Test I

The first 10 questions are multiple choice, worth 4 points each. Please fill in the appropriate selection completely on your Scantron form. The second part of the test is short answer and worth 70 points, for a total of 100 points.

Answer questions 1-4 with respect to the molecule on the right:

1. Describe the C-C-N bond angle.
   a. 90°    b. 109.5°   c. 120°   d. 150°   e. 180°

2. What is the hybridization at C in the CH$_3$ group (not attached to N)?
   a. sp    b. sp$^2$   c. sp$^3$   d. sp$^4$   e. not hybridized

3. In what type of orbital does the nitrogen lone pair reside?
   a. s    b. p    c. sp    d. sp$^2$   e. sp$^3$

4. Which of the following best describes the C=N bond?
   a. Cs-Ns $\sigma$ & Cp-Np $\pi$   b. Csp-Nsp $\sigma$ & Cp-Np $\pi$
   c. Csp$^2$-Nsp$^2$ $\sigma$ & Cp-Np $\pi$
   d. Two Cp-Np $\pi$ bonds   e. Csp$^2$-Np $\sigma$ & Cp-Np $\pi$

For each set of compounds below, choose the substance that has the highest boiling point.

5. 

6. 

7. 
   a. O    b. O    c. HO    d. HO

8. What is the functional group present in structure 6a above?
   a. carboxylic acid   b. ester   c. ketone   d. ether   alcohol

9. What is the functional group present in structure 6b above?
   a. carboxylic acid   b. ester   c. ketone   d. ether   alcohol

10. Which of the following has a zero dipole moment?
    a. NH$_3$   b. NO$_2$   c. SiCl$_4$   d. SO$_2$   e. HCN
SHORT ANSWER PORTION
Please provide detailed and complete answers. Partial credit is available, so it is to your
advantage to write your thoughts and ideas, even if you don’t know how to solve the
problem completely. Show all of your calculations in order to receive full credit.

11. **(25 points)** Answer the following questions with respect to the molecule below.

   ![Molecule](image)

   a. Provide an acceptable IUPAC name for this compound.

   b. Draw Newman projections of the THREE STAGGERED CONFORMATIONS around
      the C2-C3 bond. Put the C2 atom in front.

   c. Calculate the strain energy of each staggered conformation in part b. (Use the strain data
      appended to the test to do this calculation.) Circle the most stable conformer in part b.

   d. Calculate the equilibrium constant (K) for the interconversion from the second most
      stable to the most stable (high energy to low energy) conformer at 25 °C (298 K). **If you
did not get an answer for part c, assume ΔG for this interconversion is -1.2 kcal/mol (not
the correct answer).** \( R = 1.987 \text{ cal/mol.K} \)
12. (20 points)
Consider the two cyclohexane isomers drawn below. Draw each isomer in its MOST STABLE chair conformation. Based on these structures, predict which isomer is more stable. You may find the strain data from Table 2.4 (appended to the test) helpful.

13. (15 points)
a. Draw two additional resonance structures for the following molecule and circle the most stable of the three resonance structures.

\[
\begin{align*}
\text{H}_2\text{C} & \equiv \text{C} & \equiv \text{C} & \equiv \text{C} & \equiv \text{CH}_3 \\
\text{H} & & \text{H} & & \text{H}
\end{align*}
\]

b. Circle the most acidic hydrogen(s) in the following molecule. Explain your answer by drawing the complete Lewis structures of the possible conjugate bases.

\[
\begin{align*}
\text{H}_3\text{C} & \equiv \text{C} & \equiv \text{C} & \equiv \text{C} & \equiv \text{CH}_3 \\
\text{H} & & \text{H} & & \text{H}
\end{align*}
\]