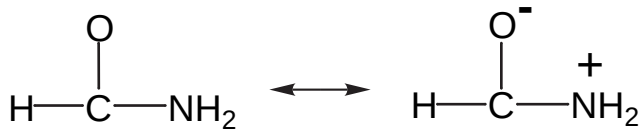
Chemistry 125 First Examination

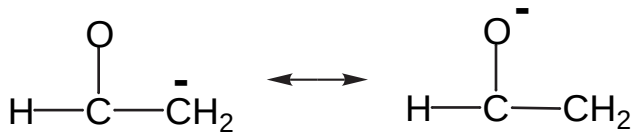
Name _____

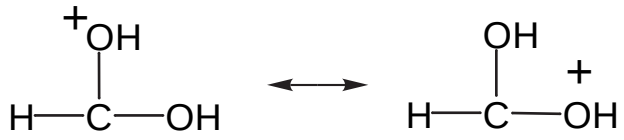
September 26, 2001

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 allotted time; don't waste too much time on cheap questions.
Read each question carefully to see what it asks for, and be sure to answer all of its parts.

1. (4.5 minutes) **Draw a bond in each formula** below to complete a reasonable resonance structure. Then in each pair of resonance structures **circle the more important one**. (In case of a tie, circle both.) Write a few words **explaining** your choices.







2 . (4.5 min) The ribosome is a pretty big structure containing some 300,000-400,000 atoms (including water molecules inside the ribosome and hydrogen atoms). Pretending that these atoms are packed in a cube, which of the values below gives a reasonable estimate for the **length of an edge** of the cube (**circle** one value):

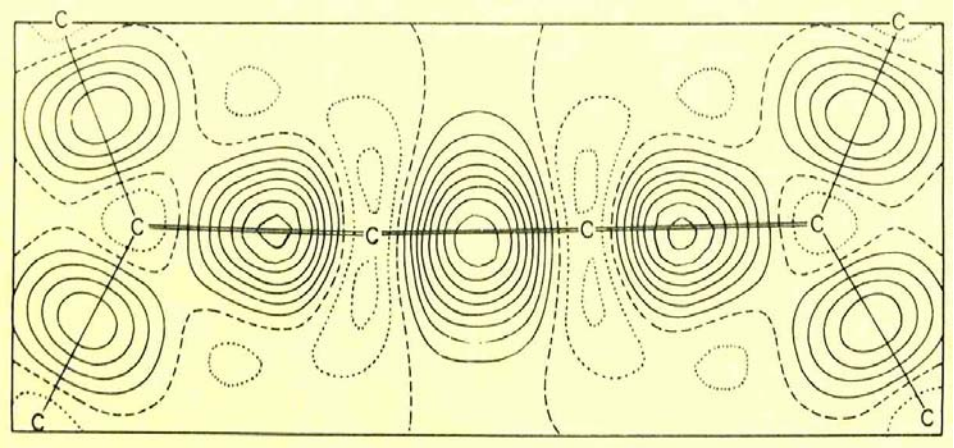
15 atoms 70 atoms 500 atoms 1500 atoms 5000 atoms

Assuming that the distance between neighboring atoms is on average 1.5 bond distances, **circle** the approximate **length of an edge** of this ribosome box:

30 Å 16 nm 160 nm 0.75 μm 11 μm 0.3 mm

If a bunch of ribosomes were lying next to one another on a glass slide, would a high-powered **optical microscope** be able to see them as separate structures? **Explain** your thinking, being sure to mention how scattered light incorporates information on the distance between such particles.

3 . (16 minutes) Consider the following figure in which the four terminal C atoms are parts of benzene rings not shown.



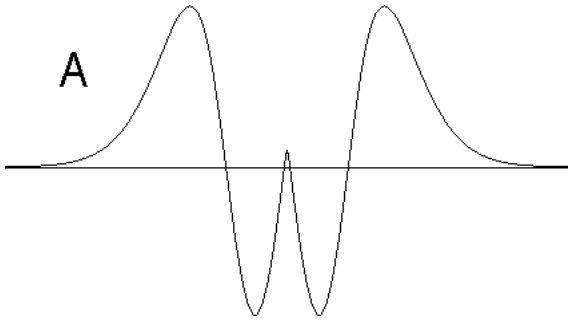
A. Explain the procedure that was used to generate data plotted in this figure (mention both experiments and calculations).

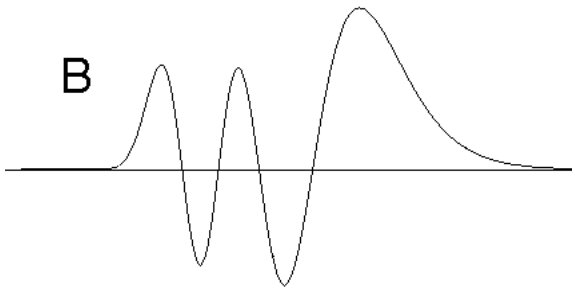
B. Explain exactly what the straight and curved lines show (and how dotted and solid curves differ).

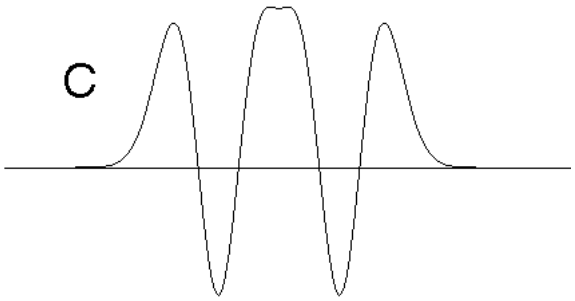
C. What qualitative and quantitative insight does one gain about the nature of carbon-carbon bonds from this figure?

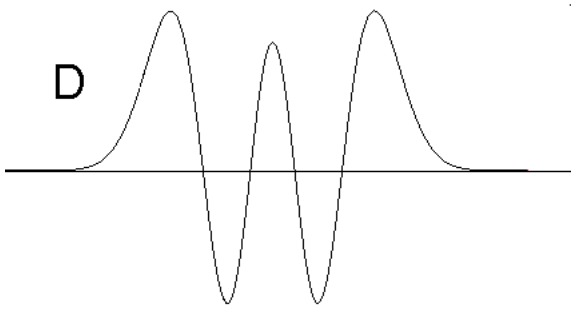
D. Explain a way in which this plot supports the Lewis theory of bonding and a way in which it refutes the theory.

4. (12 min) These four 1-dimensionalwave functions look superficially similar, but they represent different potentials - **Coulombic, Harmonic Oscillator, Double Minimum,** and **Morse** (not necessarily in that order). **Label** each picture with the name of the appropriate potential, and for each **explain** what distinctive feature(s) proves your assignment.









5. (3 min) Write the formula of the wave function for the electron in a ***2s*** hydrogen atom. [You may omit all multiplicative constants.]

6 . (4 min) **Explain** what function would you plot to make a graph of the **relative** probabilities of finding a 2s electron at various distances from the nucleus. **Sketch** a rough graph of the function.

7 . (2 min) Why should one believe that the Schrödinger equation gives a correct picture of the hydrogen atom composed of an electron and a nucleus, and that the clairvoyant picture of the hydrogen atom composed of 18 anu is incorrect?

8 . (4 min) **ANSWER A OR B (NOT BOTH)** Hard question for small credit, finish your other answers first.

A. Why would it be difficult to devise a version of "Erwin meets Goldilocks" to handle more than one dimension?
or

B. Explain how data in the following figure were used to show that at least some of the "clairvoyants" were intentionally cheating rather that being innocently self-deceived by their 1895-1907 "observations."

Top triangles: 1905 Chemists' atomic wts. Diamonds: number of Occult Anu / 18
Bottom triangles: Meyer (1884) experimental values Middle triangles: Meyer text (1884) rounded to integers