutes) What is reciprocal about the "reciprocal space" of x-ray diffraction photographs?

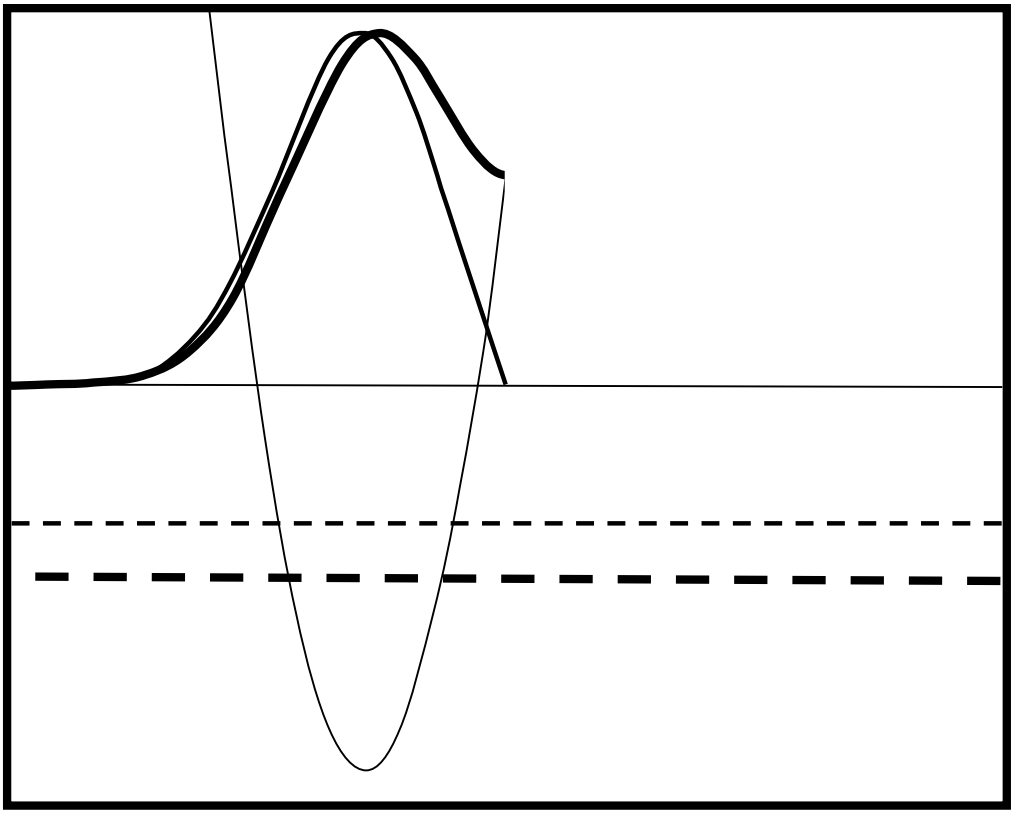
7. (5 minutes) Discuss a bonding curiosity in **ONE** of these two difference density maps. **(Don't do both)**

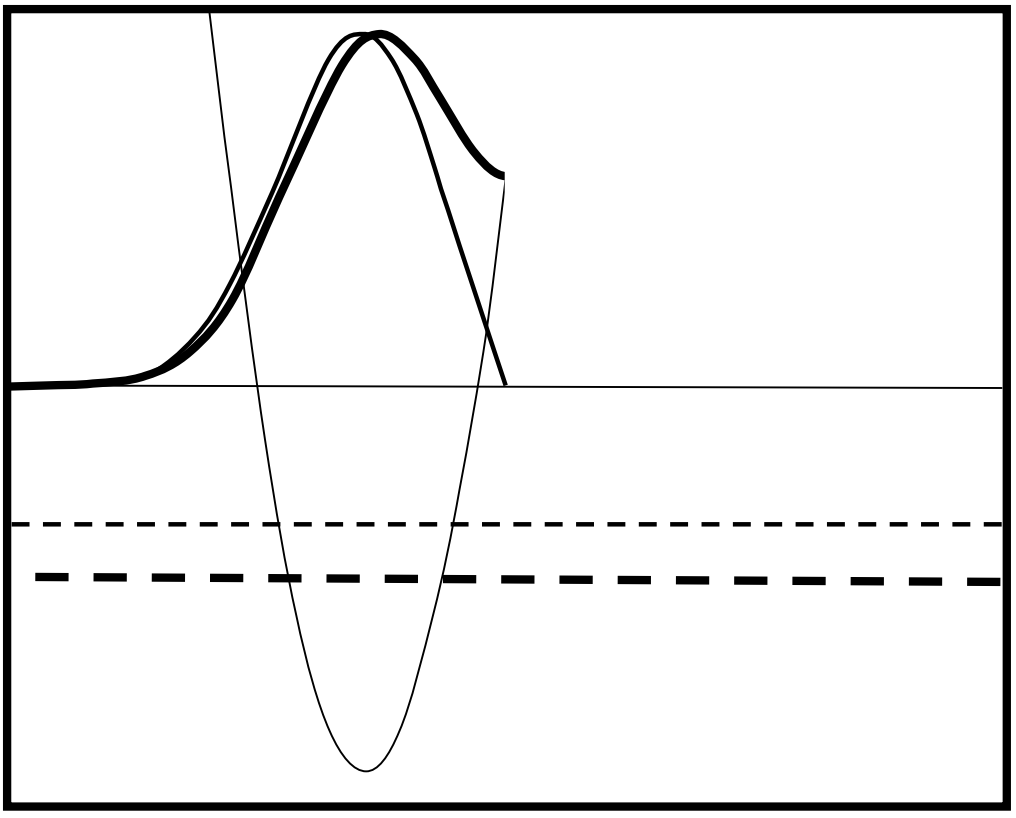




8. (5 minutes) **Explain** why wave functions for the "1-dimensional atom" (Coulombic potential) are decaying exponentials far from the nucleus.

9. (12 min) The two figures below are incomplete. The three **straight** lines (denoting Ψ=0 and two trial total energies) are complete, but only the left half of the three **curves** denoting two trial wave functions and the potential energy are shown. It is possible to complete these three curves in two different ways (corresponding to a single minimum and a double minimum) and to draw another Ψ and energy so as to explain the source of bonding. **Complete the** single-minimum and double-minimum **figures,** and use a few words to **show how they explain bonding**





What chemical facts did Lewis's concept of the "cubic" octet explain? Describe two serious weaknesses of his theory.

a) draw schematic versions of the Decaying Exponential, Hooke's Law, and Morse Potentials. (b) Explain why it is reasonable for the "Erwin Meets Goldilocks" to assume a slope of zero at the far left when beginning to trace out a wave function for any of these three potentials.