Chemistry 210 -- EXAM 1 (Fall 2007 - 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: _____

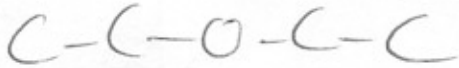
I certify that I did all the work myself and did not cheat in any way.

Signed _____

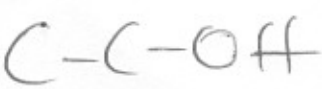
EXTRA CREDIT (4 points): Please show structures for the following compounds, three of which have been used in the lab and a fourth compound to draw its structure.

Benzoic acid

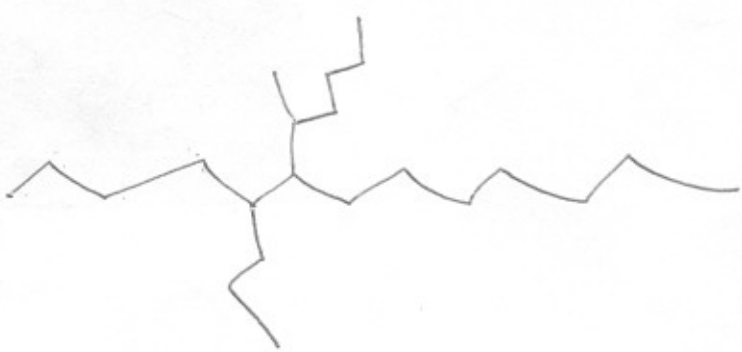
Diethyl ether



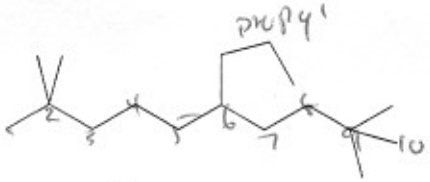
Ethyl alcohol



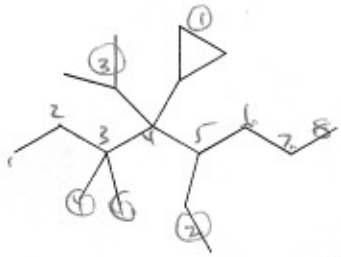
6-(1-methylpentyl)-5-propyltridecane



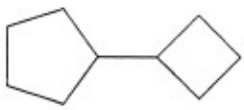
1 (8) Give names for each of the following compounds.



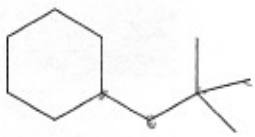
2,2,9,9-Tetramethyl-6-propyldecane



4-cyclopropyl-5-ethyl-4-isopropyl-4,4-dimethyloctane



cyclobutylcyclopentane



1-cyclohexyl-2,2-dimethyl propane

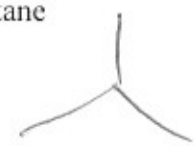
2 (8) Give the names for the alkanes having the number of carbons listed below:

3	propane	5	pentane
6	hexane	8	octane
10	decane	12	dodecane

Show structures for the two compounds listed below:

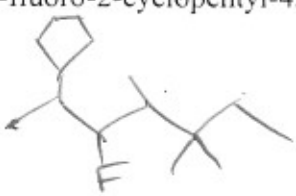
Butane

Isobutane

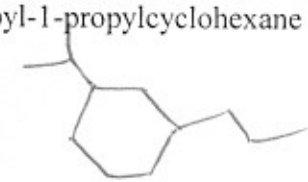


3 (8) Show structures for the compounds named below:

3-fluoro-2-cyclopentyl-4,5,5-trimethylheptane

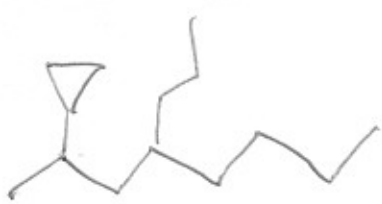


3-isopropyl-1-propylcyclohexane



5-*sec*-butyl-4-*t*-butyl-6-isobutylnonane

2-cyclopropyl-4-propyloctane



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

Polycyclic compound

a compound containing more than one ring

Heterocyclic compound

a ring structure that contains an atom other than carbon

Constitutional isomer

structural - different connectivity isomer

etc

Gauche structure

two carbons that are 1 & 4 relative to each other 60° apart

Aromatic hydrocarbon

Hybrid orbitals

e.g. sp^3 - where atomic orbitals hybridize to form molecular orbitals

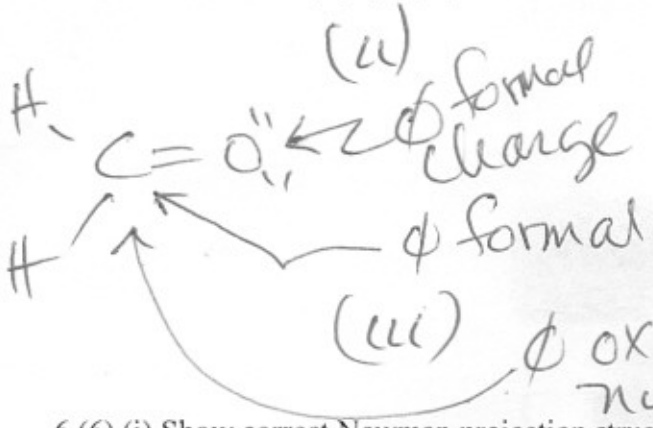
Steric effects

e⁻ repulsion of neighboring groups

London dispersion forces

van der Waal interation - Intermolecular forces in nonpolar & non charged Molecules

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

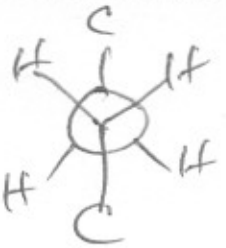
(i) 

(iv) C = sp^2

6 (6) (i) Show correct Newman projection structures for the *anti* and *gauche* conformations of butane (2 pts each). (ii) Shew a 3-dimensional perspective diagram for a molecule of methane, using wedges and dashes, as appropriate (2 pt).

(i) 

Gauche



Anti

(ii) 

7 (4) For a new acid, the formula is H_5ZO_4, show the correct conjugate below. Then, using that conjugate base just produced as a conjugate acid, show the correct conjugate base when it undergoes ionization of an additional proton (H^+).

Conjugate acid		Conjugate base
H_5ZO_4	→	$H^+ + H_4ZO_4^-$
$H_4ZO_4^-$	→	$H^+ + H_3ZO_4^{2-}$

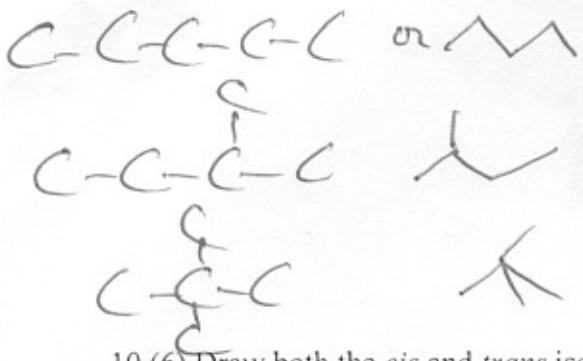
8 (4) HI(aq) has a pK_a of –10.4, and HF(aq) has a pK_a of 3.1. Rank the following acids in order of increasing acidity: HI, HF, HBr, and HCl, using appropriate Periodic Table trends.

Least acidic: HF < HCl < HBr < HI :*Most Acidic*

(IV) neopentane (IV) pentane

9 (11) (i) Draw the structures (3 pts) for the three constitutional isomers for an alkane having the molecular formula: C_5H_{12}. (ii) Give correct IUPAC (3 pts) and common names (3 pts) for each structure. (iii) Predict which structure would have the highest boiling point and which would have the lowest boiling point (2 pts).

(c)



(ii) IUPAC COMMON

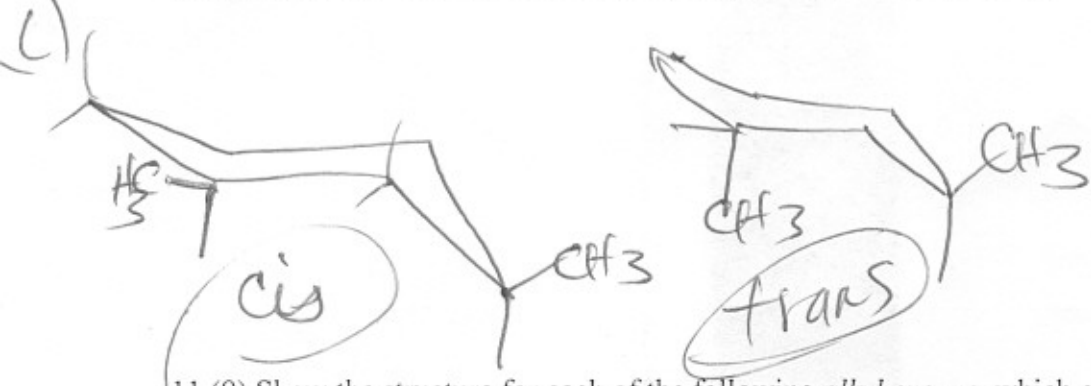
pentane n-pentane

2-methylbutane isopentane

2,2-dimethylpropane neopentane

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)?

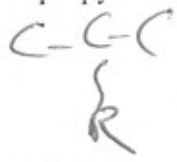
(c)



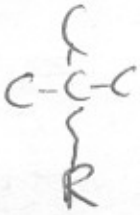
(ii) cis is more stable as both CH_3 groups are equatorial

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.

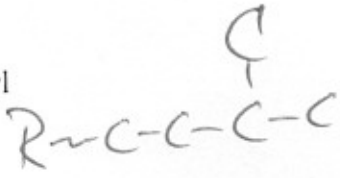
Isopropyl



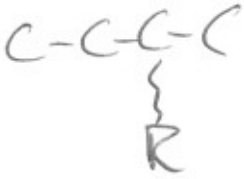
tert-butyl



Isopentyl

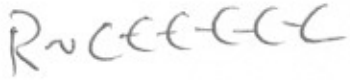


sec-butyl

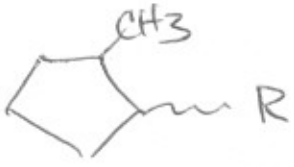


Cyclopentyl

hexyl



2-methylcyclopentyl



phenyl

sec-butyl

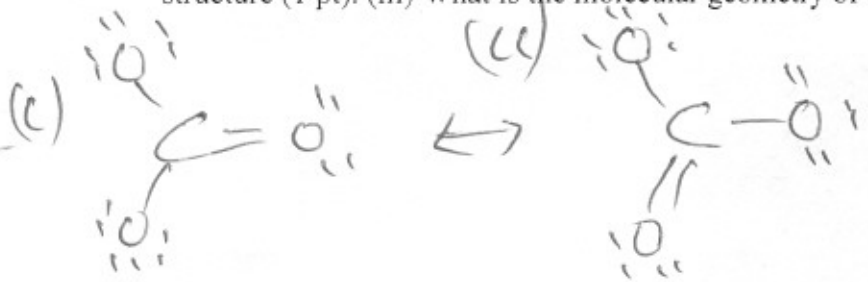
12 (5) Rank each of the following in order of increasing pKa value (going from most acidic to least acidic, left to right).

3	-1	15.7	36	60
H–F	H–Cl	H–OH	$H–NH_2$	$H–CH_3$

Smallest: HCl < HF < HOH < NH_3 < CH_4 < Largest

13 (5) (i) Draw the Lewis Structure for the CO_3^{2-} ion (2 pts). (ii) Show one acceptable resonance structure (1 pt). (iii) What is the molecular geometry of this ion (2 pts)?

(i)



(ii)

(iii) trigonal planar

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

Arrhenius definition: Acid: H^+ ion

Base: OH^- ion

Bronsted-Lowry definition: Acid: proton donor

Base: proton acceptor

Lewis definition: Acid: e⁻ pair acceptor

Base: e⁻ pair donor