

Chemistry 210 -- EXAM 1 (Fall 2003 - Dr. Robertson)

***** BEFORE BEGINNING EXAM, PLEASE READ THE FOLLOWING *****

The exam consists of this cover sheet and fourteen problems, worth the amounts indicated. The extra credit problem shown on the cover sheet is optional. The time limit for this exam is *2 hours* (if more time is needed, you will be moved to the lab).

Please read each of the problems carefully so that you understand the entire problem. No work = no credit.

Name: _____

I certify that I did all the work myself and did not cheat in any way.

Signed _____

EXTRA CREDIT (4 points): Because the laboratory is an integral part of this course, what we talk about and do in the lab is often related to what is happening in lecture or vice versa. Therefore, even though some of the chemicals listed below have not been formally talked about in the lecture, we have encountered them in the lab. Show the structures for the following chemicals which have been used in the lab. The first two chemicals are from the lab, and the latter two are chemicals that you should know how to produce their structural formulas.

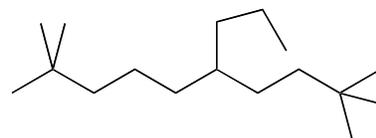
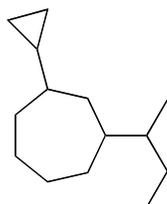
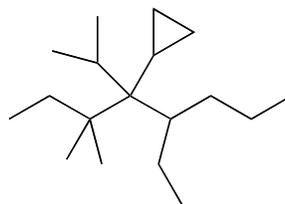
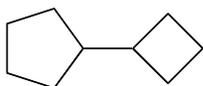
Benzoic acid

Diethyl ether

Ethyl alcohol

6-(1-methylpentyl)-5-propyltridecane

1 (8) Give names for each of the following compounds.



2 (10) Give the names for the alkanes having the number of carbons listed below (6 pts):

2 _____

8 _____

12 _____

3 _____

15 _____

10 _____

Show the structural formulas and give names (IUPAC or common) for the three isomeric alkanes having the molecular formula C_5H_{12} . (4 pts):

3 (8) Show structures for the compounds named below:

3-bromo-2-cyclopentyl-4,5,5-trimethylnonane

3-isopropyl-1-propylcyclohexane

5-sec-butyl-4-t-butyl-6-isobutyldodecane

2-cyclopropyl-4-propyl-octane

4 (16) Give definitions or show a structure which explains the following.

Polycyclic compound

Heterocyclic compound

Constitutional isomer

Gauche conformer of butane

Aromatic hydrocarbon

Hybrid orbitals

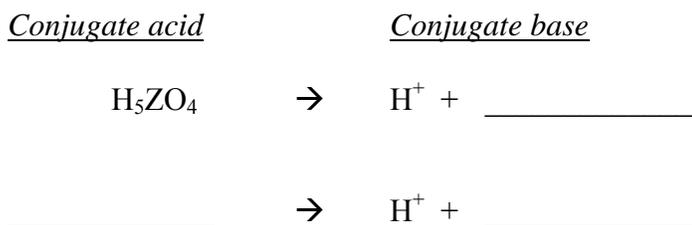
Nucleophile

pK_a value

5 (6) (i) Draw the Lewis structure for methanal H_2CO (C is center atom) (3 pts). (ii) What is the formal charge for the carbon in this structure? (1 pt). (iii) What would be the oxidation number for the carbon and atoms (1 pt each)? (iv) What is the orbital hybridization value for the oxygen atom (1 pt) ?

6 (6) (i) Show correct Newman projection structures for the *anti* and *gauche* conformations of pentane, looking down carbons two and three of this molecule (2 pts each). (ii) Explain why, in one or two sentences, the anti-conformer is most stable. (2 pt).

7 (4) A new acid that you just discovered has the formula H_5ZO_4 . Show the formula for its conjugate base. Then, using the conjugate base you just produced, let it function as an acid, and show the formula for its conjugate base. .



8 (4) $\text{HI}(\text{aq})$ has a pK_a of -10.4 , and $\text{HF}(\text{aq})$ has a pK_a of 3.1 . Rank the following acids in order of increasing acidity: HI , HF , HBr , and HCl , using appropriate Periodic Table trends.

Least acidic: $\underline{\hspace{2cm}} < \underline{\hspace{2cm}} < \underline{\hspace{2cm}} < \underline{\hspace{2cm}}$:Most Acidic

9 (11) (i) Draw structures (7 pts) for as many constitutional isomers having the molecular formula of C_6H_{12} (you need at least seven to receive full credit for this part). (ii) Give correct IUPAC (2 pts) and common names (2 pts) for the two isomeric butanes.

10 (6) Draw both the *cis* and *trans* isomers of 1,3-dimethylcyclohexane, using the chair conformation for cyclohexane. Be sure to clearly show axial and equatorial orientation in the structure. For both structures, put the methyl group on carbon number 1 in the equatorial position. (4 pts). Which is more stable, and justify your answer (2 pt)?

11 (9) Show the structure for each of the following *alkyl groups*, which can be attached to hydrocarbon chains. Show the attachment position going to "R" as the hydrocarbon group to avoid any ambiguity.

Isopropyl

tert-butyl

Isobutyl

sec-butyl

2-methylcyclopentyl

hexyl

2-methylpropyl

3-chlorocyclohexyl

butyl

12 (5) Rank each of the following in order of increasing pKa value (going from most acidic to least acidic, left to right).



Smallest: _____ < _____ < _____ < _____ < _____ < Largest

13 (5) (i) Draw the Lewis Structure for the NO₃⁻ ion (2 pts). (ii) Show one acceptable resonance structure (1 pt). (iii) What is the molecular geometry of this ion (2 pts)?

14 (6) Give correct acid and base definitions based on the following acid/base descriptions listed below (1 pt each):

Arrhenius definition: Acid:

Base:

Bronsted-Lowry definition: Acid:

Base:

Lewis definition: Acid:

Base: