EXAM 1

CHEMISTRY 220

Friday, September 24, 2010

NAME (print): ____

TA:________________ Sect. Day:________________ Sect. Time:____________

Take a few moments to look over the exam. Answer each question on the exam paper.

No calculators or electronic devices. You may use molecular models. Important clues and structures are in **bold**. There is a **Periodic Table** on page 7.

Do all **preliminary** drawing or computations on the work sheets at the end of the exam. The work sheets will not be graded. You may detach the work sheets from the exam.

The exam is 55 minutes.

STOP writing and hand in your exam when you are asked to do so.

REMEMBER: Neatness is to your advantage.

1. (20 pts) Conformation I ______

2. (20 pts) Conformation II ______

3. (25 pts.) Potpourri ______

4. (20 pts) Thermochemistry ______

5. (15 pts) Bonding/Orbitals ______

____

Total (100 pts)

Name:________________________________

1. **Conformation I:** (20 pts) For the eclipsed and staggered conformations of 2,2-dimethybutane viewed along the C_2-C_3 sigma bond, **draw a Newman projection** of the **most** stable eclipsed and staggered conformations. Place the energies for each interaction in the Newman projections below. [Use the **circles** as templates for the Newman projections.] Calculate the total energy (kcal/mol) of both conformations. Place your answer in the appropriate **box**. [H/H, eclipsed, 1.0 kcal/mol; CH_3/H eclipsed, 1.3 kcal/mol; CH_3/CH_3, eclipsed, 3.0 kcal/mol; CH_3/CH_3, gauche, 0.9 kcal/mol.] **Show your work!**

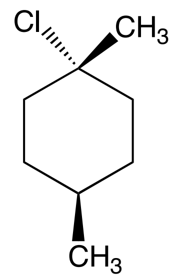
Staggered

Energy → [ ]

Eclipsed

Energy → [ ]

2. **Conformation II:** (20 pts) Consider the stereoisomer of 1-chloro-1,4-dimethylcyclohexane (**1**) shown here.



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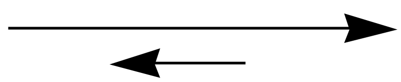
a) (10 pts) **Draw** the chair conformations below so that the equilibrium arrows are correct. Be sure all groups are **clearly** labeled axial or equatorial.



chair A chair B

b) (10 pts) What is the value of $\Delta(\Delta G^{o})$ for the above equilibrium given the following A-values for the monosubstituted (X) cyclohexane: X = Cl = 0.5 kcal/mol; X = CH_3 = 1.8 kcal/mol; X = C_2H_5 = 1.9 kcal/mol? **Show calculations**.

Chair A energy = ___________ Chair B energy= ___________

3. **Potpourri**: (25 pts.; equal weight) **Circle** the best answer(s) where applicable in each of the following:

a) **Estimate** the difference in the heat of combustion and heat of formation in kcal/mol for *cis*- and *trans*-1,4-dimethylcyclohexane. **Explain briefly.**

b) **Circle** the "acids" that are readily deprotonated by n-butyllithium (n-$CH_3CH_2CH_2CH_2Li$).

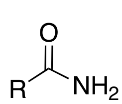
ethanol CH_3CO_2H NH_3 NH_4^+ acetylene

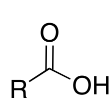
c) **Circle** the species with sp^2 hybrid **atoms.**

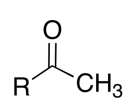
HCN ethylene CO_2 $CH_2{=}C{=}CH_2$ $[BeCl_3]^{-1}$

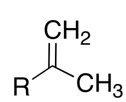
d) **Briefly** explain and illustrate why $ClCH_2CH_2Cl$ has a net dipole while *trans*-ClCH=CHCl does not. [Newman projections of the most stable conformations of 1,2-dichloroethane might be helpful.]

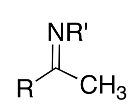
e) The following "acids" all have resonance stabilized conjugate bases. Rank these acids (low pKa to high pKa) with the numbers 1 – 5, respectively. [Most acidic gets number 1.]











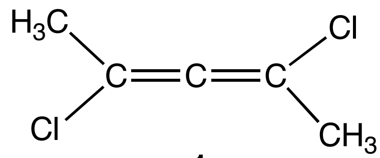
4. **Thermochemistry:** (20 pts.) n-Heptane (ΔH_f^o = -44.8 kcal/mol) and 2-methylhexane (ΔH_f^o = --46.6 kcal/mol) both have the formula C_7H_{16}.

a) (5 pts.) What type of isomers are they?

b) (5 pts.) What is the difference in their heats of combustion?

c) (10 pts.) Prove part b) with a “Standard State” illustration of the combustion of the two isomers. [Your diagram should show the products of combustion and the number of moles of each.] Write an equation for the heat of combustion of n-heptane using its heat of formation.

5. **Bonding/Orbitals:** (15 pts) The "planar" compound **1** has a dipole moment. **Explai**n and **illustrate** with an orbital diagram how this is possible.



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Periodic Table

Name:______________________________________

Work Sheet

Name:______________________________________

Work Sheet

Name:____

Work Sheet