Hey guys! For some of you, you have 2 exams down and 2 more to go! You can do this! If you have any questions or need study tips, please do not hesitate to reach out to me at Megan_Hudson2@baylor.edu!

In-person group tutoring sessions will take place every Thursday from 5:15 - 6:15 pm in Sid Rich Rm. 75! HOWEVER, this week, there is NO GROUP TUTORING on 10/21 for Fall Break. In these sessions I will provide practice problems and be available for specific questions. To reserve a spot, go to https://baylor.edu/tutoring. I hope to see you there!

Key Words: Sigma Complex, Meisenheimer Complex, Substitution, Activators, Deactivators

**TOPIC OF THE WEEK:**

**AROMATIC SUBSTITUTION REACTIONS**

An Electrophilic Aromatic Substitution is a reaction where aromatic protons are replaced with an electrophile, but the aromatic moiety is preserved.
Reactions to Note:

<table>
<thead>
<tr>
<th>Halogenation (occurs before bromination and chlorination)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Halogenation diagram" /></td>
</tr>
<tr>
<td>Bromination</td>
</tr>
<tr>
<td><img src="image" alt="Bromination reaction" /></td>
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<tr>
<td>Chlorination</td>
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<tr>
<td><img src="image" alt="Chlorination reaction" /></td>
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<tr>
<td>Sulfonation</td>
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<tr>
<td><img src="image" alt="Sulfonation reaction" /></td>
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<tr>
<td>Nitration</td>
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<td><img src="image" alt="Nitration reaction" /></td>
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<tr>
<td>Friedel-Crafts Alkylation</td>
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<td><img src="image" alt="Friedel-Crafts Alkylation reaction" /></td>
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</tbody>
</table>
**Friedel-Crafts Acylation**

\[
\text{Cl} + \text{R} + \text{AlCl}_3 \rightarrow \text{Cl} \rightarrow \text{RCO}_2\text{H} + \text{HCl}
\]

1. Create Electrophilic Species (R\(^{\ominus}\))
2. Nucleophilic attack; sigma complex
3. Loss of H to regain aromaticity

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**Clemmensen Reduction**

\[
\text{RCO}_2\text{H} + \text{Zn-Hg} + \text{H}_2\text{O} \rightarrow \text{R} + \text{H}_2\text{O}
\]

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**REVIEW:**

- R = Alkyl group
- R = Acyl group
- Ortho, Meta, Para

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HIGHLIGHT #1: ACTIVATORS AND DEACTIVATORS

- Activators favor adding to the para position first, then the ortho position
- Deactivators favor adding to the meta position
- If there are multiple substituents, the strongest group decides where the new group gets added
- Bulky alkyl substituents favor adding to the less hindered position (so adding to ortho instead of para)
- If there is a moderate or strong activator present, you cannot perform a Friedel-Craft Addition reaction

<table>
<thead>
<tr>
<th>Activators (favor ortho &amp; para)</th>
<th>Strong</th>
<th>Moderate</th>
<th>Weak</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OH</td>
<td>O⁻</td>
<td>NR₂</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Deactivators (favor meta)</td>
<td>Weak*</td>
<td>Moderate</td>
<td>Strong</td>
</tr>
<tr>
<td></td>
<td>X (halogen)</td>
<td>CN</td>
<td>NO₂</td>
</tr>
</tbody>
</table>

*exception – halogens are deactivators but favor ortho and para

HIGHLIGHT #2: NUCLEOPHILIC AROMATIC SUBSTITUTION

\[ S_{N}Ar: \]

1. Ring must have EWG
2. Ring has leaving group
3. Leaving group is ortho/para to EWG
THINGS YOU MAY STRUGGLE WITH:

1. REVIEW THESE MECHANISMS AND THE ARROW PUSHING! It can get confusing with the resonance structures/ sigma complexes/ Meisenheimer complexes, so it is vital that you draw everything out to ensure you are following the mechanism correctly!

2. Identifying activators and deactivators is difficult! You will not recognize them if you do not practice identifying the directing effects for different functional groups. I have provided a couple of problems below, but I highly recommend doing as many problems as possible from the back of the chapter.

PRACTICE PROBLEMS:

1. Determine directing effects and whether it’s an activator/deactivator
   
   a.  
   
   b.  

2. Draw out the mechanism
   
   ![Reaction Diagram](image1)

3. Propose synthesis
   
   ![Reaction Diagram](image2)
ANSWERS TO PRACTICE PROBLEMS:

1. Determine directing effects and whether it's an activator/deactivator
   
   a. \( \text{Cl} \)
   b. \( \text{OH} \)
   c. \( \text{NO}_2 \)
   d. \( \text{C}_6\text{H}_5 \)

   - Weak Deactivator
   - Ortho/Para Director
   - (1 order)
   - Moderate Deactivator
   - Meta Director

2. Draw out the mechanism

   \[ \text{C}_6\text{H}_5 + \text{HNO}_3 \rightarrow \text{C}_6\text{H}_4\text{NO}_2 \]

   \[ \text{C}_6\text{H}_5\text{NO}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{C}_6\text{H}_4\text{NO}_2 + \text{H}_3\text{O}^+ \]

   \[ \text{C}_6\text{H}_5\text{CH}_3 + \text{AlCl}_3 \rightarrow \text{C}_6\text{H}_4\text{CH}_3 + \text{HCl} + \text{AlCl}_3 \]
3. Propose Synthesis

(a) $\text{Br}_2 \underbrace{\text{FeBr}_3}_\text{Bromination at Para position}$

(b) Alkyl group = OLP Director

BUT... Notice our alkyl group changed & NO2 is added at Meta position