EXAM 1

CHEMISTRY 220a

Friday, September 25, 2009

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. You may use molecular models. Important clues and structures are in **bold**.

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

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. (25 pts) Potpourri _____

3. (20 pts) Thermochemistry _____

4. (15 pts) Bonding/Orbitals _____

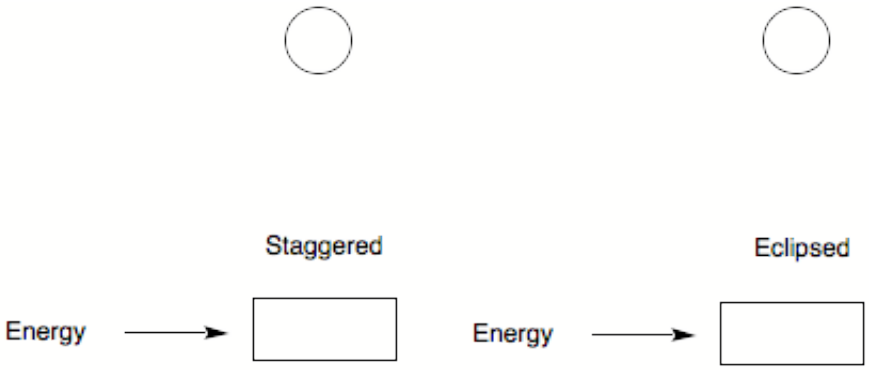
5. (20 pts) Conformation II _____

_____

Total (100 pts)

1. **Conformation I:** (20 pts) For the eclipsed and staggered conformations of 2,3-dimethybutane

viewed along the C2-C3 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; CH3/H eclipsed, 1.3 kcal/mol; CH3/CH3, eclipsed, 3.0 kcal/mol; CH3/CH3, gauche, 0.9 kcal/mol.] **Show your work!**



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

a) The heat of formation (DH_f^o) of 2-methylpentane is -41.7 kcal/mole. Estimate the heat of formation of 2-methylhexane. **Explain briefly.**

b) **Circle** the compound C_8H_{18} that is expected to have the **fewest** number of degrees between its melting and boiling points. [Remember shapes of molecules.]

n-octane 2,2,3,3-tetramethylbutane 2,2-dimethylhexane

2,3-dimethylhexane 2,3,4-trimethylpentane

c) **Circle** the "acids" that are readily deprotonated by potassium hydroxide (KOH).

n-octane CH_3CO_2H NH_3 NH_4^+ acetylene

d) **Circle** the species with sp hybrided atoms

HCN ethylene CS_2 $CH_2=C=CH_2$ $BeCl_2$

e) **Briefly** explain and illustrate why $BrCH_2CH_2Br$ has a net dipole while trans-BrCH=CHBr does not. [Newman projections of the most stable conformations of 1,2-dibromoethane might help.]

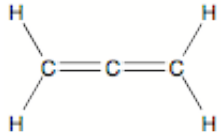
3. **Thermochemistry:** (20 pts.) n-Butane (DH_f^o = -30.0 kcal/mol) and 2-methylpropane (isobutane; DH_f^o = -32.1 kcal/mol) both have the formula C_4H_{10}.

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.]

4. **Bonding/Orbitals:** (15 pts) Allene **1** (1,2-propadiene) is often drawn as shown below. However, the picture is not an accurate representation of allene.



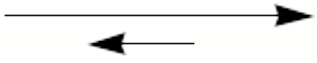
1

a) (10 pts) Use p-orbitals/p-bonds to draw a meaningful representation of allene.

b) (5 pts) Redraw allene in the same style as picture **1** but in a meaningful way.

5**. Conformation II:** (20 pts) Consider trans-1-chloro-3-ethylcyclohexane.

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



chair A chair B

b) (10 pts) What is the value of DGo for the above equilibrium given the following A- values for the monosubstituted (X) cyclohexane: X = Cl = 0.5 kcal/mol; X = C2H5 = 1.9 kcal/mol? **Show calculations**.

Chair A energy = _____

Chair B energy= _____

Work Sheet
Work Sheet

Work Sheet