PRINT your name legibly on the line below.

________________________________________

PRINT your student id number on the line below.

________________________________________
Place your student identification on your desk. A proctor will come around to check your ID. **Put your name and number on your test?**
It is critically important that your answers be written in a clear, unambiguous manner. Answers in which your intentions are unclear may not receive credit. **SHOW YOUR WORK!**

<table>
<thead>
<tr>
<th>Problem Number</th>
<th>Points possible</th>
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**Total** 200 _____
Problem 1a

Problem 1b

1. 

a. (5 pts.) This is a neutral species. There are some electrons missing (nothing else is missing). Put the missing electrons on the structure to complete the structure. (Hint: computing the degrees of unsaturation might help.)

b. (5 pts.) Above, draw a charge separated resonance structure of your complete Lewis structure of 1a.

2. Consider molecular formula: $\text{C}_{14}\text{H}_4\text{Cl}_{10}$.

a. (10 pts.) Compute the degrees of unsaturation.

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

b. (10 pts.) There is one ring in the structure. Could the structure possibly be aromatic?

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

3. (15 pts.) How are these two molecules related to each other? Do they have the same physical properties?

\[
\text{Cl} \quad \text{Cl}
\]
4. Consider the molecule below.

a. (10 pts.) Circle the weakest C-C bond in structure 4A below.

\[4A\]

b. (10 pts.) At right above, draw a product of molecule 4A and

5. Consider molecule 5A.

a. (10 pts.) Below, draw the enantiomer of molecule 5A. Count the carbon atoms in your

\[5A\]

b. (10 pts.) Name 5A as a cyclohexane derivative. \textbf{Stereochemistry}!
6. (15 pts.) Draw the Diels – Alder product of \( \text{O} \) + \( \text{C} = \text{N} \). Count your carbon atoms. Stereochemistry is important.

7. 7A 7B

a. (5 pts.) How many \(^{13}\text{C}\) NMR in 7A. 

b. (5 pts.) How many \(^{13}\text{C}\) NMR in 7B. 

8. (20 pts.) Draw the two highest-energy occupied molecular orbitals in 1,3-butadiene. Same question: draw only the occupied pi molecular orbitals of 1,3-butadiene.

9. (15 pts.) Draw the product.
10. (20 pts.) Consider the reaction energy diagrams below. **Use each letter only once.**

![Reaction Energy Diagrams](image)

a. The diagram of the fastest reaction is __________ .

b. The diagram that might represent the conversion of one enantiomer into another is __________ .

c. The diagram that represents an endothermic reaction with one intermediate is __________ .

d. The diagram that represents the twisting of a double bond through a dihedral angle of 180° starting from a *cis*-alkene and producing a *trans*-alkene is __________ .

11. (15 pts.) Predict the product.

Problem 11

1) $(\text{CH}_3\text{CH}_2)_2\text{BH}$

Ether (solvent)

2) $\text{H}_2\text{O}_2, \text{NaOH}_{(aq)}$
12. (10 pts.) Predict the product.

Problem 12

\[
\text{1) } \ce{O3} \\
\text{Ether (solvent)} \\
\text{2) } \ce{H2O2, NaOH(aq)}
\]

13. (10 pts.) Predict the product.

Problem 13

\[
\text{1) } \ce{H3O(+)} \\
\text{water} \\
\text{Heat}
\]