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!**

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**Total** 150 ______
Problem One

```
BF₃  N(CH₃)₃  (CH₃)₂NCHO
```

1. (15 pts.) Draw the line structures of BF₃, N(CH₃)₃ and (CH₃)₂NCHO. All lone pairs and all non-zero formal charges must be shown on the atoms. Complete the structure on the right.

2. Consider your structures above.
   a. (6 pts.) How many pure p orbitals are there in BF₃ ______ ? How many pure p orbitals are there in N(CH₃)₃ ______ ? How many pure p orbitals are there in (CH₃)₂NCHO ______ ?
   b. (9 pts.) Briefly justify your answers above. Be careful with the first and last molecule above.

   ______________________________________________________________________________

   ______________________________________________________________________________

   ______________________________________________________________________________

3. (10 pts.) Which C-H bonds have greater dissociation energy, the ones in methane or the ones in methyl cation (ie. which bonds are more stable)? Provide a reason for your answer. Hint: you can figure this out by thinking about hybridization.

   ______________________________________________________________________________

   ______________________________________________________________________________

   ______________________________________________________________________________
4. (10 pts.) The enantiomers of the chiral drug, Thalidomide, have identical chemical properties; however, in the body they have drastically different effects. Can you briefly explain this? The words proteins, enantiomer and diastereomer must appear in your explanation. Write so we can easily read your answer!

____________________________________________________________________________

____________________________________________________________________________

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____________________________________________________________________________

5. (10 pts.) Draw the mirror image of the stereoisomer shown below of trans-1-methyl-3-isopropylcyclohexane.

6. (10 pts.) Put an * at the stereogenic carbon atoms in the structure above. Starting with the name given in problem 5, name the specific enantiomer shown above. Remember that more substituted carbon atoms have higher priority than less substituted carbon atoms.

____________________________________________________________________________

____________________________________________________________________________
7. (10 pts.) Draw a semi-quantitative energy diagram in which you rotate about the C3–isopropyl bond in \textit{trans}-1-methyl-3-isopropylocyclohexane. This bond is dashed and horizontal in the structure in problem 5. Each gauche C–C interaction is worth 0.9 kcal/mol. Each eclipsed C–C, C–H and H–H interactions are worth 3, 1.25 and 1 kcal/mol respectively. Choose a C-C-C-C dihedral angle and complete 360 degrees.

8. Consider the following E2 reaction.

\[
\begin{array}{c}
\text{Cl} \\
\text{ONa} \\
\text{(solvent)} \\
\end{array}
\]

a. (10 pts.) Above draw the most stable conformation of the reactant. You will need to use a chair cyclohexane structure and your answer will have to clearly show which groups are axial and equatorial.

b. (10 pts.) Above draw the predominant E2 product; there is only one for full credit.
9. (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 addition of R₂BH across a double bond.

10. (10 pts.) Predict the product.

```
Problem 10

1) (CH₃CH₂)₂BH
   Ether (solvent)
2) H₂O₂, NaOH(aq)
```
11. (10 pts.) Predict the product of the following Diels–Alder reaction. There is stereochemistry and regiochemistry to worry about for full credit. Check your work; count your atoms.

Problem 11

12. (10 pts.) Below, draw the $\pi$-system HOMO and the $\pi$-system LUMO of a Diels–Alder reaction. Use the bare bones, simplest, Diels–Alder reaction with no substituents. Label these two molecular orbitals so I know which is which.