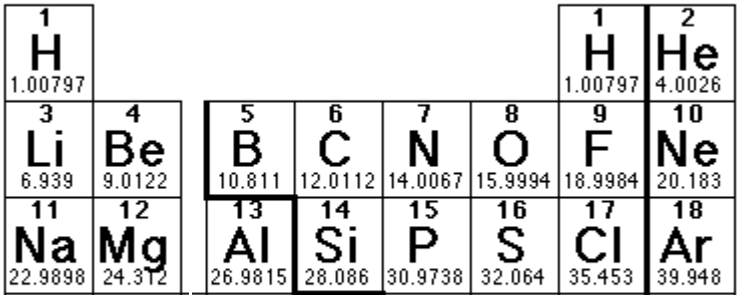
Name_____ SISD_____

Chemistry 350
Exam 1 - February 27, 2008

Put your name and SISD number on **EVERY PAGE** of the exam.
Write all answers on the exam.
There are several blank pages at the end of the exam for you to use as scratch paper.



1. (15 points)_____

2. (15 points)_____

3. (22 points)_____

4. (20 points)_____

5. (10 points)_____

6. (10 points)_____

7. (8 points)_____

Total (100 points)_____

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Table 4.2

Energy differences ($\Delta G°$) for equilibration of monosubstituted cyclohexanes, $C_6H_{11}X$.

Substituent, X	*$\Delta G°$ (equatorial − axial) (kcal/mol)*
—H	0.0
—F	−0.2
—CN	−0.2
—Cl	−0.5
—Br	−0.5
—C≡CH	−0.5
—OCH_2	−0.6
—OH	−1.0
—COOH	−1.4
—CH_3	−1.7
—$CH{=}CH_2$	−1.7
—CH_2CH_3	−1.8
—$CH(CH_3)_2$	−2.1
—C_6H_5	−2.9
—$C(CH_3)_3$	−5.4

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Problem 1. (15 points)

(i) Provide structures of all isomers that have the formula $\mathbf{C_3H_6O}$. For each isomer, all atoms must have complete octets and zero formal charge. There may be more or fewer boxes than isomers.

(ii) List the names of the functional groups found in your drawings (list each functional group only once, no matter how often it appears):

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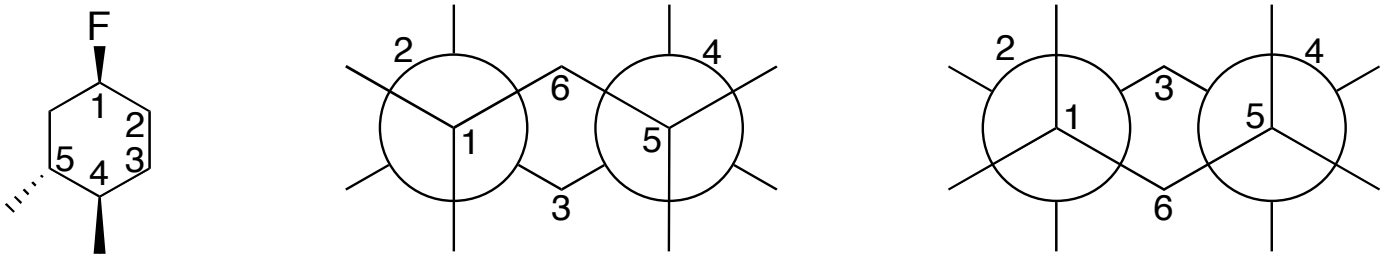
Problem 2. (15 points) For each molecule (parts A - C):

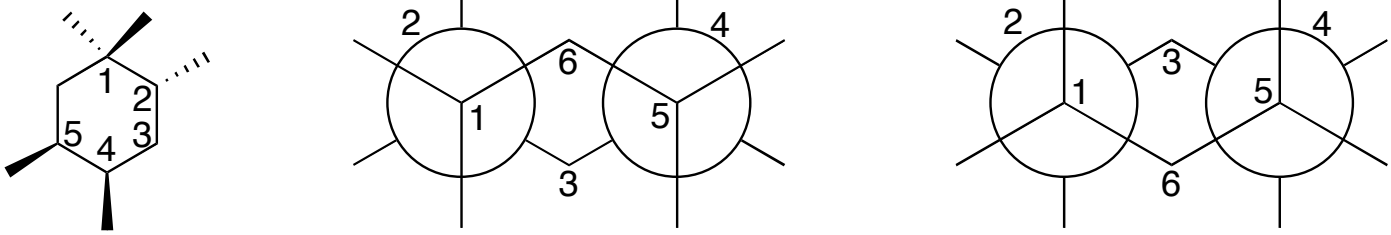
(i) **Fill in the substituents on the Newman projections** for the two possible cyclohexane chair conformations, including hydrogen atoms.
(ii) Circle the conformer that is **Lower** in energy (more stable).

Use the templates provided to draw the Newman projections. The molecules and the templates are numbered. Make sure to fill in the Newman projections using the numbering scheme that matches the given structure. You do not need to fill in the hydrogen atoms on C3 and C6.

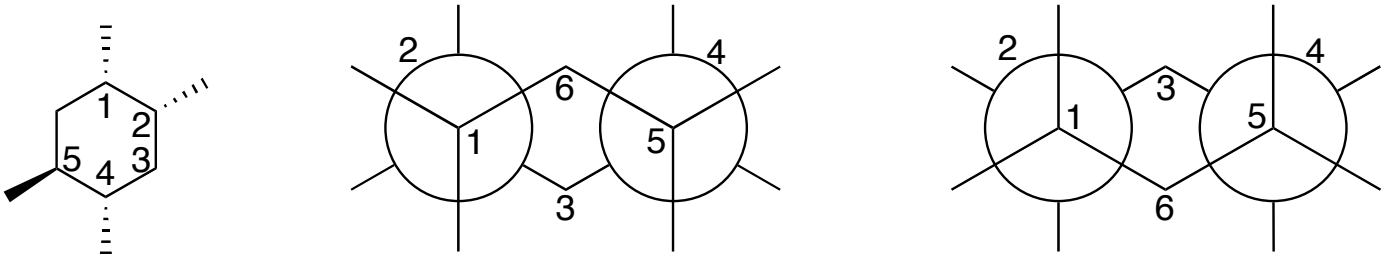
A) (5 points)



B) (5 points)



C) (5 points)



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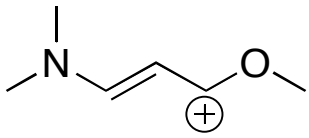
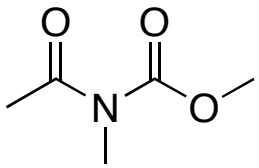
Problem 3 (22 points) In parts A - C, **draw all lone pairs and all formal charges.**

A) (6 points) Draw all resonance structures for the molecule shown below that have **full octets** on all atoms other than hydrogen. **Draw in arrows** to show how the electrons move to get from one resonance structure to the next. On the original structure that we provide, **indicate the correct hybridization** (sp^3, sp^2, or sp) of all carbon atoms. **Circle the structure** that is **lowest** in energy (most stable).



B) (8 points) Draw all resonance structures for the molecule shown below that have **full octets** on all atoms other than hydrogen. **Draw in arrows** to show how the electrons move to get from one resonance structure to the next. On the original structure that we provide, **indicate the correct hybridization** (sp^3, sp^2, or sp) of all carbon atoms. **Put a square around the structure** that is **highest** in energy (least stable).



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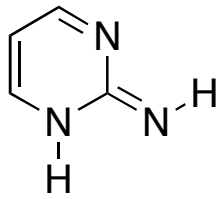
C) (8 points) Draw all resonance structures for the molecule shown below that have **full octets** on all atoms other than hydrogen. **Draw in arrows** to show how the electrons move to get from one resonance structure to the next. On the original structure that we provide, indicate for each nonbonding electron pair if it is in the plane of the paper (x,y plane) or perpendicular to the plane (z axis). **Put a square around the structure** that is **highest** in energy (least stable).



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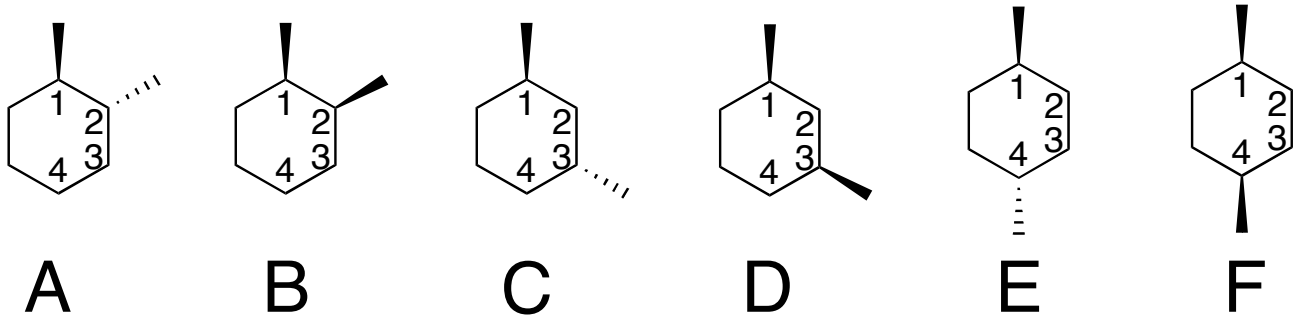
Problem 4. (20 points)

Shown below are six different isomers of dimethylcyclohexane; each isomer has been assigned a letter.



For each of the six isomers, a pair of cyclohexane templates are provided, along with the corresponding energies of the two chair conformations. Your job is to use the energies of these chair conformations to assign the correct isomer (as identified by its letter) to the correct pair of templates.

Once you have assigned an isomer, fill in the two cyclohexane chair templates so that they match the energies that are provided. For some isomers the two chair conformations have the same energies. In these cases it does not matter which template you use for the two conformations. The information below will help you with these assignments.

Me/Me gauche interaction = 0.9 kcal/mol
ΔG for interconversion of methylcyclohexane chair conformations (equitorial to axial) = 1.7 kcal/mol

When you fill in the chair templates you must draw, unambiguously, the methyl groups in the proper equatorial or axial positions. The molecules and the chair templates are numbered. Make sure to draw the chair conformations using the numbering scheme that matches the given structure.

The first isomer has been assigned for you to provide an example of how you should answer this problem. You can only use each isomer once, so don't use isomer **F** for any of your answers.

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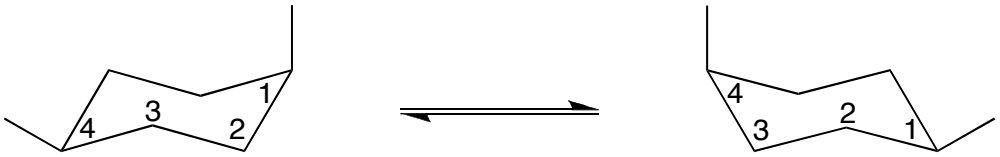
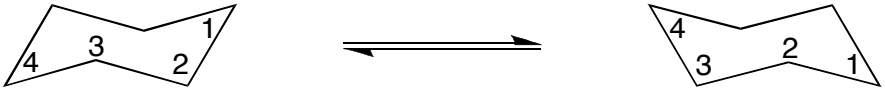
F
isomer letter



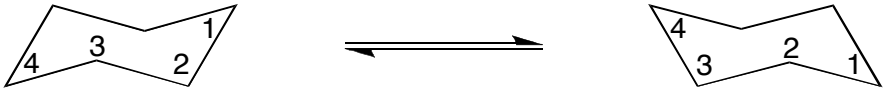
1.7 kcal/mol 1.7 kcal/mol

isomer letter



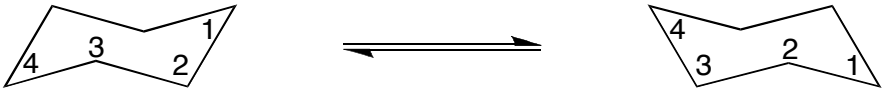
0.0 kcal/mol 3.4 kcal/mol

isomer letter



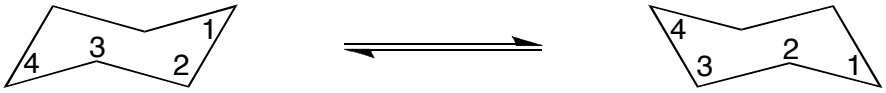
2.6 kcal/mol 2.6 kcal/mol

isomer letter



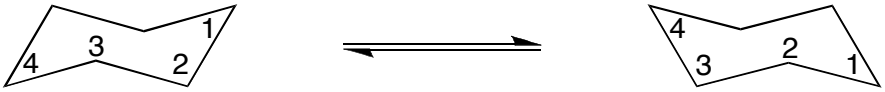
1.7 kcal/mol 1.7 kcal/mol

isomer letter



0.0 kcal/mol >3.4 kcal/mol

isomer letter



0.9 kcal/mol 3.4 kcal/mol

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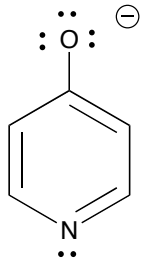
Problem 5. (10 points)

A) (8 points) Draw all important contributing resonance structures for



B) (2 points) Circle the structure or structures that are **Lowest** in energy (including the original structure that is provided).

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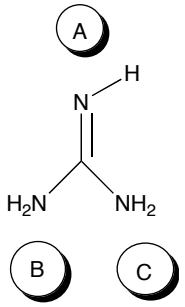
Problem 6. (10 points)



A) (3 points) Add a H^+ to nitrogen **A** (making it a NH_2^+ group) and draw all contributing resonance structures, if any.

B) (3 points) Add a H^+ to nitrogen **B** (making it a NH_3^+ group) and draw all contributing resonance structures, if any.

C) (4 points) Which structure is lower in energy, the one formed in part A or part B? Briefly explain your answer.

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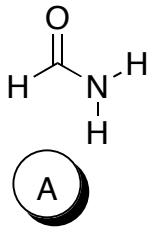
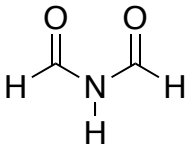
Problem 7 (8 points)

Which compound, A or B would you expect to have a **Shorter** C=O bond? Explain your answer, using diagrams if possible and 40 words or less.



A



B

Name_____ SISD_____

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