Chemistry 125   First Examination   Name _____
September 29, 2006

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. (5 minutes)

A) Complete this structure of methylphenidate (Ritalin) by adding **H atoms** and the bonds that attach them together with unshared electron pairs.

B) **Circle** and **name** each functional group in Ritalin.
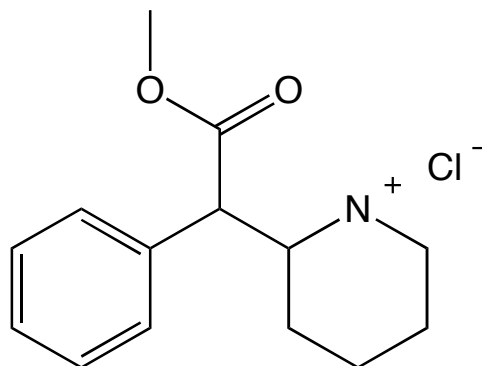
2. (6 min) It would be appropriate to write two **"resonance structures"** for **one portion** of Ritalin. **Draw the two structures of this group** below using R to denote the remainder of the molecule, and connecting them with the appropriate **arrow symbol**.

Explain the meaning of what you have drawn, being sure that your explanation includes the term "**double minimum**".

3. (9 minutes) Give the **approximate distance** in appropriate units for each of the following and **explain how it was measured** near the year indicated in parentheses.

A) the thickness of a layer that generates a visible color by reflection of incident light (~1700).

B) the diameter of the DNA double helix (~1950).

C) the length of an organic molecule about 20 bonds long (~1760).

4. (6 minutes) Explain **why** and **where** each of the following features appears in (different) one-dimensional wavefunctions that are solutions of the Schrödinger equation for the **Morse** potential.

A) exponential decay (e^{-x})

B) sin(ax)

5. (12 minutes) The C-H and C-F single bonds have fairly similar strengths, but in their lowest-energy states one of them vibrates with a much larger amplitude, that is, it covers a much wider range as it stretches and shrinks.

   A) (3 min) **Write** the quantum-mechanical expression for **kinetic energy**

   B) (9 min) In terms of your kinetic-energy expression above **explain**, by modifying the following C-H stretching figure, whether the lowest **energy** for C-F stretching should higher or lower than that for C-H, and whether is has a higher or lower vibrational **amplitude.**

E:50.0 kcal

E=4.063 kcal, M=1.0AMU

E: 0.0 kcal
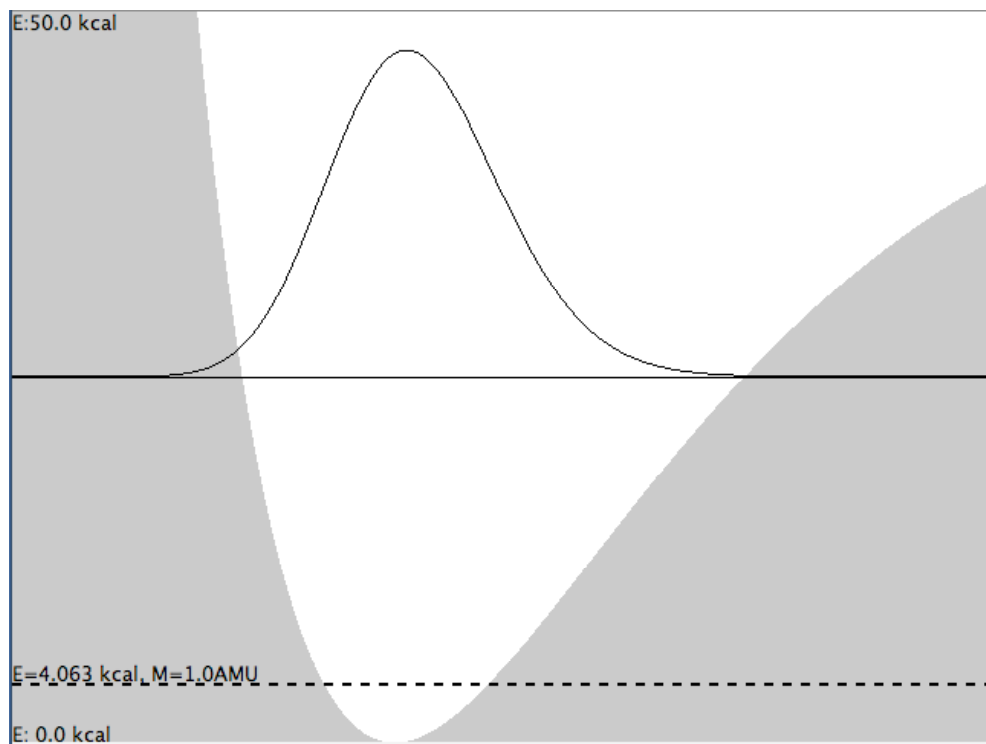
6. Tetrafluorodicyanobenzene

    A) (3 min) Explain **how** and **why** the map below was generated using **experimental** and **theoretical** input.
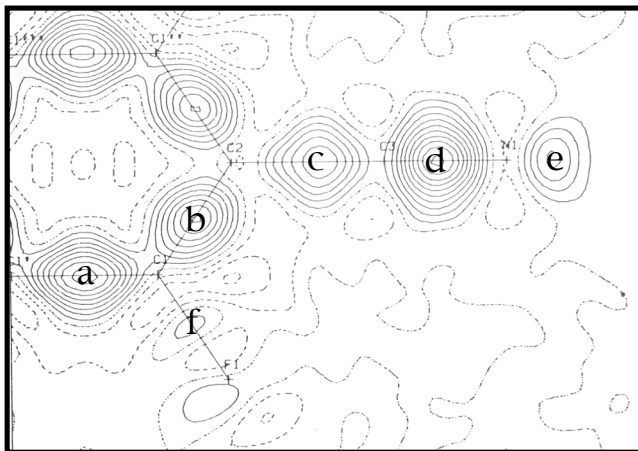
    b) (9 min) Explain what is to be learned from each of the labeled sets of contours in the figure **(a-f)**,
        or from their cross-sections perpendicular to the plane of the page.