

Answer Key

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															

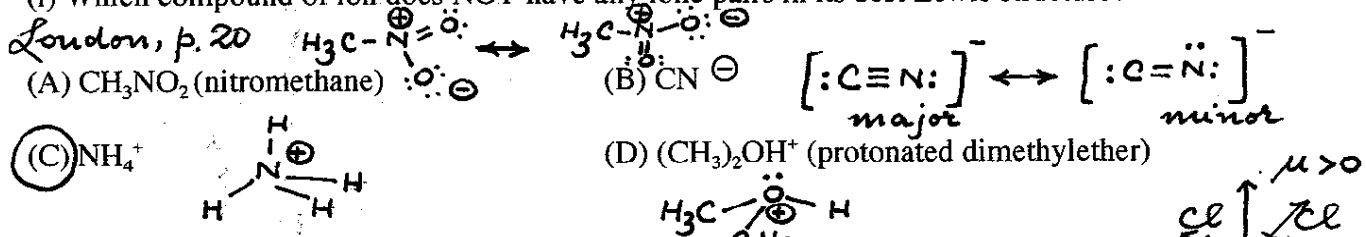
CHEM 3311 Table of Acidities

Acid **pK_a Value**

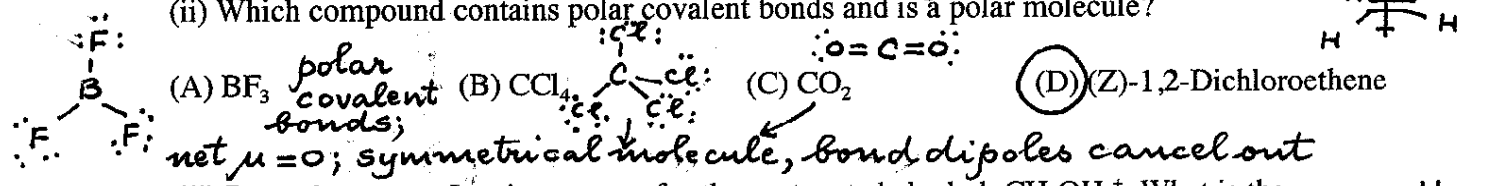
HI	-10.1
HCl	-3.9
H ₃ O ⁺	-1.7
CH ₃ COOH	4.7
NH ₄ ⁺	9.3
Phenol	10
H ₂ O	15.7
Alcohols	16-18
HC≡CH	26
NH ₃	36
H ₂ C=CH ₂	45
CH ₄	60

1) Multiple Choice Questions (4 points each)

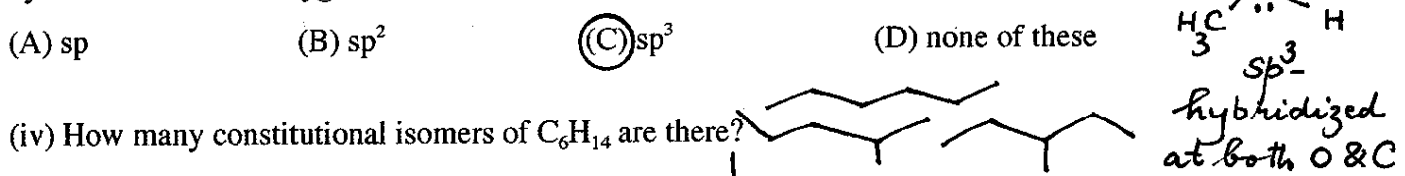
(i) Which compound or ion does NOT have any lone pairs in its best Lewis structure?



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



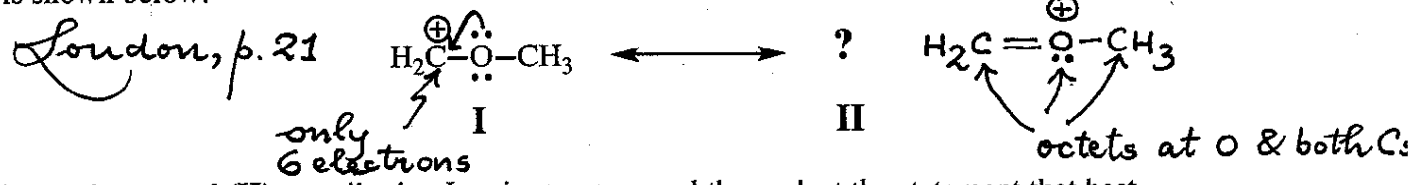
(iii) Draw the correct Lewis structure for the protonated alcohol, CH_3OH_2^+ . What is the hybridization of the oxygen atom?



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



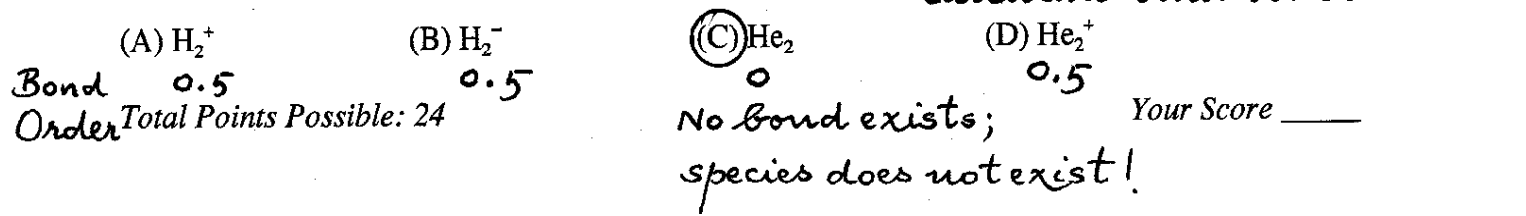
(v) The structure of the methoxymethyl cation is a resonance hybrid of 2 structures. One of these is shown below:



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. *Draw correlation diagrams & calculate bond order.*



1) Multiple Choice Questions (4 points each)

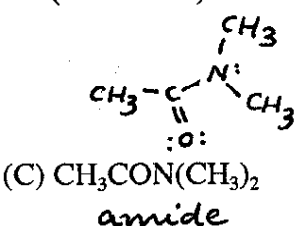
(vii) Which of these is a secondary amine?



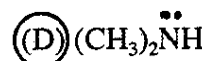
3° amine



amide



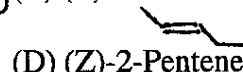
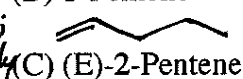
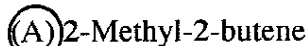
amide



2° amine

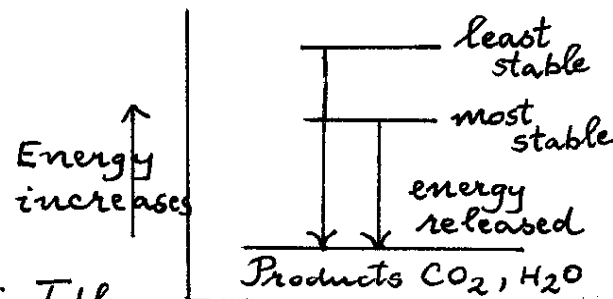
(viii) Which alkene would release the least amount of heat on combustion?

exothermic process

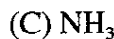
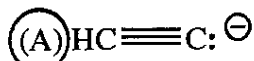


most highly substituted alkene; relatively most stable

constitutionally isomeric alkenes



(ix) Which of these is a strong base? *Refer to Acidities Table*



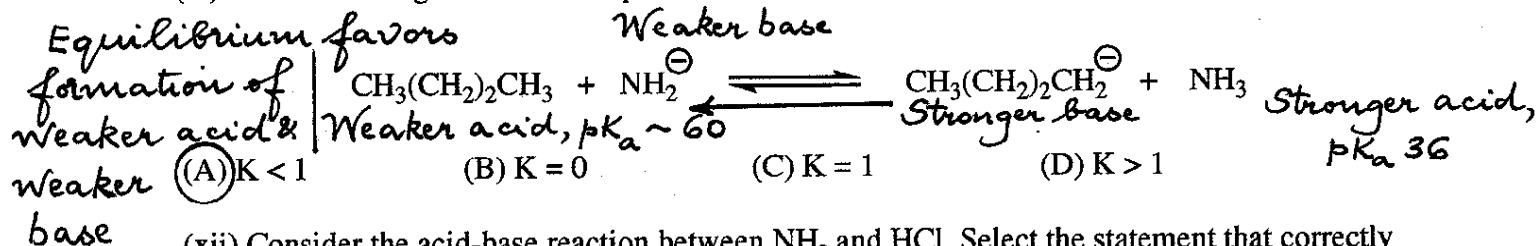
Strong bases: $OH^{\ominus}, OR^{\ominus}, HC\equiv C:^{\ominus}, :NH_2^{\ominus}, CH_2=C:^{\ominus}, RCH_2^{\ominus}$

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

Refer to Acidities Table. Weaker the acid, stronger the conjugate base



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



(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.

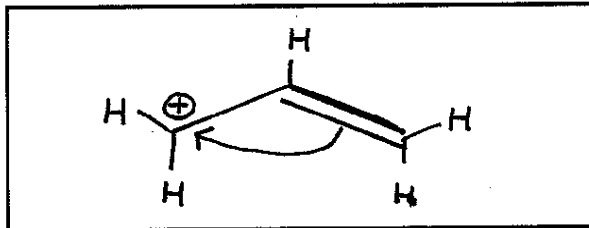
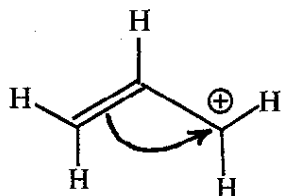
- (A) Electrons are transferred from the σ_{HCl} MO to the nonbonding MO in the NH_3 molecule.
- (B) Electrons are transferred from the nonbonding MO in the NH_3 molecule to the σ_{HCl} MO.
- (C) Electrons are transferred from the nonbonding MO in the NH_3 molecule to the σ^*_{HCl} MO.
- (D) Electrons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

Total Points Possible: 24 Your Score _____

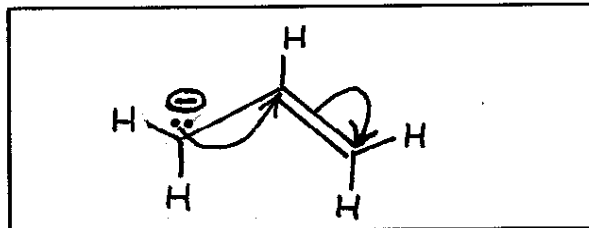
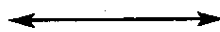
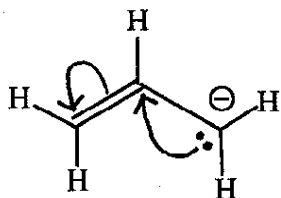
*Lone pair in NH_3 is in the nonbonding MO of NH_3 . Lone pair is transferred to empty antibonding MO of HCl , σ^*_{HCl} ; O-H bond breaks as H^+ is accepted by NH_3 .*

2A) 6 points

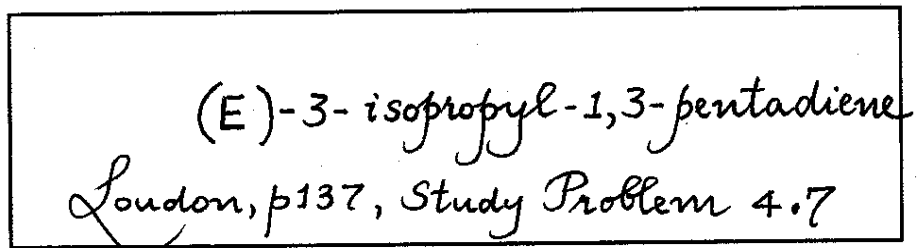
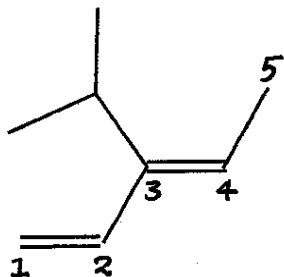
Draw the most important resonance structure for the **cation** (IN THE BOX) shown below. Using the curved arrow notation, show all arrows required to go from one resonance structure to the other (BOTH structures should have arrows).

**2B) 6 points**

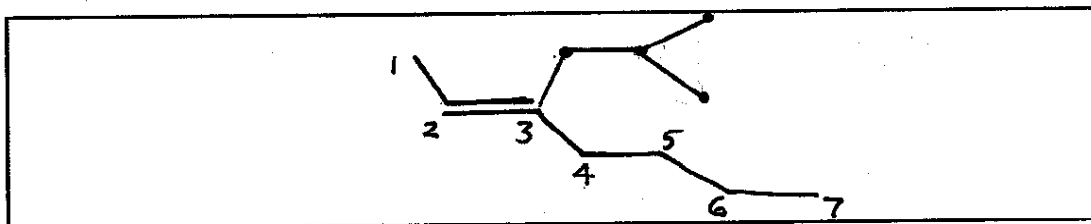
Draw the most important resonance structure for the **anion** (IN THE BOX) shown below. Using the curved arrow notation, show all arrows required to go from one resonance structure to the other (BOTH structures should have arrows).

**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.

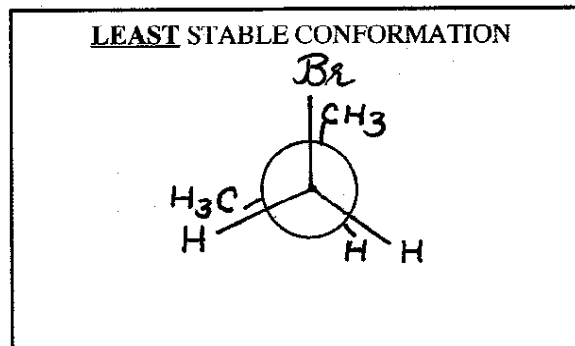
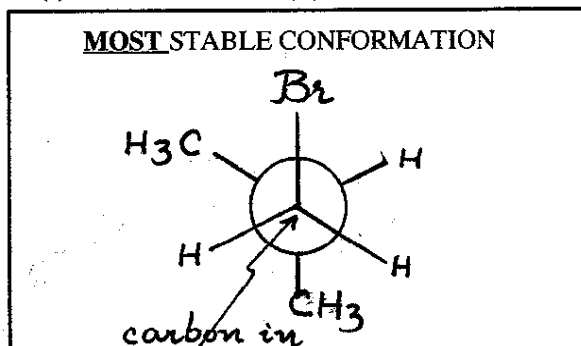


4) 8 points

Examine the molecule shown below:

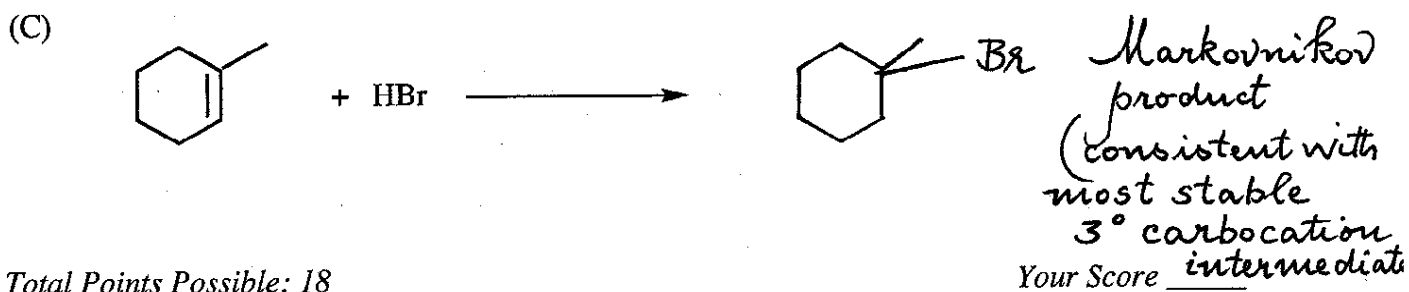
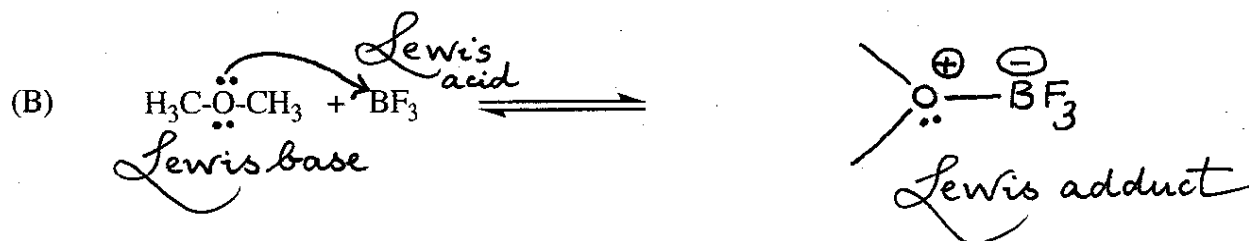
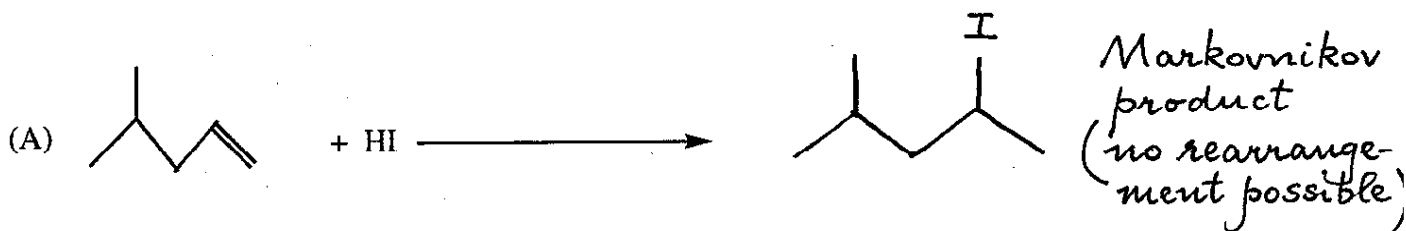


Sighting down the C1-C2 bond, draw the Newman projections (in the CORRECT BOXES) for the (i) most stable and (ii) least stable conformations of the molecule shown above.



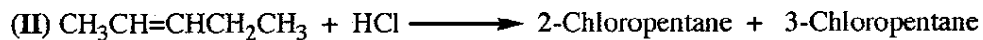
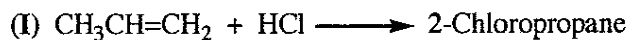
5) 10 points

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.

