Chem 51A Midterm Exam
100 points; 50 minutes
November 2, 2009

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**Academic Honesty Policy.** Academic honesty is strictly enforced on quizzes, exams, and other aspects of this course. Academic dishonesty will result in a failing grade in the class and a letter in the student's file. Activities constituting academic dishonesty include:

**Cheating**
- Copying from others during an examination.
- Communicating exam answers with other students during an examination.
- Offering another person's work as one's own.
- Taking an examination for another student or having someone take an examination for oneself.
- Tampering with an examination after it has been corrected, then returning it for more credit.
- Using unauthorized materials, prepared answers, written notes, or concealed information during an examination.

**Dishonest Conduct**
- Stealing or attempting to steal an examination or answer key from the instructor.
- Allowing another student to copy off of one's own work during a test.

**Collusion**
- Any student who knowingly or intentionally helps another student perform any of the above acts is subject to discipline for academic dishonesty.

I understand and will abide by this academic honesty policy: __________________________ (signature)

Seat: _______
1. Heptane has nine (9) constitutional isomers (15 points)

a. Write the skeletal structure of the constitutional isomer that has the highest boiling point:

b. Write the skeletal structure of the constitutional isomer with no secondary (2°) carbon atoms:

c. Name the constitutional isomer with threefold symmetry: __________________________
   (Hint, ammonia, NH₃, is an example of a molecule with threefold symmetry.)

Hint: A good strategy for solving parts a-c of this problem is to write the structures of all nine isomers. Feel free to do so in the space below. No credit or penalties will be given for these drawings.

2. Acids or bases can increase the solubility of some organic molecules in water by protonating basic functional groups to give cations or deprotonating acidic functional groups to give anions. (15 points)

From structures A-E above, identify:

a. The two compounds that are soluble in pure water: _____ & _____

b. The one compound that is not soluble in pure water, but is soluble in aqueous HCl: _____

d. The one compound that is not soluble in pure water, but is soluble in aqueous NaOH: _____

e. The one compound that is not soluble in water under any conditions: _____
3. A decalin is a molecule that contains two adjacent (fused) cyclohexane rings. Consider the decalin shown below. (16 points)

Build a model of this molecule with your Darling (Molecular Visions) molecular models. Make sure that the cyclohexane rings are in the most stable conformations.

a. What is the distance in centimeters between the centers of the methyl and hydroxy groups? _______ cm

b. What is the distance in centimeters between the centers of the methyl group and the hydrogen indicated by the arrow? _______ cm

c. The conformation of decalin can be represented as two adjacent chair drawings. Complete the drawing below by adding the methyl group, the hydroxy group, and all of the hydrogens shown on the drawing above.

4. Newman projections are not limited to acyclic alkanes. For example, the chair conformation of cyclohexane can be drawn as two side-by-side Newman projections, by looking down the bonds indicated by arrows, as shown below. (12 points).

a. Based on the above example, convert the following Newman projection to a chair structure. Make sure that your drawing of the chair structure clearly shows whether substituents are axial or equatorial.

b. Draw a skeletal structure. Make sure that the skeletal structure clearly shows whether the substituents point above and below the ring. (Hint: If you are having trouble, build a model.)
5. Meldrum's acid was discovered in 1908 and was thought to contain a carboxylic acid group. The true structure was later determined to be that shown below. (18 points)

![Meldrum's acid structure]

Meldrum's acid $pK_a = 5$

a. Draw the three most important resonance structures of the conjugate base of Meldrum's acid. Make sure to show all charges and lone pairs of electrons:

b. Complete the acid-base equilibrium equation for the reaction of Meldrum's acid with sodium acetate.

\[
\text{Meldrum's acid} + \text{Na}^+ - \text{O}^+ \rightarrow \text{Meldrum's base} + \text{Na}^+ - \text{O}^- \]

c. Does the equilibrium lie far to the left, far to the right, or just about in the middle? _______________________

Explain. ____________________________________________________________________________________
___________________________________________________________________________________________
6. Write the letter corresponding to the term that describes each pair of molecules on the line next to the pair of molecules. Choose from among the following terms. (12 points)

A. Constitutional isomers.
B. Different conformers of the same molecule.
C. Identical molecules in identical conformations.
D. None of the above.

(Hint: If you are having trouble, build models.)

```
H3C   Br
H     H3C   Br
H     CH3
H     CH3

letter: _____
```

```
H3C   Cl
H     H3C   Cl
H     Cl
H     Br

letter: _____
```

```
HO   Br
CH3
HO   Br
CH3

letter: _____
```

```
Br~CH2CH3 and Br~CH2CH3

letter: _____
```

7. Consider the acid-base reaction below. (12 points)

a. Assign formal charges to the products.

b. Draw curved arrows to indicate the flow of electrons.

c. Draw a second major resonance structure for the product. Make sure to show all charges and lone pairs of electrons. (Note: there are several possible additional resonance structures, but only one is a major contributor.)

```
N  N  Cl
CH3  H

N  N  +  H-Cl
CH3

:Cl  +  :Cl

N  N  H
CH3
```

PLEASE REVIEW THE ACADEMIC HONESTY STATEMENT ON PAGE 1 AND SIGN IT IF YOU ARE ABLE