1. Provide the Name of Structure for the following. (7 points)
   
   a. 3-nitroaniline
   
   b. o-isopropyltoluene
   
   ![c. a structural diagram]

2. Circle the aromatic molecules. (7 points)
   
   ![a set of molecular structures]

3. The molecule has 3 different nitrogens. For each of them, classify the hybridization of the nitrogen atom, the hybridization of the nitrogen lone pair, and whether the basicity of the nitrogen is "normal" or "low". (6 points)
   
   ![a molecular structure diagram]

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Lone-Pair</th>
<th>Nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybridization</td>
<td>Hybridization</td>
<td>Basicity</td>
</tr>
<tr>
<td>Na</td>
<td>Nb</td>
<td>Nc</td>
</tr>
</tbody>
</table>
4. Draw the major products of the following reaction (4 points).

\[ \text{H-Br} \quad \text{(no peroxides)} \]

5. Draw the Major Product of the Following Reactions. Note: I want one major product in each case. (3 points each)

- \[ \text{Br}_2, \text{FeBr}_3 \]

- \[ \text{1. } \text{HNO}_3, \text{H}_2\text{SO}_4 \]
  \[ \text{2. } \text{Cl}_2, \text{AlCl}_3 \]
  \[ \text{3. } \text{Fe, HCl} \]

- \[ \text{1. } \text{Br}_2, \text{hv} \]
  \[ \text{2. } \text{NaOH} \]

- \[ \text{1. } \text{Cl, AlCl}_3 \]
  \[ \text{2. } \text{Zn(Hg), HCl} \]

- \[ \text{OMe} \quad \text{+} \quad \text{heat} \]

- \[ \text{1. } \text{SO}_4, \text{H}_2\text{SO}_4 \]
  \[ \text{2. } \text{HNO}_3, \text{H}_2\text{SO}_4 \]
  \[ \text{3. } \text{KMnO}_4 \]
  \[ \text{4. } \text{H}_2\text{O, H}_2\text{SO}_4 \]

Answer key shows only one, but either of two structural isomers will be accepted. (Carbonyl on either spot 5 or 6)
6. Rank the following, with 1 being highest/most. (2 points each)

\[
\begin{align*}
\text{OCH}_3 & \quad \text{SO}_3 & \quad \text{CH}_3 \\
\text{H}_2 & \quad \text{H}_3 & \quad \text{H}_3
\end{align*}
\]

Reactivity toward \( \text{Br}_2, \text{FeBr}_3 \)

\[
\begin{align*}
\text{H}_2 & \quad \text{H}_3 & \quad \text{H}_3
\end{align*}
\]

Heat of hydrogenation

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

Stability

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

Combined Diels-Alder Reactivity

\[
\begin{align*}
\text{H}_2 & \quad \text{H}_2 & \quad \text{H}_2 & \quad \text{H}_2
\end{align*}
\]

Cation Stability

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

Reactivity toward NaOMe

7. Outline the \( \pi \)-molecular orbitals of cyclopentadiene cation (use a Frost diagram), indicate which are occupied by electrons, and indicate whether the species is unusually stable or not. (6 points)

\textbf{Not Test Responsible this Semester for this problem.}
8. Treatment of an alkyl halide with methanolic AgNO₃ often promotes ionization, via the following:

\[
\begin{align*}
R-X &\xrightarrow{Ag^+} R^+ + AgX \\
\end{align*}
\]

When 3-bromo-1-butene undergoes this reaction, two isomeric products A and B are formed. Draw the structure for product B and the detailed mechanism for formation of product B. (7 pts)

![Structure and mechanism](image)

9. Draw the product for the following reaction and draw the mechanism for its formation. Identify the slow step. Draw all the resonance structures for the cation intermediate and circle the most important contributor. (7 points)

![Reaction](image)
10. (6 pt) When comparing cyclopentadiene (A) versus 1,3-pentadiene (CH$_2$=CH-CH=CH-CH$_3$, B),

a. One is much more acidic. Which is it, and why?

b. One is a much more reactive diene. Which is it, and why?

11. Draw the Reactants for the Following Reactions (7 points)

12. Provide reagents for the following transformations. (5 points each)