Questions 1-10 are paired 3 point questions. Questions 11-16 are five point questions.

Consider the following Diels Alder reaction.

\[
\text{Diene} + \text{Diels Alder product}
\]

Here are some possible dienes.

\(\text{(A)}\) \(\text{(B)}\) \(\text{(C)}\) \(\text{(D)}\) \(\text{(E)}\)

1. Which diene would be the predicted to be the most reactive in the Diels Alder reaction?
2. Which diene would be the predicted to be the least reactive in the Diels Alder reaction?

Consider the following nitration reaction.

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

Here are some possible reactants.

\(\text{(A)}\) \(\text{(B)}\) \(\text{(C)}\) \(\text{(D)}\) \(\text{(E)}\)

3. Which compound would be predicted to be the most reactive?
4. Which compound would be predicted to be the least reactive?

Consider the following compounds.

\(\text{(A)}\) \(\text{(B)}\) \(\text{(C)}\) \(\text{(D)}\) \(\text{(E)}\)

5. Which compound would be classified as aromatic?
6. Which compound would be classified as anti-aromatic?
Consider the six pi molecular orbitals of hexatriene.

\[
\text{Hexa-1,3,5-triene}
\]

Here are five possible molecular orbitals of hexatriene.

(A)  

(B)  

(C)  

(D)  

(E)  

7. Which orbital set represents the HOMO of hexatriene?

8. Which orbital is invalid and does not represent any of the six MOs of hexatriene.

Consider the following isomeric compounds.

(A)  

(B)  

(C)  

(D)  

(E)  

9. Which compound is predicted to be the major product of the following reaction?

\[
\text{Br}_2 + \text{FeBr}_3 \rightarrow ?
\]

10. Which compound is predicted to be the major product of the following reaction?

\[
\text{NBS} \quad \text{light} \quad \rightarrow ?
\]

11. Predict the major product of the following reaction.

\[
\text{AlCl}_3 \quad \rightarrow ?
\]

(A)  

(B)  

(C)  

(D)  

(E)
12. The following compound has four nitrogen atoms. Which of the four nitrogen atoms would be the most basic?

\[
\begin{array}{c}
\text{(A)} \quad \text{(B)} \quad \text{(C)} \quad \text{(D)}
\end{array}
\]

13. Predict product of the following Diels Alder reaction?

\[
\text{\text{+}} \quad \rightarrow
\]

\[
\begin{array}{c}
\text{(A)} \quad \text{(B)} \quad \text{(C)} \quad \text{(D)} \quad \text{(E)}
\end{array}
\]

14. Which of the following compounds would be the most acidic?

\[
\begin{array}{c}
\text{(A)} \quad \text{(B)} \quad \text{(C)} \quad \text{(D)} \quad \text{(E)}
\end{array}
\]

15. Predict the product of the following reaction sequence.

\[
\begin{array}{c}
\text{\text{Cl}} \quad \text{O} \quad \text{HCl} \quad \text{NO}_2 \quad \text{NO}_2 \quad \text{NO}_2
\end{array}
\]

\[
\begin{array}{c}
\text{(A)} \quad \text{(B)} \quad \text{(C)} \quad \text{(D)} \quad \text{(E)}
\end{array}
\]

16. Which of the following phenols would be the most acidic?

\[
\begin{array}{c}
\text{(A)} \quad \text{(B)} \quad \text{(C)} \quad \text{(D)} \quad \text{(E)}
\end{array}
\]
Answer the following short answer questions in the indicated spaces on your answer sheet. Each question is worth 10 points.

17. Draw structures for compounds A and B in the following reaction sequence.

\[
\begin{align*}
\text{CH}_3 & \quad + \quad \text{Cl} \quad \text{O} \\
\text{C} & \quad \text{H} \quad \text{Zn(Hg)} \\
\text{HCl} & \quad \text{C}_6\text{H}_{12} \\
\text{AlCl}_3 & \quad \text{A} \quad \text{B}
\end{align*}
\]

18. Draw a curved arrow mechanism for the acylation of benzene. Clearly draw all intermediates.

\[
\begin{align*}
\text{Cl} & \quad \text{O} \\
\text{O} & \quad \text{CH}_3 \\
\text{AlCl}_3 & \quad \text{A}
\end{align*}
\]

19. 1,3-Cyclohexadiene reacts with one mole of bromine to give three isomeric products. At low temperature only two products A and B are obtained with A the major product. At high temperature the major product is C with only minor amounts of A and B obtained.

\[
\begin{align*}
\text{Br}_2 & \quad \text{A} \quad \text{B} \\
-70^\circ \text{C} & \quad \text{major} \quad \text{minor} \\
\text{Br}_2 & \quad \text{A} \quad \text{B} \quad \text{C} \\
25^\circ \text{C} & \quad \text{minor} \quad \text{minor} \quad \text{major}
\end{align*}
\]

All three products have the formula C_6H_8Br_2. Compounds A and C are chiral molecules and actually occur as racemic mixtures. Compound B is achiral.

Identify compounds A, B and C.
20. Propose a synthesis of the compound shown below. You may start with benzene and other compounds of four carbons or less. Be sure to account for the stereochemistry.