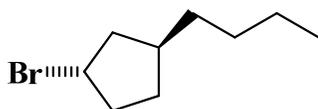
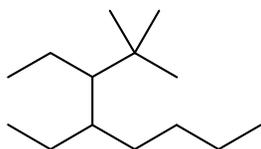


CHEMISTRY 31**Exam #1****100 pts****Name:** KEY

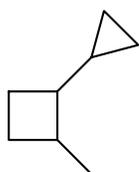
1. (6 pts) Provide the complete IUPAC name for each of the following compounds:



(1S,3S)-1-bromo-3-butylcyclopentane

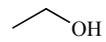
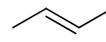
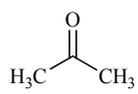
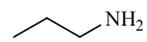
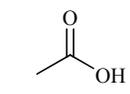
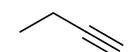


3,4-diethyl-2,2-dimethyloctane

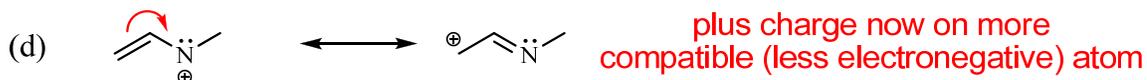
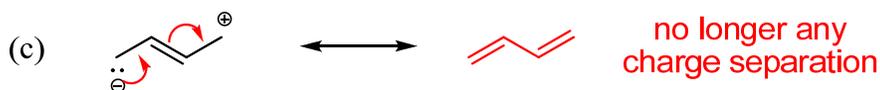
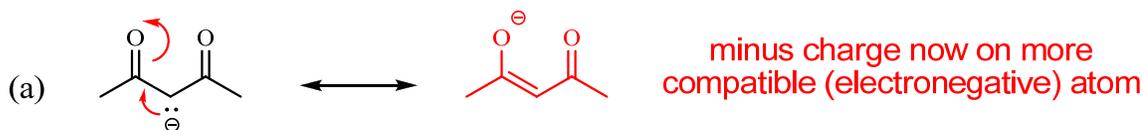


1-cyclopropyl-2-methylcyclobutane

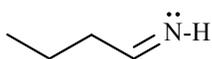
2. (12 pts) For each molecule given below provide the pKa value for the most acidic hydrogen atom and list all functional groups, excluding alkanes.

	pKa	functional group
	<u>16</u>	<u>alcohol</u>
	<u>45</u>	<u>alkene</u>
	<u>20</u>	<u>ketone</u>
	<u>36</u>	<u>amine</u>
	<u>5</u>	<u>carboxylic acid</u>
	<u>25</u>	<u>alkyne</u>

3. (12 pts) For each structure shown below a better resonance structure can be drawn. Using curved arrows to illustrate, draw the more stable resonance structure for each compound below. In addition, *briefly* (under ten words) state why your drawing is a better resonance structure.



4. (10 pts) Consider the molecule shown below to answer the following questions:

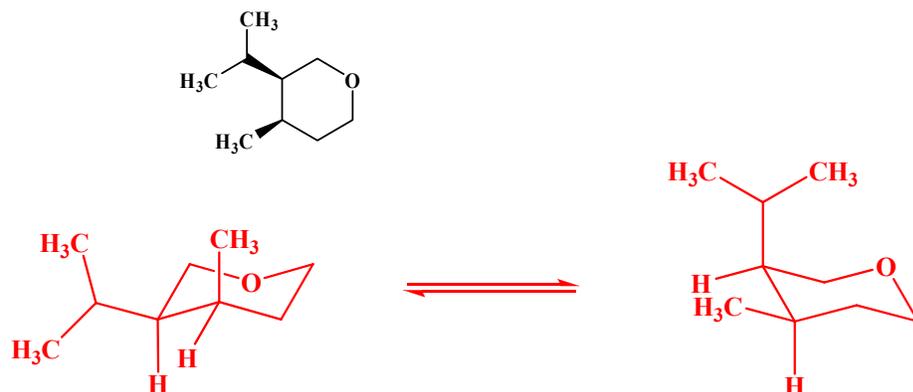


- (a) How many σ bonds are present in this molecule? 13
- (b) How many π bonds are present in this molecule? 1
- (c) What is the approximate H-N-C bond angle in this molecule? 120°
- (d) What orbital/orbitals overlap to form the nitrogen – carbon double bond? Be specific.

Csp² orbital overlaps with Nsp² orbital to make sigma bond
C2p orbital overlaps with N2p orbital to make the pi bond

- (e) What orbital is the lone pair of electrons in? N sp²

5. (8 pts) Draw the two possible chair conformations for the following molecule. In your drawing clearly show the chair – to – chair inversion process. Using data on the last page, estimate the relative percentages of the two chair conformers.



2 CH₃ - H 1,3-diaxial interactions = 7.6 kJ/mole
 1 CH₃ - isopropyl gauche interaction = 4.6 kJ/mol

Total = 12.2 kJ/mol

~20%

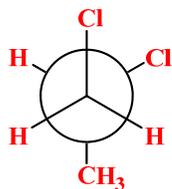
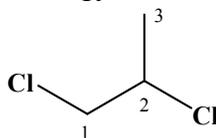
1 isopropyl - H 1,3-diaxial interactions = 4.6 kJ/mole
 1 CH₃ - isopropyl gauche interaction = 4.6 kJ/mol

Total = 9.2 kJ/mol

~80%

Energy Difference = 3 kJ/mol

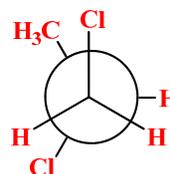
6. (10 pts) (a) Draw the most and least stable Newman projection of the compound below when viewed down the C1-C2 bond and calculate the energy of each conformer.



staggered
**most
 stable**

1 gauche Cl - Cl interaction = 0.25 kJ mol

Total = 0.25 kJ/mol



eclipsed
**least
 stable**

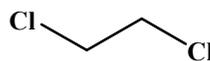
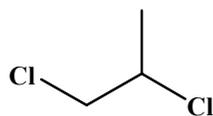
1 eclipsing Cl - CH₃ interaction = 8.0 kJ mol

1 eclipsing Cl - H interaction = 4.8 kJ/mol

1 eclipsing H - H interaction = 4.0 kJ/mol

Total = 16.8 kJ/mol

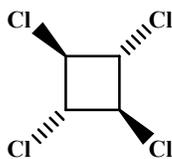
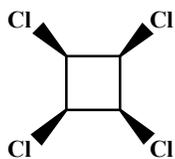
- (b) Which compound below do you predict is more polar? Circle your choice and provide a brief (1-2 sentence) explanation.



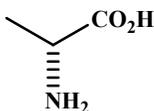
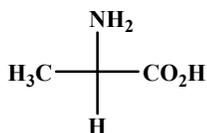
Look at the most stable Newman projections. In the first structure the two Cl's are gauche with a net dipole; in second structure the two Cl's are anti and will have no net dipole moment. As a result, the first compound is more polar.

7. (9 pts)

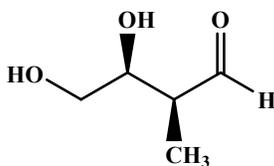
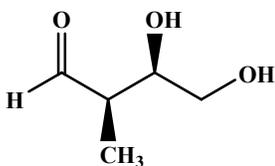
What is the relationship between each pair of compounds shown below, enantiomers, diastereomers, identical, constitutional isomers or different compounds altogether.



diastereomers



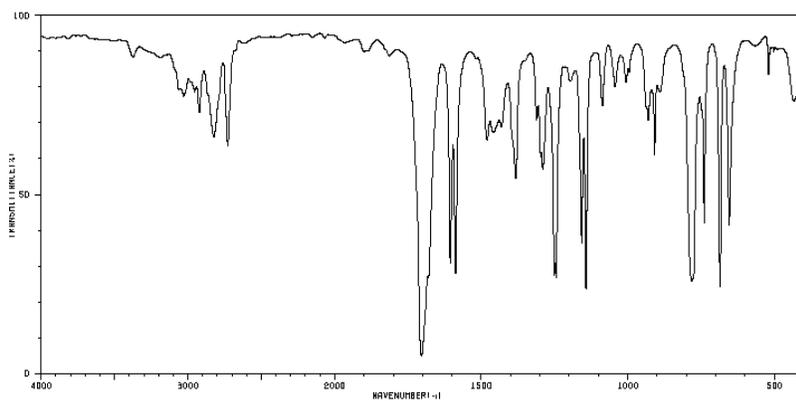
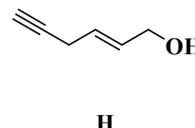
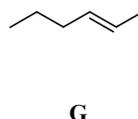
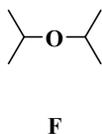
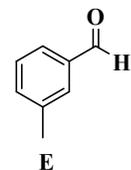
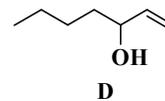
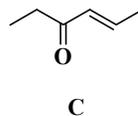
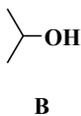
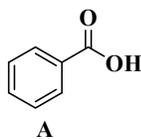
identical



enantiomers

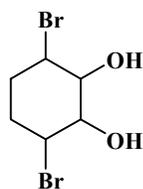
8. (5 pts)

For the IR spectrum given below provide the corresponding letter for the molecule that best fits the data from the choices below: (note the cm^{-1} scale lists values at 4000, 3000, 2000, 1500, 1000 and 500 cm^{-1} if you cannot read the values)



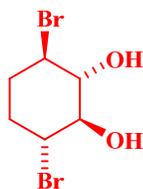
Note large $\text{C}=\text{O} \sim 1700 \text{ cm}^{-1}$, aldehyde $\text{C}-\text{H} \sim 2700 \text{ cm}^{-1}$ (this one is key), aromatic $\text{C}=\text{C}$ between $1500\text{-}1600 \text{ cm}^{-1}$, and both $\text{Csp}3\text{-H}$ and $\text{Csp}2\text{-H}$ below and above 3000 cm^{-1} . ANSWER = E

9. (14 pts) Consider the compound drawn below to answer the following questions:



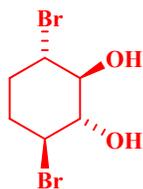
(a) What is the maximum number of stereoisomers possible? = $2^4 = 16$

(b) Draw the stereoisomer with all chiral centers in the R configuration below:

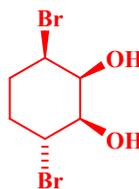


(c) Draw the enantiomer and a diastereomer of your answer in part b below:

Enantiomer

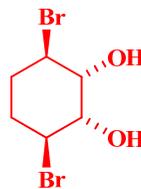
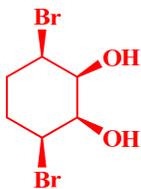


Diastereomer



one of multiple answers

(d) There are two meso forms of this compound, draw them below:



same as all dashes

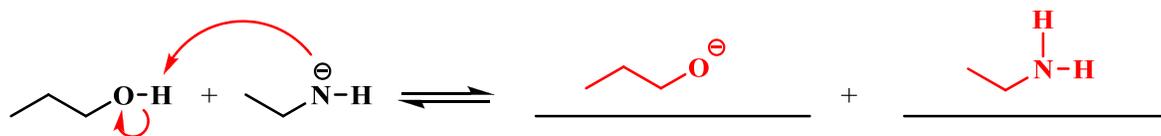
(e) If the specific rotation for your answer in part b is $[\alpha] = +76.1^\circ$, answer the following:
(give a specific value or state 'no way to determine')

The $[\alpha]$ of my enantiomer is = -76.1°

The $[\alpha]$ of my diastereomer is = no way to determine

The $[\alpha]$ of my meso forms, are = 0° and 0°

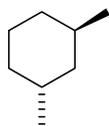
10. (10 pts) If the following two compounds were mixed together, what would be the products if a Bronsted-Lowry acid/base reaction were to occur (be sure to show lone pairs and charges if any)?



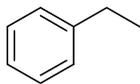
(b) What would be favored, reactants or products? Products

(c) Draw in the curved arrows to show the flow of electrons when going from the reactants to the products on the reaction above.

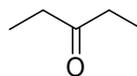
2. (4 pts) For each compound below provide the number of signals you would expect to see in ^{13}C NMR spectroscopy.



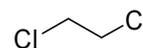
5



6



3

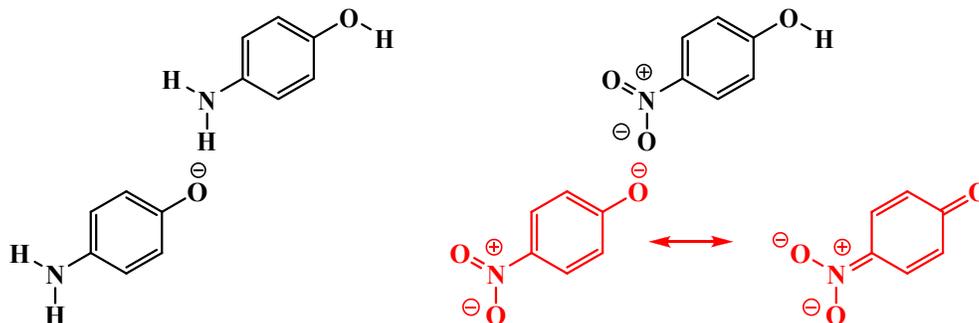


1

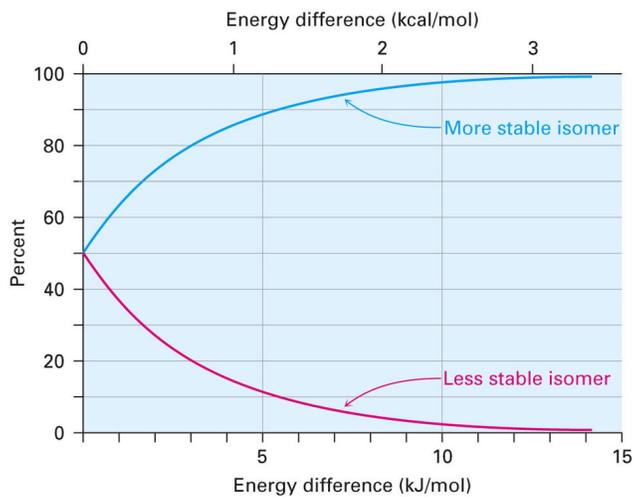
Extra Credit

(5 pts)

Which of the following two molecules is a stronger acid (circle your choice)? To receive full points you must provide a clear explanation for your choice. Hint, a picture is worth a thousand words!

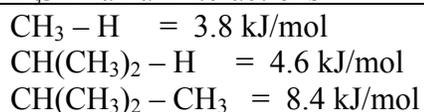


This anion has better resonance stabilization where the minus charge can be delocalized onto three ring carbons as well as the oxygen in the NO_2 group (which the NH_2 group for compound on left cannot do)

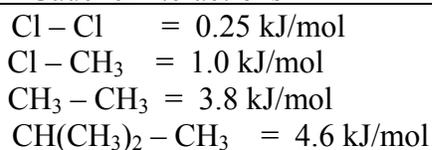


Destabilizing Strain Energies

1,3-Diaxial Interactions



Gauche Interactions



Eclipsing Interactions

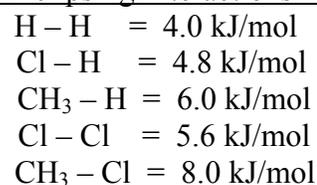


Table 12.1 Characteristic IR Absorptions of Some Functional Groups

Functional Group	Absorption (cm^{-1})	Intensity	Functional Group	Absorption (cm^{-1})	Intensity
Alkane			Amine		
C-H	2850–2960	Medium	N-H	3300–3500	Medium
Alkene			C-N	1030–1230	Medium
=C-H	3020–3100	Medium	Carbonyl compound		
C=C	1640–1680	Medium	C=O	1670–1780	Strong
Alkyne			Carboxylic acid		
≡C-H	3300	Strong	O-H	2500–3100	Strong, broad
C≡C	2100–2260	Medium	Nitrile		
Alkyl halide			C=N	2210–2260	Medium
C-Cl	600–800	Strong	Nitro		
C-Br	500–600	Strong	NO ₂	1540	Strong
Alcohol					
O-H	3400–3650	Strong, broad			
C-O	1050–1150	Strong			
Arene					
C-H	3030	Weak			
Aromatic ring	1660–2000	Weak			
	1450–1600	Medium			