1. (8 pts) Draw these alcohols:

- p-methoxyphenol
- sec-butyl alcohol
- 2-phenylethanol
- ethylene glycol

2. (9 pts) 2,4-Dinitrophenol reacts easily with NaOH → 2,4-dinitrophenoxide. Draw the 3 most important resonance structures for 2,4-Dinitrophenoxide. 2 must push neg charge on nitro group. Don't forget FORMAL CHARGE.

![Resonance structures for 2,4-Dinitrophenoxide](image)

Given that pKa of phenol is 10. Predict the pKa of 2,4-dnp. __________

3. (16 pts) Mechanism: Provide arrows and lone pairs where necessary. Answer questions.

**Path A**

- HBr
- C → H
- Br

**Path B**

- HBr
- C → H
- Br

Don't draw on this structure.

What is the mechanism?

What is the role of HBr in this reaction?

Which product is the major one? Path A or Path B? Why?

C₆ shifts but not C₄ in this reaction. What is the driving force here?
4. (4 pts) Predict values for the two blanks in the table for the acid reaction below.

<table>
<thead>
<tr>
<th>X</th>
<th>pKa</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-</td>
<td>15.5</td>
</tr>
<tr>
<td>CH3-</td>
<td>16.2</td>
</tr>
<tr>
<td>(CH₃)₃C-</td>
<td>18.0</td>
</tr>
<tr>
<td>CH₂O-</td>
<td></td>
</tr>
<tr>
<td>N≡C-</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{Y} \overset{\text{CH}_2\text{-OH}}{\rightleftharpoons} \text{Y} \overset{\text{CH}_2\text{-O}^-}{\rightleftharpoons} + \text{H}^+ \]

5. (22 pts) Multistep synthesis. You might get some reagents from #7.

\[
\begin{align*}
& \text{A} \quad \text{B} \quad \text{C} \quad \text{D} \quad \text{E} \quad \text{F} \\
& \text{G} \quad \text{H} \quad \text{I} \quad \text{J} \quad \text{K}
\end{align*}
\]

6. (8 pts) Devise synthetic schemes that involves any Grignard reagent and any aldehyde or ketone to make the alcohols below:

\[
\begin{align*}
\text{Grignard} & \quad + \quad \text{Ketone/Aldehyde} \\
\text{Grignard} & \quad + \quad \text{Ketone/Aldehyde}
\end{align*}
\]
7. (24 pts) Use the following list of reagents to carry out the transformations. Place the letter in the box. There may be more than one way. 3 is enough, but if you want you can add more steps.

- KMnO₄, H₃O⁺
- Br₂, FeBr₃
- NaOH(aq) 300° C
- HNO₃, H₂SO₄
- HCl, Sn
- CH₃CH₂CH₂Cl, AlCl₃
- NaNH₂, NH₃
- NaOH, H₂O
- H₂, Pd
- H₂SO₄ (fuming)
- CH₃CH₂Cl, AlCl₃
- CH₃CH₂Cl, AlCl₃
- Na fusion (heat), aqueous acid

![Chemical structures and reactions](image)

8. (10 pts) Provide products of the following synthetic sequences:

- **a.**
  - CH₃OH
  - CH₃Br
  - NaBr, HBr
  - S_N 1
  - 100°C
- **b.**
  - Br
  - 300°C, High P
  - Acid workup
- **c.**
  - O
  - 1. TMSCl, pyridine
  - 2. MgBr
  - 3. F⁻, aqueous acid
(10 pts) Identify the organic compound that matches most closely to the spectra on the page. Draw the structure and then draw lines from the H's to the peaks in the NMR. Identify any peaks you can in the IR. \( \text{C}_9\text{H}_{12}\text{O}_2 \)