Before you begin this exam:  First: You are allowed to have a simple model set at your seat. Please put away all other materials. Calculators will not be needed.  Second: Place your student identification on your desk. A proctor will come around to check everyone’s ID.  Third: Read through the entire exam. Your goal, as always, is to score as many points as possible. Do not waste time on problems that you can’t do if there are others that look easy.  Fourth: READ EACH QUESTION CAREFULLY. Be sure you answer the question that is asked.  Fifth: This exam must be turned in by 9:50 AM SHARP. There will be no extensions, so budget your time carefully.

1.  (10 points) Complete the Lewis DOT structures for the molecules below.  Show DOTS, not lines, to represent electrons and bonds.

   \[
   \begin{align*}
   & \text{H} & \text{N} & \text{H} \\
   & \ & \ & \text{O} \\
   & \text{H} & \ & \text{H} & \text{C} & \text{H}
   \end{align*}
   \]

2.  (10 points) Assign formal charges to the indicated atoms in the molecules below.  Assume that every non-H atom has a complete octet.

   \[
   \begin{align*}
   & \text{CH}_3 & - & \text{N} & \text{-CH}_3 \\
   & \text{H} & - & \text{C} & \text{-H} \\
   & \text{N} \\
   & \text{C}_2\text{H}_5 & - & \text{O} & \text{C}_2\text{H}_5
   \end{align*}
   \]

   Charge on N: ___  Charge on C: ___  Charge on N: ___  Charge on O: ___  Charge on O: ___
3. (10 points) Identify the hybridization state of the atoms indicated by arrows in the two anti-cancer drugs below.

![Doxorubicin](image)

![The ‘ene-diyne’ ‘warhead’ of Calicheamicin](image)

4. (10 points) One resonance form of the “allyl” anion (C₃H₅⁻) has the structure A (carbons are numbered). The hybrid looks like B. There are 3 p-orbitals that overlap (shown in C).

![Structure A](image)

![Structure B](image)

![Structure C](image)

a) What is the hybridization of each carbon in this anion?

C#1: _____  C#2: _____  C#3: _____

b) How many π molecular orbitals must be formed by overlap of these 3 p orbitals?

*Answer: _____*

5. (10 points) Identify the circled functional groups in the molecules below.

![Penicillin G](image)

![Glucose](image)
6.  
   a. (5 points) Which of the following is a skeletal isomer of 3-methylheptane? (circle one)

   ![Diagram of isomers]

   b. (5 points) Draw the structure of 4-isopropyl-2,4,5-trimethylheptane.
7. (15 points) For each of the conformational equilibria below, determine if the two compounds shown are conformers (ring-flip isomers), skeletal isomers, or identical.

   a) 
   
   b) 
   
   c) 

8. (5 points) Draw the structure of butylcyclohexane, in a chair conformation in which the butyl is in an equatorial position.
9. (10 points) a) Draw the conformational energy profile diagram for chair-boat-chair interconversion of ethylcyclohexane. Be sure to properly show the relative energies of the different conformations. b) In the box, draw the structure of the *lowest energy conformation*, being careful to clearly show the 3-dimensional structure.

10. (10 points) One of the three resonance forms shown below is invalid. Which one, and why? Your explanation must not exceed the space provided.