Exam 1

Name (print) _____________________________________________________________
I have neither given nor received aid on this exam (sign) _____________________________

TA (circle one): Barriere Long Tsakotellis Circle one: Undergrad Grad

There are 4 pages and 150 pts on this exam. Please read each question carefully before answering.

1. (12 pts) Provide correct IUPAC names for these compounds:

   (a) \[
   \begin{array}{c}
   \text{CH}_3 \\
   \text{OH} \\
   \text{Br}
   \end{array}
   \]
   (b) \[
   \begin{array}{c}
   \text{CH}_3 \\
   \text{CH}_3 \\
   \text{H}_2\text{N} \\
   \text{H}_2\text{N} \\
   \text{NO}_2
   \end{array}
   \]
   (c) \[
   \begin{array}{c}
   \text{OH} \\
   \text{Cl}
   \end{array}
   \]
   (d) \[
   \begin{array}{c}
   \text{CH}_2\text{CH}_3 \\
   \text{NO}_2 \\
   \text{HO}_2\text{C}
   \end{array}
   \]

2. (32 pts) For the following groups, provide whether the substituent is activating (A) or deactivating (D) as well as ortho-para (O-P) or meta (M) directing. Write A, D, O-P or M in the appropriate spaces.

<table>
<thead>
<tr>
<th>Group</th>
<th>Activating / Deactivating</th>
<th>O-P or M directing</th>
</tr>
</thead>
<tbody>
<tr>
<td>-NO_2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Cl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-CH_2CH_3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-CN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-OH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-NH_2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-CO_2H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-N(CH_3)_3+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. (4 pts) Draw structures corresponding to these names.
   (a) \( \text{o-Aminobenzoic acid} \)  
   (b) \( \text{p-Iodonitrobenzene} \)
4. (8 pts) What is the most favored site for protonation of imidazole? Draw the structure of protonated imidazole and explain the preference for protonation.

![Imidazole structure](image)

5. (8 pts) Which of the following pairs is more stable? (CIRCLE)

(a) ![Structure A](image) or ![Structure B](image)

(b) ![Structure C](image) or ![Structure D](image)

(c) ![Structure E](image) or ![Structure F](image)

6. (6 pts) Rank the compounds in each group according to their reactivity toward electrophilic substitution (1 being fastest and 3 being slowest):

(a) chlorobenzene _____ o-dichlorobenzene _____ methoxybenzene _____
(b) fluorobenzene _____ benzaldehyde _____ o-xylene _____
(c) cyanobenzene _____ methoxybenzene _____ benzene _____

7. (10 pts) Draw resonance structures of intermediates involved in the electrophilic bromination of nitrosobenzene in the para and meta positions. Where does the -NO group direct Br? Explain.
8. (30 pts) Provide syntheses for these compounds starting from benzene or toluene. Provide complete reagents and conditions. Assume that you can separate ortho and para isomers.

(a) \[
\text{CH}_2=\text{CH}_2
\]

(b) \[
\begin{array}{c}
\text{CH}_3 \\
\text{CH}_3 \\
\text{CH}_3 \\
\end{array}
\]

(c) \[
\text{CO}_2\text{H}
\]

\[
\text{Cl}
\]
9. (10 pts) Provide the products for the following reactions (indicate the major product if a mixture).

(a) \[
\text{Na, CH}_3\text{OH, NH}_3\text{ (liquid)} \quad \text{H}_2\text{SO}_4, \text{SO}_3
\]

(b) \[
\text{CO}_2\text{H} \quad \text{N(CH}_3)_2 \quad \text{I}_2, \text{CuCl}_2
\]

(c) \[
\text{Cl} \quad \text{NaOH, 300 °C}
\]

10. (30 pts) Provide mechanisms for the following transformations using the curved arrow formalism. Draw 3 resonance structures for any intermediates and show steps to generate the reactive species.

(a) \[
\text{CH}_3\text{C}-\text{Cl} \quad \text{CH}_3\text{C}=\text{O, CH}_3\text{Cl, AlCl}_3
\]

(b) \[
\text{Br, NO}_2 \quad \text{Na}^+\text{CH}_3\text{O}^-\text{, CH}_3\text{OH}
\]