EXAM 1

Organic Chemistry

Chemistry 220a

Friday, September 24, 1999

NAME (print): _____

TA:_____ Day:_____ Section Time:_____

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

Important points are in **bold**.

Do all **preliminary** drawing or computations on the **Work Sheets** at the end of the exam. **They will not be graded.**

A Periodic Table is at the end of the exam should you need it.

The exam is 55 minutes.

STOP writing when you are told to do so.

REMEMBER: Neatness is to your advantage.

1. (26 pts) _____

2. (24 pts) _____

3. (15 pts) _____

4. (20 pts) _____

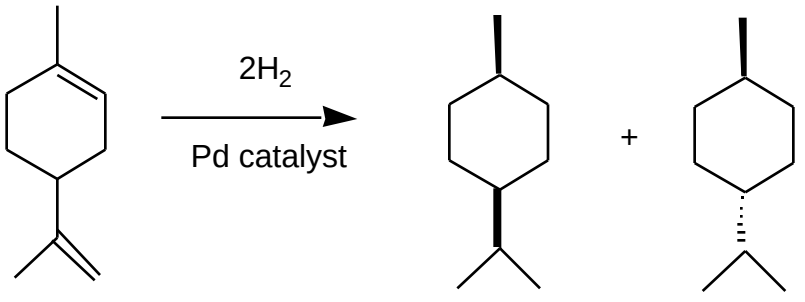
5. (15 pts) _____

_____

Total (100 pts)

The Tetrahedral Carbon
1874-1999

1) (26 pts) The terpene limonene ($C_{10}H_{16}$) **1**, a constituent of lemon grass, reacts with 2 equivalents of hydrogen in the presence of a catalyst to produce two compounds, **2** and **3**, both of which have the molecular formula $C_{10}H_{20}$.



1 **2** **3**

a) (2 pts) In a **single** word, what is the relationship between cycloalkanes **2** and **3**?

b) (12 pts) Draw a 3D view of each cycloalkane in its two chair conformations with the **more stable** and **less stable** conformations in their proper location. [Note the direction of the equilibrium arrows.]

2 --->

3 --->

Problem 1 is continued on the next page

c) (12 pts, equally weighted) One of the cycloalkanes has an energy difference (ΔG^o) of 0.4 kcal/mol between its chair conformations. Which cycloalkane is it?

i) Structure number goes here ---> _____ Is it cis or trans? _____

Given ΔG^o=1.7 kcal/mol for the difference in energy between the axial and equatorial chair conformations of methylcyclohexane, what is the value of ΔG^o for isopropylcyclohexane? **Show work**.

ii) Answer goes here -----> _____ kcal/mol

What is the difference in energy (ΔG^o) between the chair conformations of the **other** cycloalkane (not the one in 1ci above)? **Show work**.

iii) Answer goes here ---> _____ kcal/mol

2) (24 pts) To analyze the barrier of rotation about the C_2-C_3 bond of 2,3-dimethylbutane, there are three staggered conformations and three eclipsed conformations to consider. [Data: 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]

a) (12 pts) Draw a **Newman projection** of the **most stable** conformation and **determine** its energy. **Label** interactions with their appropriate values.

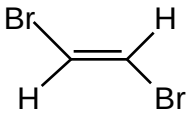
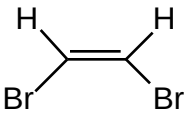
b) (12 pts) Draw a **3D (sawhorse)** structure of the **least stable** conformation and determine its energy. **Label** interactions with their appropriate values. [You may use "CH_3" as opposed to drawing the methyl groups. [You need only draw the bonds with their substituents emanating from C_2 and C_3.]

3) (15 pts) **Circle** the **best** answer(s) or follow specific instructions.

a) C-H bond length in an alkane

1.54 Å 154^{o} 1.1 cm 1.1 Å 109^{o} 28'

b) Compounds with a net dipole moment

$CH_3CH_2CH_3$   $BrCH_2CH_2Br$ $HCCl_3$

c) Number the following acids in order of **increasing pKa** value (lowest = 1, highest = 5).

HBr ammonia acetic acid cyclopentane methanol

d) This year, 1999, is the 125th anniversary of the tetrahedral carbon concept proposed by

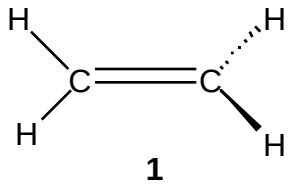
Kekule van't Hoff Liebig Baeyer Berzelius

e) Which of the following term(s) applies to cyclopropane?

CH bond eclipsing flagpole interaction angle strain

gauche interactions resonance

4) (20 pts) Structure **1** is a poor rendering of ethylene (ethene).



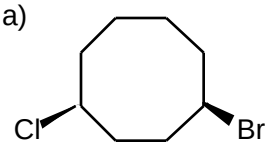
1

a) (5 pts) What is wrong with structure **1** as it is drawn?

b) (15 pts) Use molecular orbitals to provide a proper representation of ethylene. **Include** and **label** orbitals, bond angles (approximate) and types of bonds.

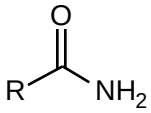
5) (15 pts, equal weight) Complete the following:

a)



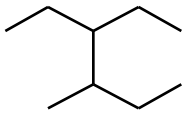
name me

b)



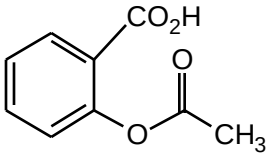
functional group

c)



name me

d)



common name
PS1 and somewhere else

e) Name the two functional groups in (d) other than the aromatic (benzene) ring.

Work Sheets --- They will not be graded

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Periodic Table