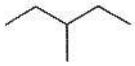
1. The following questions are about the 5 constitutional isomers of C_6H_{14} (14 pts).

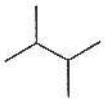
Provide an acceptable IUPAC name for this molecule:

hexane

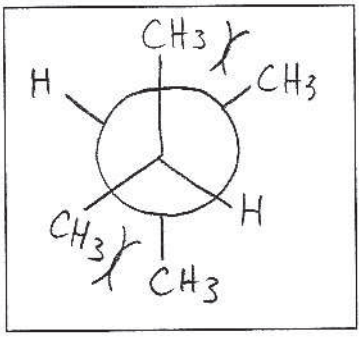


Does this molecule have a higher or lower heat of combustion than the molecule directly above it? Circle your answer.

Higher **Lower** (more branching)



Draw the Newman projection for the most stable conformation of this molecule looking down the C2-C3 bond:



How many gauche butane interactions are there in this conformation?

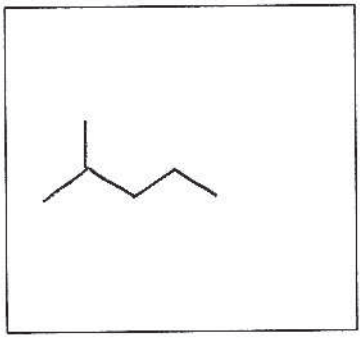
Zero **One** **Two** **Three**

Provide an acceptable IUPAC name for this molecule:

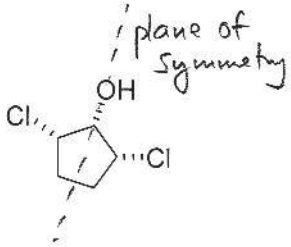
2,2-dimethylbutane

What is the missing C_6H_{14} constitutional isomer? Draw it in the box to the right, and provide an acceptable IUPAC name for it:

2-methylpentane



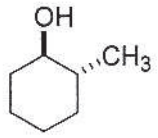
2a. Label each of the following compounds as chiral, achiral, or achiral and meso by circling the correct word under the compound (12 pts).



Chiral

Achiral

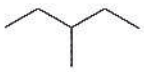
Achiral, meso



Chiral

Achiral

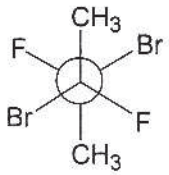
Achiral, meso



Chiral

Achiral

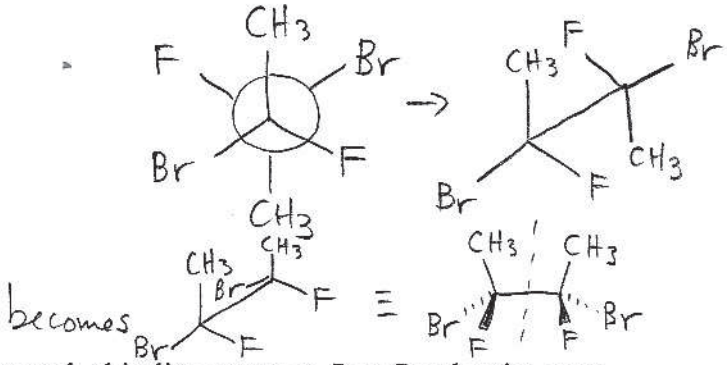
Achiral, meso



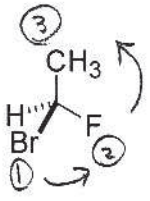
Chiral

Achiral

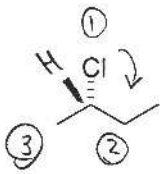
Achiral, meso



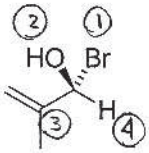
2b. Assign the absolute configuration at each chirality center as *R* or *S* and write your assignment in the box under each compound (12 pts).



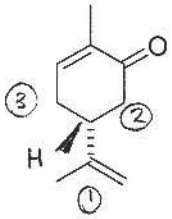
S



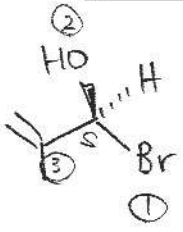
S



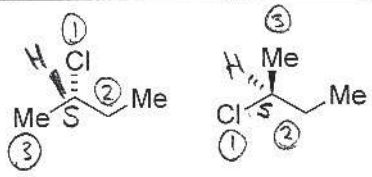
R



R



3a) For each of the following pairs of molecules, state whether they are enantiomers, diastereomers, constitutional isomers, or identical by circling the correct word (12 pts).

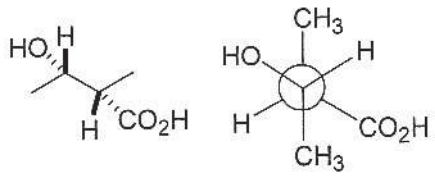


Enantiomers

Diastereomers

Constitutional isomers

Identical



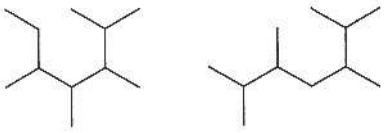
Enantiomers

Diastereomers

Constitutional isomers

Identical

See below

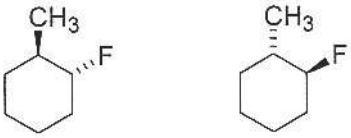


Enantiomers

Diastereomers

Constitutional isomers

Identical

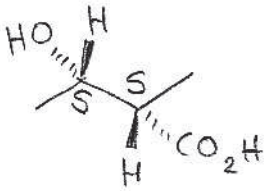


Enantiomers

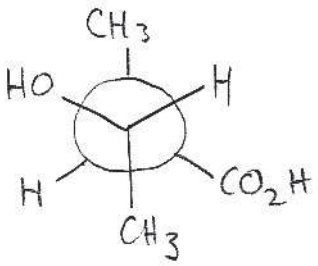
Diastereomers

Constitutional isomers

Identical



left molecule



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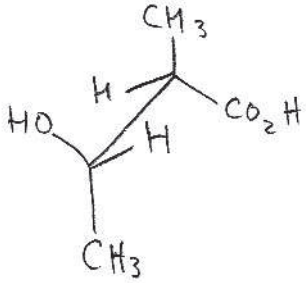

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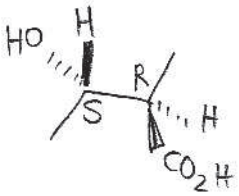
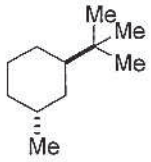
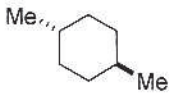


4a. Draw the most stable chair conformation of each of the molecules shown. Draw your chair structures neatly and following the guidelines in class and text. Draw every hydrogen on the cyclohexane ring. You do not have to draw the hydrogens on the methyl groups (10 pts).

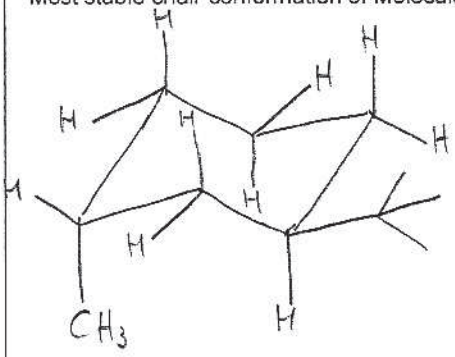


Molecule "A"

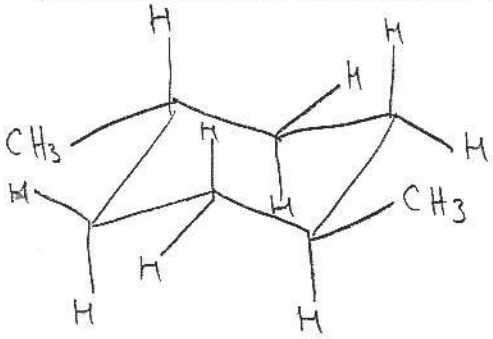


Molecule "B"

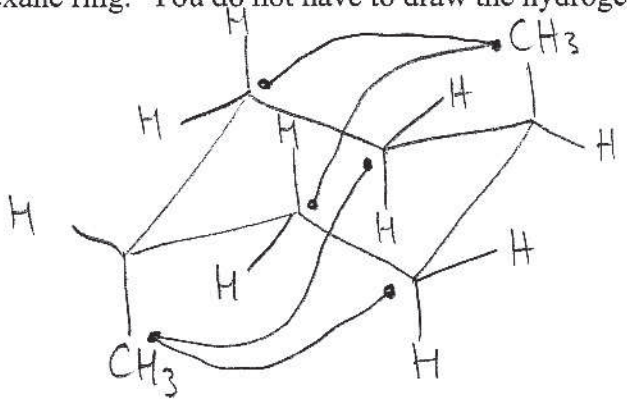
Most stable chair conformation of Molecule "A":



Most stable chair conformation of Molecule "B":



4b. Draw the *least stable chair conformation* for Molecule "B". Draw your chair neatly and following the guidelines in class and text. Draw every hydrogen on the cyclohexane ring. You do not have to draw the hydrogens on the methyl groups (5 pts).



4 gauche butane interactions

4c. In your drawing for the least stable conformation of Molecule "B", identify every interaction that raises its energy relative to the more stable conformation (5 pts).

5. Ethane has two major conformations: staggered and eclipsed. The eclipsed conformation is destabilized by torsional strain, while the staggered conformation is stabilized by hyperconjugation. Van der Waals strain is not a component of the overall strain in ethane.

Write **one sentence definitions** for each of the following terms. Yes, I really mean **one sentence only.**

5a. Strain (3 pts)

Difference between the measured (experimental) $\Delta H^\circ_{combustion}$ and the calculated $\Delta H^\circ_{combustion}$ for a hypothetical, strain-free molecule

5b. Torsional strain (3 pts)

Destabilization that occurs when bonding e^- approach each other too closely

5c. van der Waals strain (3 pts)

Destabilization resulting when non-bonded atoms approach too closely

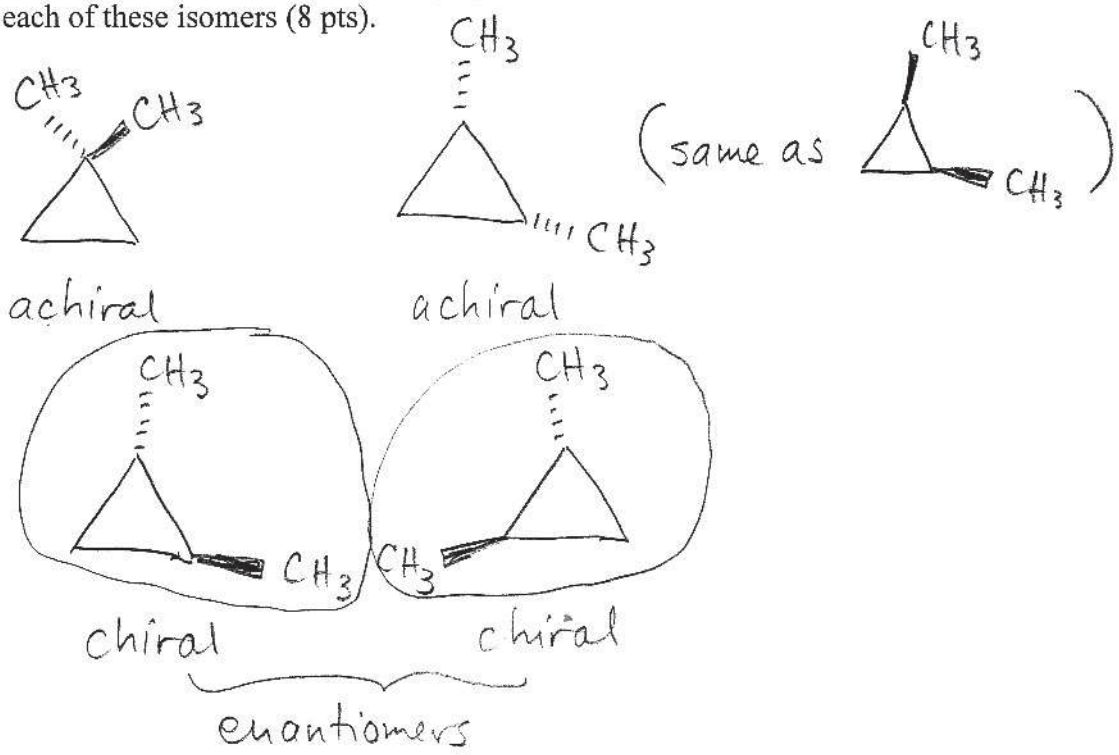
5c. Hyperconjugation (3 pts)

Mixing (overlap) of filled and empty orbitals, resulting in stabilization but not bonding

5d. The staggered conformation of ethane is stabilized by hyperconjugation. Which orbitals are involved? You don't have to draw a picture, just list the orbitals (2 pts).

C-H σ and C-H σ^*

6a) There are four dimethylcyclopropane isomers. Draw wedge-and-dash formulas for each of these isomers (8 pts).



6b) Circle any and all chiral isomers you drew in 6a. (4 pts)

6c) Gas chromatography (GC) is an analytical method that separates compounds from each other based on their boiling points. When a mixture is analyzed by GC, each component with a unique boiling point generates one signal in the GC detector. If you used GC to analyze a mixture that contained 1 mol each of the four dimethylcyclopropane isomers, what is the maximum number of signals you would see? Circle the correct answer. (2 pts)

Zero **One** **Two** **Three** **Four**

The two enantiomers have the same boiling point

6d) How many of these peaks would represent optically active material? Circle the correct answer. (2 pts)

Zero **One** **Two** **Three** **Four**

The two achiral molecules (see 6a) are optically inactive. The 2 enantiomers are in equimolar amounts and therefore constitute a racemic mixture, which is optically inactive.