I. **Nomenclature**

1. Provide a correct name for each compound below. (12 points)

![Chemical structures]

II. **Theory**

1. UV spectroscopy measures the energy required to promote an electron from the __________________ molecular orbital to the __________________ molecular orbital. (4 points)

2. Circle all factors that influence the melting point of an organic solid. (3 points)
   
   a) Intermolecular forces.
   b) Stability of the compound.
   c) Number of possible conformations available through bond rotations.
   d) Packing efficiency.

3. TLC revealed that a sample contained 3 different compounds. Using an eluent of (20:80) ethyl acetate:hexane, compound A had an $R_f$ of 0.5, compound B had an $R_f$ of 0.25, and compound C had an $R_f$ of 0.7. If these three compounds were purified by column chromatography, using the same eluent system, which compound would elute from the column first? (2 points)
4. The complete combustion of benzene is approximately $\Delta H = -789 \text{ Kcal/mol}$. What would this value be in Kcal/mole if benzene were not aromatic (cyclohexatriene)? (2 points)

   a) -717  b) -753  c) -825  d) -861  e) inconclusive

Use the structure of vitamin D$_3$ below to answer questions 5 - 8.

5. Given that 1,3-butadiene has a UV absorption of 217nm, predict the approximate absorption for the conjugated system in vitamin D$_3$. (2 points)

   a) 185nm  b) 217nm  c) 240nm  d) 250nm  e) 270nm

6. How many molecular orbitals are needed to represent the conjugated system above? (2 points)

   a) 1  b) 2  c) 3  d) 4  e) 5  f) 6

7. Draw the highest occupied molecular orbital for the pi system. (3 points)

8. State the number of nodes and net bonding/antibonding interactions of the highest occupied molecular orbital above. (4 points)
9. Use the polygon rule to draw an energy diagram for cyclopentadienyl anion, and then fill in all the electrons in the system. (3 points)

10. Indicate whether the following cyclizations, conducted under thermal conditions, is symmetry allowed. Justify your answer by drawing out the molecular orbitals for each system. Treat ethylene as the nucleophile. (5 points)

11. Which sequence correctly ranks the following dienes in order of increasing reactivity in the D-A reaction? (3 points)

   a) 1-2-3   b) 2-3-1   c) 3-1-2   d) 3-2-1   e) 2-1-3   f) 1-3-2

12. Label the compounds below as aromatic, nonaromatic, or antiaromatic. (9 points)
III. Reactions

1. Draw the product of the following reaction. (3 points)

\[
\begin{array}{c}
\text{Br}_2 \\
\end{array}
\]

2. Provide the correct stereochemistry and regiochemistry of the major product of the following reaction. (5 points)

\[
\begin{array}{c}
\text{O} \quad \text{C} \\
\end{array}
\]

3. Complete the following transformation. (5 points)

\[
\begin{array}{c}
\text{NO}_2 \\
\end{array}
\]

1) 

\[
\begin{array}{c}
\text{Br} \\
\end{array}
\]

2)
4. The following compound was constructed using a Diels-Alder reaction. Draw the structure of the starting material. (3 points)

\[ \text{Δ} \quad \text{starting material} \rightarrow \text{product} \]

5. Predict the product of the reaction below. (3 points)

\[ \text{Ar} \quad \text{Cl} \quad \text{Cl} \quad \text{AlCl}_3 \]

IV. Mechanism

1. Which of the following is an intermediate when 1,2-dibromo-4-nitrobenzene is heated with NaOH in leading to nucleophilic aromatic substitution? (3 points)

a) ![Intermediate a]

b) ![Intermediate b]

c) ![Intermediate c]

d) ![Intermediate d]
2. The first step features a Birch reduction. Provide a structure for the radical anion intermediate, leading to the diene. (3 points)

3. Draw one of the resonance intermediate structures leading from the 1,4-cyclohexadiene to the unsaturated bromide. (3 points)

4. The unsaturated bromide above is unstable and decomposes back to toluene. Provide a mechanism for this process. (6 points)
V. Synthesis

1. Provide the necessary reagents to accomplish the following transformation. (Hint: block the para position with a removable group.) (6 points)

   1) 
   \[ \text{H}_3\text{C}-\text{CH}_{3} \]
   2) 
   3) 
   \[ \text{H}_3\text{C}-\text{CH}_{3} \]
   \[ \text{Br} \quad \text{Br} \]

   Only

2. Show how the following product can be made from benzene. (6 points)

   1) 
   2) 
   3) 
   \[ \text{I} \]
VI. **Extra Credit** (5 points possible)

1. Predict the product of the following series of reactions.

On exam 2 you received _________ points out of 100 points possible. To check your overall lecture grade go to http://courses.weber.edu/.