Chem 314

Spring, 2005
Midterm Exam
Chem 314

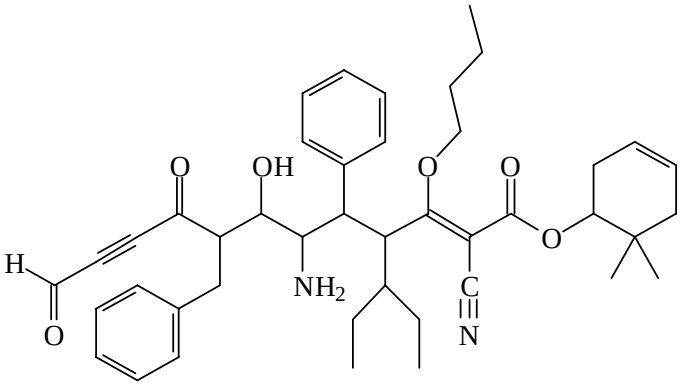
Name _____

Problem	Points	Credit
1. Nomenclature	25	
2. 2D Lewis structures	20	
3. 3D Structures, Formal Charge & Resonance	30	
4. Formulas, Functional Groups & Special Terms	22	
5. Thermodynamics, Bond Energies & Reactions	26	
6. Acid/Base Chemistry	34	
7. Physical Properties	10	
Total	167	

This is a long exam. It has been designed so that no one question will make or break you. You are not expected to completely finish the exam. The best strategy is to work steadily, starting with those problems you understand best. Make sure you show all of your work. Draw in any lone pairs of electrons, formal charge and curved arrows to show electron movement wherever necessary. Also, consider the point values in your choice of questions. Do your best to show me what you know in the available time.

You always have time for the things you put first.

1. Provide an acceptable name for the following structure. (25 pts)

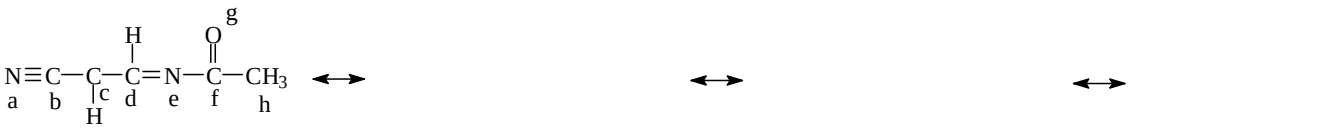


2. Draw an acceptable 2D Lewis structure for each of the following formulas. Indicate any formal charges present, all lone pair electrons and completely draw out all atoms (e.g. do not write CH_3). (20 pts)

$OHCC_6H_4CH(NO_2)C(CH_3)C(OCH_3)CCCH(OH)CH(CN)CHNH_2CH(CH(CH_3)_2)COCO_2CH_2CO_2^{\ominus}$

six carbon ring

3. First, draw three other reasonable resonance structures as two-dimensional representations. Include proper arrow conventions. Rank your structures from best (= 1) to poorest. Draw a three-dimensional Lewis structure for the given representation and the best resonance structure among B, C and D. Show σ bonds as lines, wedges and dashes and the p orbitals in π bonds, as well as any orbitals holding lone pairs. Draw two dots for lone pair and pi bond electrons. Indicate any formal charge present and give the hybridization, bond angles and shape of each nonhydrogen atom (below). Assume that all non-hydrogen atoms have full octets, unless a carbocation is written. (30 pts)



A B C D

3D (A) 3D (best other)

Use structure A to fill in the following table.

	Hybridization	Angles	Shape	#σ bonds	#π bonds	lone pairs
a						
b						
c						
d						
e						
f						
g						
h						

4. a. Us the given formula to provide an example that includes the listed functional groups. If you draw any other functional groups, identify them as well. Calculate the degree of unsaturation for your formula. (10 pts)

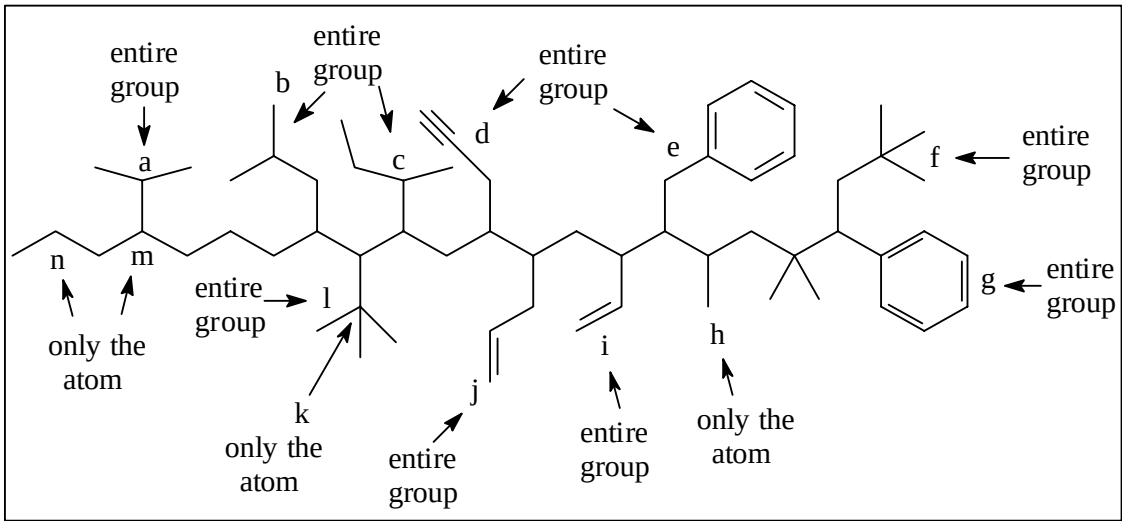
$C_{15}H_{17}BrN_2O_4$

(aldehyde, amide, ether, aromatic, nitrile, alcohol)

degree of unsaturation calculation

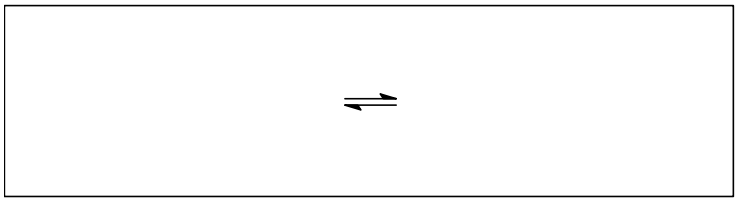
b. Match the arrows with the terms. Some arrows may be associated with more than one term. (12 pts)

1. methyl _____
2. methylene _____
3. methine _____
4. primary _____
5. secondary _____
6. tertiary _____
7. quarternary _____
8. isopropyl _____
9. isobutyl _____
10. sec-butyl _____
11. t-butyl _____
12. neopentyl _____
13. vinyl _____
14. allyl _____
15. propargyl _____
16. phenyl _____
17. benzyl _____

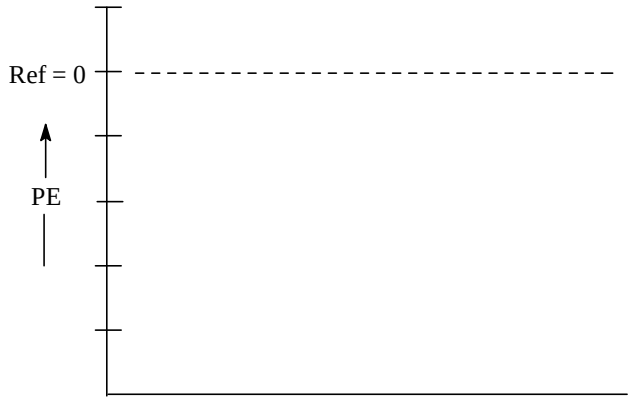


5. a The heat of combustion of propanoic acid is –347.2 kcal/mole. Limited heats of formation are provided below. Write an equation for this reaction. Use this information to calculate a heat of formation for propanoic acid. Draw an energy diagram that includes the zero energy reference point and the various other energy values. (14 pts)

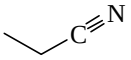
Combustion equation:



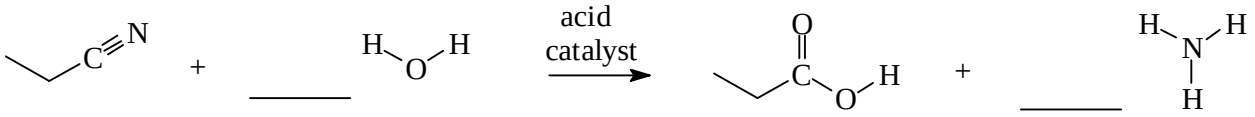
Show work.



Energy Diagram

	ΔH_f^o (kcal/mole)
CO_2	-94.0
H_2O	-57.8
NH_3	-10.9
	+12.1

b. Calculate the heat of reaction for the equation below. Clearly show your set up and the appropriate energy values. (4 pts)

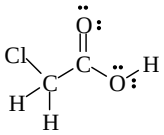


c. Calculate the same heat of reaction in part b using the following average bond energies. How does this value compare to that of part b? (8 pts)

Bond	Bond Energy
C—H	98
N—H	93
O—H	109
C—O	86
C=O	176
C—N	73
C=N	147
C≡N	204

6. a. Specify each base and acid in the equations below. Distinguish one acid/base pair from another with notations in each equation. Use the given pK_a information to estimate an equilibrium constant, K_{eq}, for each reaction. Are the products or reactants favored in each equation? Add in curved arrows to show the flow of electrons in each equation. Circle the strongest acid and strongest base shown below? (24 pts)

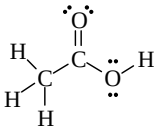
a.



1

2 ⇌ 3 4

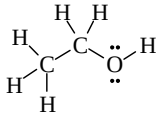
K_{eq} =



5

6 ⇌ 7 8

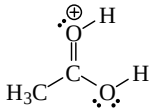
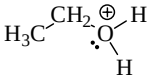
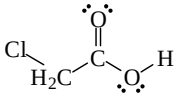
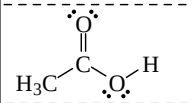
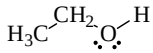
K_{eq} =



9

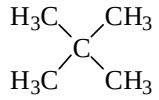
10 ⇌ 11 12

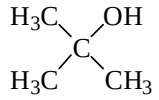
K_{eq} =

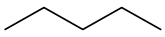
Acid	pK_a values
	-6
	-3
	3
	5
	16
	9
NH_3	35

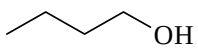
b. Suggest any possible reasons for the relative order of acidities in part a. (10 pts)

7. The following structures have similar molecular weights, however, they have different melting points and boiling points. Match the melting point/boiling point pairs with the correct structures. Provide a very brief explanation for your choices. (10 pts)





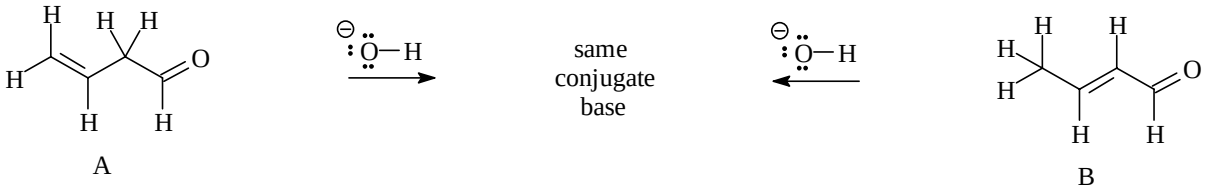




boiling point	melting point
+10	- 17
+36	-130
+82	+ 25
+97	-126

Not used on this exam, but consider as a possible question.

d. Acids A and B have different structures, but share a common conjugate base. Draw the curved arrows to show how the proton transfer occurs in each case and explain why the conjugate base is the same for each acid. (10 pts)



A B