

NAME (Print): \_\_\_\_\_

Chemistry 310M/318M

Dr. Brent Iverson

1st Midterm

September 29, 2011

SIGNATURE: \_\_\_\_\_

Please print the  
first three letters  
of your last name  
in the three boxes

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**Please Note:** This test may be a bit long, but there is a reason. I would like to give you a lot of little questions, so you can find ones you can answer and show me what you know, rather than just a few questions that may be testing the one thing you forgot. **I recommend you look the exam over and answer the questions you are sure of first**, then go back and try to figure out the rest. Also make sure to **look at the point totals** on the questions as a guide to help budget your time.

**You must have your answers written in PERMANENT ink if you want a regrade!!!! This means no test written in pencil or ERASABLE INK will be regraded.**

**Please note: We routinely xerox a number of exams following initial grading to guard against receiving altered answers during the regrading process.**

**FINALLY, DUE TO SOME UNFORTUNATE RECENT INCIDENTS YOU ARE NOT ALLOWED TO INTERACT WITH YOUR CELL PHONE IN ANY WAY. IF YOU TOUCH YOUR CELL PHONE DURING THE EXAM YOU WILL GET A "0" NO MATTER WHAT YOU ARE DOING WITH THE PHONE. PUT IT AWAY AND LEAVE IT THERE!!!**

## Honor Code

The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

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(Your signature)

Page	Points	
1		(22)
2		(15)
3		(13)
4		(15)
5		(20)
6		(14)
7		(14)
8		(24)
9		(20)
10		(14)
11		(26)
12		(29)
13		(20)
14		(12)
15		(8)
Total		(266)
%		
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HW		
Total Grade		

(HW score + Exam Grade)  $\Longrightarrow$

[illegible]

**Editors:** T. K. Varga, M.A.Sc. & C. Bello, M.A.Sc.  
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Pg 1 \_\_\_\_\_ (22)

1. (5 points) What is the most important question in Organic Chemistry (Also used as the preferred greeting when you see your organic prof outside of class)?

2. (5 pts each) For the following molecular formulas, draw complete Lewis line structures in which all atoms (even H atoms) are drawn, lines are used as bonds, and all lone pairs are drawn. You must include all formal charges.



(1 pt) How many stereoisomers are possible for this molecule? \_\_\_\_\_



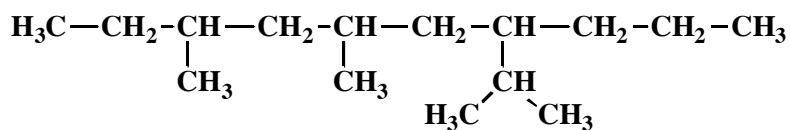
(1 pt) How many stereoisomers are possible for this molecule? \_\_\_\_\_

Signature \_\_\_\_\_

Pg 2 \_\_\_\_\_(15)

3. (4 pts each) Provide an acceptable IUPAC name for the following molecules. You can ignore R and S for this one.

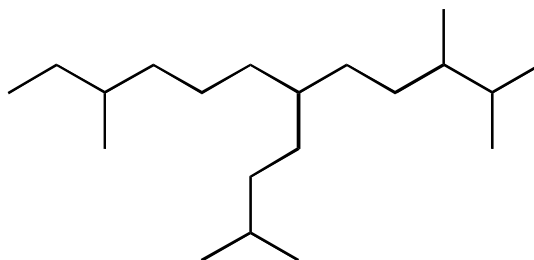
A)



(1 pt) How many stereoisomers are possible for this molecule? \_\_\_\_\_

\_\_\_\_\_

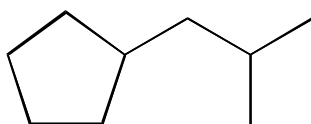
B)



(1 pt) How many stereoisomers are possible for this molecule? \_\_\_\_\_

\_\_\_\_\_

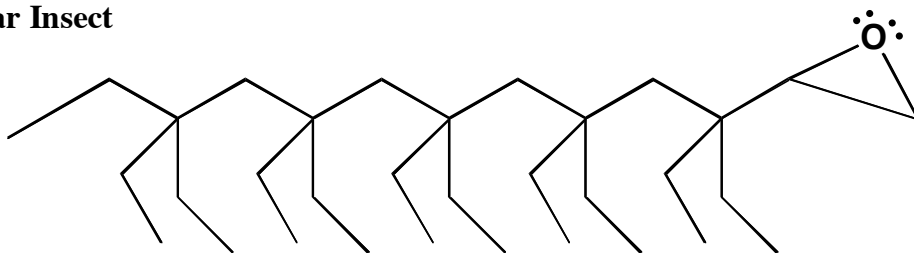
C)



(1 pt) How many stereoisomers are possible for this molecule? \_\_\_\_\_

\_\_\_\_\_

**Molecular Insect**



(You don't need to name this one!)

Signature\_\_\_\_\_

Pg 3 \_\_\_\_\_(13)

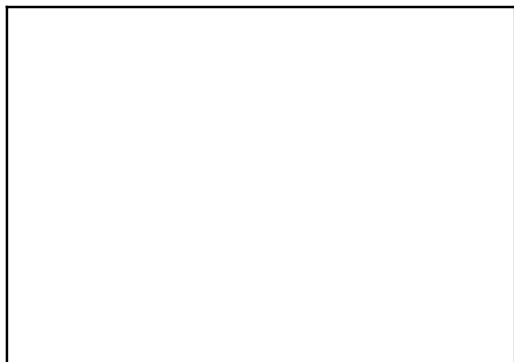
5. (3 or 6 pts each) For the following IUPAC names, draw the appropriate line angle drawing.

A) **6-*tert*-butyl-3,4,5-trimethyldecane** (you can ignore R and S for this one)

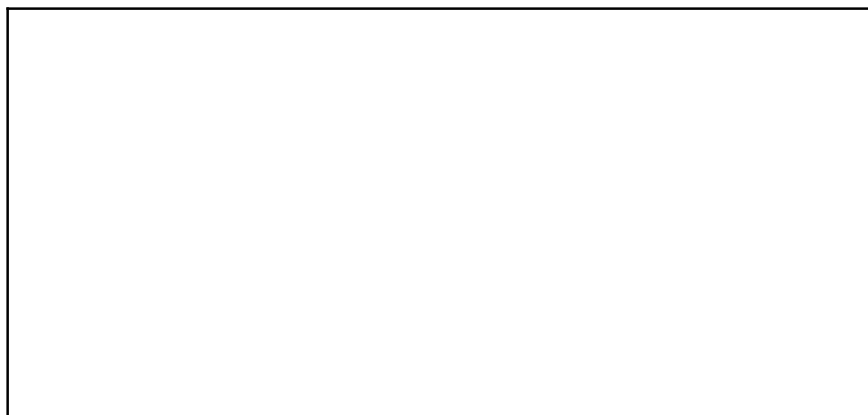


(1 pt) How many stereoisomers are possible for this molecule? \_\_\_\_\_

B) ***R*-2,3-dimethylpentane**

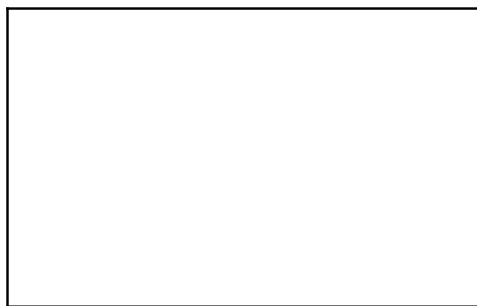
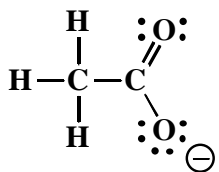


C) Draw all the different stereoisomers of ***trans*-1-isopropyl-3-methylcyclohexane**

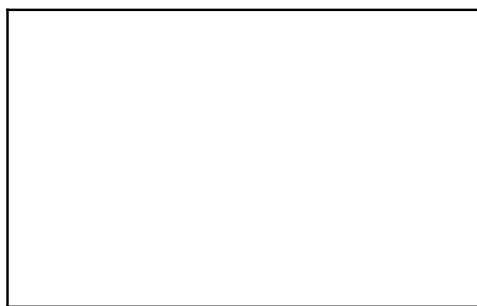
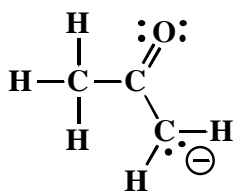


6. (5 pts each) The following molecules are best represented as the hybrid of contributing structures. **Draw the second important contributing structure** in the space provided, including all lone pairs and formal charges. **For the structure on the left, use arrows to indicate the movement of electrons to give the structure you drew.** Finally, if one of the two contributing structures makes a dominant (major) contribution to the resonance hybrid, **draw a circle around the dominant (major) contributor.** You might want to read these directions again to make sure you know what we want.

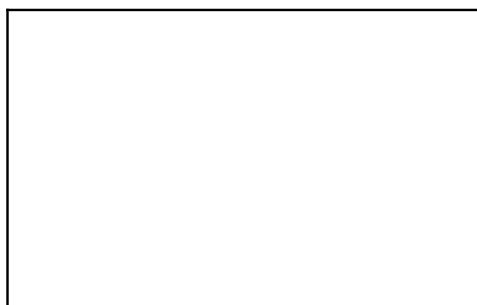
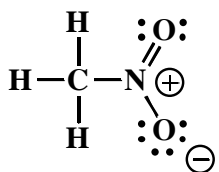
A.



B.



C.



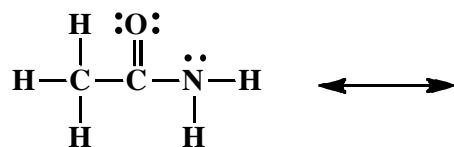


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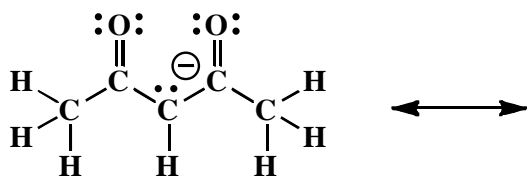
Pg 5 \_\_\_\_\_(20)

7. (10 pts each) The following molecules are best represented as the hybrid of three contributing structures. **Draw the second and third important contributing structures** in the spaces provided, including all lone pairs and formal charges. **For the two structures on the left in each problem, use arrows to indicate the movement of electrons to give the structures you drew.** There is **no need to draw any circles around any of these contributing structures**. You might want to read these directions again to make sure you know what we want.

A. *I promised you this one, the contributing structures for an amide bond*



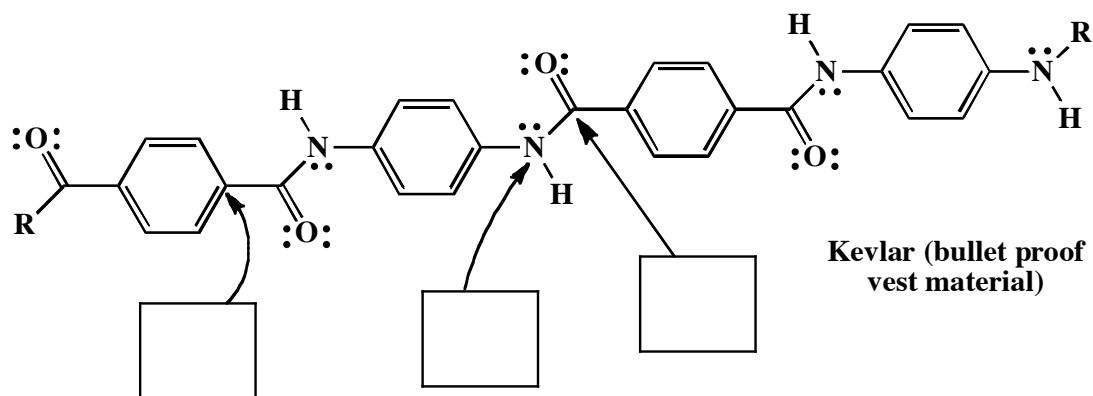
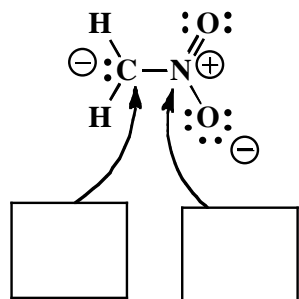
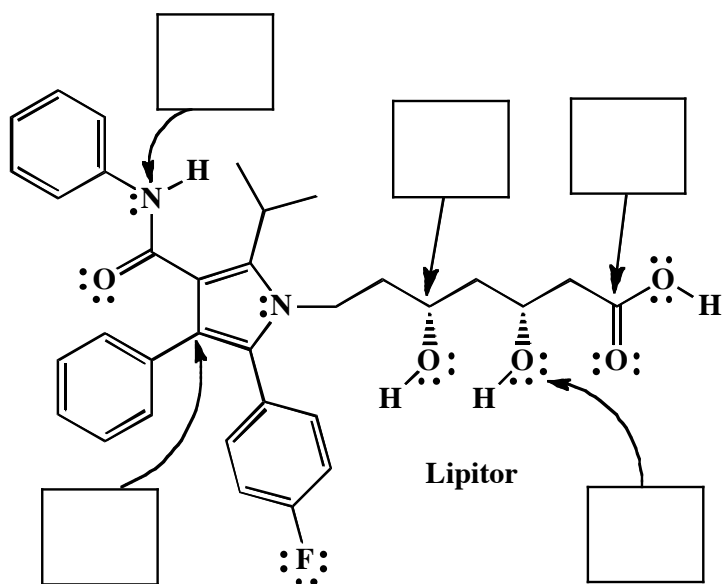
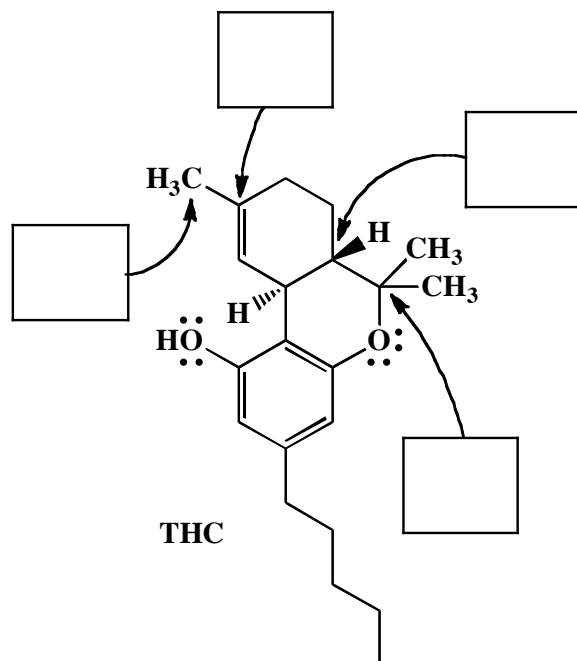
B.



9. (1 pt each) For the following TRUE and FALSE questions, CIRCLE ALL THE TRUE STATEMENTS. This is not meant to be tricky, but please read the statements carefully so that you do not make any careless errors. We are not attempting to trick you here with complicated statements, but you still might want to take your time on these.

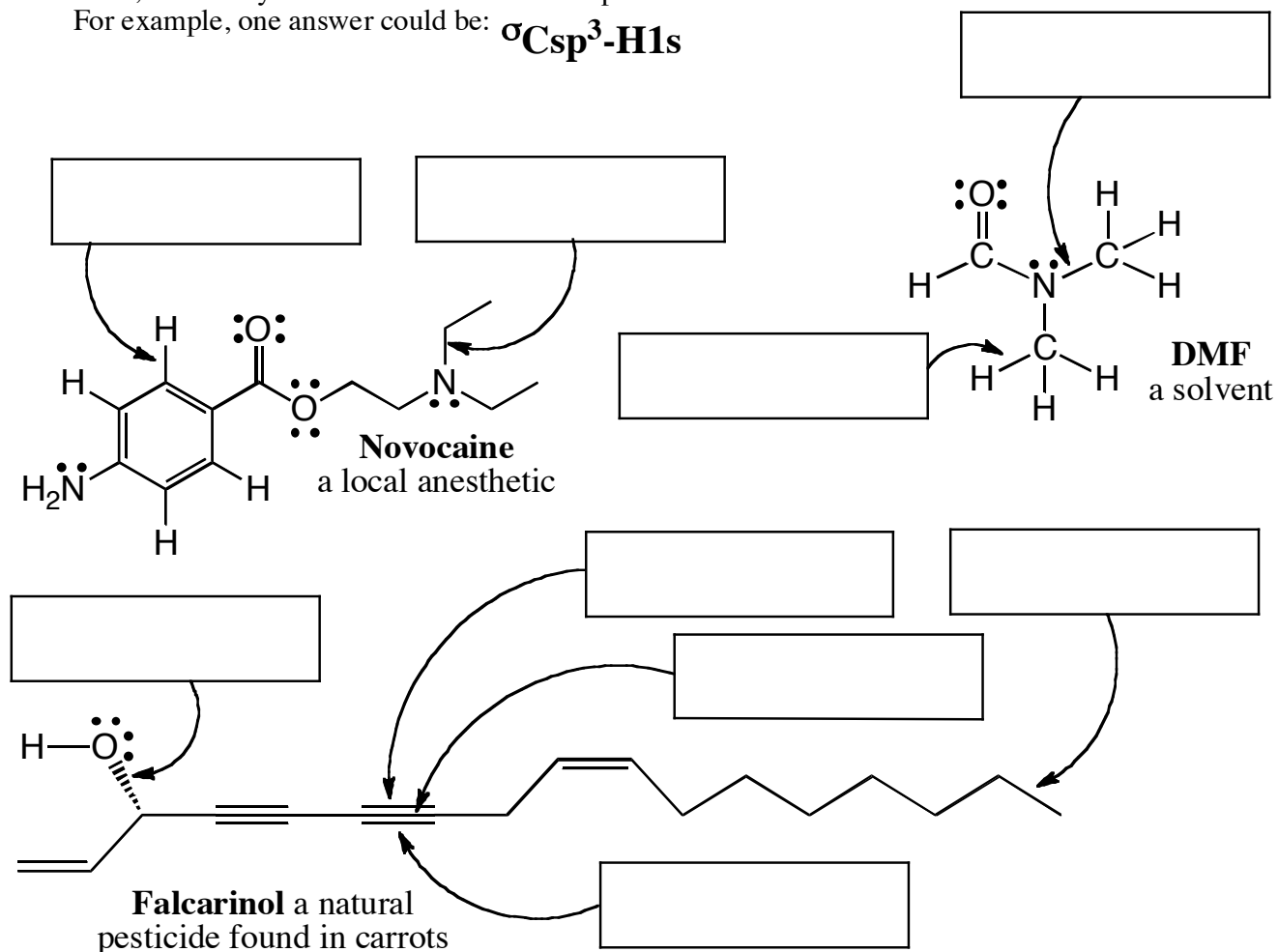
- A. Resonance contributing structures are used when more than one structure is required to describe accurately how the electrons and charges are distributed in a molecule, generally to indicate the presence of a "pi-way".
- B. Resonance contributing structures do not represent equilibrating structures, rather the hybrid (blending) of them is the true molecular representation.
- C. When drawing resonance contributing structures you generally move atom nuclei and sigma bonds.
- D. When drawing resonance contributing structures, you should move pi bonds (*one* bond of a double or triple bond) and lone pair electrons, not atom nuclei or sigma bonds.
- E. For organic chemistry, it is best to think of electron density as particles, described by Newton's laws.
- F. For organic chemistry, it is best to think of electron density as waves, described by wave equations.
- G. According to the valence bond approach, the atomic orbitals on each atom are combined (hybridized) first, and bonds are derived from overlap of hybridized orbitals.
- H. An  $sp^2$  hybridized carbon atom has three hybridized orbitals, arranged in a trigonal planar geometry.
- I. An  $sp$  hybridized carbon atom has two hybridized orbitals in a linear geometry.
- J. An  $sp^3$  hybridized carbon atom has four hybridized orbitals, arranged in a tetrahedral geometry.
- K. A sigma bond occurs when the majority of the electron density is found on the bond axis.
- L. A pi bond occurs when the majority of the electron density is found on the bond axis.
- M. When comparing relative acid strengths, it is helpful to compare the relative stabilities of the conjugate base anions.
- N. When comparing relative acid strength, you should put your finger in each acid to see which acid dissolves it faster.

10. (14 pts) In the box provided, write the hybridization state ( $sp^3$ , etc.) of the atom indicated by the arrow.

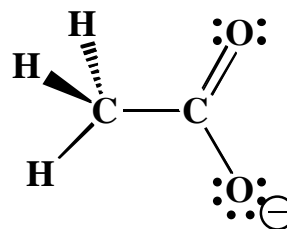
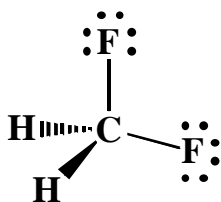
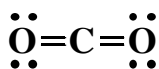


11. (18 pts) You knew this was going to be on the test. In the spaces provided, indicate the type of bond, and the hybridized orbitals that overlap to form the bond.

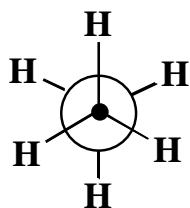
For example, one answer could be:  $\sigma_{\text{Csp}^3-\text{H}1\text{s}}$



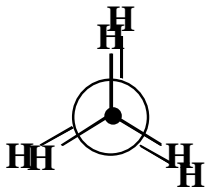
12. (2 pts each) For the following molecules, use the dipole moment symbol  $\rightarrow$  to show the direction of the molecular dipole moment in all molecules that have an overall molecular dipole. Note for this one you do NOT need to draw the individual bond dipole moments, just the overall molecular dipole moment,



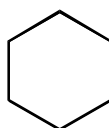
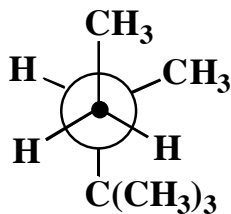
13. (4 pts each) For each pair of molecules, circle the one that has LESS STRAIN, then put an "X" in the box under all the types of strain that explain(s) your answer:



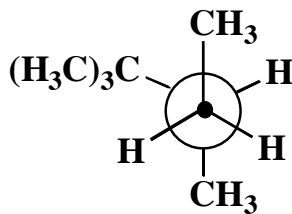
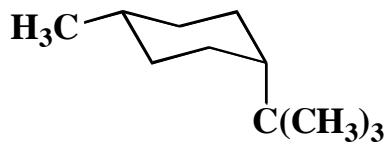
vs.

Angle  
strain☐Torsional  
strain☐Steric  
strain☐

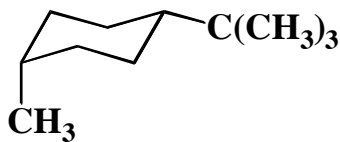
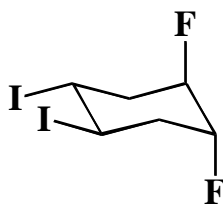
vs.

☐☐☐

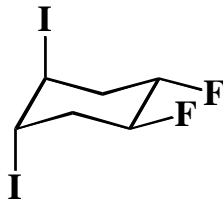
vs.

☐☐☐

vs.

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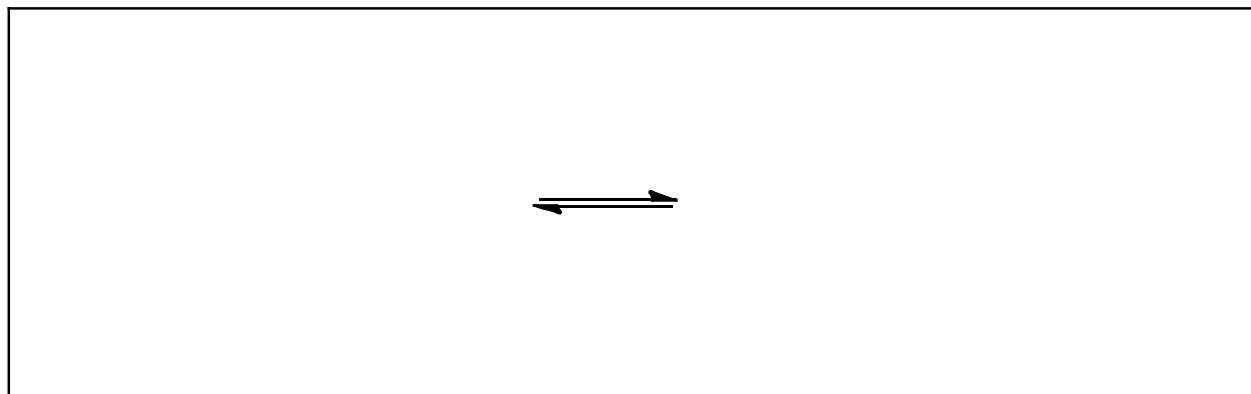
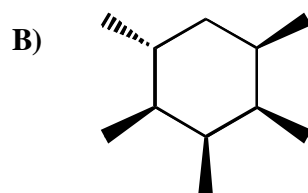
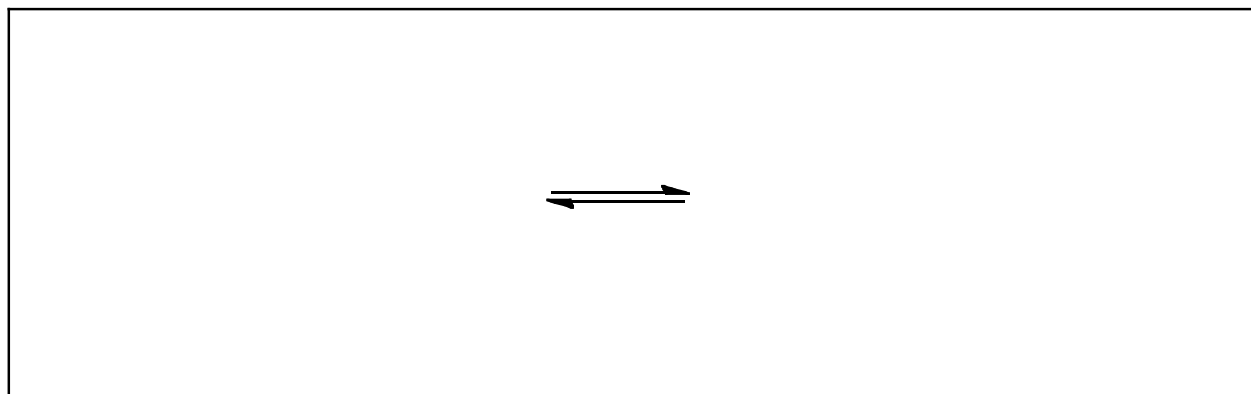
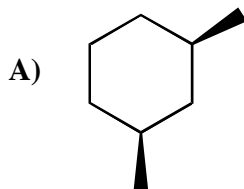
vs.

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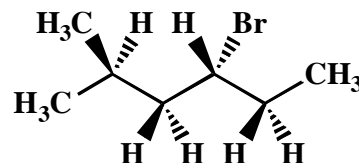
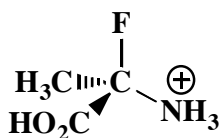
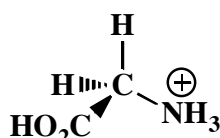
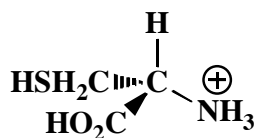
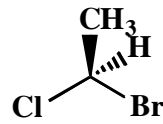
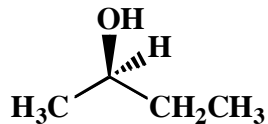
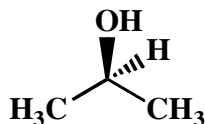
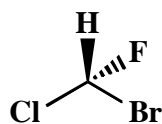
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Pg 10 \_\_\_\_\_(14)

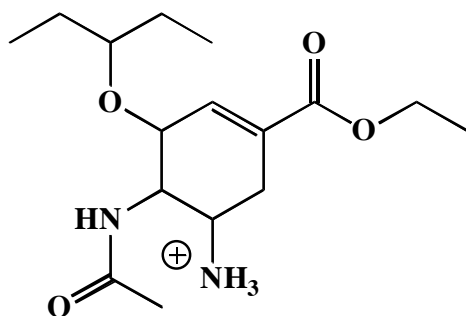
**14.** (7 pts each) For the following cyclohexane derivatives, draw the two alternative chair conformations. IF there is a difference in stability, draw a circle around the more stable conformation. If there is not difference in stability, do not circle either chair form.



15. (2 pts each) Examine the following structures. For each molecule with a chiral center, assign the stereochemistry then write "R" or "S" as appropriate in the box provided below each structure. For all molecules that have no chiral centers, leave the box blank.

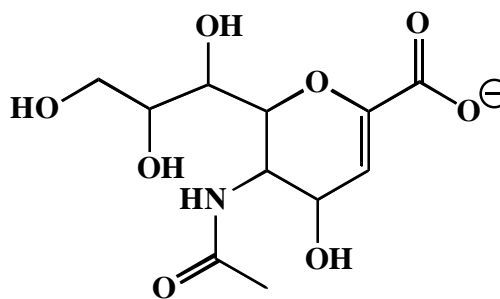


16. (10 pts) For the following molecules, identify all the chiral centers. Put an asterisk next to all chiral centers you find.



**Tamiflu**  
(anti-flu medication)

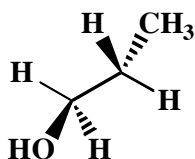
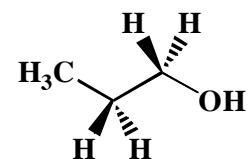
(1 pt) How many stereoisomers are possible for this molecule? \_\_\_\_\_



**Relenza**  
(anti-flu medication)

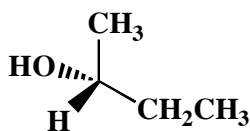
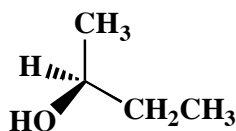
(1 pt) How many stereoisomers are possible for this molecule? \_\_\_\_\_

17. (29 pts) For each pair of molecules, on the line provided state whether they are (1) **enantiomers**, (2) **diastereomers**, (3) **constitutional isomers**, or (4) **same molecule**. Each pair of molecules will best be described by one of these four terms. **Next draw a circle around all the molecules that would be optically active (i.e rotate the plane of plane polarized light), and write "MESO" under any meso compounds.**

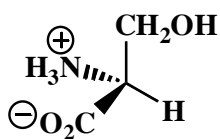
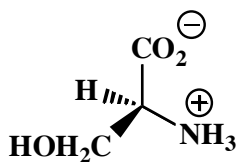


Relationship:

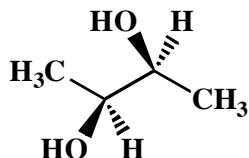
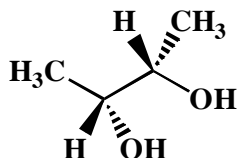
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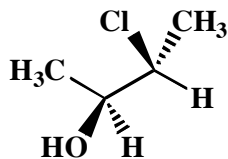
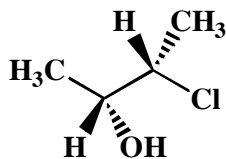
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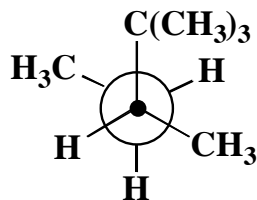
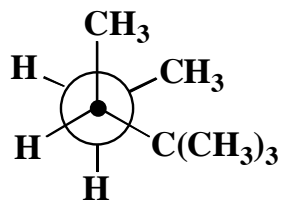
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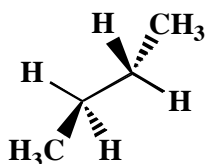
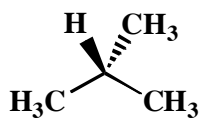
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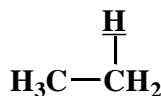


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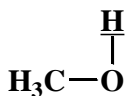
Pg 13 \_\_\_\_\_(20)

18. (10 pts) For the following series of molecules, rank each with respect to the indicated parameter

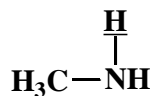
A) **Relative acidity, 1 under the least acidic and 3 under the most acidic.** The acidic H atom is indicated with the underline.



\_\_\_\_\_



\_\_\_\_\_

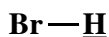


\_\_\_\_\_

B) **Relative acidity, 1 under the least acidic and 4 under the most acidic.** The acidic H atom is indicated with the underline.



\_\_\_\_\_



\_\_\_\_\_

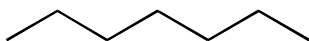


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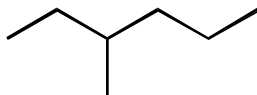


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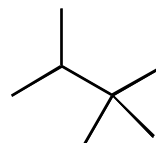
C) **Relative boiling point, 1 under the lowest boiling point and 3 under the highest boiling point.**



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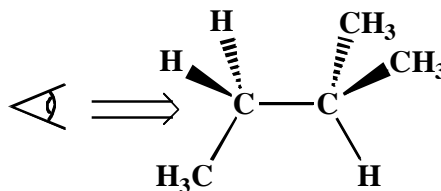
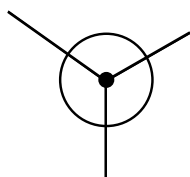
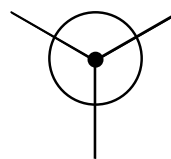
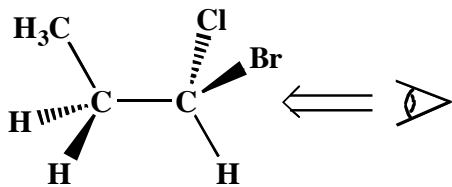


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16. (5 pts each) For the following conformations, draw the Newman Projection from the perspective indicated by the eye of the observer



**19.** (20 points total) Here is an "apply what you know" problem in the format of an MCAT style passage. Circle the correct answers.

In the early 1990's Stephen Kent and coworkers, then at the Scripps Research Institute in La Jolla, California, became the first team to synthesize the pure enantiomer of a natural protein. They synthesized the enantiomer of a protein called the AIDS protease, a 99 amino acid protein that is encoded by the HIV-1 virus. The AIDS protease is an enzyme, meaning it is a protein that carries out a chemical reaction. The reaction carried out by the AIDS protease is cleavage of other proteins, a process that involves breaking amide bonds. The reaction caused by the AIDS protease helps to cause the fatal symptoms of HIV-1, so stopping the action of the AIDS protease with drugs is an important way in which HIV-1 infection is managed.

The Kent team synthesized the enantiomer of the AIDS protease by starting with the enantiomers of the natural L-amino acids. Within the 99 amino acids there are a total of 106 chiral centers. One of the ways in which Kent and his team proved they had succeeded in making the first enantiomer of a natural protein is that their enzyme reacted with the enantiomer of the substrate molecule known to react with the natural version of the AIDS protease.

1. (4 pts) The common amino acids are referred to as being "L" amino acids. The "L" designation means:

- A. They rotate plane polarized light in the "L" or "+" direction
- B. They rotate plane polarized light in the "L" or "-" direction
- C. They all possess a chiral center that is structurally related to the chiral center in L-glyceraldehyde
- D. They are Less filling

2. (4 pts) What is the maximum number of stereoisomers possible for a molecule with the same number of chiral centers as the AIDS protease?

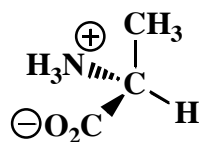
- A. 1
- B.  $2^{99}$
- C.  $10^{99}$
- D.  $2^{106}$

3. (4 pts) If a solution of the natural AIDS protease rotates the plane of plane polarized  $-25^\circ$ , the Kent enantiomer at the same concentration will rotate the plane of plane polarized light:

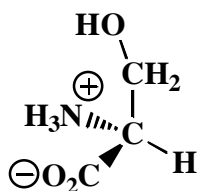
- A.  $+25^\circ$
- B.  $-25^\circ$
- C.  $-50^\circ$
- D. No rotation will be observed

19. (cont.)

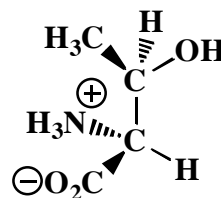
4. (8 pts) The following structures are the three L amino acids L-alanine, L-serine and L-threonine:



L-alanine



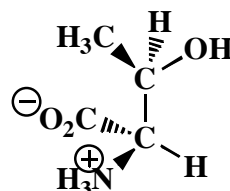
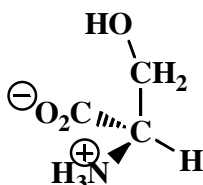
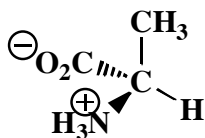
L-serine



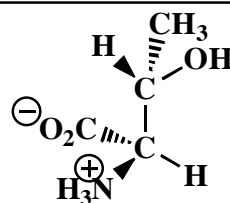
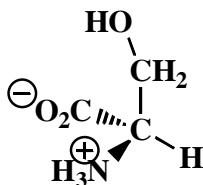
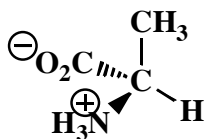
L-threonine

Draw a circle around the correct group (A., B., or C.) of these amino acids that Kent and his team had to use to produce the actual enantiomer of the natural AIDS protease:

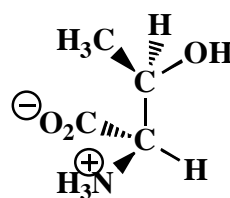
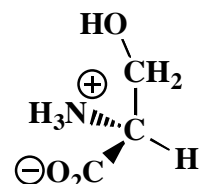
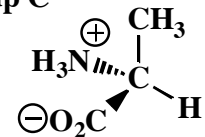
Group A



Group B



Group C

**NOTICE THIS!!**

In no more than two sentences, explain why your answer is the correct one and why the other two are wrong.