Exam I
23 January 2004
Name: ________________________________

- This exam contains 5 pages of questions – confirm this once you begin.
- You will have 70 minutes
- An abbreviated Periodic Table can be found on the last page.
- No calculators or models 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. (6 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) NaCN

b) CH$_3$NNH

2. (10 pts) Name or draw the following compounds, adhering to IUPAC nomenclature rules.

1,1,4-trimethylcyclooctane

4-(1-methylethyl)decane
3. (8 pts) Identify which of the following compounds (A - F)...
   a) are the same compound? ____ = ____
   b) are cis-trans isomers? ____ + ____
   c) are constitutional isomers? ____ + ____
   d) have no isomeric relationship? ____ + ____

4. (6 pts) Identify each of the following alkenes as cis, trans, or neither.

5. (10 pts) Which of the electronic configurations shown below...
   a) violates Hund’s rule? _____
   b) violates the Aufbau principle? _____
   c) violates the Pauli exclusion principle? _____
   d) represents C in the ground state? _____
   e) represents C in the excited state? _____
6. (18 pts) Taxol (paclitaxel) is an antitumor agent that was first isolated from the bark of the yew tree in 1971. Arguably the greatest bio-prospected success ever, it is FDA approved for the treatment of many ovarian, breast, Kaposi’s sarcoma, and lung cancers.

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

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

- Aldehyde
- Aromatic
- Halide
- Alkene
- Carboxylic acid
- Ketone
- Amide
- Ester
- Alcohol
- Amine
- Ether
- Thiol

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

\[ \begin{align*}
1^\circ & \quad 2^\circ & \quad 3^\circ \\
\end{align*} \]

d) If you identified a halide or alcohol indicate (circle) whether the one you selected is primary, secondary, or tertiary.

\[ \begin{align*}
1^\circ & \quad 2^\circ & \quad 3^\circ \\
\end{align*} \]
7. (18 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?

![Chemical structures]

b) Which compound has the highest boiling point?

![Chemical structures]

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

PCl₃  BCl₃  CH₃NH₂

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

HF  H₃O⁺  H₂O  H₂S

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

![Chemical structures]

f) The electron density of a π-bond is located ___________ the internuclear axis.

above and below  along  120° to

g) Which of the following best describes the bonding scheme for the indicated bond?

sp-sp³  sp²-sp²  sp-sp²

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

![Chemical structures]

i) What is the dominant intermolecular force for Cl₂?

London  H-bonding  ionic  dipole-dipole
8. (6 pts) Answer the questions that follow for acetonitrile (CH$_3$CN)
   
   What is the hybridization for C1? _____
   
   What is the C2-C1-N bond angle? _______°
   
   How many total electrons are involved in pi bonds in acetonitrile? _____

9. (10 pts) Draw an MO bonding picture for acetonitrile independently showing the σ-framework and the π-framework.

   σ-framework:                       π-framework:

10. (8 pts) Follow the instructions that follow for the reaction between propyne and hydroxide.  
    *(Hint: the acidic proton on propyne is explicitly shown.)*

   a) Write an equation for the following acid-base reaction.
   
   b) Label the acid (A), base (B), conjugate acid (CA), and conjugate base (CB).
   
   c) Predict whether the equilibrium favors the reactants or products.
   
   d) Write the $K_{eq}$ value above the equilibrium arrows.

   ![Equation]

   $pK_a$ 25

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