

CHEM 3311-100

Exam 1, Fall 2011

Time: 2 Hours

By printing my name below, I pledge that

“On my honor, as a University of Colorado-Boulder student, I have neither given nor received unauthorized assistance on this work.”

Your Name (PRINTED IN CAPITAL LETTERS)

Last Name

First Name

Middle Initial

Your CU Student ID # (NOT Your Social Security Number)

Your Recitation TA's Name

Last Name

First Name

[-1 if missing or incorrect]

Circle Your Recitation Day & Time [-1 if missing or incorrect]

Mon 8 AM Mon 2 PM Mon 5 PM Tues 8 AM Tues 5 PM

Wed 8 AM (130) Mai Wed 8AM (131) Clancey

Wed 11 AM Wed 12 PM Wed 5 PM Thurs 8 AM

Grading Details

| Page # (Question #s) | Points Possible | Points Earned |
|----------------------|-----------------|---------------|
| 3 (Q 1) | 24 | _____ |
| 4 (Q 1) | 24 | _____ |
| 5 (Q 2&3) | 24 | _____ |
| 6 (Q 4&5) | 18 | _____ |
| 7 (Q 6) | 10 | _____ |

TOTAL SCORE (out of 100) _____

General Instructions

- (1) This is a CLOSED BOOK exam; nothing is allowed except a few pencils or pens, eraser, and student ID.
- (2) Please WRITE LEGIBLY & CLEARLY; minimize erasing! Untidy/illegible work will NOT be graded.
- (3) Print your name after acknowledging the student honor code. Write your name on each exam page in the space provided.
- (4) Use the back of the exam pages as scratch paper, if necessary.
- (5) If suspected of/caught cheating, you will receive at best an F for the exam. The instructor reserves the right to proceed further in compliance with university policies on academic violations.
- (6) You may not leave the room after the exam has started. Please leave quietly after you submit your exam to the TA or instructor.

Periodic Table

| | | | | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| H | | | | | | | | | | | | | | | | | | He |
| Li | Be | | | | | | | | | | | B | C | N | O | F | Ne | |
| Na | Mg | | | | | | | | | | | Al | Si | P | S | Cl | Ar | |
| K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr | |
| Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe | |
| Cs | Ba | La | Ha | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn | |
| Fr | Ra | Ac | | | | | | | | | | | | | | | | |

CHEM 3311 Table of Acidities

| <u>Acid</u> | <u>pK_a Value</u> |
|-------------|-----------------------------|
|-------------|-----------------------------|

| | |
|----------------------------------|-------|
| HI | -10.1 |
| HCl | -3.9 |
| H ₃ O ⁺ | -1.7 |
| CH ₃ COOH | 4.7 |
| NH ₄ ⁺ | 9.3 |
| Phenol | 10 |
| H ₂ O | 15.7 |
| Alcohols | 16-18 |
| HC≡CH | 26 |
| NH ₃ | 36 |
| H ₂ C=CH ₂ | 45 |
| CH ₄ | 60 |

1) Multiple Choice Questions (4 points each)

(i) Which compound or ion does NOT have any lone pairs in its best Lewis structure?

- (A) CH_3NO_2 (nitromethane) (B) CN^\ominus
 (C) NH_4^+ (D) $(\text{CH}_3)_2\text{OH}^+$ (protonated dimethylether)

(ii) Which compound contains polar covalent bonds and is a polar molecule?

- (A) BF_3 (B) CCl_4 (C) CO_2 (D) (Z)-1,2-Dichloroethene

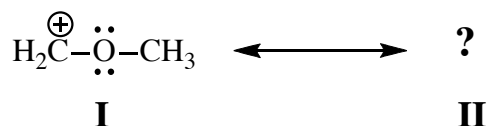
(iii) Draw the correct Lewis structure for the protonated alcohol, CH_3OH_2^+ . What is the hybridization of the **oxygen** atom?

- (A) sp (B) sp^2 (C) sp^3 (D) none of these

(iv) How many constitutional isomers of C_6H_{14} are there?

- (A) 3 (B) 4 (C) 5 (D) 6

(v) The structure of the methoxymethyl cation is a resonance hybrid of 2 structures. One of these is shown below:



Draw the second (**II**) contributing Lewis structure and then select the statement that best describes the resonance hybrid for the cation structure.

- (A) Both structures contribute equally to the structure of the cation.
 (B) Structure **I** is the major contributor to the structure of the cation.
 (C) Structure **II** is the major contributor to the structure of the cation.
 (D) Neither structure contributes to the structure of the cation.

(vi) Using MO theory, select the species that may not exist.

- (A) H_2^+ (B) H_2^- (C) He_2 (D) He_2^+

1) Multiple Choice Questions (4 points each)

(vii) Which of these is a secondary amine?

- (A)
- $(\text{CH}_3)_3\text{N}$
- (B)
- $\text{CH}_3\text{CONHCH}_3$
- (C)
- $\text{CH}_3\text{CON}(\text{CH}_3)_2$
- (D)
- $(\text{CH}_3)_2\text{NH}$

(viii) Which alkene would release the least amount of heat on combustion?

(A) 2-Methyl-2-butene

(B) 1-Pentene

(C) (E)-2-Pentene

(D) (Z)-2-Pentene

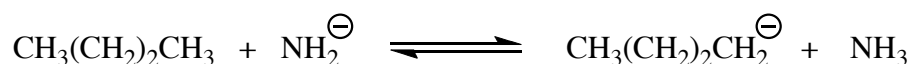
(ix) Which of these is a strong base?

- (A)
- $\text{HC}\equiv\text{C}:\ominus$
- (B)
- NH_4^\oplus
- (C)
- NH_3
- (D)
- $\text{CH}_3\text{COO}^\ominus$

(x) Which is the relatively strongest base among the four choices listed?

- (A)
- $\text{CH}_3\text{O}^\ominus$
- (B)
- $\text{HC}\equiv\text{C}:\ominus$
- (C)
- OH^\ominus
- (D)
- NH_2^\ominus

(xi) Predict the magnitude of the equilibrium constant for the reaction:



- (A)
- $K < 1$
- (B)
- $K = 0$
- (C)
- $K = 1$
- (D)
- $K > 1$

(xii) Consider the acid-base reaction between NH_3 and HCl . Select the statement that correctly represents the molecular orbitals involved in this electron transfer reaction.

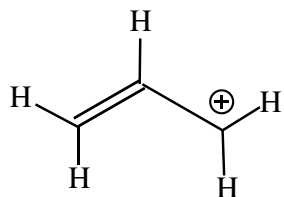
- (A) Electrons are transferred from the σ_{HCl} MO to the nonbonding MO in the NH_3 molecule.
- (B) Electrons are transferred from the nonbonding MO in the NH_3 molecule to the σ_{HCl} MO.
- (C) Electrons are transferred from the nonbonding MO in the NH_3 molecule to the σ^*_{HCl} MO.
- (D) Electrons are transferred from the σ^*_{HCl} MO to the nonbonding MO in the NH_3 molecule.

Total Points Possible: 24

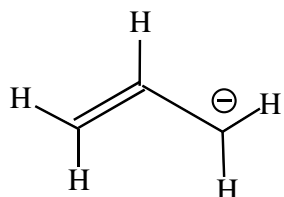
Your Score _____

2A) 6 points

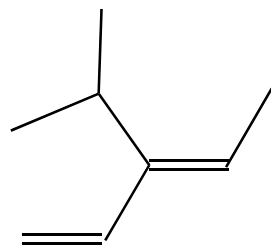
Draw the most important resonance structure for the **cation** (IN THE BOX) shown below. Using the curved arrow notation, show all arrows required to go from one resonance structure to the other (BOTH structures should have arrows).

**2B) 6 points**

Draw the most important resonance structure for the **anion** (IN THE BOX) shown below. Using the curved arrow notation, show all arrows required to go from one resonance structure to the other (BOTH structures should have arrows).

**3A) 6 points**

Give the IUPAC name (IN THE BOX) of the compound shown below, including the (*E*, *Z*) designation for the double bond stereochemistry.

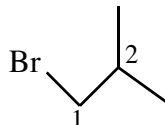
**3B) 6 points**

Draw the correct stereoisomer with the IUPAC name: (*Z*)-3-isobutyl-2-heptene.

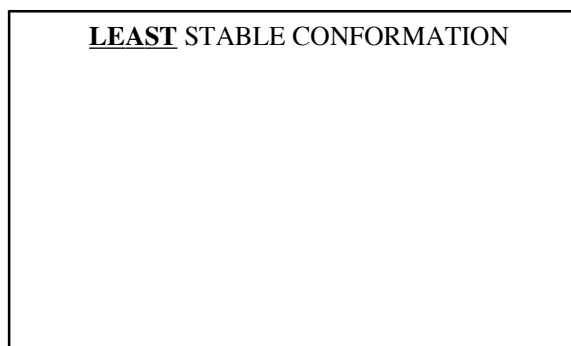
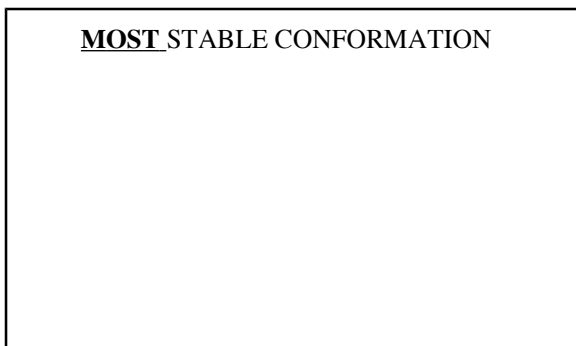


4) 8 points

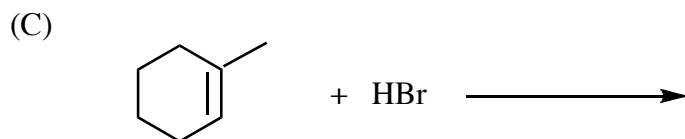
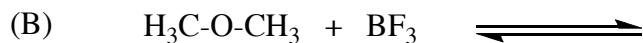
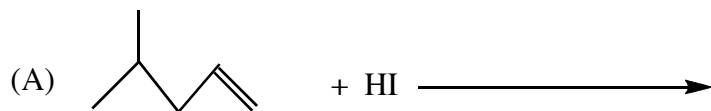
Examine the molecule shown below:



Sighting down the C1-C2 bond, draw the Newman projections (in the CORRECT BOXES) for the (i) most stable and (ii) least stable conformations of the molecule shown above.

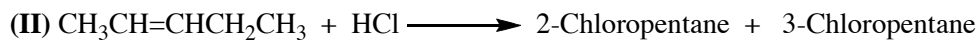
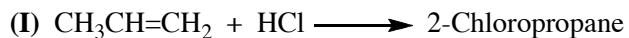
**5) 10 points**

Draw the structure of the single major product in each of the following reactions.



6) 10 points

Consider the reactions shown below:



Draw the structure (IN THE APPROPRIATE BOX) of each carbocation that leads to the product shown. To receive credit, you **MUST SHOW** the **curved arrow notation** for the capture of EACH carbocation by the nucleophile. You **MUST SHOW lone pairs and formal charges** where relevant, as well as the curved arrow formalism.

