CHEM 233, Fall 2019 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) _____

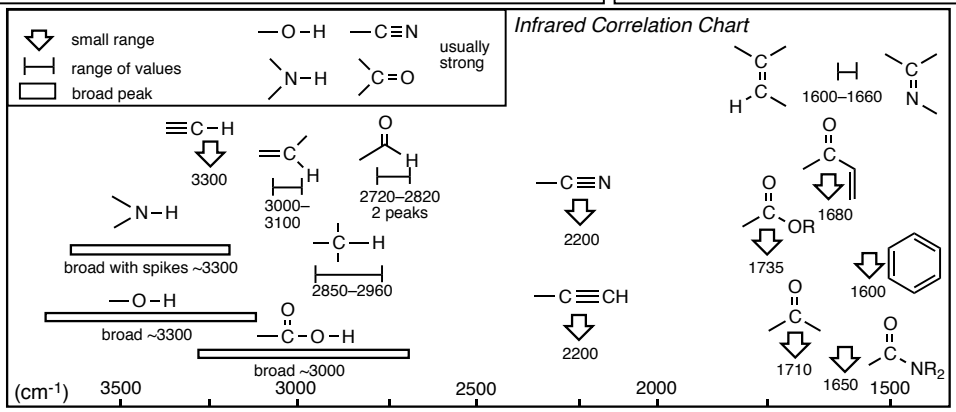
*****YOU ARE NOT ALLOWED TO TAKE SPARE COPIES OF THIS EXAM FROM THE TESTING ROOM*****

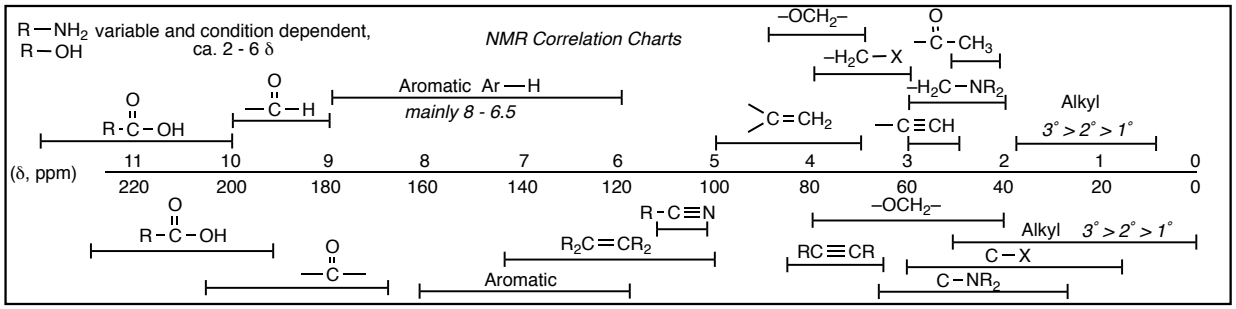
- *PRINT YOUR NAME ON EACH PAGE!*
- *READ THE DIRECTIONS CAREFULLY!*
- *USE BLANK PAGES AS SCRATCH PAPER*
  work on blank pages will not be graded...
- *WRITE CLEARLY!*
- *MOLECULAR MODELS ARE ALLOWED*
- *DO NOT USE RED INK*
- *DON'T CHEAT, USE COMMON SENSE!*

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_____**/14**

2_____**/18**

3_____**/18**

4_____**/8**

5_____**/34**

6_____**/28**

7_____**/27**

8_____**/28**

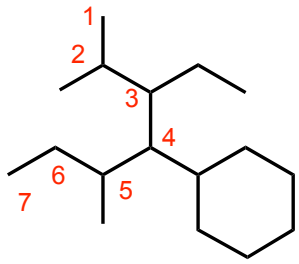
Points Removed for cover errors ____/2

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.



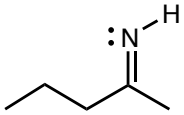
4-cyclohexyl-3-ethyl-2,5-dimethylheptane

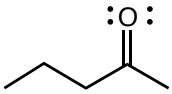
Question 2 (18 pts.)
Which has a higher frequency bond vibration observable in an infrared spectrum, as a peak at higher frequency, the C-N triple bond of a nitrile functional group (**A**) or the C-N double bond of an imine (**B**)? Give a BRIEF explanation.

A $H_3C-C\equiv N:$ **B** H_3C, $C=N$, H, H

the triple bond in the nitrile is stronger than the double bond in the imine, the nitrile would have a higher vibrational frequency

Question 3 (18 pts). Between the C=N double bond in an imine and the C=O double bond in a ketone, which would you expect to have a stronger or more intense peak in an IR spectrum? Give an explanation for your choice.

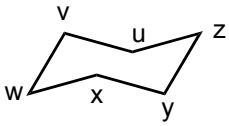
imine 

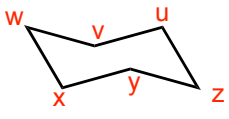


ketone

the C=N bond has a smaller dipole moment because N is less electronegative than O, IR absorption strength is related to dipole moment size, thus the absorption band for the C=N bond should be weaker (less intense) than that of the C=O bond

Question 4 (8 pts.)
a) Shown below are two conventional drawings of a cyclohexane chair. In one, the carbon atoms are labeled u through z. Label the atoms on the **other chair** with u, v, w, x, y and z according to the normal understanding of which atom is which in each chair, i.e. atom u in the first chair should be labelled u in the other chair etc.

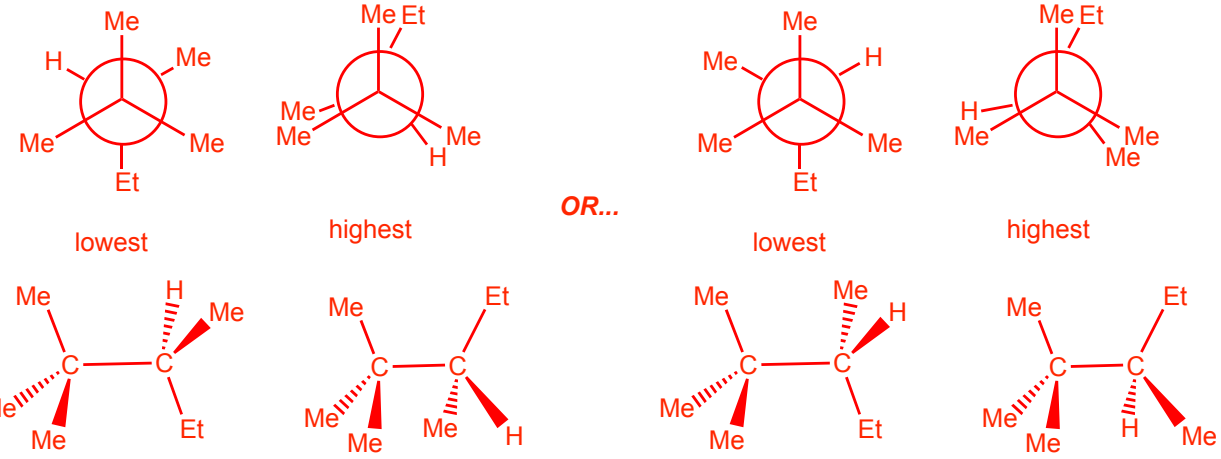




b) Which of the 6 atoms, u, v, w, x, y or z, are understood to be ABOVE the plane of the paper in the conventional drawings of a cyclohexane chair, i.e. which atoms are understodd to be closer to you?

X and Y

Question 5 (34 pts.) For rotation around the C2-C3 bond of 2,2,3-trimethylpentane:
a) Draw Newman projections AND 3D (sawhorse) structures for BOTH the HIGHEST and the LOWEST energy conformations, (clearly indicate which is which). **Your Newman projections should look FROM carbon 2 TO carbon 3.**

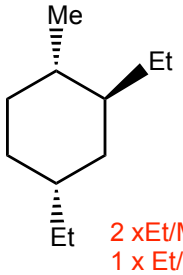


c) Determine the energy difference between these two conformations. CLEARLY indicate the energy factors that you included in your calculation of this energy difference

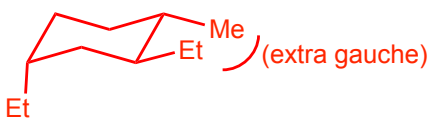
lowest E conformation: 2 Me/Me gauche = 2 x 0.9 = 1.8
+ 2 Me/Et gauche = 2 x 0.95 = 1.9
Total = 3.7 kcal/mol
highest E conformation: 1 Me/Me eclipse = 2.6
+ 1 Me/H eclipse = 1.4
+ 1 Me/Et eclipse = 2.9
Total = 6.9 kcal/mol

ΔE = 6.9 - 3.7 = 3.2 kcal/mol

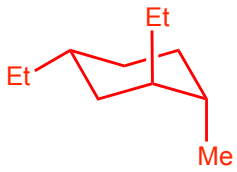
Question 6 (28 pts) For the following structure
a) draw **both chair conformations**
b) determine the **energy difference** between the two chair conformations. CLEARLY indicate the energy factors that you included in your calculation of this energy difference
c) indicate the **lower energy chair**



lower energy



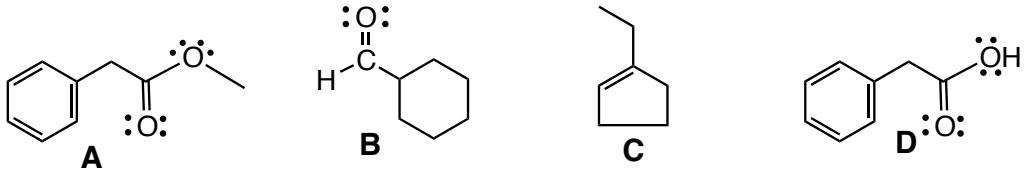
2 xEt/Me gauche for axial Et = 2 x 0.95 = 1.9
1 x Et/Me (extra) gauche = 0.95
total E = 2.85 kcal/mol

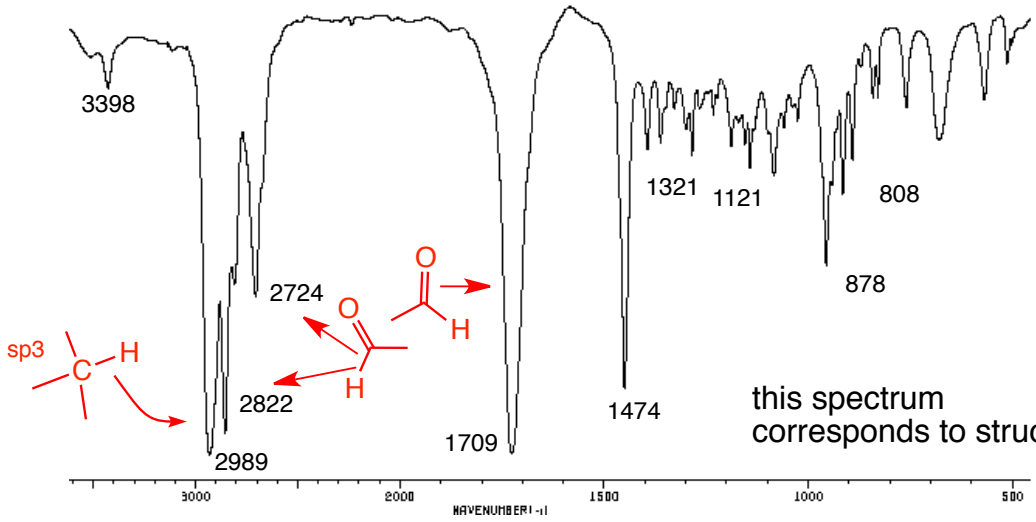


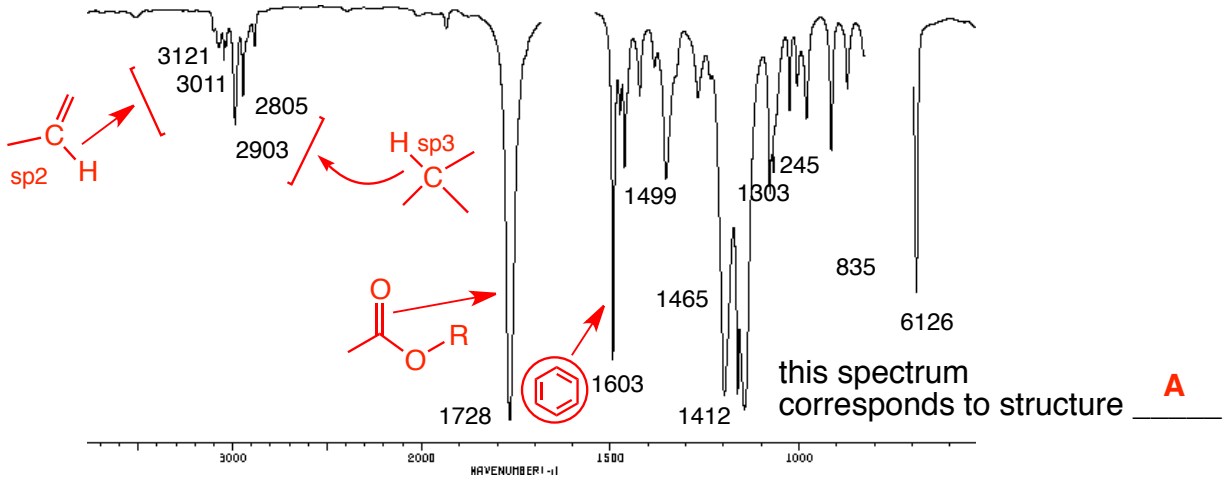
2 x Me/Me gauche (axial Me)= 2 x 0.9 = 1.8
2 x Et/Me gauche (axial Et) = 2 x 0.95 = 1.9
total E = 3.7 kcal/mol

ΔE = 3.7 - 2.85 = 0.85 kcal/mol

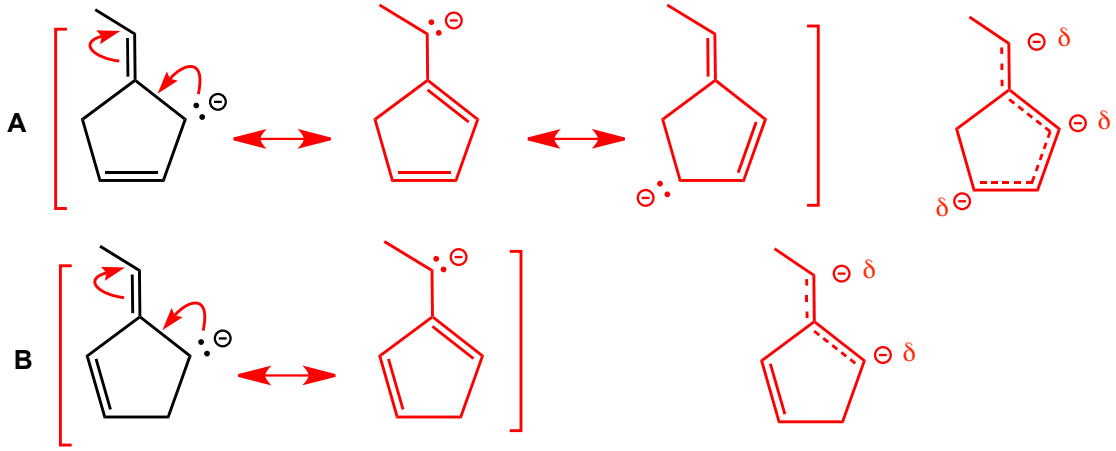
Question 7 (27 pts.) Assign the BOTH IR spectra to ONE of the FOUR provided structures **A** - **D**. Two of the structures do not have a provided spectra. On each spectrum, **identify the peaks that are associated with a specific functional group or type of C-H** bond by **drawing the functional g or bond** and **drawing an arrow from the specific bond in the functional group that vibrates to t absorption peak**, as appropriate.





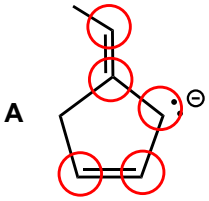


Question 8 (28 pts) For the following two anions **A** and **B**
a) Draw all reasonable resonance contributors including curved arrow pushing and resonance arrows/brackets as appropriate, and **idendity** the major contributor if there is one.
b) Which of the anions **A** or **B** would be more chemically reactive? Give a brief explanation that includes the term "energy of the electrons"
c) For both **A** and **B**, draw an "actual" structures and use the delta symbol to indicate the atoms with fractional charges

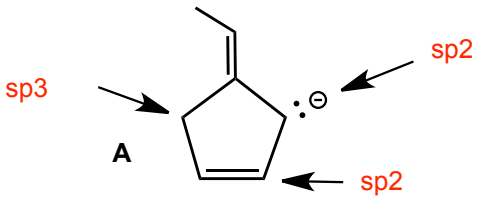


higher energy electrons are more chemcially reactive, the non-bonding electrons in **A** they more stabilized by delocalization and thus are lower in energy than those in **B**, whgich will thus be more chemically reactive

d) Anion **A** is drawn for you again below. In this drawing (below), circle all of the carbon atoms that are part of the conjugated system.



e) Anion **A** is drawn for you yet again below. In this drawing, give the hybridization of the 3 atoms indicated by the arrows



EXTRA CREDIT (5 pts) Which types of structures are the primary constituent of gasoline?

alkenes ketones alkanes aromatics