Please legibly write answers in the blue booklet. Answers are due next week.

1. (5) Using resonance form(s) to aid your explanation, state why the following compound has such a low barrier to rotation about the carbon–carbon double bond (the barrier being less than 20 kcal/mol):

![Resonance Form](image)

2. (6) The following nitrogen-containing monosaccharides inhibit an enzyme needed for tuberculosis bacterium survival:

![Monosaccharides](image)

(a) Assign R or S configuration to each chirality center.
(b) What is the stereochemical relationship between the two isomeric compounds?

3. (5) A drug called Vioxx has been in the news recently.

(a) Look up the structure of this compound and draw it in the major contributing Lewis form.
(b) Does Vioxx contain any chirality center(s)?

4. (6) Cis-decalin is about 2.8 kcal/mol less stable than trans-decalin. Clearly indicate why this is so using an argument based upon gauche-butane interactions. Note the following figure represents a change in configuration, not conformation.
5. The following enantioselective transformation based on an enzyme-catalyzed reaction was able to differentiate between enantiotopic hydroxymethyl groups:

\[
\begin{align*}
\text{CH}_2\text{OH} & \quad \text{CH}_2\text{OH} \\
\text{cis} & \quad \text{trans}
\end{align*}
\]

\[\Delta H^\circ \sim -2.8 \text{ kcal/mol}\]

(a) Was the pro-\(R\) or pro-\(S\) hydroxymethyl group oxidized? Show your work.
(b) What percentage of the minor enantiomer formed?

6. (a) What is the point group for the half-chair conformer of cyclohexane?
(b) What is the point group for the twist boat conformer of cyclohexane?

Show your work! Hint: both are chiral!

7. Using the data incorporated into Figure 3.5 (p. 128) and assuming the additivity of gauche and eclipsing interactions of similar type, sketch the rotational energy profile you would expect for 2,3-dimethylbutane (for rotation about the C2–C3 bond).

8. (a) From problem 4 of the in-class exam you should have estimated a 1,3-diaxial interaction between two methyl groups to be \(\sim 3.7 \text{ kcal/mol}\). With this value, estimate the difference in energy between the two chair conformers of the “all-cis” 1,3,5-trimethylcyclohexane:
(b) Using your answer from part a (assuming it approximates \( \Delta G \) at room temp), calculate the percentage of the all-equatorial form of \( cis-1,3,5 \)-trimethylcyclohexane at room temperature.