FIRST HOUR EXAMINATION

All answers should be written on the exam in the spaces provided. Clearly indicate your answers in the spaces provided. If I have to guess as to what or where your answer is, it's wrong. Where applicable, outline the logic or mystical principle you used to arrive at your answer, as partial credit may be awarded for correct approaches.

This exam is long for the time allowed and you are strongly advised to read through it completely before you begin.

(1) 20 pts........................._______

(2) 12 pts........................._______

(3) 12 pts........................._______

(4) 24 pts........................._______

(5) 16 pts........................._______

(6) 16 pts........................._______

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TOTAL (100 pts).................._______
1. Structures
a. [4 pts] Draw Lewis Dot structures for the following molecule:

\[ \text{CH}_3\text{OCN} \]

b. [4 pts] Draw the following skeletal structure as a line bond structure:

\[
\begin{array}{c}
\text{O} \\
\end{array}
\]

c. [4 pts] Draw the following as a skeletal (zig-zag) structure:

\[ \text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}(\text{CH}_2\text{CH}_3)\text{CH}_3 \]

d. [4 pts] Write the following as a condensed structure:

\[
\begin{array}{c}
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{B} \\
\text{H} \\
\text{H} \\
\end{array}
\]

e. [4 pts] Calculate the formal charge on the following highlighted atom: (show work)

\[
\begin{array}{c}
\text{O} \\
\end{array}
\]

2. Hybridization:
   a. [4 pts] What orbitals make up the indicated O-C sigma bond?

\[
\begin{array}{c}
\text{H} \\
\text{C} \\
\text{H} \\
\end{array}
\]

b. [2 pts] What is the hybridization of the following indicated bold atom?

\[
\begin{array}{c}
\text{H} \\
\text{H} \\
\text{B} \\
\text{H} \\
\text{H} \\
\end{array}
\]
c. [2 pts] What is the H-C-C bond angle in the following molecule?

\[ \text{CH}_3\text{C} \equiv \text{H} \]

d. [2 pts] What is the geometry of the oxygen atom in the molecule (ethanol) shown below?

\[ \text{CH}_3\text{-CH}_2\text{-O-H} \]

e. [2 pts] In what orbital is the lone pair on nitrogen contained?

\[ \text{N} \cdot \cdot \cdot \]

3. Answer the following questions regarding Bronsted-Lowry Acid/Base Theory:

a. [4 pts] In the reaction shown below, label the acid, base, conjugate acid and conjugate base.

\[ \text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_2^- + \text{H}_3\text{O}^+ \]

b. [4 pts] Given the following possible pKa values shown below, determine in which direction (forwards or backwards) the equilibrium lies for the equation shown.

\[ \text{NH}_4^+ + \text{H}_2\text{O} \rightleftharpoons \text{NH}_3 + \text{H}_3\text{O}^+ \]

pKa of NH\(_4^+\) is 9.4
pKa of NH\(_3\) is 36
pKa of H\(_3\)O\(^+\) is -1.7
pKa of H\(_2\)O is 15.7

c. [4 pts] Which of the following is more acidic, acetic acid (Ka is 1.58 \times 10^{-5}) or benzoic acid (pKa is 4.2)? Explain your conclusion. Show all work.

4. Nomenclature: Name the following compounds based on IUPAC rules.

a. [2 pts] What is the parent name for a nine carbon chain?

\[ \text{___________} \]

b. [2 pts] What is the parent name for a cyclic seven carbon alkane?

\[ \text{___________} \]

c. [2 pts] What is the name for a –CH(CH\(_3\))\(_2\) alkyl group?

\[ \text{___________} \]

(Continued on next page)
d. [2 pts] What is the name for a –C(\(\text{CH}_3\))\(_3\) alkyl group? 

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e. [2 pts] Name the following branch (substituent):

\[\text{\begin{tikzpicture}
\path[->,thick] (0,0) -- (1,1) -- (2,0);
\end{tikzpicture}}\]

__________________

f. [4 pts] Arrange the following prefixes for a molecule according to IUPAC rules (1 = first in name, 4 = last in name):

- triethyl
- isobutyl
- sec-butyl
- dimethyl

g. [5 pts] Name the following acyclic molecule according to IUPAC rules:

\[\text{\begin{tikzpicture}
\path[->,thick] (0,0) -- (1,1) -- (2,0) -- (3,1) -- (4,0) -- (5,1) -- (6,0) -- cycle;
\end{tikzpicture}}\]

h. [5 pts] Name the following cyclic molecule according to IUPAC rules:

\[\text{\begin{tikzpicture}
\path[->,thick] (0,0) -- (1,1) -- (2,0) -- (3,1) -- (4,0) -- (5,1) -- (6,0) -- cycle;
\end{tikzpicture}}\]

5. [16 pts] Conformational Analysis:
Part A. Acyclic Molecules
[8 pts] Consider 2-methylpentane, (CH\(_3\))\(_2\)CHCH\(_2\)CH\(_2\)CH\(_3\) (analyzing the C\(_3\)-C\(_4\) bond):


\[\text{\begin{tikzpicture}
\path[->,thick] (0,0) -- (1,1) -- (2,0) -- (3,1) -- (4,0) -- (5,1) -- (6,0) -- cycle;
\end{tikzpicture}}\]

b. Draw a Newman projection for the Anti conformation.

\[\text{\begin{tikzpicture}
\path[->,thick] (0,0) -- (1,1) -- (2,0) -- (3,1) -- (4,0) -- (5,1) -- (6,0) -- cycle;
\end{tikzpicture}}\]

c. Which of these is the lowest energy conformation? (circle one) 

Gauche 

Anti

(continued on next page)
d. Draw the Newman projection for the highest energy conformation of the C₃-C₄ bond of 2-methylpentane.

Part B. Cyclohexane Analysis

[8 pts] The following is a chair conformation of 1,3-dimethylcyclohexane.

a. Is this a chair conformation of cis-1,3-dimethylcyclohexane or trans-1,3-dimethylcyclohexane?

b. Draw a 2-dimensional representation of the isomer shown, using wedges and/or dashes to show stereochemistry.

c. Draw the alternative chair-flip conformation of this isomer on the template provided. Of the two chair conformations, which is the more stable conformation? (circle it)

6. [16 pts] **Short Answer Questions**: Answer 4 of the following 6 questions. If you answer more than four, please indicate which four questions you wish to have graded.

a. Electrons are more stable in sp³ orbitals than in p orbitals. Explain why.
b. The single bond in 1,3-butadiene is shorter than the single bonds in butane. Why?

\[ \begin{array}{c}
\text{butadiene} \\
\text{butane}
\end{array} \]

c. Explain why weak acids have lower acidity constants (Ka values).

d. Give one reason why the ground state electronic configuration for the valence electrons of carbon (2s^2 2p^2) does not permit formation of a stable octet (four covalent bonds).

e. Define what a Lewis Acid is.

f. Which is a stronger VanderWaal’s force: London dispersion forces or dipole-dipole forces? Explain.