CHEM 3311-200
Exam 1
Fall 2007

By printing my name below, I pledge that
"On my honor, as a University of Colorado at Boulder student, I have neither given nor received unauthorized assistance on this work."

Name _____

Recitation TA's Name _____ (Doug Bevan, Carolynn Chin)
Recitation Day & Time _____

Grading Information

Page #	Points Possible	Your Score
2 (Question 1)	15	__
3 (Questions 2 & 3)	21	__
4 (Question 4)	10	__
5 (Questions 5 & 6)	21	__
6 (Question 7)	15	__
7 (Question 8)	18	__

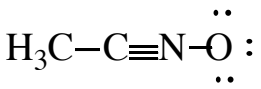
_____ **TOTAL (out of 100)**

General Instructions

(1) This is a CLOSED BOOK exam! No notes and molecular models are allowed.
(2) You have 2 hours to complete the exam.
(3) Write your name at the top of each page, starting with page 2.
(4) Use the back of exam pages for scratch paper.
(5) If caught cheating, you will receive at best an F for this exam. The instructor reserves the right to proceed further in compliance with university policies.

1. Multiple Choice Questions (15 points)
Please **circle the best answer** to each question. Lone pairs are generally not shown.

(i) The formal charges on the nitrogen and oxygen atoms in the structure



are, respectively:
(A) 0, 0 (B) +1, -1 (C) –1, +1 (D) 0, -1

(ii) Do these two structures have the same molecular geometry?

(A) Yes, both are linear.
(B) Yes, both are bent.
(C) No; the first is linear and the second is bent.
(D) No; the first is bent and the second is linear.

(iii) How many π bonds are there in the molecule $H_2C{=}CH{-}C{\equiv}N$?
(A) two (B) three (C) four (D) five

(iv) Select the <u>correct</u> statement about the $H_3C{-}O{-}CH_3$ molecule.
(A) It is nonpolar.
(B) The C-O-C bond angle is 180°.
(C) It is a stereoisomer of ethanol, CH_3CH_2OH.
(D) It is a constitutional isomer of ethanol, CH_3CH_2OH.

(v) Cycloalkanes are characterized by the general molecular formula:
(A) C_nH_{2n-2}
(B) C_nH_{2n+2}
(C) C_nH_{2n}
(D) C_nH_{2n+4}

Points earned on this page ___

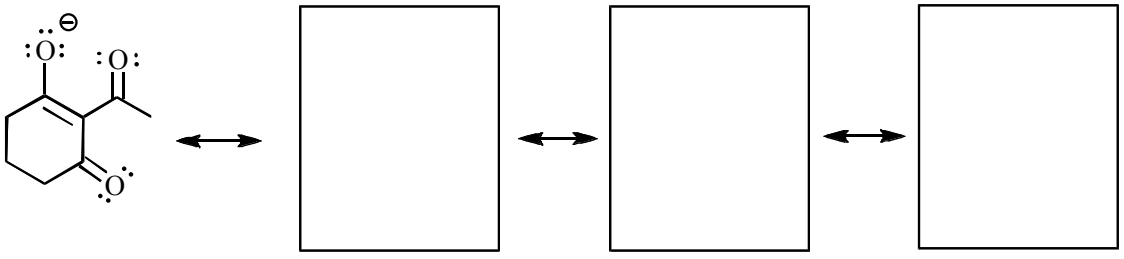
2. (12 points)

Using **bond-line formulas**, draw ONLY the constitutional isomers of C_8H_{18} that are described below and write the corresponding IUPAC name.

	Bond-line formula	Correct IUPAC name
(A) a substituted hexane		
(B) a substituted pentane		
(C) a substituted butane		

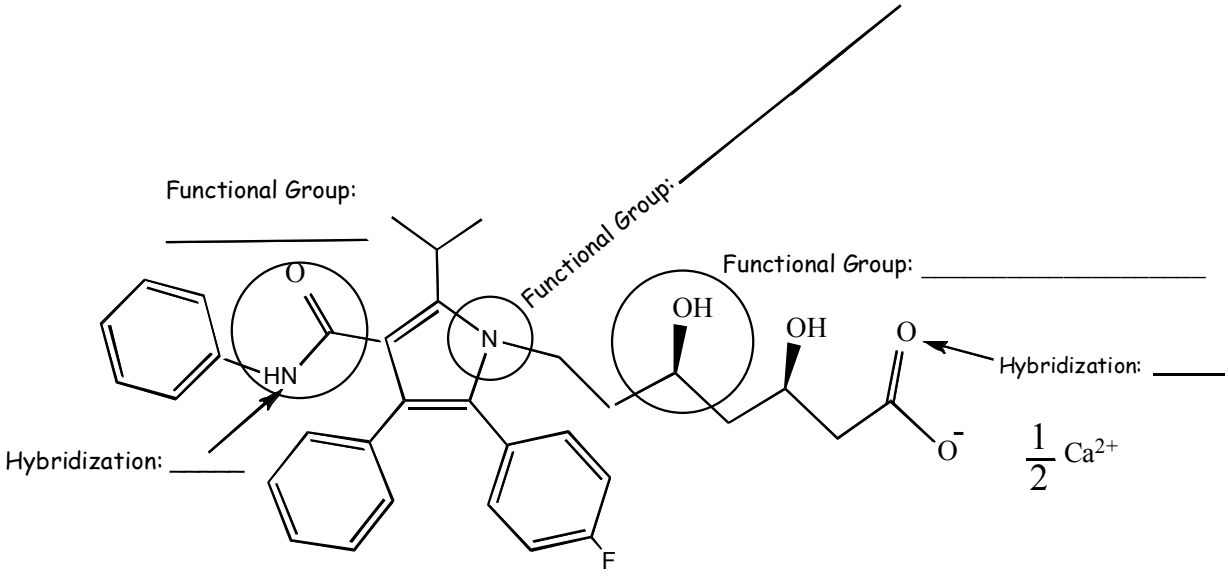
3. (9 points)

Draw three other stable resonance contributors for this anion, showing all non-zero formal charges. Clearly show all lone pairs and appropriate curved arrow notation to interconvert the contributing structures.



Points earned on this page __

4. (10 points) Statin drugs lower cholesterol by inhibiting the enzyme 3-hydroxy-3-methylglutaryl coenzyme A reductase that is required for the biosynthesis of mevalonic acid (a precursor to cholesterol). Name all the circled functional groups in the spaces provided and indicate the hybridization of the atoms that the arrows point to in the structure for Atorvastatin calcium (marketed as Lipitor). If an alcohol or amine group is present, please identify it as primary, secondary, or tertiary. NOTE: Lone pairs are not shown.



Circle the best answer possible.

(A) The hybridization of the carbon atom in the carboxylic acid functional group is:

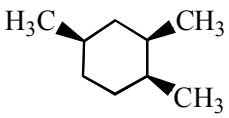
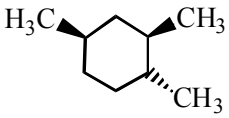
sp^3 sp^2 sp

(B) An _____ is a carboxylic acid derivative.

ether aldehyde ester

Points earned on this page ___

5. (15 points) Draw a structure for each compound as described in the table below. Then, **circle the more stable compound in each pair.**

(A) *cis*-1-isopropyl-3-methylcyclohexane	or	*trans*-1-isopropyl-3-methylcyclohexane
Draw most stable chair conformation below:		Draw most stable chair conformation below:
(B) 	or	
Draw most stable chair conformation below:		Draw most stable chair conformation below:
(C) 2, 4-Dimethylpentane	or	2, 2, 3-trimethylbutane
Draw bond-line formula below:		Draw bond-line formula below:

6. (6 points) Draw Newman projections looking down the C2-C3 bond of 2, 3-dimethylbutane for (A) the least stable eclipsed conformation and (B) the relatively more stable eclipsed conformation .

A

B

Points earned on this page ___

7. (15 points)
(A) Identify each statement as true(**T**) or false(**F**).

__(i) $CHCl_2COOH$ is a weaker acid than Cl_2CHCH_2COOH.

__(ii) The t-butoxide ion, $(CH_3)_3CO^-$, is a stronger base than the hydroxide ion.

__(iii) Phenol, C_6H_5OH, is a stronger acid than CH_3COOH.

7(B) Draw an arrow-pushing mechanism for the acid-base reaction between propanoic acid, CH_3CH_2COOH, pK_a = 4.9, and the methoxide ion, CH_3O^-. **Draw the structures of the products.** The pK_a of methanol, CH_3OH, is 15.2. Clearly indicate **on the arrow(s)** which side of the reaction is favored at equilibrium and explain your reasoning in one sentence. Show all lone pairs and formal charges throughout your mechanism.

7(C) When NH_3 reacts with water:

(i) the attacking electrons are in a(n) ____ molecular orbital
(choices are s, p, sp^2, sp^3, nonbonding, N-H σ, N-H σ^*),

and

(ii) the empty orbital into which the electrons are transferred is a(an) ____ molecular orbital.
(Choices are s, p, sp^2, sp^3, O-H σ, O-H σ^*).

Points earned on this page ___

8. (18 points) Heats of combustion data are useful in comparing relative stabilities of organic compounds.

(i) Arrange these isomeric cycloalkanes in <u>increasing</u> order of $|\Delta H_{comb}|$. Write the <u>names of the compounds in the boxes</u> below.

cis-1,2-dimethyl cyclopropane, cyclopentane, and methylcyclobutane

[ ] < [ ] < [ ]

(ii) When comparing $|\Delta H_{comb}|$ for the isomeric dimethylcyclohexanes, the values ranged from 5212 kJ/mol to 5223 kJ/mol. Two stereoisomers have the value of 5212 kJ/mol while only one stereoisomer has the value of 5223 kJ/mol. Draw the most stable chair comformations for these stereoisomers in the appropriate boxes.

[ ]	[ ]	[ ]
$\|\Delta H_{comb}\|$ = 5212 kJ/mol	$\|\Delta H_{comb}\|$ = 5212 kJ/mol	$\|\Delta H_{comb}\|$ = 5223 kJ/mol

Points earned on this page ___