Chem 225b - Comprehensive Organic Chemistry

Problem Set 2

Chapter 3, Alkanes

Due: Monday, February 4, 2008

The Baeyer Laboratory, Munich, 1893

(This photograph is in the hallway across from 110 SCL)

- Adolf von Baeyer (1835-1917); Nobel Prize 1905. (center, seated with derby), who was a student of Kekulé, succeeded Liebig at Munich. In the photograph (second row; third from right) is Henry Lord Wheeler (1867-1914); Yale Faculty 1896-1911. As was the custom in the 19th century, many Americans, such as Wheeler, would do advanced study in chemistry in Europe. Karl is the laboratory assistant. (The only person wearing an apron and no tie; upper left.)

  In 1885, as an addendum to a paper on acetylenic compounds, Baeyer proposed that cyclopentane was the least strained of the cycloalkanes. While he accepted the idea that the carbon atoms in cycloalkanes were tetrahedral, he treated the cycloalkanes as though they were flat. He argued that there is only one cyclohexane carboxylic acid, not two (axial and equatorial) as was predicted by a chair cyclohexane.

- Equatorial is frequently misspelled.

- A Projection of Melvin Newman (Son of Yale: 1929, BS; 1932, PhD)

Reading and Enrichment Assignments:

a. Work through How to Draw Cyclohexanes (PowerPoint)

b. The Conformation Module in the Study Aids will give you a good overview of the subject of conformation.

c. View The Evolution of Formulas and Structure in Organic Chemistry During the 19th Century (PowerPoint).

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1. Redraw (line angle formula) and name (IUPAC) the hydrocarbon in this problem. For a dynamic view click here. For a static view click here. How to manipulate Jmol structures. [What if there are two different longest chains? Check here.]

2. Compound **A** (MW=142.19), a 1,4-disubstituted cyclohexane, has the following composition: C, 67.57%; H, 9.92%. The difference in conformational energy for the two chair conformations of **A** is

0.4 kcal/mol. Using the data in Table 3-6, page 113 (Energy Differences Between ..... Cyclohexanes), determine the structure of **A**. Illustrate and explain. What is the conformational energy difference for the stereoisomer of **A**, ---namely **A'**. Explain and illustrate. Show the chair comformations of **A** and **A'** with the appropriate equilibrium arrows to illustrate the major and minor conformations. Label each conformation with its energy.

3. Predict the heat of formation of n-decane using the data present here. Explain.

4. Using the heats of formation tables, explain the difference in the heats of formation of cis- and trans-1,4-dimethylcyclohexane. What are the heats of combustion of these stereoisomers? Show work. Draw a diagram of the heats of formation and combustion for these stereoisomers relative to the standard state. Put your values on the chart.

5. Compare the reported molar heat of combustion of cyclopentane reported in Table 3-5 with that calculated using the data (ΔH_f^o of cyclopentane, CO_2 and H_2O) present in the heats of formation tables.

6. Draw Newman projections for the eclipsed and staggered conformations of 2-methylbutane viewed along the C_2-C_3 axis. Calculate the energy of each conformation, both staggered and eclipsed.

7. Check out the structure of limonene on Wikipedia (don't worry about the issue of (+)-limonene or (*R*)-enantiomer.) While the 2-D structure is truthful, the 3-D version contains only "truthiness". What would be a better presentation? Your 2-D version of your 3-D revision must be able to be superimposed on the original 2-D version of limonene.

2.