CHEM 233, Fall 2018 Final Exam Ian R. Gould

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

PRINTED **FIRST** NAME _____ 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) _____

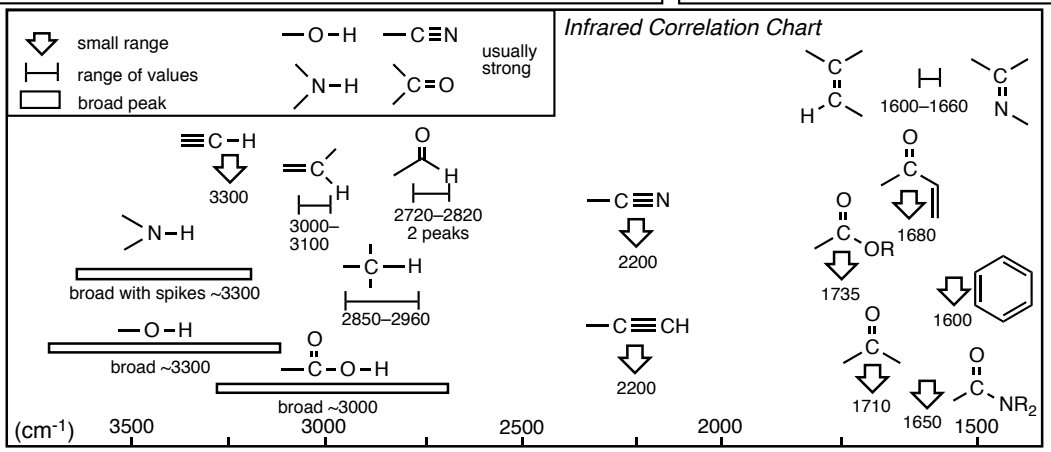
*****YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM*****

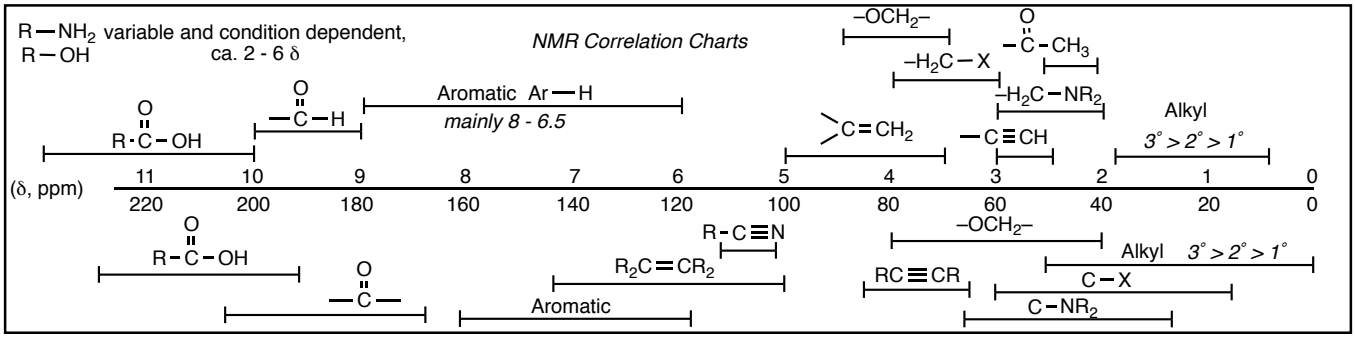
- *PRINT YOUR NAME ON EACH PAGE!*
- *READ THE DIRECTIONS CAREFULLY!*
- *USE BLANK PAGES AS SCRATCH PAPER*
  work on blank pages will not be graded...
- *WRITE CLEARLY!*
- *MOLECULAR MODELS ARE ALLOWED*
- *DO NOT USE RED INK*
- *DON'T CHEAT, USE COMMON SENSE!*

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_____/15

2_____/30

3_____/18

4_____/32

5_____/32

6_____/22

7_____/63

8_____/24

9_____/30

10_____/42

11_____/18

12_____/24

13_____/25

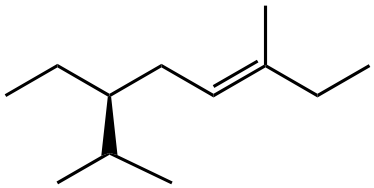
Points Removed for cover errors ____/2

Extra Credit_____/5

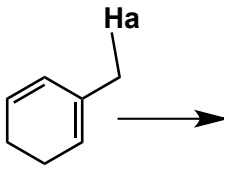
Total (incl Extra)_____/375+5

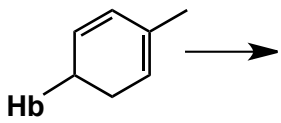
*****YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM*****

Question 1 (15 pts.) Give the IUPAC name for the following. Specify stereochemistry as appropriate.

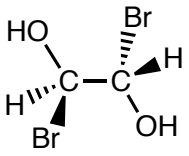


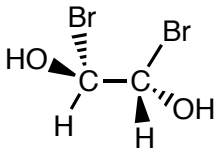
Question 2 (30 pts.) For each of the two C-H bonds indicated below as C-**Ha** and C-**Hb**:
a) Draw the curved arrow pushing for bond cleavage and show the products, including all reasonable resonance contributors as appropriate.
b) Indicate which has the larger bond dissociation energy.
c) Draw an energy diagram for homolytic cleavage of the two C-H bonds
d) Give a BRIEF explanation for the difference in bond dissociation energies that includes:
• The energies of the electrons in the bonds
• The energies of the electrons in the radicals





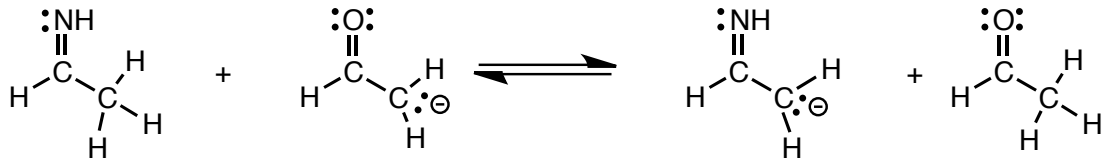
Question 3 (18 pts.)
1. Determine whether the following structures are identical, enantiomers or diastereomers
2. Identify any meso compounds.
3. Give the absolute configuration at each chiral (asymmetric) center



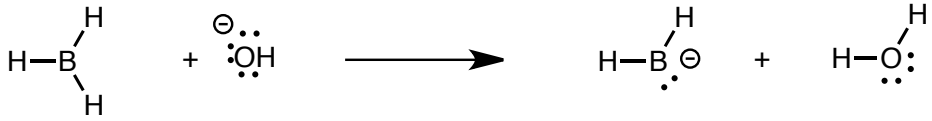


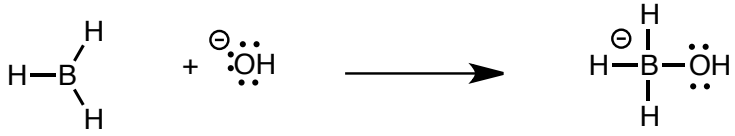
Question 4 (32 pts) For the acid/base reaction shown below
a) add the curved arrow pushing that shows bond making/breaking **IN BOTH DIRECTIONS**
b) identify the stronger and weaker acids and stronger and weaker bases, **and give a brief explanation for your choice**
c) state which reaction would have the larger rate constant (be faster) left to right or right to left
d) identify on which side the equilibrium would lie
e) draw a reaction energy diagram that includes a drawing of the transition state

if your explanation uses resonance arguments, draw all important resonance contributors

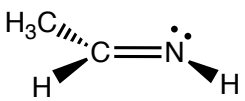


Question 5 (32 pts.) For the following reactions A and B
a) Add the curved arrows that indicated bond breaking/making and indicate the Lewis acid/base and whether they are also Brønsted acids/bases
b) Draw a reaction energy diagram for both ON THE SAME DIAGRAM, clearly indicating which is which, and draw the TRANSITION SATES for each reaction and indicate their positions on the diagrams
c) One of tehse reactions is EXOTHERMIC, the other is ENDO thermic. On the diagram, indicate the activation energy and the endo- or exothermicity as appropriate for each reaction and give a brief explanation for your choice of endothermic or exothermic reaction

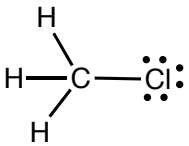
A 

B 

Question 6 (22 pts.) For the orbitals indicated
a) Draw a picture of the Ψ for the molecular orbital requested ON TOP of the structures
b) Indicate the atomic orbital or orbitals that you used to construct the requested orbitals
c) Indicate the positions of any nodes in the moelcular orbitals

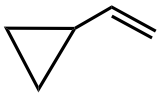


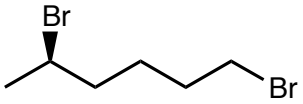
Ψ for the C-N π M.O.

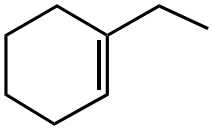


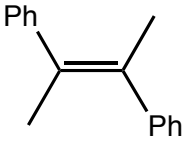
Ψ for the C-Cl σ* M.O.

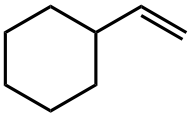
Question 7 (63 pts.) Give the missing major **ORGANIC PRODUCT** for each reaction
a) **Show all stereochemistry** as appropriate**, identify any MESO compounds**
b) **Briefly explain whether and why a solution of the product would be optically active or not**
c) assign each reaction as addition, elimination, substitution or rearrangement

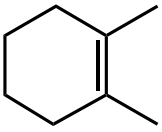
a) 

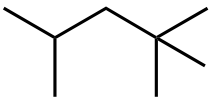
b) 

c) 

d) 

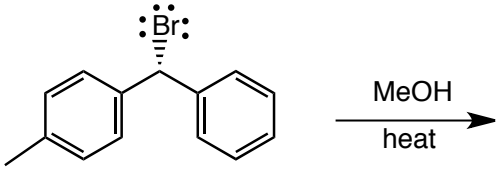
e) 

f) 

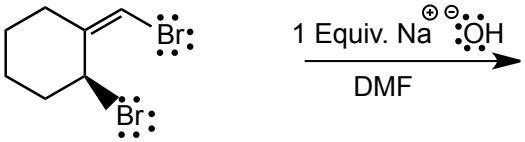
g) 

Question 8 (24 pts.) Give the missing major organic product for each reaction
a) **Show all stereochemistry** as appropriate
b) Briefly explain whether and why a solution of the product would be optically active or not
c) Assign each reaction as SN1 or SN2 and give a very brief explanation for your choice

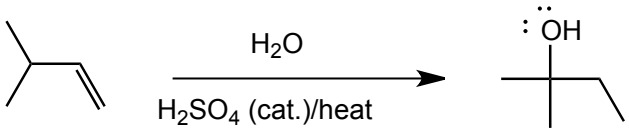
a)



b)



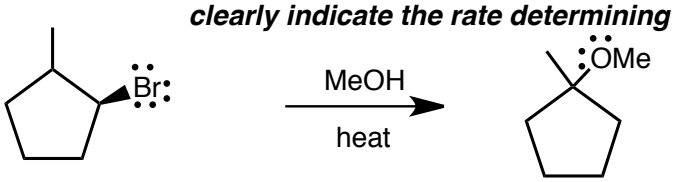
Question 9 (30 pts.) Provide a curved-arrow pushing mechanism for the following reaction, indicate the Lewis acid and base at each step as appropriate, and whether they are also Bronsted acids and bases. Indicate the number of steps and the number of sets of intermediates.



number of steps _____ number of sets of intermediates _____

Question 10 (42 pts.)
a) Give a curved arrow mechanism for the provided bromide in hot methanol. Label the Lewis acid and Lewis base in each step as appropriate, and whether they are also Brønsted acids and bases. Indicate the number of sets of intermediates and transition states for each mechanism

clearly indicate the rate determining step

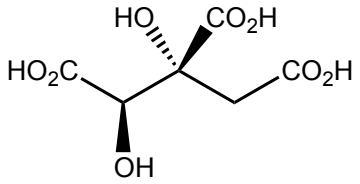


b) Draw a properly labelled reaction energy diagram the reaction. **Assume that the reaction is exothermic under the conditions**, do not draw any transition states, but **INDICATE THEIR POSITIONS Clearly indicate the activation energy for the rate determining step and the exothermicity for the reaction.**

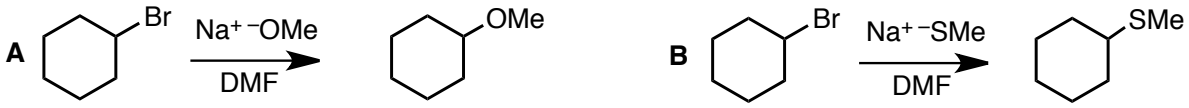
Extra Credit (5 pts) The hole in the ozone layer has been attributed to the atmospheric chemistry of which kind of molecule?

halides alkanes alkanes alcohols

Question 11 (18 pts) The 3D structure of (+)-hydroxycitric acid is shown below (non-bonding electrons omitted for clarity).
a) Indicate the positions of all chiral/asymmetric carbons with the * symbol
b) Give the absolute configuration for all chiral/asymmetric carbons
c) Draw a 3D structure for (–)-hydroxycitric acid and give the absolute configuration for ALL chiral/asymmetric carbons



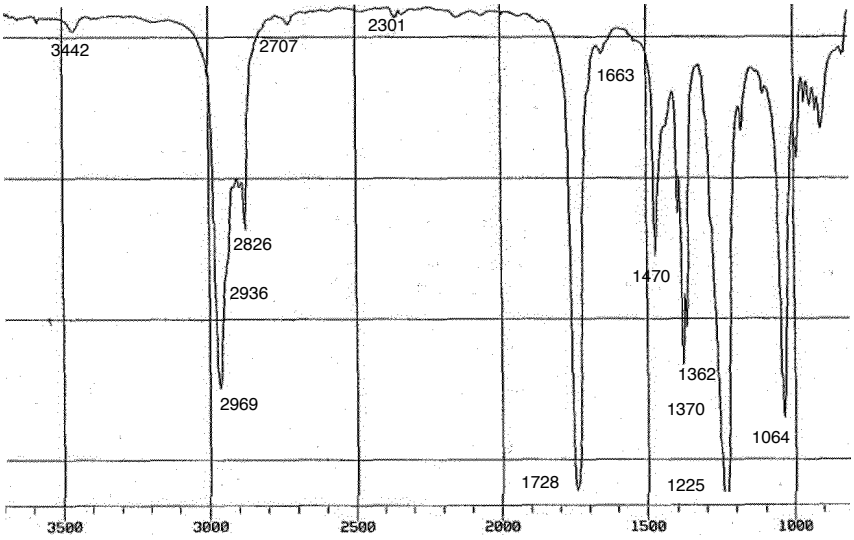
Question 12 (24 pts.) For the following two reactions:
a) Draw a reaction energy diagram for both on THE SAME DIAGRAM (normalize them at the reactants). **Indicate the positions of the transition states and the activation energies for both reactions and draw the transition state for reaction A only!**
b) Indicate which reaction is faster and give a BRIEF EXPLANATION that ibncludes:
• An indication of the type of mechanism for this reaction(SN1/SN2/E1/E2 etc.).
• An explanation for any differences base strength or nucelophile strength, as appropriate
• You must talk about how the Hammond postulate explains which reaction will be faster



Question 13 (25 pts) Provided are spectra for a compound with molecular formula $\mathbf{C_6H_{12}O_2}$

a) Give the degrees of unsaturation _____

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



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