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Organic Chemistry II Drill (CHEM2220D). Module 5 - Sample Problems

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1. (6 points) Rank the following compounds from fastest to slowest as they react in an EAS with Cl₂/FeCl₃. 1 = fastest

2. (18 points) Predict the product(s) of these reactions. Remember that some of these can have two important products. If nothing occurs, write “no reaction”.

- **NO₂**
  - **Br**
  - **OH**
  - **CH₃**
  - **H**
  - **O**
3. (6 points) Starting with HNO₃ and H₂SO₄, show the mechanistic arrows and steps that it takes to make the electrophile NO₂⁺. You must show all arrows and intermediates to receive full credit.

4. Provide the correct reagents and intermediate structure(s) to complete the reaction schemes. There may be more than one correct scheme to complete the synthesis.

(5 points)

(7 points)

(8 points)
5. Complete these reactions. There may be more than one important product, or it is possible that no reaction occurs. (20 pts)

(a) \[
\text{Br}_2, \text{FeBr}_3 \quad \xrightarrow{\text{AlCl}_3} \quad \text{Cl} \]

(b) \[
\begin{align*}
\text{Cl} & \quad \xrightarrow{\text{NaOCH}_3, \text{heat}} \\
\text{SO}_3 & \quad \text{H}_2\text{SO}_4
\end{align*}
\]

(c) \[
\begin{align*}
\text{F}_3\text{C} & \quad \xrightarrow{1. \text{HNO}_3, \text{H}_2\text{SO}_4} \\
\text{H}_2\text{SO}_4 & \quad 2. \text{Zn, HCl} \\
\text{NaNO}_2 & \quad 3. \text{HCl} \\
\text{CuI} & \quad 4. \text{CuI}
\end{align*}
\]

(d) \[
\text{NaNH}_2, \text{NH}_3(\text{l}) \quad \xrightarrow{-33^\circ \text{C}}
\]

(e) \[
\begin{align*}
\text{H}_2\text{CrO}_4 & \quad 1. \\
\text{SOCl}_2 & \quad 2. \\
\text{benzene} & \quad 3.
\end{align*}
\]

6. Propose a mechanism. Show all intermediates and arrows. It is not necessary to draw all resonance forms of intermediates, but be sure to show how the electrophile forms. (6 pts)

7. Draw all major resonance forms of the intermediate shown. (6 pts)
8. Arrange these aromatic molecules based on the rate of reaction with CH$_3$Cl/AlCl$_3$, $1 =$ fastest reaction. (6 pts)

9. Propose syntheses of these compounds. (12 pts)

(a) 

(b) 

from 

from
10. Draw three more resonance structures for the following arenium cation $\sigma$–complex (4 points).

\[
\begin{array}{c}
\text{HO} \\
\text{H} \\
\text{H} \\
\text{H}
\end{array}
\]

11. Rank the following groups from the most deactivating (least activating) to most activating? (4 points).

- $\text{-OH}$  
- $\text{-OC(O)R}$  
- $\text{-SO}_3\text{H}$  
- $\text{-CH}_3$  
- $\text{-Br}$  
- $\text{N(CH}_3\text{)}_3^+$

12. Give the structure of the major organic product or products expected from the following reactions. “No reaction” might be an appropriate answer in some cases. Show the stereochemistry of the products if applicable. (5 points each)

a) $\text{NC} \quad \text{Br}_2 \quad \text{FeBr}_3$

b) $\text{CH}_3\text{O} \quad \text{NaNH}_2 \quad \text{liquid NH}_3$

c) $\text{CH}_3\text{C} = \text{CH}_2\text{Cl} \quad + \quad \text{excess}$

d) $\text{H-Br}$
13. Give a short, efficient synthesis of the target compound from the indicated starting material and any other needed reagents (7 points each).

\[
\text{from benzene}
\]

\[
\text{SO}_3\text{H} \quad \text{F}
\]

\[
\text{from benzene}
\]

14. Provide a reasonable mechanism for the following reaction. Make sure to draw all of the relevant resonance structures! (8 points):

\[
\text{SO}_3 \quad \text{H}_2\text{SO}_4
\]

\[
\text{from benzene}
\]

\[
\text{SO}_3\text{H}
\]
15. Complete these reactions. There may be more than one important product, or it is possible that no reaction occurs. (20 pts)
(a)

(b)

(c)

(d)

(e)

16. Propose mechanisms for these reactions. Show all intermediates and arrows. (6 pts)
(a)

(b)

(c)

(d)

(e)
17. Arrange these aromatic molecules based on the rate of reaction with Cl\(_2\), FeCl\(_3\), 1 = fastest reaction.

(6 pts)

\[ \text{aromatic molecules} \]

18. Propose syntheses of these compounds from the given starting materials. (12 pts)

(a)

\[ \text{starting material} \rightarrow \text{synthesis} \]

(b)

\[ \text{starting material} \rightarrow \text{synthesis} \]

19. Write the reagents required for the following transformation. (6 pts.)

\[ \text{starting material} \rightarrow \text{transformation} \]