**Final Exam--Short Answer Portion**

The following part of the test is short answer and worth 136 points, for a total of 200 points. Please provide detailed and complete answers. Partial credit is available, so it is to your advantage to write your thoughts and ideas, even if you don’t know how to solve the problem completely. Show all of your calculations in order to receive full credit.

1. a. (15 points) Show all of the steps in the mechanism for this reaction. Indicate electron flow in each step by drawing arrows and make sure to calculate formal charges and draw relevant resonance structures of any intermediates.

![Chemical Reaction Diagram]

b. (5 points) What substitution product(s) will also be formed in this reaction?

c. (8 points) Estimate the $\Delta H^\circ$ for the above reaction using bond dissociation energy data inserted in the exam

2. The following reaction will NOT proceed as indicated.

![Chemical Reaction Diagram]

a. (3 points) Provide an acceptable IUPAC name for the organic product.

b. (5 points) Explain why the reaction is not favored as written.

c. (10 points) Provide an alternative synthesis that will yield the desired ether, starting with an alcohol and an alkyl halide of your choice.
3. **(25 points)** Indicate the reagents (write them in over the arrows) that can be used to accomplish the following series of transformations, which ultimately provide the 2-cyanocyclohexanone product from cyclohexane. More than one step may be necessary for a given transformation.

4. **(30 points)** Complete the following reactions by drawing the structures of the product(s). Make sure to consider regio- and stereo-chemistry, and indicate stereochemistry in your products using wedge/dash notation. **Notice that the last reaction sequence has two separate steps.**
5. Two stereoisomers of a chloro-substituted cyclohexane derivative are drawn below (A & B). These two stereoisomers will eliminate in alcohol with heat to produce the same alkene (C).

a. (4 points) Are either A or B chiral? Explain.

b. (10 points) Draw the compounds A and B in their most stable chair conformations.

c. (8 points) Calculate the strain energy of the most stable chair conformations of A and B, using data from Table 2.4, appended to your test.

d. (5 points) A reaction coordinate diagram that corresponds to the elimination reaction from compound A to form C is drawn below. Sketch the reaction coordinate diagram for the elimination from B to form C directly on top of the reaction coordinate diagram for compound A.

[Reaction Coordinate Diagram]

E

Reaction Coordinate

e. (8 points) Indicate the activation energy of the rate limiting step for the elimination reactions from A and B on the diagram above, and label them $E_a(A)$ and $E_a(B)$. Predict which compound will react more quickly in this elimination reaction, A or B. Explain.