1. Draw a second resonance structure for the given cation. Circle the more stable resonance form.

(6 points)

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

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

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

Benzene has \( \pi \) molecular orbitals (bonding and antibonding). There are \( \pi \) electrons in the system. The lowest \( 3 \) molecular orbital(s) is/are filled with electrons in the ground state.

2 pts each
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.

\[
\text{H}_2\text{O} \quad \text{Na}_2\text{CO}_3
\]

6.

\[
\text{NBS}
\]

7.

\[
\text{KOH} / \text{heat}
\]

8.

\[
\text{Br}_2 \quad 1, 2 \text{ addition}
\]

9.

\[
\text{CO}_2\text{CH}_3 \quad \text{CO}_2\text{CH}_3
\]

-2 if no stereochem

10.

\[
\text{HBr}
\]
11. 
\[
\begin{align*}
&\text{1. Br}_2 \\
&\text{2. NaNH}_2 / \text{NH}_3
\end{align*}
\]

12. 
\[
\begin{align*}
&\text{Na} / \text{NH}_3 \\
&\text{CH}_3 \text{OH}
\end{align*}
\]

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. 
\[
\begin{align*}
&\text{HNO}_3 \\
&\text{H}_2\text{SO}_4
\end{align*}
\]

NR according to the book. Accept either ans.
For questions 17 to 19, provide reagents necessary to carry out the following transformations. More than one step is necessary. (4 points each)

17.

1. CH₃C=Cl

   AlCl₃

2. Cl₂/FeCl₃

2 pts each reagent

18.

1. ClC

   AlCl₃

2. Zn(H₂)Cl

   or H₂NNNH₂

   +OH⁻

2 pts each step

19.

1. NBS

2. -OCH₃

3. BH₃·THF

   then -OH, H₂O₂

EXTRA CREDIT: Provide reagents necessary to carry out the following transformations. More than one step is necessary. (4 points each)

1. Na₂Cr₂O₇

2. HNO₃

Allow partial credit

3. Br₂/FeBr₃
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)

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)