

CHEM 3311-100 Spring 2007

Exam 1

Professor R. Hoenigman

High = 97

Low = 9

Average = 76

I pledge to uphold the CU Honor Code:

Signature _____

Name (printed) _____

Last four digits of your student ID number _____

Recitation TA _____

Recitation number, day, and time _____

You have 1 hour and 30 minutes to complete this exam.

No model kits or calculators allowed.

Periodic table and scratch paper are attached.

DO NOT TURN THIS PAGE UNTIL INSTRUCTED TO DO SO.

Recitation Sections:

#	Day	Time	TA
121	Tuesday	8 am	Kelly
131	Tuesday	1 pm	Kelly
141	Wednesday	8 am	Greg
151	Wednesday	12 pm	Greg
153	Wednesday	12 pm	Kelly
152	Wednesday	5 pm	Kelly
171	Thursday	12 pm	Greg

SCORE:

Page 1 _____/14 Page 5 _____/18

Page 2 _____/14 Page 6 _____/14

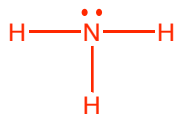
Page 3 _____/12 Page 7 _____/10

Page 4 _____/18

TOTAL _____/100

1. (8 pts) Ammonia can act as either an acid or a base.

A. Draw the Lewis structure of ammonia.
(2 pts)



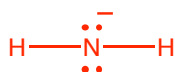
B. What is the pK_a of ammonia?
(1 pt)

36

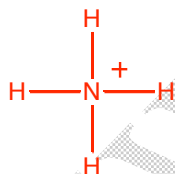
C. Fill in the equation below to relate the pK_a of ammonia to its K_a .
(1 pt)

$$\text{K}_a = 10^{-\text{pK}_a} = 10^{-36}$$

D. Draw the Lewis structure of the conjugate base of ammonia.
(2 pts)

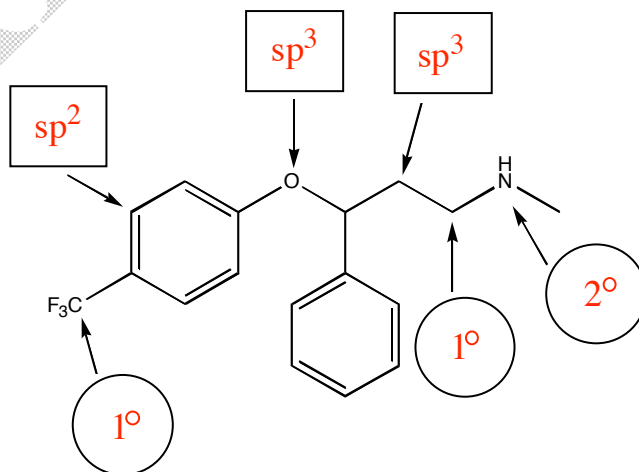


E. Draw the Lewis structure of the conjugate acid of ammonia.
(2 pts)



2. (6 pts) Prozac®, shown below, is a widely prescribed antidepressant.
(1 pt each)

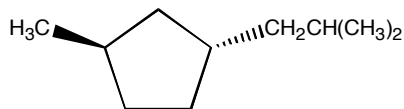
A. Label each atom indicated by a box as sp^3 , sp^2 , sp , or none of these.
B. Label each atom indicated by a circle as 1° , 2° , 3° , or 4° .



3. (9 pts) Give the IUPAC name for each of the following compounds.

(3 pts each)

A.



trans-1-isobutyl-3-methylcyclopentane

-or-

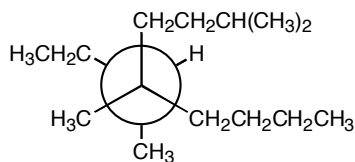
trans-1-methyl-3-(2-methylpropyl)cyclopentane

B. $(\text{CH}_3\text{CH}_2)_2\text{CHCH}_2\text{CH}(\text{CH}_3)_2$

Book Problem 2.10b

4-ethyl-2-methylhexane

C.



5-*sec*-butyl-2,5-dimethylnonane

-or-

2,5-dimethyl-5-(1-methylpropyl)nonane

4. (5 pts) Circle the compounds below that have a dipole moment.

Book Problem 1.21

HCN

H₂O

BF₃

CH₃CH₂COOH

CCl₄

CH₃Cl

CH₂O

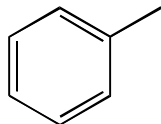
NCCH₂CH₂CN

cyclobutane

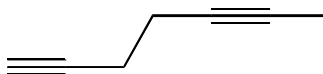
5. (12 pts) State whether the following pairs of compounds are constitutional isomers, stereoisomers, conformers, resonance structures, identical structures, or have no relation. Place your answer in the box.

(2 pts each)

A.



and



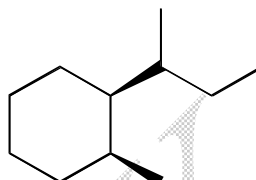
Constitutional Isomers

Book Problem 2.22c

B.

sec-butylcycloheptane

and



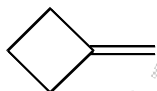
Constitutional Isomers

Book Problem 2.28d

C.



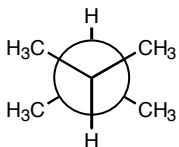
and



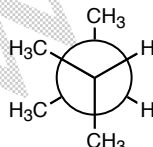
No Relation

Book Problem 3.12

D.



and



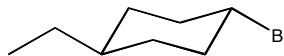
Conformers

Book Problem 3.24c

E.

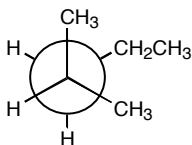


and

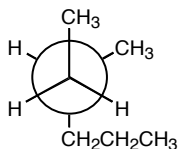


Identical Structures

F.



and



No Relation

6. (18 pts) For each of the following pairs, circle the more stable compound or ion. In the box, give a brief reason for your choice.

(3 pts each)

A.

1,1-dimethylcyclopentane

or

1-ethyl-3-methylcyclobutane

Less ring strain

B. Book Problem 3.28a

cis-1-methyl-2-(1-methylethyl)cyclohexane

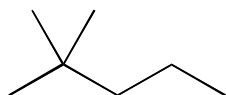
or

trans-1-methyl-2-(1-methylethyl)cyclohexane

Less 1,3-diaxial repulsions

- both substituents are equatorial

C.

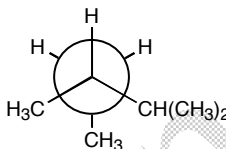


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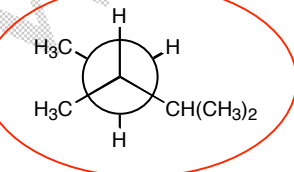


More branched isomer

D.



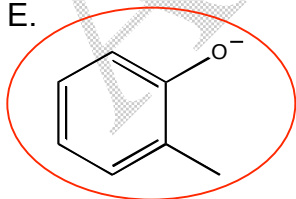
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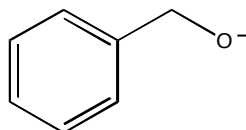
Less torsional strain

- big groups are anti to one another

E.

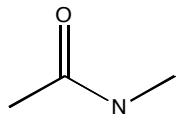


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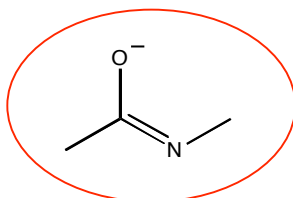


More resonance structures

F.



or

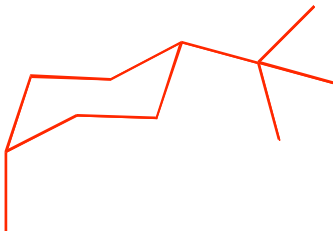


Extra electrons on more negative atom

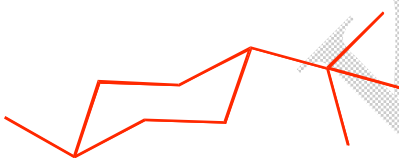
7. (9 pts) The following is a three-part question. Be sure to draw neat chair cyclohexanes.

Book Problem 3.10c and d

A. Draw the most stable conformer of *cis*-1-*tert*-butyl-4-methylcyclohexane. (3 pts)



B. Draw the most stable conformer of *trans*-1-*tert*-butyl-4-methylcyclohexane. (3 pts)



C. Which of the isomers (*cis* or *trans*) is more stable? Why? (3 pts)

The *trans* isomer is more stable because both substituents are equatorial in the most stable chair conformation. (It has less 1,3-diaxial repulsions.)

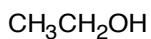
8. (9 pts) Circle the more acidic compound in the following pairs. In the box, give a brief reason for your choice.

(3 pts)

A.

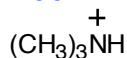


or

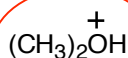


Hydrogen is on the more electronegative element

B. Book Problem 1.31a

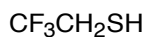


or



Hydrogen is on the more electronegative element

C.

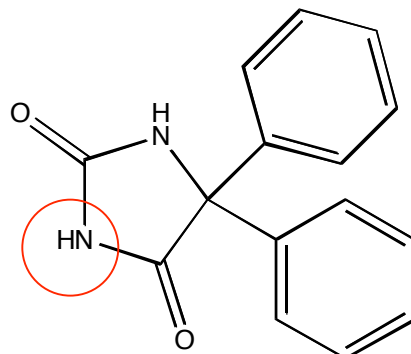


or



Inductive effect

9. (4 pts) Circle the most acidic hydrogen in phenytoin, an anti-seizure drug.

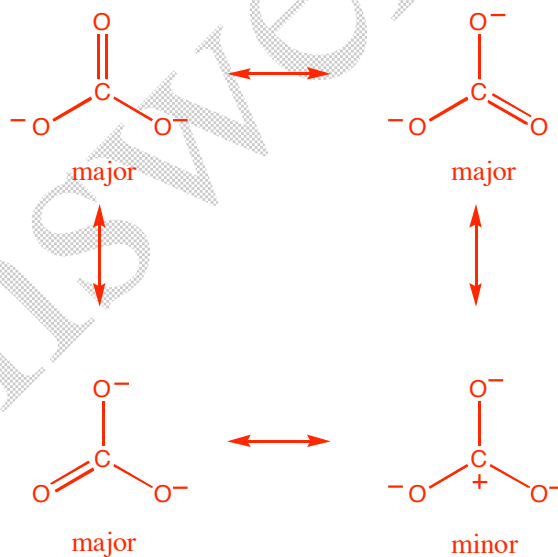


phenytoin

10. (10 pts) Carbonate (CO_3^{2-}) is a very common polyatomic ion.

[Book Problem 1.17](#)

A. Draw all of the resonance structures of the carbonate ion. Be sure to show any non-zero formal charges. Label each structure as a major or minor resonance contributor. (8 pts)



B. Explain why all of the carbon–oxygen bonds in the carbonate ion have the same bond length. (2 pts)

Due to electron delocalization, the actual structure is a resonance hybrid of the three major resonance structures. Thus each C-O bond has 2 parts single and 1 part double bond character and each oxygen has a 2/3 negative charge.

11. (10 pts) Complete the following acid-base reactions. Show all non-zero formal charges. If no reaction occurs write NR.
(2 pts each)

