1. (35 points) Predict the major product for each of the following reactions. If no reaction is expected, briefly explain why. You may neglect stereochemistry. Where an EAS reaction takes place, you may assume that only one substitution takes place.

A) ![Nitrile Reaction with Nitric Acid](image1)

B) ![Amination with Bromine](image2)

C) ![Hydrocarbon Combination](image3)

D) ![Aromatization with Alcl3](image4)

E) ![Oxidation and Dehydrohalogenation](image5)
2. (8 points) In the presence of a strong acid in ethanol, the compound shown below, 
(1Z,3Z,5Z)-7-bromocyclohepta-1,3,5-triene, will dissociate to form a cation and bromide.

• Give the structure of the cation.

• Draw an orbital energy level diagram showing the relative energies of all of any \( \pi \), \( \pi \) (non-bonding) and \( \pi^* \) orbitals, and fill with electrons.

• Do you predict this cation will be aromatic? Explain.
3. (12 points) Predict the major product for the following reaction.

Write a complete arrow-pushing mechanism for the formation of that compound, including all important resonance structures for any intermediates.
4. (8 points) Predict the structures of the two stereoisomers formed in the following reaction. Show the mechanism by which one of the stereoisomers is formed.

5. (8 points) Pyridine (on the left) has a basicity similar to ammonia and most alkyl amines (like methylamine). Pyrrole (on the right) is much less basic. Explain both of these observations.
6. (10 points) Using resonance structures for the intermediate in an electrophilic aromatic substitution (EAS) and a brief explanation, demonstrate why the nitro group (-NO₂) is a meta-director, and is deactivating for EAS.

7. (7 points) Suggest a reasonable diene and dienophile for the formation of the following product by a Diels-Alder reaction.
8. (12 points) Suggest a reasonable scheme for the preparation of the following compound using toluene, carboxylic acids, or alkyl chlorides as your only sources of carbon. You may use any other reagents or solvents you require.
BONUS (5 points): Name: ________________________________

The following compound is heated in concentrated H₂SO₄. When the resulting product is analyzed, it is found to be a bicyclic compound containing only carbon and hydrogen. Show the mechanism for all steps involved, including the required conformations where applicable, and predict the product. You may neglect stereochemistry in the product.

\[
\text{OH}
\]

\[
=\begin{array}{c}
\text{OH}\\
\end{array}
\]

Reaction Conditions – Oxidation / Reduction:

**Clemmensen Reduction Conditions:**

\[
\text{Zn(Hg)} \quad \text{HCl, reflux}
\]

**Permanganate Oxidation Conditions:**

1) KMnO₄, OH⁻, Δ

2) H₂O⁺