CHEM 346 – Organic Chemistry I (for Majors)

Instructor: Paul J. Bracher

Practice Hour Examination #1-1

Monday, September 9th, 2013
1:10 p.m.

Student Name (Printed)	
Student Signature	

Please also write your name on the back of the exam

Scoring

Question	Points Earned	Points Available
1		15
2		25
3		30
4		20
TOTAL		90

Problem 1. (15 points total, 3 points each) Determine whether the following five statements are true or false. Write out the full word "true" or "false" beside each statement; do not just write "T" or "F". If any part of the statement is false, the entire statement is false.

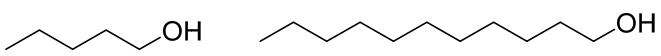
(i) _____ Boron trifluoride (BF_3) is a strong Lewis base, but does not typically act as a Brønsted–Lowry base.

(ii) _____ Water (H_2O) can serve as both a Lewis acid and a Lewis base.

(iii) _____ Sodium hydroxide (pK_a of conjugate acid = 15.7) cannot deprotonate acetone (pK_a = 20)

(iv) _____ While the individual bonds in methylene chloride (CH_2Cl_2) are polar, the molecule has no net dipole moment.

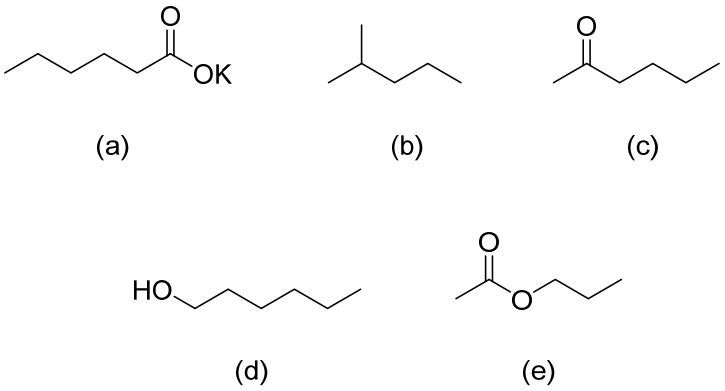
(v) _____ 1-undecanol, drawn below, has a lower melting point than 1-pentanol.



1-pentanol 1-undecanol

Problem 2. (25 points total, 5 points each) For each question, select the best answer of the choices given. Write the answer, legibly, in the space provided.

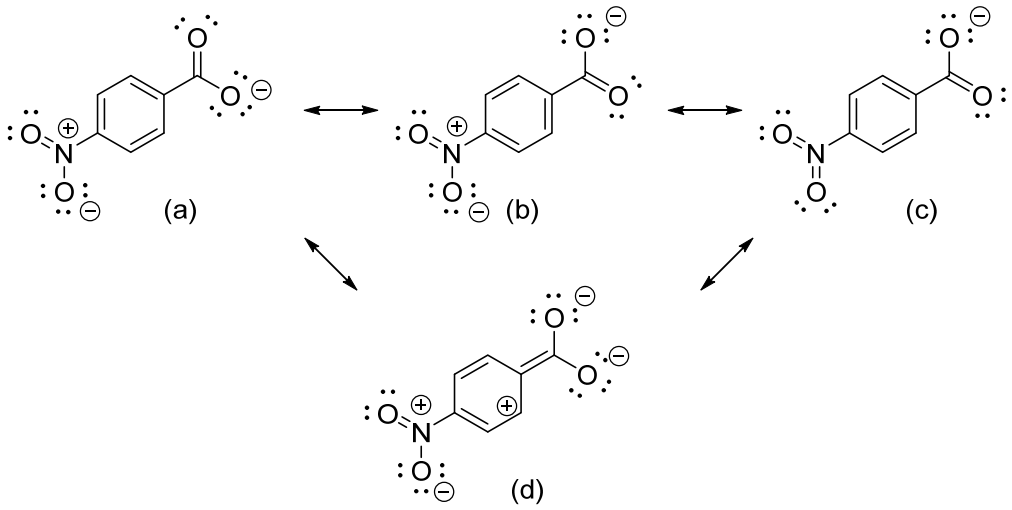
(i) _____ Which of the following molecules has the highest solubility in water?



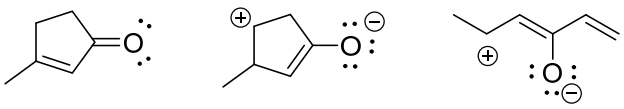
(ii) _____ Which of the following molecules is the most polar?

(a) H_2
(b) BH_3
(c) CH_4
(d) NH_3
(e) F_2

(iii) _____ Which of the following resonance forms will have the least contribution to the resonance hybrid of the *p*-nitrobenzoate anion?



(iv) _____ Choose the most correct and complete statement about the following Lewis structures:



X **Y** **Z**

(a) Structures **X** and **Y** are resonance forms
(b) Structures **X** and **Z** are isomers
(c) Structures **Y** and **Z** are resonance forms
(d) Statements (a) and (b) are both true
(e) Statements (a), (b), and (c) are all false

(v) _____ Benzoic acid has a pK_a of 4.2 in water. In a dilute aqueous solution buffered at pH 6.2, approximately what percentage of a sample of benzoic acid will be deprotonated?

(a) 99% deprotonated
(b) 91% deprotonated
(c) 50% deprotonated
(d) 9% deprotonated
(e) 1% deprotonated

Problem 3. (30 points total) Consider the molecules benzene (C_6H_6) and cyclohexane (C_6H_{12}).

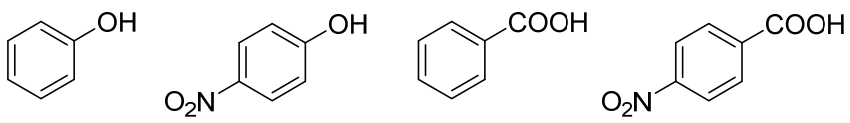
(i) (8 points) Draw Lewis structures for benzene and cyclohexane given the fact that every carbon in each molecule has the same number of hydrogens bound to it.

(ii) (8 points) Do you expect all of the carbon atoms of each molecule to lie in the same plane? Explain.

(iii) (8 points) Which of the compounds is the stronger Brønsted−Lowry acid? Explain.

(iv) (6 points) Which of the compounds is the stronger Lewis base? Explain.

Problem 4. (20 points total) Consider the following four molecules and their pK_a values in water.

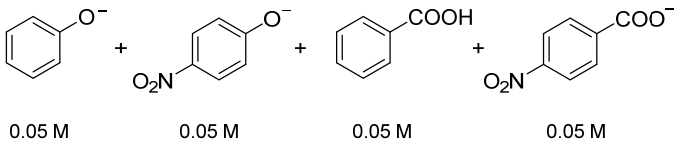


phenol	4-nitrophenol	benzoic acid	4-nitrobenzoic acid
pK_a = 10.0	pK_a = 7.1	pK_a = 4.2	pK_a = 3.4

(i) (8 points) Explain why benzoic acid is a stronger acid than phenol. Hint: You're going to want to draw things here.

(ii) (8 points) Explain why adding the nitro group at the 4 position of the phenyl group has a much more significant impact on the acidity of phenol (~3 orders of magnitude) relative to benzoic acid (<1 order of magnitude).

(iii) (4 points) Predict the major product of the following proton-transfer reaction:



0.05 M 0.05 M 0.05 M 0.05 M

DMF
(a general polar, aprotic organic solvent)

? + ? + ? + ?