CHM 231 Spring 2000

Exam I

1- (4 points). Which element has the ground state configuration of

a- $1s^2 \ 2s^2 \ 2p^5$  
   $\frac{\text{\textcircled{2}}}{\text{\textcircled{2}}}$

b- $1s^2 \ 2s^2 \ 2p^1$  
   $\text{\textcircled{B}}$  
   $\frac{\text{\textcircled{2}}}{\text{\textcircled{2}}}$

2- (8 points). Write Lewis structures for the following molecules. Be sure to show all the valence electrons.

a- CH$_3$NH$_2$ (Methylamine)

b- CH$_3$CO$_2$H (Acetic acid)

3- (5 points)

a- Draw the Lewis structure for of the ion shown below.

b- Indicate with an arrow which atom bears the formal 1+ charge.

CH$_3$NH$_3^+$

4- (6 points) Using the symbols $\delta^-$ and $\delta^+$, show the direction of polarity in each bond shown as — in the compounds below:

\[
\begin{align*}
\text{H}_3\text{C} & - \text{OH} \\
\text{H} & - \text{NH}_2 \\
\text{H}_3\text{C} & - \text{Li}
\end{align*}
\]

5- (10 points) Use the VSEPR model to predict bond angles about each of the atoms marked with the arrows. Write your answer in the corresponding squares.

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

6- (10 points) Write structural formulas for the following alkanes.

\[
\begin{align*}
\text{C}_6\text{H}_{13} & - \text{C} - \text{C}_4\text{H}_3 \\
\text{C}_6\text{H}_{13} & - \text{C} - \text{C}_4\text{H}_3 - \text{C}_4\text{H}_3 - \text{C}_4\text{H}_3
\end{align*}
\]

- 2,2,4-Trimethylhexane
- \textit{cis}-1,2-Diethylcyclobutane
7. (5 points) Indicate the orbital hybridization of each of the atoms marked with arrows in the following compounds. Write your answer in the corresponding squares.

8. (10 points) Write the IUPAC names for the following compounds.

\[
\begin{align*}
\text{CH}_3 & \quad \text{CH}_3 \\
\text{C} & \quad \text{CH}_2 \\
\text{CH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_3 & \quad \text{CH}_3 \\
(\text{CH}_3)_2 \text{CHCH}_2 \text{CH}_2 \text{C}(\text{CH}_3)_3
\end{align*}
\]

2,2,5-Trimethylhexane

\[
\begin{align*}
\text{C} & \quad \text{C} \\
\text{C} & \quad \text{C} \\
\text{C} & \quad \text{C} \\
\text{C} & \quad \text{C} \\
\text{C} & \quad \text{C} \\
\text{C} & \quad \text{C}
\end{align*}
\]

1-Ethyl-2,4-dimethylcyclohexane
9- (6 points) The following pairs of compounds are constitutional isomers. Indicate whether this statement is true in the following cases (circle your choice).

\[ \text{True} \quad \text{False} \]

10- (8 points) Looking along the bond between carbon 2 and 3 of butane, there are two different staggered conformations and two different eclipsed conformations. Complete the following drawings to show the two staggered conformations and the two eclipsed conformations. Draw the most stable and the least stable conformations in the places with the corresponding designation.

Most stable

Least stable
11- (12 points)
a. Draw the two chair conformations of trans-1,4-dimethylcyclohexane. Complete the drawings below and indicate by a label whether each methyl group is axial or equatorial.

More stable

Less stable

b. Draw the two chair conformations of cis-1,3-dimethylcyclohexane. Complete the drawings below and indicate by a label whether each methyl group is axial or equatorial.

More stable

Less stable

12- (7 points). Consider the following proton transfer reaction.

H₃C:OH + NH₃ → \[\text{conjugate base}\] + \[\text{conjugate acid}\]

a. Show the products of the reaction above in the spaces provided.

b. Show all the unshared pairs of electrons in reagents and products.
b- Use curved arrows to show the flow of the electron pair(s).

\[ \text{pK}_a \quad \text{CH}_3\text{OH} = 15 \]
\[ \text{pK}_a \quad \text{NH}_3 = 38 \]

13- (9 Points) Consider the following reactions and indicate which equilibria lie toward the left and which lie toward the right. Circle your choice.

\[ \text{CH}_3\text{CH}_2\text{OH} + \text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{O}^- + \text{NH}_4^+ \quad \text{Right} \quad \text{Left} \]

\[ \text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3\text{CH}_2\text{S}^- \rightarrow \text{CH}_3\text{CH}_2\text{O}^- + \text{CH}_3\text{CH}_2\text{SH} \quad \text{Right} \quad \text{Left} \]

\[ \text{C}_6\text{H}_5\text{OH} + \text{OH}^- \rightarrow \text{C}_6\text{H}_5\text{O}^- + \text{H}_2\text{O} \quad \text{Right} \quad \text{Left} \]

\[ \text{CH}_3\text{CH}_2\text{OH} \quad \text{pK}_a = 15.9 \]
\[ \text{CH}_3\text{CH}_2\text{SH} \quad \text{pK}_a = 8.5 \]
\[ \text{NH}_4^+ \quad \text{pK}_a = 9.24 \]
\[ \text{C}_6\text{H}_5\text{OH} \quad \text{pK}_a = 9.95 \]
\[ \text{H}_2\text{O}^- \quad \text{pK}_a = 15.7 \]