CHEM 346 – Organic Chemistry I (for Majors)

Instructor: Paul J. Bracher

Hour Examination #1

Wednesday, September 25th, 2013
6:30 p.m.

Student Name (Printed)	
Student Signature	

Please also write your name on the back of the exam

Scoring

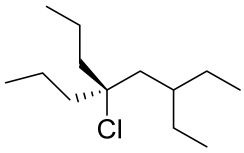
Question	Points Earned	Points Available
1		15
2		25
3		20
4		20
5		20
TOTAL		100

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) _____ Cyclopropene is more strained than cyclopropane.

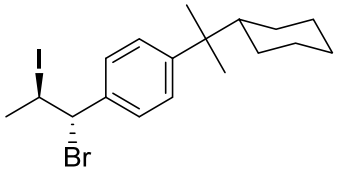
cyclopropene cyclopropane

(ii) _____ The correct systematic name of compound **A** is 5-chloro-3-ethyloctane.



A

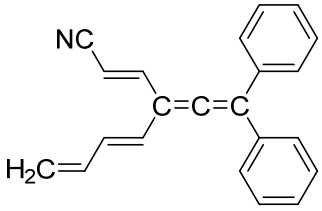
(iii) _____ Compound **B** has two stereogenic centers, only one of which is designated *R*.



B

(iv) _____ Chloroform ($CHCl_3$) is polar, achiral, and capable of serving as a Brønsted-Lowry acid.

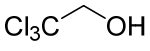
(v) _____ Every carbon atom in compound **C** is sp^2 hybridized except for one, which is *sp* hybridized.



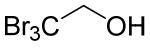
C

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.

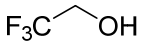
(i) _____ Arrange the following four molecules in ascending order of pK_a (lowest pK_a to highest pK_a)



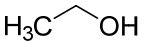
D



E



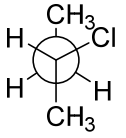
F



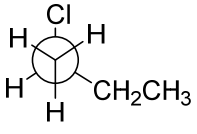
G

(a) **G** < **E** < **D** < **F**
(b) **G** < **F** < **E** < **D**
(c) **G** < **D** < **E** < **F**
(d) **F** < **D** < **E** < **G**
(e) **F** < **E** < **D** < **G**

(ii) _____ The compounds represented by Newman projections **H** and **I** are:



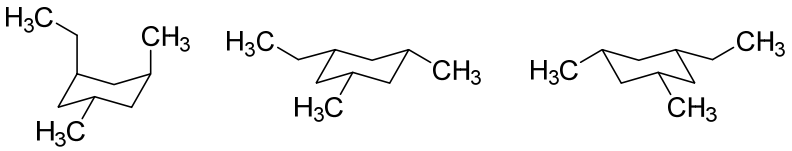
H



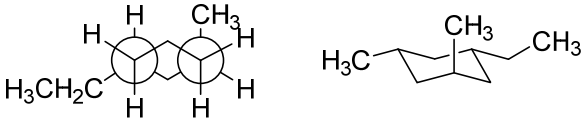
I

(a) identical compounds
(b) enantiomers
(c) diastereomers
(d) constitutional isomers
(e) *cis* and *trans* compounds

(iii) _____ What is the most stable conformation of (3*S*,5*S*)-1-ethyl-3,5-dimethylcyclohexane?

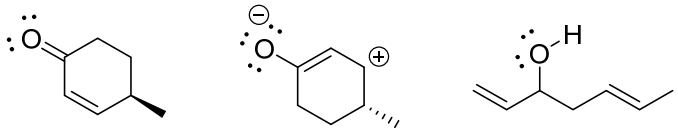


(a) (b) (c)



(d) (e)

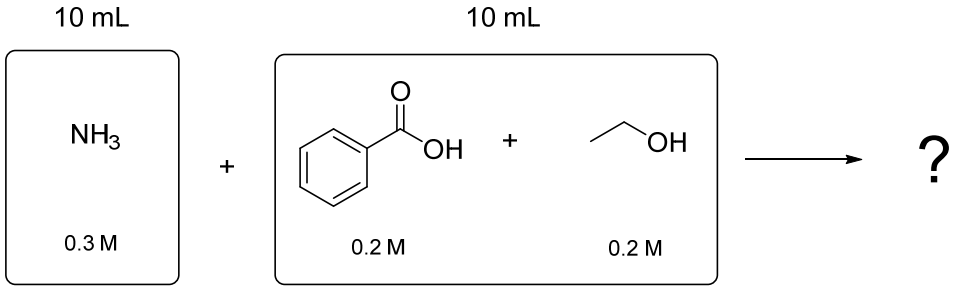
(iv) _____ Choose the most correct and complete statement about the following Lewis structures:



J **K** **L**

(a) Structures **J** and **K** represent resonance forms of the same molecule
(b) Structures **J** and **K** represent enantiomers
(c) Structures **J** and **L** represent constitutional isomers
(d) Statements (b) and (c) are both true
(e) Statements (a), (b), and (c) are all false

(v) _____ A 10 mL 0.3 *M* solution of ammonia is added to a 10 mL solution that is 0.2 *M* benzoic acid and 0.2 *M* ethanol. What percentage <u>of the ethanol</u> is deprotonated in the final reaction mixture? (Assume that the solvent does not play a role in the reaction.)

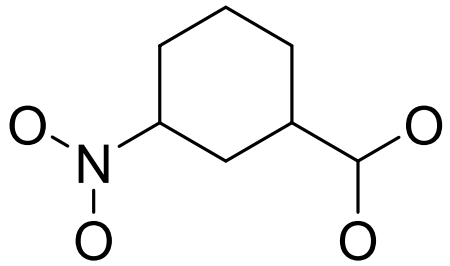


Compound	pK_a
ammonia (NH_3)	38.0
ammonium (NH_4^+)	9.2
benzoic acid (C_6H_5COOH)	4.2
ethanol (CH_3CH_2OH)	15.9

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

Problem 3. (20 points total) Short answers.

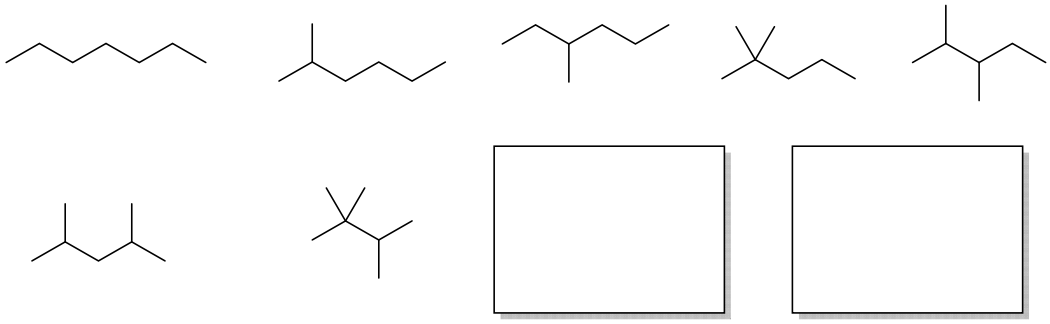
(i) (12 points) Complete the following Lewis structure for 3-nitrobenzoic acid, which has the structural formula $O_2NC_6H_4COOH$. The molecule has a carboxylic acid functional group, an aromatic ring, and a nitro group. Draw the most stable resonance form and explicitly include all hydrogens, bonding pairs, lone pairs, and formal charges on your Lewis structure.



(ii) (8 points) Draw the most acidic optically-active isomer of C_6H_{10}.

Problem 4. (20 points total) Isomers of C_7H_{16}.

(i) (8 points) Draw in the two missing structures from the set of constitutional isomers with the molecular formula C_7H_{16}.



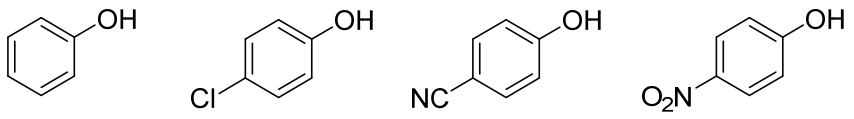
(ii) (4 points) How many of the nine constitutional isomers of C_7H_{16} are chiral?

(iii) (8 points) Triptane is the isomer of C_7H_{16} with the highest melting point. What is its structure and systematic IUPAC name?

Structure

Name

Problem 5. (20 points total) Consider the following four molecules and their pK_a values in water.



phenol
pK_a = 10.0

4-chlorophenol
pK_a = 9.4

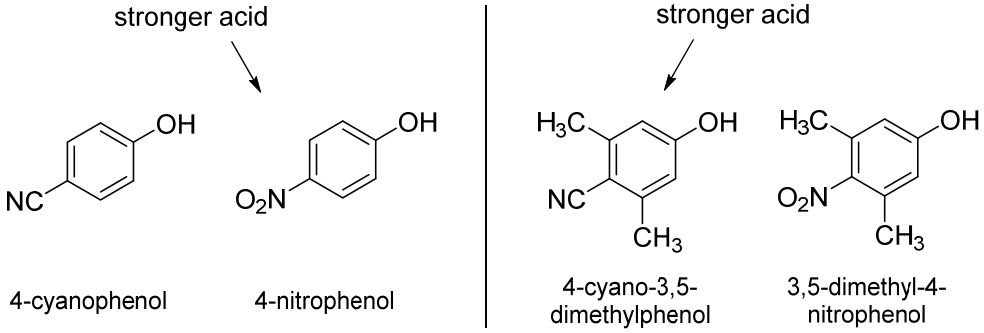
4-cyanophenol
pK_a = 8.0

4-nitrophenol
pK_a = 7.1

(i) (5 points) In one or two sentences, explain why 4-chlorophenol is a stronger acid than phenol.

(ii) (8 points) Explain why 4-cyanophenol is a much stronger acid than 4-chlorophenol. You will want to draw something here.

(iii) (7 points) Explain why when methyl groups are added to the 3 and 5 positions of the ring, the relative strength of acidity of the 4-cyano and 4-nitro phenols switches (see below).



4-cyanophenol

4-nitrophenol

4-cyano-3,5-dimethylphenol

3,5-dimethyl-4-nitrophenol