Multiple Choice Questions: 50 points

1. Select the major product of the following reaction.

\[ \text{[Diagram of reaction]} \]

\[ \begin{align*}
\text{A} & \quad \text{B} \\
\text{C} & \quad \text{D} \\
\text{E} & 
\end{align*} \]

2. Consider the following Diels-Alder reaction.

\[ \begin{align*}
\text{[Diagram of reaction]} \\
\text{Select the diene that would be the least reactive for the reaction shown above.} \\
\end{align*} \]

\[ \begin{align*}
\text{A} & \quad \text{B} \\
\text{C} & \quad \text{D} \\
\text{E} & 
\end{align*} \]
3. Choose the order that has the following carbocations correctly arranged with respect to \textit{increasing} stability.

\[
\begin{align*}
\text{1} & : \text{Me} \\
\text{2} & : \text{O} \\
\text{3} & : \text{K}
\end{align*}
\]

A : 1 < 2 < 3  
B : 1 < 3 < 2  
C : 2 < 1 < 3  
D : 2 < 3 < 1  
E : 3 < 1 < 2

\text{increasing stability} \quad \text{increasing stability} \quad \text{increasing stability} \quad \text{increasing stability} \quad \text{increasing stability}

4. Select the major product of the following intramolecular Diels-Alder reaction.

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

\[\text{heat} \rightarrow ?\]

A : + enantiomer  
B : + enantiomer  
C : + enantiomer  
D : + enantiomer  
E : + enantiomer
5. Consider the free-energy diagram of the reaction shown below. Select the incorrect statement.

\[ \text{Product } Y \text{ is a tertiary bromide.} \]

A. The intermediate, X, is a tertiary allylic carbocation.
B. Product Y is a tertiary bromide.
C. At low temperature, the major product formed is Y.
D. Product Z contains a trisubstituted alkene.
E. At high temperatures, product Z is the major product because the transition state from X to Z becomes more stable.

6. Select the major product of the following reaction sequence.

\[
\begin{align*}
\text{C} & \xrightarrow{\text{OCl}} \text{Zn(Hg)} \xrightarrow{\text{HCl}} \text{Zn(OH)} \xrightarrow{1. \text{KMnO}_4, \text{OH}^-, \text{heat}} \text{SOCl}_2 \xrightarrow{2. \text{H}_3\text{O}^+} \text{AlCl}_3 \\
\end{align*}
\]

A. 
B. 
C. 
D. 
E. 

7. Choose the order that has the following compounds correctly arranged with respect to increasing wavelength of their $\pi$ to $\pi^*$ absorptions in the UV-visible spectrum.

![Compounds](image)

A 1 < 2 < 3  
B 1 < 3 < 2  
C 2 < 1 < 3  
D 2 < 3 < 1  
E 3 < 1 < 2

8. Select the molecular orbital that represents the highest occupied molecular orbital of 1,3,5-hexatriene in the ground-state.

![1,3,5-hexatriene](image)

A  
B  
C  
D  
E

9. Choose the order that has the following compounds correctly arranged with respect to increasing acidity. One of the acidic hydrogen atoms in each compound has been circled.

![Compounds](image)

A 1 < 2 < 3  
B 1 < 3 < 2  
C 2 < 1 < 3  
D 2 < 3 < 1  
E 3 < 1 < 2

increasing acidity
10. What is the major problem with the following synthesis, according to CHE 322 standards?

A. In the first step, there will be a significant amount of product formed containing 2 isopropyl groups attached to benzene.
B. In the first step, the major product (1) should contain a propyl group instead of an isopropyl group.
C. In the second step, there will be a significant amount of product formed where the electrophile is added at the ortho position.
D. Product 2 should contain an alcohol, not a carboxylic acid.
E. Product 3 has the carbonyl in the wrong location.

Short Answer Questions: 50 points

11. Give the structure of the major product of the following reaction. HINT: D is the symbol for deuterium, an isotope of hydrogen which shows the same reactivity as hydrogen in this reaction. 5 pts

\[ \text{Product Structure} \]

\[ \text{D-Cl} \]

\[ \text{high temperature} \]

12. Give the structure of the major product of the following Diels-Alder reaction. You only need to provide one enantiomer. Use wedged or dashed bonds where appropriate. 7 pts

\[ \text{Product Structure} \]
13. Give the structure of the reactant of the following Diels-Alder reaction. 7 pts

14. Give reagents that could be used to transform benzene into 1-bromo-3-propylbenzene (the number of arrows do not necessarily correspond to the number of required steps, but more than one step will be necessary. Your answer only needs to show the reagents). 5 pts

15. Propose a synthesis of the following compound starting from any compound(s) containing four carbon atoms or less. 8 pts
16. Using the curved arrow formalism, show all the bond making and bond breaking steps of the following reaction. 8 pts

![Reaction Diagram]

17. Propose a synthesis of the following compound starting from benzene. You may use any reagents. 10 pts

![Compound Diagram]