Exam I
8 October 2003

Name: ___________________________________________

- This exam contains 4 pages of questions – confirm this once you begin.
- You will have 50 minutes.
- No calculators are permitted.
- Read all questions carefully – answer the question that is asked!
- Illegible or indecipherable answers may not receive potential partial credit.
- Good luck!

1. (8 pts) Draw the Lewis structure for the compounds below. Be certain to show all lone pairs and formal charges. Your final structure must be in the box provided.
   a) CH₃CH₂CHO
   b) CH₃OLi

2. (8 pts) Name the following compounds using IUPAC nomenclature.

3. (8 pts) Identify each of the following alkenes as cis, trans, or neither.
4. (9 pts) The boiling points for three amines of equivalent molecular weight are shown at right. Clearly explain the observed boiling point values.

<table>
<thead>
<tr>
<th>Compound</th>
<th>b.p. (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(CH₃)₃N</td>
<td>3.5</td>
</tr>
<tr>
<td>CH₃CH₂NHCH₃</td>
<td>37</td>
</tr>
<tr>
<td>CH₃CH₂CH₂NH₂</td>
<td>49</td>
</tr>
</tbody>
</table>

5. (18 pts) In July 2002 the FDA approved neotame, an artificial non-nutritive sweetener 8000 times sweeter than sugar. It would take over 15 pounds of sugar to equal the sweetening power of one gram of neotame. The structure for neotame is shown below.

![Structure of Neotame]

a) In the boxes provided indicate the hybridization of the specified carbons.

b) Identify each of the following functional groups in neotame by circling and clearly labelling them in the structure above. If a functional group listed is not present then write “None” next to it.

- Aldehyde
- Amine
- Halide
- Alkyl group
- Aromatic
- Ketone
- Alkyne
- Carboxylic acid
- Nitrile
- Amide
- Ester

c) If you identified an amine or halide indicate (circle) whether it is primary, secondary, or tertiary.  

1°  2°  3°
6. (20 pts) Clearly circle the correct answer for the following questions. There is only one correct answer for each; no credit will be given if more than one answer is circled for each question.

a) Which compound has the **lowest** boiling point?

![Compounds](image)

b) What is dominant intermolecular force for each of the preceding compounds?

- dipole-dipole
- ionic
- London
- H-bonding

c) Identify the Lewis acid from among the following compounds.

- AlCl₃
- NaOH
- CH₃NH₂

d) Which of the following compounds is the **weakest** acid?

- NH₃
- H₂O
- CH₄
- H₂S

e) Provide curved arrow notation for the following reaction step (*hint*: you might need to draw lone pairs):

![Reaction](image)

f) What is the % s character associated with the carbon atoms in ethylene?

![Ethylene](image)

% s character: 25%  33%  50%

g) Under each of the following compounds, draw the conventional dipole moment arrow to indicate the bond polarity for the bond shown.

- Cl—Br
- Li—CH₃
- H₃C—Si(CH₃)₃

h) Which of the following compounds will have the **highest** boiling point?

![Compounds](image)

i) The electron density of a σ-bond is located __________ the internuclear axis.

- along
- perpendicular to
- at 109.5° to
7. (13 pts) What is the C1-C2-C3 bond angle in propene? _______°
   What is the H-C1-H bond angle? _______°
   What is the bond angle between any two hydrogen on C3? _______°
   How many electrons are involved in sigma bonds? _____
   How many electrons are involved in pi bonds? _____
   Mark as True or False: The C2-C3 bond is: able to freely rotate _____
                        shorter than the C1-C2 bond _____
                        an sp³-sp³ bond _____

8. (10 pts) Draw an MO bonding picture for propene independently showing the \( \sigma \)-framework and the \( \pi \)-framework.

   \( \sigma \)-framework:

   \( \pi \)-framework:

9. (6 pts) Indicate the position of equilibrium for the following acid-base reactions by using equilibrium arrows (as shown).

   \[
   \text{NH}_3 + \text{Na}^+ \overset{+}{\text{OH}} \rightleftharpoons \text{NH}_2\text{Na}^+ + \text{H}_2\text{O}
   \]
   \( pK_a \) 33

   \[
   \text{CH}_3\text{NH}_2 + \overset{+}{\text{CH}_3\text{NH}_3} \rightleftharpoons \underset{+}{\text{CH}_3\text{NH}_2}
   \]
   \( pK_a \) 4.8

   \[
   \text{H}_2\text{O} + \text{CH}_3\text{NH}_2 \rightleftharpoons \overset{+}{\text{CH}_3\text{NH}_2}
   \]
   \( pK_a \) 15.7

<table>
<thead>
<tr>
<th>Page</th>
<th>Score</th>
<th>Possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>