CHEM 233, Fall 2017 Midterm #2 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) _____

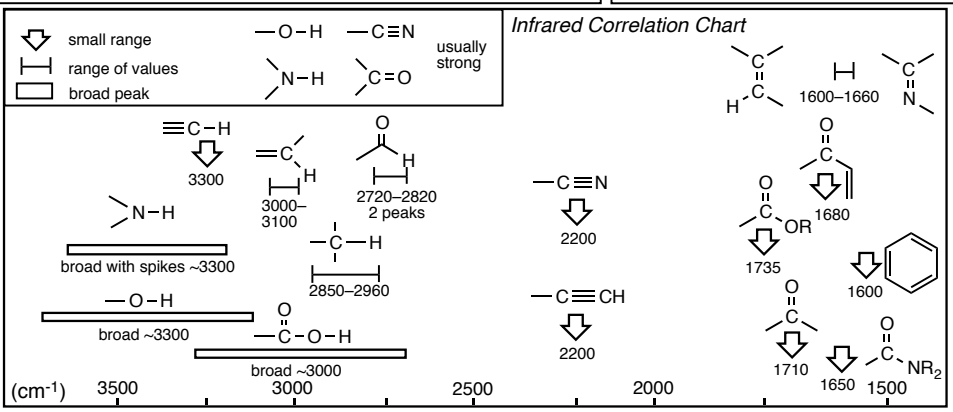
*****YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM*****

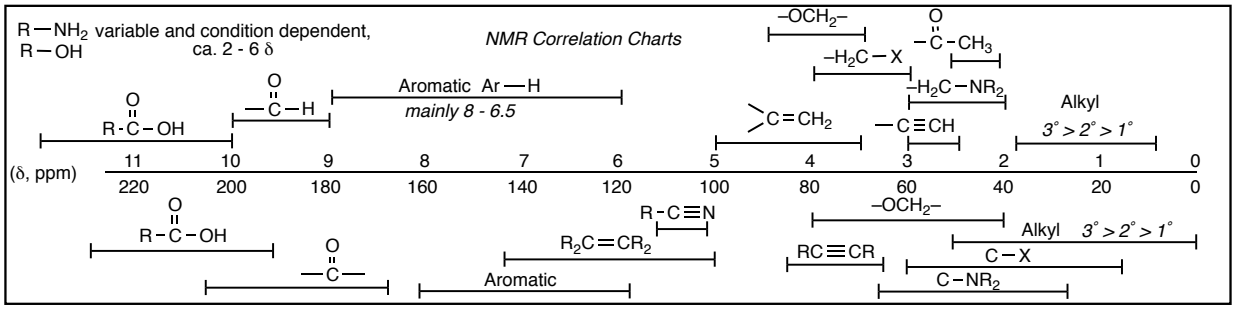
- *PRINT YOUR NAME ON EACH PAGE!*
- *READ THE DIRECTIONS CAREFULLY!*
- *USE BLANK PAGES AS SCRATCH PAPER*
  work on blank pages will not be graded...
- *WRITE CLEARLY!*
- *MOLECULAR MODELS ARE ALLOWED*
- *DO NOT USE RED INK*
- *DON'T CHEAT, USE COMMON SENSE!*

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
Et/H	~1.8	i-Pr/Me	~1.1
Me/Me	~2.6	t-Bu/Me	~2.7
Et/Me	~2.8		
Et/Et	~3.1		





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 **ANSWER** *PRINTED* **LAST** NAME **KEY** *ASU ID or Posting ID* _____

Points by question

1_____**/12**
2_____**/25**
3_____**/24**
4_____**/25**
5_____**/25**
6_____**/26**
7_____**/38**

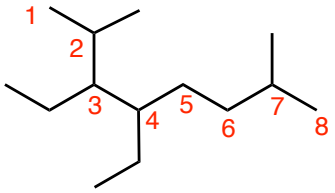
Points Removed for cover errors ____/2

Extra Credit_____/5

Total (incl Extra)_____/175+5

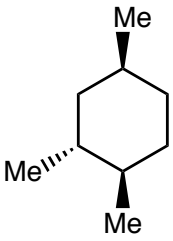
*****YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM*****

Question 1 (12 pts) Give the IUPAC name for the following structure

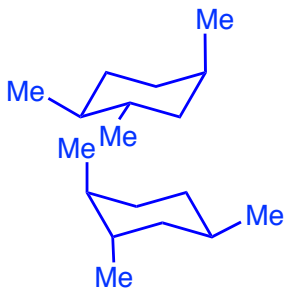


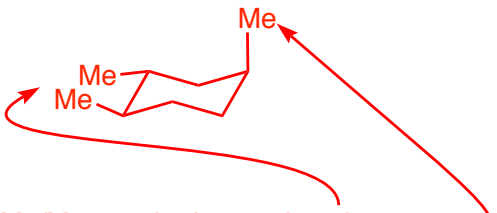
3,4-diethyl-2,7-dimethyloctane

Question 2 (25 pts) For the following structure
a) Draw **both chair conformations**
b) Determine the **energy difference** between the two chair conformations using the tables on the front page of this test, ***be sure to clearly show each energy contribution that you take into account when answering this question***
c) Indicate the **lower energy chair**

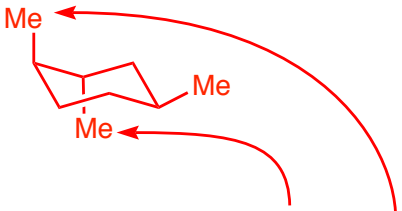


these are incorrect





1 xMe/Me gauche interactions here = 0.9
2 Me/Me gauche interactions here = 1.8
TOTAL = 2.7 kcal/mol



2 x Me/Me gauche interactions here = 1.8
2 x Me/Me gauche interactions here = 1.8
TOTAL = 3.6 kcal/mol

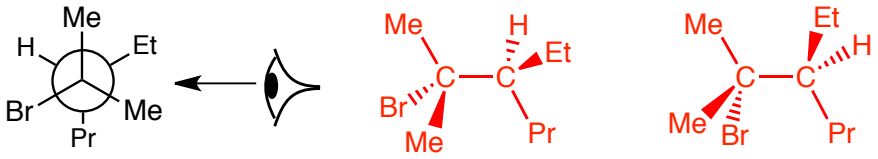
LOWER energy CHAIR

$\Delta E = 0.9$ kcal/mol

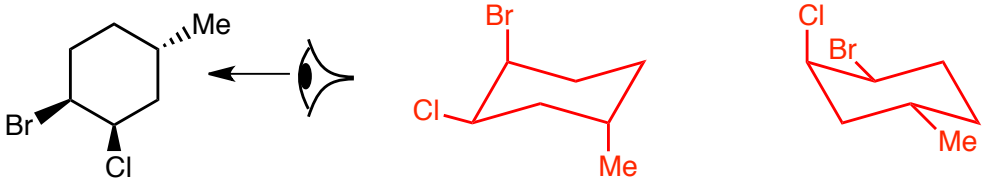
EXTRA CREDIT (5 pts) Which of these techniques forms the basis for the device that is used to detect traces explosives and/or narcotics at airport security checkpoints?

mass spectrometry	infrared spectroscopy	proton nmr spectroscopy	carbon nmr spectroscopy

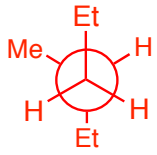
Question 3 (24 pts.) In this question, non-bonding electrons are omitted for clarity.
a) Convert the following Newman projection into a 3-D/sawhorse structure. You MUST draw your sawhorse as if you are looking at the structure from the direction indicated by the arrow.



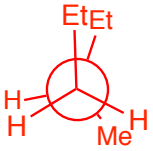
b) Draw BOTH chair conformations for the following cyclohexane. You MUST draw your chairs as if you are looking at the structure from the direction indicated by the arrow. You do NOT NEED to indicate which chair would be lower in energy.



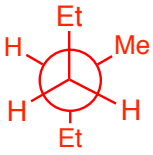
Question 4 (25 pts.) For 3-methylhexane
a) Draw a line-angle structure
b) Draw Newman projections (only, no 3-D/sawhorse structures) corresponding to the lowest AND highest energy conformations for rotation around the C3-C4 bond, **draw the Newmans looking FROM THE C4 CARBON TO THE C3 CARBON (i.e. with the C4 carbon in "front")**
c) Determine the energy difference between these conformations (use the data in the tables on the front page of this test), ***be sure to clearly show each energy contribution that you take into account when answering this question***



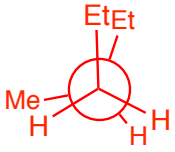
but if you did this then the eclipsed has to be this



OR...



but if you did this then the eclipsed has to be this

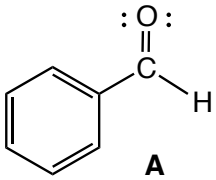


1 x Et/Me gauche interaction = 0.95 kcal/mol

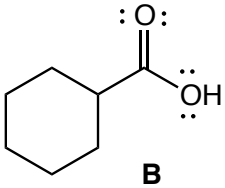
energy difference = 4.55 kcal/mol

1 x Et/Et eclipse interaction = 3.1 kcal/mol
1 x Me/H eclipse interaction = 1.4 kcal/mol
1 x H/H eclipse interaction = 1.0 kcal/mol
total = 5.5 kcal/mol

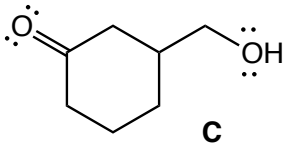
Question 5 (25 pts.) Assign the BOTH IR spectra to ONE of the THREE provided structures **A** - **C**. ONE of the structures does not have a provided spectrum. On each spectrum, **identify the peaks that are associated with a specific functional group or type of C-H** bond by **drawing the functional group or bond** and **drawing an arrow from the specific bond in the functional group that vibrates to the absorption peak**, as appropriate, include all C-H bond types.



A

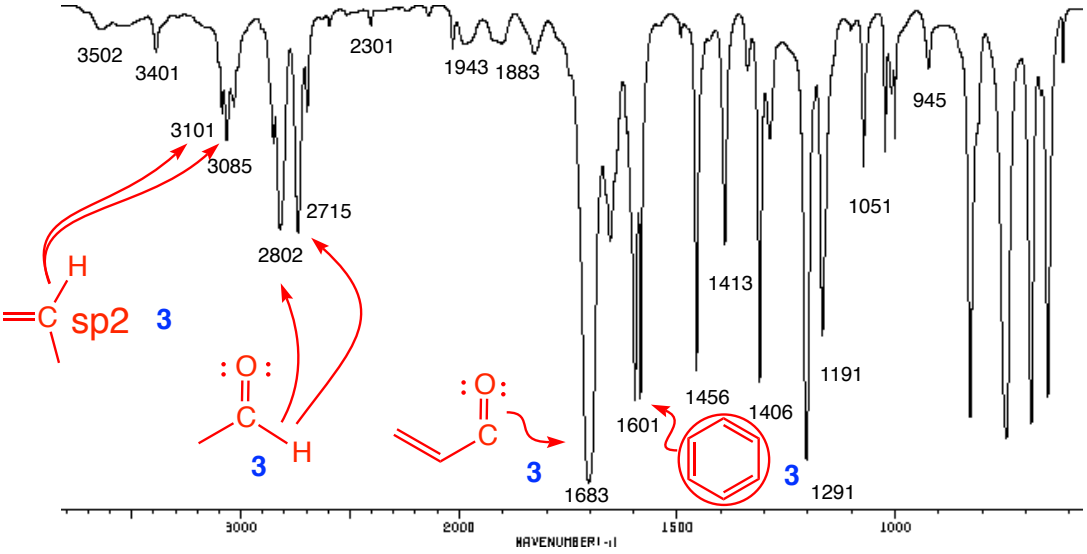


B

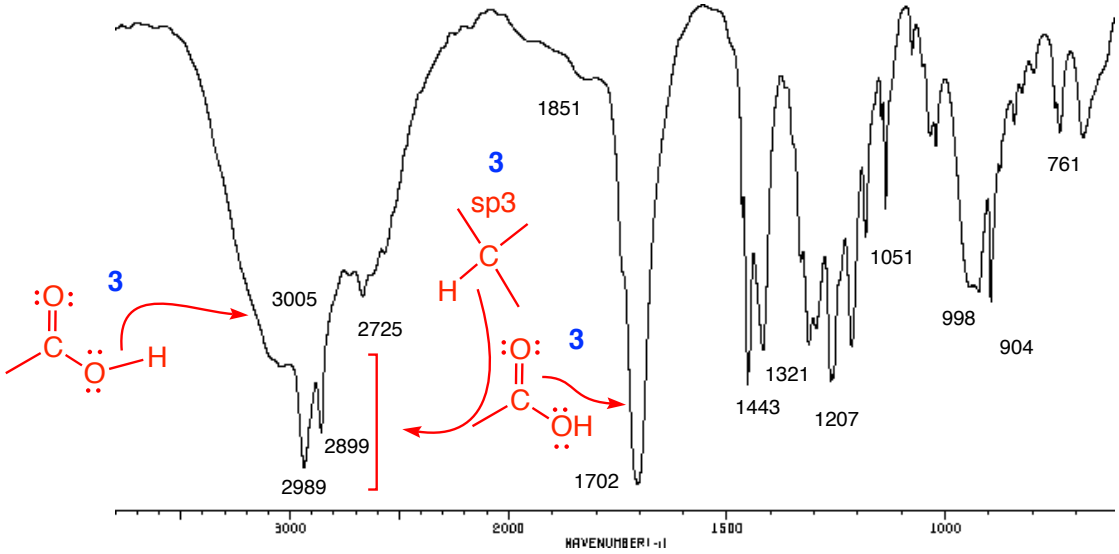


C

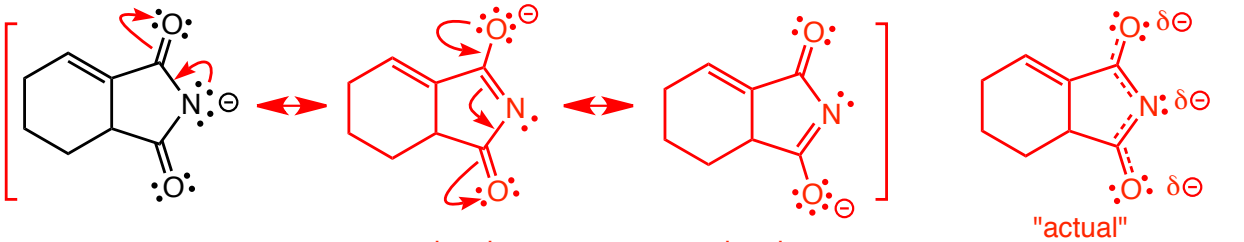
the spectrum below corresponds to structure **A** 2



the spectrum below corresponds to structure **B** 2



Question 6 (26 pts.) This anion is inadequately represented by the provided Lewis structure.
a) Draw additional resonance contributors that show how the negative charge is delocalized, include curved arrow-pushing and resonance arrows/brackets.
b) Indicate the major contributor or contributors and give a BRIEF justification for your choice that includes the phrase "energy of the electrons".
c) Draw an "actual" or resonance hybrid anion and on this structure AND, clearly indicate the atom or atoms where the greatest partial negative charge would be found (you should use the δ notation to indicate partial charges).
d) **The hybridization of the NITROGEN ATOM is** sp2



equal major equal major "actual"

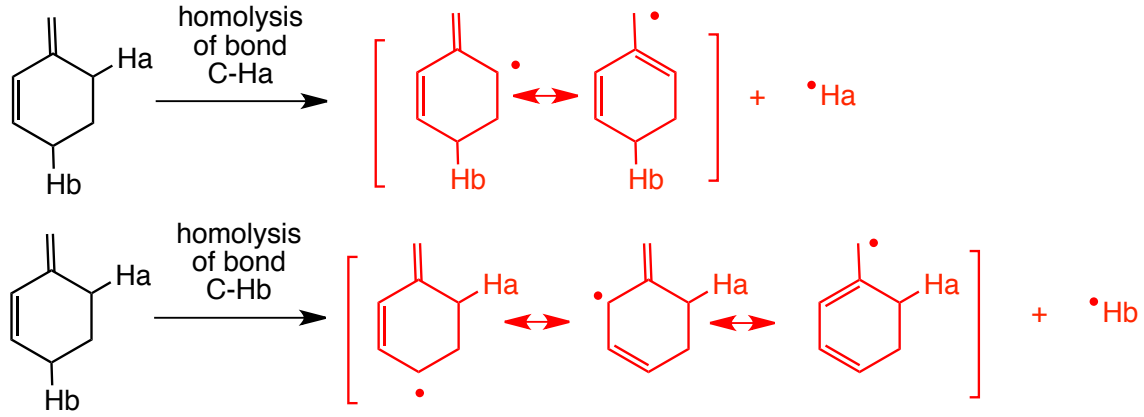
highest partial negative charge on the TWO oxygen atoms

the major contributors have the formal negative charge on the more electronegative oxygen atoms, which results in the lowest formal energy of the electrons

make SURE you answer ALL PARTS of this question!

Question 7 (38 pts.) The purpose of this question is to decided which of the bonds C-Ha and C-Hb, has the higher and which the lower bond dissociation energy.

a) Give the products of homolytic cleavage of both of the C-H bonds as indicated below, and include ALL REASONABLE resonance contributors for the radical products. It is not necessary to show the curved arrow pushing for either the bond cleavages or to show how the resonance contributors are interrelated, but if it helps you, you can include these. **But you MUST include all resonance arrows and resonance brackets.**



b) Indicate which of C-Ha and C-Hb has the larger and which the smaller bond dissociation energy and give a BRIEF explanation for your choice. Your explanation must include the term **"energy of the electrons**", or something close or equivalent.

homolytic cleavage of C-Ha generates a radical with 2 resonance contributors
homolytic cleavage of C-Hb generates a radical with 3 resonance contributors
more resonance contributors results in lower energy of the electrons in the radicalsthe lower energy radical costs less energy to form, C-Hb has the lower BDE

c) Axes for an energy diagram are provided below.
1) On these axes, **draw the energy diagram for homolytic bond dissocation for BOTH of the bonds C-Ha and C-Hb ON THE SAME DIAGRAM.** Because both are in the same molecule, your diagrams should both start at the same energy in the bonds.
2) Indicate the bond dissociation energies for BOTH BONDS on the diagram.
3) LABEL BOTH AXES.