CHEM 252 PRACTICE EXAM

1. For the following azo dye synthesis (reaction #1) fill in the missing structures of the diazonium salt and the azo dye.

Reaction #1

\[
\text{primary amine} \quad \xrightarrow{\text{NaNO}_2} \quad \text{Diazonium salt} \quad \xrightarrow{\text{Activated aromatic}} \quad \text{Azo dye}
\]

b. (4 pts) For reaction #1, draw the structure of the Azo dye at pH 10.

c. (4 pts) For reaction #1, draw the structure of the Azo dye at pH 2.

2. (12 pts) For the following azo dye synthesis (reaction #2) fill in the missing structures of the primary amine, diazonium salt and the activated aromatic.

Reaction #2

\[
\text{primary amine} \quad \xrightarrow{\text{NaNO}_2} \quad \text{Diazonium salt} \quad \xrightarrow{\text{Activated aromatic}} \quad \text{Azo dye}
\]
2. Monoacetyl ferrocene is reacted with one equivalence of benzoyl chloride and aluminum chloride to generate a benzoylated acetylferrocene. Depict the most likely product of this reaction.

\[
\begin{array}{c}
\text{Fe}^{++} \quad \text{CH}_3 \quad + \quad \text{O} \\
\text{Acetate} \quad \text{Cl} \quad \text{AlCl}_3 \quad \rightarrow \quad \text{Fe}^+ \quad \text{CH}_3 \quad \text{Cl} \\
\end{array}
\]

b) (4 pts) If water contaminated this reaction what would be the consequence of this? Show the reaction(s) that water would undergo.

\[
\begin{align*}
\text{H}_2\text{O} & \quad + \quad \text{H}_2\text{O} \\
\text{or} & \quad \text{H}_2\text{O} \\
\text{AlCl}_3 & \quad \text{H}_2\text{O} \quad \rightarrow \quad \text{Al(OH)}_4^- \\
\text{HCl} & \quad + \quad \text{HCl}
\end{align*}
\]

3. Answer the following for the esterification reaction below.

What are the final products of the reaction?

What is the limiting reagent for this reaction?

What is the role of Sulfuric acid in this reaction?

Calculate the theoretical yield (in grams) of the ester product for this reaction.

**Reaction equation:**

\[
\text{H}_3\text{C}\quad \text{O} \quad + \quad \text{CH}_3\text{C} \quad \text{O} \quad \rightarrow \quad \text{CH}_3\text{C} \quad \text{O} \quad + \quad \text{H}_2\text{O}
\]

**Reagent table:**

<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>mp</th>
<th>bp</th>
<th>Density</th>
<th>amt used/exp</th>
<th>moles used/exp</th>
<th>notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic acid</td>
<td>60</td>
<td>130C</td>
<td>1.1 g/mL</td>
<td>3.5 mL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isopentyl alcohol</td>
<td>88</td>
<td>156C</td>
<td>0.9 g/mL</td>
<td>2.5 mL</td>
<td>0.025</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>98</td>
<td>180C</td>
<td>1.9 g/mL</td>
<td>0.5 mL</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ester</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. What acid and alcohol would you use to synthesize the ester below.
5. Circle the compounds below could NOT be used as a solvent in a Grignard reaction?

- methyl propionate
- phenol
- methyl propyl ether
- cyclohexanone

6. For the Grignard reaction shown below, draw the structure of the Grignard reagent and ketone that it would be added to make the final product listed.

Grignard: 

Ketone:

b) (6 pts) Draw the structures of the 2 main impurities of this reaction—do NOT include any magnesium salts. (Assume that some water got into your reaction mixture).

From HBr → 

B. phenyl

Free


c) (4 pts) Which step if the above reaction is faster: 1) formation of the Grignard reagent or 2) reaction of the Grignard reagent with the Ketone.
7. Answer Questions 1-4 using compounds A-I shown below:

1. (4 pts) What 2 chemical tests could you use to distinguish between F and G? (you cannot use IR or NMR) Briefly describe what you would observe.
   - Chromic acid → G turns solution from red to green
   - Beilstein → G has green flame

2. (4 pts) List all the compound(s) that would turn the chromic acid test solution from red to green.
   - G is not B, is 30 Alcohol

3.a (4 pts) Which compound(s) are soluble in 5% NaHCO₃ solution?
   - Carboxylic acid
   - E, I

b. (4 pts) Draw the chemical species (structures) of the above compounds when they are dissolved in 5% NaHCO₃

4. a. (4 pts) What compound(s) would react with 2,4 DNP (dinitrophenylhydrazine) reagent.
   - F, G

b. (5 pts) Draw the structure(s) of the organic products for the above 2,4 DNP reaction.