Please write your answers neatly in the spaces provided. You may not use a calculator or molecular models. There are 21 questions. Read each question carefully and follow the instructions. If you do not readily know an answer, skip that question and move on.

1. Draw a second resonance structure for the given cation. Circle the more stable resonance form. (6 points)

![Resonance Structure](image)

2. Label the following planar compounds aromatic or antiaromatic. (4 points)

![Planar Compounds](image)

3. Name the following compound using either its common name or the IUPAC name. (4 points)

![Compound](image)

4. Fill in the blanks using a whole number from 1 to 10 (ex. 1, 2, 3, 4, etc.) (6 points)

Benzene has ______ p molecular orbitals (bonding and antibonding). There are ______ p electrons in the system. The lowest _______ molecular orbital (s) is/are filled with electrons in the ground state.
For questions 5 to 16, write the major organic product formed in the following reactions. Pay attention to the stereochemistry and include the correct stereochemistry in the product if necessary. If you expect no reaction to occur, write NR. (4 points each)

5. 

6. 

7. 

8. 

9. 

10.
11. 

\[
\begin{align*}
\text{1. } \text{Br}_2 \\
\text{2. } \text{NaNH}_2 / \text{NH}_3
\end{align*}
\]

12. 

\[
\begin{align*}
\text{Na / NH}_3
\end{align*}
\]

13. 

\[
\begin{align*}
\text{CH}_3\text{Cl} \\
\text{AlCl}_3
\end{align*}
\]

14. 

\[
\begin{align*}
\text{Br}_2/\text{FeBr}_3
\end{align*}
\]

15. 

\[
\begin{align*}
\text{CH}_3\text{COCl} \\
\text{AlCl}_3
\end{align*}
\]

16. 

\[
\begin{align*}
\text{HNO}_3 \\
\text{H}_2\text{SO}_4
\end{align*}
\]
For questions 17 to 19, provide reagents necessary to carry out the following transformations. More than one step is necessary. (4 points each)

17.

18.

19.
20. Indicate a plausible mechanism for the following reaction. Be sure to show bond making and bond breaking as well as all electron movement. You must account for both products. (10 points)

\[ \text{Br} \quad \text{CH}_3\text{OH} \quad \rightarrow \quad \text{OCH}_3 \quad \text{OCH}_3 \]

21. Indicate a plausible mechanism for the following reaction. Be sure to show bond making and bond breaking as well as all electron movement. You must show all cyclohexadienyl cation intermediates. (10 points)

\[ \text{OCH}_3 \quad \text{HNO}_3 \quad \text{H}_2\text{SO}_4 \quad \rightarrow \quad \text{OCH}_3 \quad \text{NO}_2 \]
EXTRA CREDIT: Provide reagents necessary to carry out the following transformations. More than one step is necessary. (4 points each)