Concepts covered:
Ch.16: Reactions with Aromatic Compounds
- **EAS**
  - Halogenation
  - Nitration
  - Sulfation
  - Friedel-Crafts Alkylation/Acylation
    - Carbocation rearrangement
- Activating groups
  - Ortho/Para-directors
- Deactivating groups
  - Meta-directors
- Benzylic Bromination
- Reduction of ketones to CH₂
- Multistep synthesis
- **Nucleophilic Aromatic Substitution**
  - Benzyne Chemistry

1. (18.1) Draw a stepwise mechanism for the nitration of a benzene ring.

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

**nitrobenzene**
2. (18.5) Draw the product when the benzene is treated with organic halides below in the presence of AlCl₃?

![Chemical structures](image)

- a. 
- b. 
- c. 

3. (18.3) Draw a detailed mechanism for the chlorination of a benzene, with the reagents and conditions.
4. (18.5) Draw a stepwise mechanism for the intramolecular Friedel–Crafts acylation of compound A to form B. B can be converted in one step to the antidepressant sertraline.

![Mechanism Diagram]

5. (18.5) What are the ways you can add an alkyl group to an aromatic ring without the use of RCl reagents? Consider this reaction.

![Reaction Diagram]
6. Suggest a plausible arrow-pushing mechanism for the following reaction below:

7. Observe the compound below. (a) Indicate whether each substituent is an activating or deactivating group. (b) Then, label each substituent as ortho/para-directors or meta-directors.
8. Complete the reactions below by drawing the correct products.

a.

\[
\text{\begin{tikzpicture}
\node at (0,0) {\text{\textbf{\textcolor{red}{Br}_2}}};
\node at (0,-1) {\text{\textbf{\textcolor{red}{FeBr}_3}}};
\end{tikzpicture}}
\]

b.

\[
\text{\begin{tikzpicture}
\node at (0,0) {\text{\textbf{\textcolor{red}{Cl}_2}}};
\node at (0,-1) {\text{\textbf{\textcolor{red}{FeCl}_3}}};
\end{tikzpicture}}
\]

c.

\[
\text{\begin{tikzpicture}
\node at (0,0) {\text{\textbf{\textcolor{red}{Cl}};}}
\node at (0,-1) {\text{\textbf{\textcolor{red}{AlCl}_3}}};
\end{tikzpicture}}
\]
9. Complete the following reactions.

a.

\[ \text{OH} \quad \rightarrow \quad \text{OH} \quad + \quad \text{Br}_2 \]

b.

\[ \text{NH}_2 \quad \text{Cl} \quad \text{AlCl}_3 \]

c.

\[ \text{Cl} \quad \text{AlCl}_3 \]
10. Explain why the reaction below doesn’t work. Propose a viable alternative to reach the final product from benzene.

\[ \text{Benzene} + \text{Cl propyl} \xrightarrow{\text{AlCl}_3} \]
11. NMR Spectroscopy: Deduce which compound corresponds to the following 1H NMR.
12. Explain why the reduction of NO$_2$ to NH$_2$ cannot work with the given reagents. Provide an alternative for reducing to the final product.

![Chemical Reaction Diagram]

13. Suggest a starting material that would efficiently generate the product shown.
   a. 

   ![Chemical Reaction Diagram]
b. 

\[
\begin{align*}
\text{H}_2\text{SO}_4
\end{align*}
\]

\[\text{[chemical structure]}
\]


c. 

\[
\begin{align*}
\text{heat}
\end{align*}
\]

\[\text{[chemical structure]}
\]
d.
14. Multi-step synthesis: Show any steps, reagents, and conditions necessary to efficiently carry out the following multi-step transformations from the starting material on the left to the product on the right.

a.

\[
\begin{align*}
\text{benzene} & \quad \rightarrow \quad \text{H}_2\text{N}\text{Br} \\
\end{align*}
\]

b.

\[
\begin{align*}
\text{benzene} & \quad \rightarrow \quad \text{H}_3\text{C}\text{KNO}_2 \\
\end{align*}
\]
c. 

\[
\begin{align*}
&\text{\text{Cyclic}} \\
\rightarrow &\text{\text{Benzenoid}} \\
\end{align*}
\]

\[
\begin{align*}
&\text{Cl} \\
\rightarrow &\text{HO}_3\text{S} \\
\rightarrow &\text{NO}_2 \\
\end{align*}
\]

d. 

\[
\begin{align*}
&\text{\text{Cyclic}} \\
\rightarrow &\text{\text{Benzenoid}} \\
\end{align*}
\]

\[
\begin{align*}
&\text{\text{Cl}} \\
\rightarrow &\text{NO}_2 \\
\end{align*}
\]
The reaction shown is the conversion of an aromatic ring to a phenylsulfonic acid derivative. The structure on the left represents the aromatic ring, and the structure on the right shows the addition of a sulfonyl group (SO₃H) to the ring.