CHEM 233, Fall 2019 Midterm #3 Ian R. Gould

COMPLETE THIS SECTION : Up to TWO POINTS will be removed for incorrect/missing information!

PRINTED **FIRST** NAME **ANSWER KEY** PRINTED **LAST** NAME _____

Person on your **LEFT** (or **Empty** or **Aisle**) _____

Person on your **RIGHT** (or **Empty** or **Aisle**) _____

Class you are REGISTERED FOR (onground or hybrid) _____

The room where most students will take the test for your class, i.e. LS A-191 for onground and PS H-152 for hybrid) _____

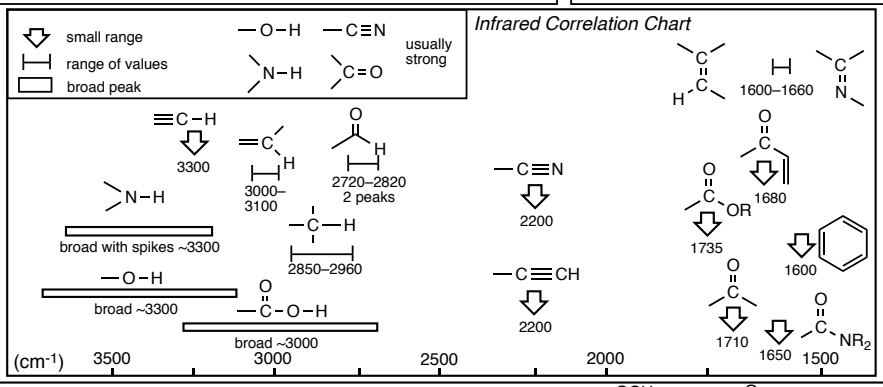
*****YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM*****

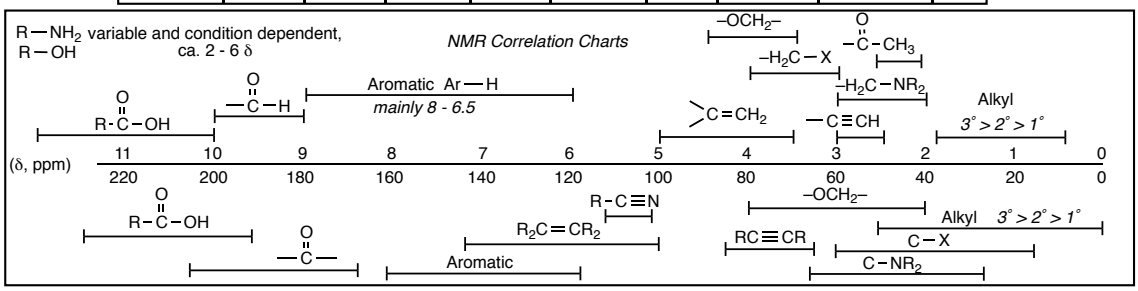
- *PRINT YOUR NAME ON EACH PAGE!*
- *READ THE DIRECTIONS CAREFULLY!*
- *USE BLANK PAGES AS SCRATCH PAPER*
  work on blank pages will not be graded...
- *WRITE CLEARLY!*
- *MOLECULAR MODELS ARE ALLOWED*
- *DO NOT USE RED INK*
- *DON'T CHEAT, USE COMMON SENSE!*

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	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn

Interaction Energies, kcal/mol

Eclipsing		Gauche	
H/H	~1.0	Me/Me	~0.9
H/Me	~1.4	Et/Me	~0.95
Me/Me	~2.6	i-Pr/Me	~1.1
Et/Et	~3.1	t-Bu/Me	~2.7





YOU MUST COMPLETE THIS PAGE WITH YOUR NAME
(EVEN THOUGH YOU ALREADY DID THIS ON THE COVER PAGE)
AND ALSO GIVE YOUR ASU OR POSTING ID NUMBER
WE NEED THIS NUMBER BECAUSE YOU WOULDN'T BELIEVE THE NUMBER OF STUDENTS WHOSE NAMES WE CAN'T READ!

PRINTED **FIRST** NAME _____ *PRINTED* **LAST** NAME _____ *ASU ID or Posting ID* _____

Points by question

1_____**/14**

2_____**/21**

3_____**/12**

4_____**/36**

5_____**/18**

6_____**/20**

7_____**/30**

8_____**/24**

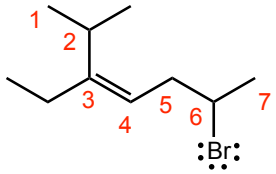
Points Removed for cover errors ____/2

Extra Credit_____/5

Total (incl Extra)_____/175+5

*****YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM*****

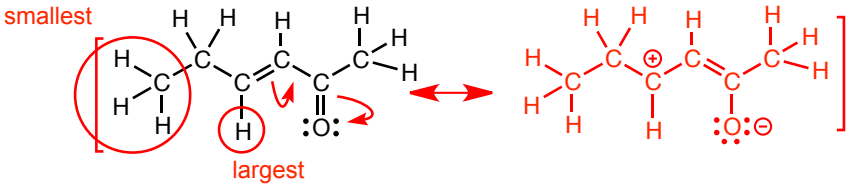
Question 1 (14 pts.) Give the IUPAC name for the following structure, include all stereochemistry as appropriate.



6-bromo-3-ethyl-2-methyl-(3Z)-heptene

Question 2 (21 pts) For the **proton nmr spectrum** of the provided structure, circle the hydrogen atom or atoms that would have the smallest chemical shift, and also the hydrogen atom or atoms that would have the largest chemical shift, clearly indicate which is which. **Give a BRIEF EXPLANATION that includes the term DESHIELDING.**

To determine which proton has the largest chemical shift yo**u will need to draw a minor resonance contributor**, draw this minor contributor as part of your answer, be sure to include all curved arrow pushing, resonance arrows and rersonance brackets.

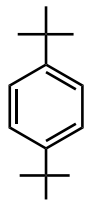


the protons with the smallest chemical shift are least deshielded, they are farthest from the functional groups

the minor resonance contributor shows a partial positive charge on the carbon carrying the proton, which deshields and increases chemical shift

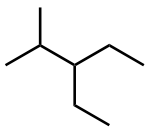
Question 3 (12 pts.) For each of the following 2 structures, indicate how many signals would you expect to see in a ^{13}Carbon nmr spectrum.

four



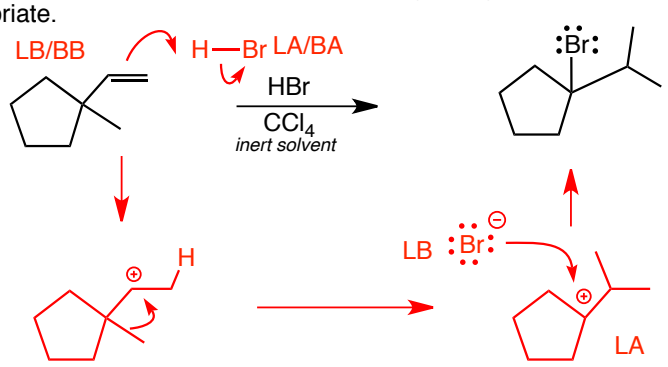
grading:
2 = 2 pts
3 = 3 pts
4 = 6 pts
6 = 3 pts
8 = 2 pts

five



grading:
3 = 2 pts
4 = 3 pts
5 = 6 pts
6 = 3 pts
8 = 1 pt

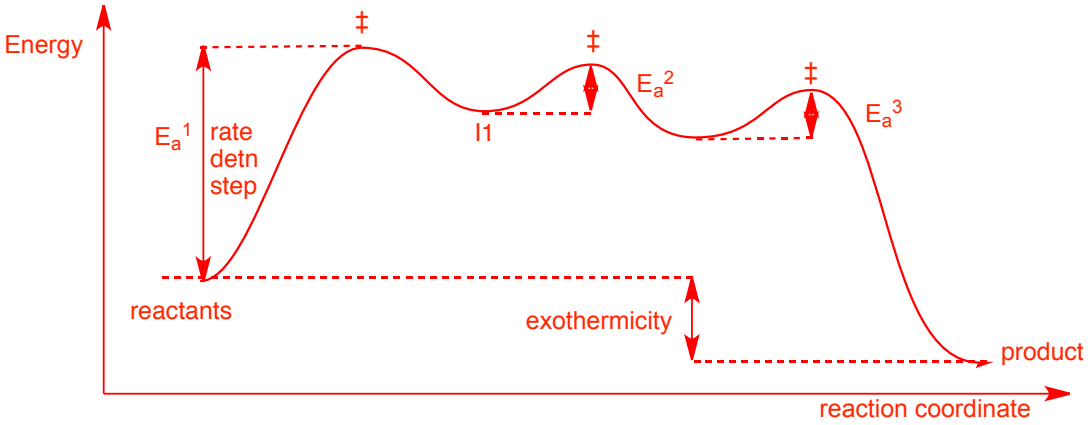
Question 4 (36 pts) Give the curved-arrow pushing fo the following reaction. For each INTERMOLECULAR, indicate the Lewis acid/base (LA/LB) and Bronsted acid/base (BA/BB) where appropriate.



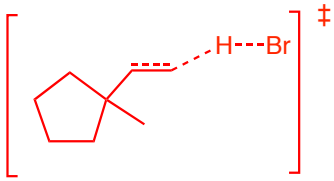
b) How many steps are there in your mechanism? depends upon their mxn

c) How many transition states are associated with your mechanism? depends upon their mxn

d) Draw a reaction energy diagram for your mechanism, label the axes, indicate the positions of the reactants, prodicts and any intermediates (don't redraw the structures, you can circle the items on the mechanism and use arrows, or use symbols such as I1 for intermediates 1 etc.). Indicate the **ACTIVATION ENERGY FOR EACH STEP**, the **REACTION EXOTHERMICITY** and the **RATE DETERMINING STEP.**

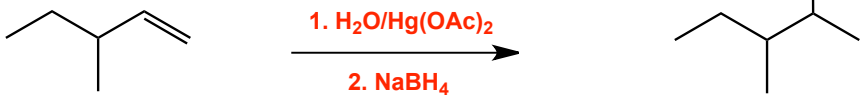


e) Draw below the TRANSITION STATE for the rate determining step (only)

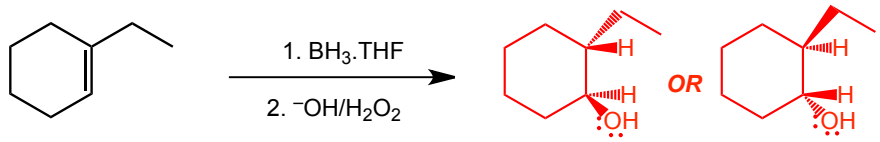


Question 5 (18 pts.) Give the missing major organic products OR reagents/conditions as appropriate for each of the following reactions, include all non-bonding electrons.

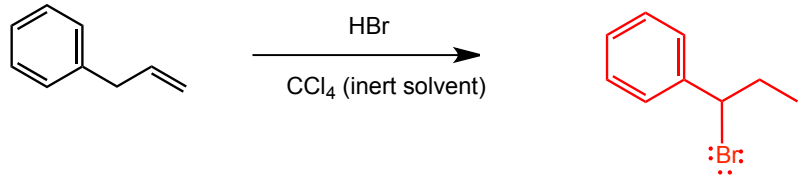
a)



b)



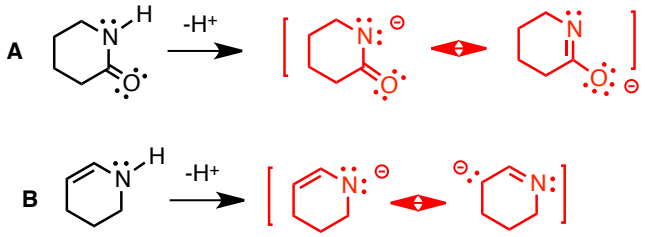
c)



Extra Credit (5 pts) Dr. Gould had a conversation with his daughter about which topic?

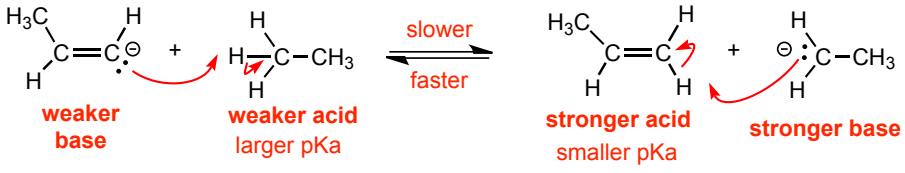
cis- and trans-	saturated and unsaturated	acids and bases	Markovnikov and Anti-Markovnikov

Question 6 (20 pts.) For the structures **A** and **B**, draw the conjugate base anion formed upon deprotonation of the hydrogen atoms bonded to nitrogen, indicated, be sure to include ALL resonance structures where appropriate.Indicate which would be the stronger Bronsted acid, **A** or **B**, and give a BRIEF explanation for your choice.

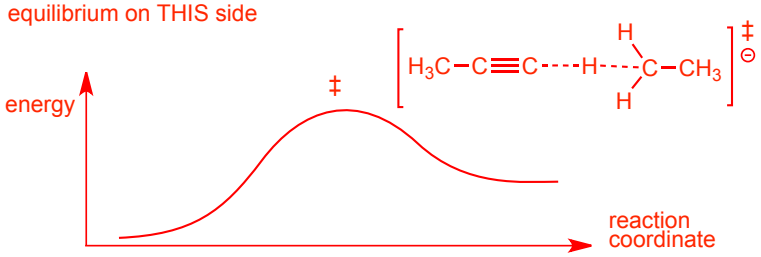


deprotonation of A gives a resonance stabilized anion with negative charges on N and O, which makes the most stable anion, deprotonation of B puts the negative charge on N and C which is thus higher in energy than that from C, hiugher energy electrons in the base means stronger base and weaker conjugate acid

Question 7 (30 pts.) For the following Bronsted acid/base equilibrium:
1. Give the curved arrow-pushing and indicate the stronger and weaker acid and base on each side and indicate which acid has the larger and smaller pKa values
2. Draw a reaction energy diagram, indicate which reaction would be faster and on which side the equilibrium would lie, give a BRIEF explanation that includes drawing of resonance cointributors as appropriate
3. Give a drawing of the transition state



equilibrium on THIS side

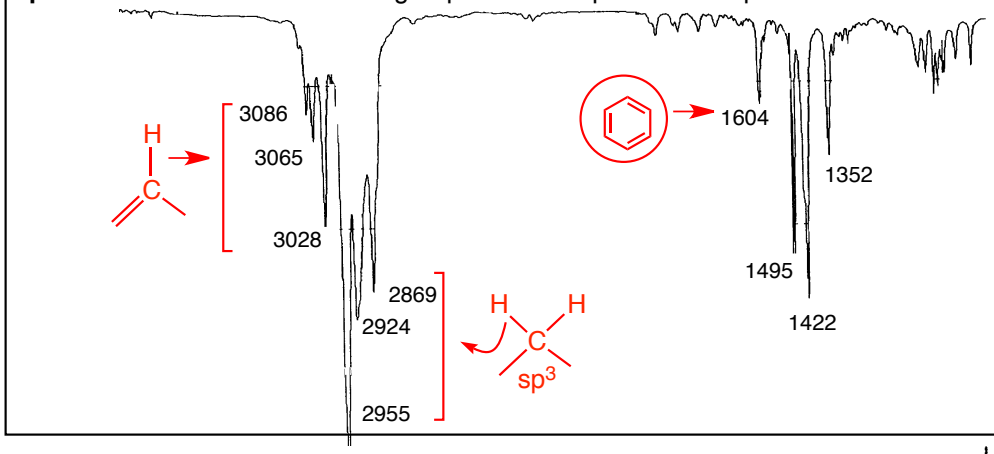


the anion base on the left is more stable (it has lower energy electrons) due to the non-bonding electrons in an sp hybridized orbital compared to sp3 on the right, thus the base on the left is weaker, the conjugate acid is stronger, the stronger acid and stronger base react faster

Question 8 (24 pts) Provided are spectra for a compound with molecular formula $C_{10}H_{14}$

a) Give the degrees of unsaturation 4

b) On the infrared spectrum, indicate which peaks correspond to which functional groups (including C(sp^3)-H). Indicate **BOTH the functional group**, and where appropriate, **the specific BOND** in the functional group that corresponds to the peak.



c) draw the structure **and clearly indicate which hydrogens correspond to which signals in the proton nmr spectrum**