NAME (Print): _____

SIGNATURE: _____

Chemistry 310M/318M
Dr. Brent Iverson
1st Midterm
October 1, 2009

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

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.

Note: You must have your answers written in pen if you want a regrade!!!!

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.

_____

(Your signature)

Page	Points	
1		(26)
2		(12)
3		(16)
4		(20)
5		(20)
6		(15)
7		(11)
8		(23)
9		(24)
10		(14)
11		(28)
12		(21)
13		(22)
14		(17)
15		(18)
Total		(297)
%		
T Score		
HW		
Total Grade		

(HW score + Exam Grade) ⟹

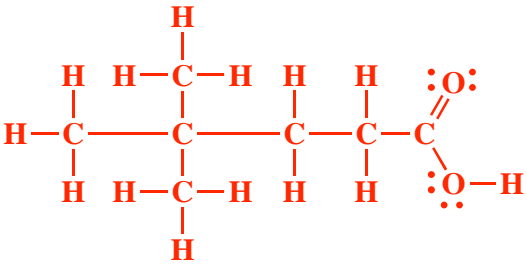
Signature_____ Pg 1 _____(26)

1. (8 points) What is the most important question in Organic Chemistry?

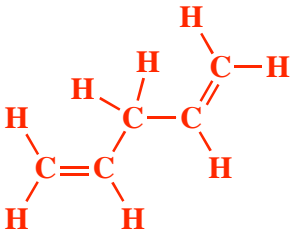
Where are the electrons?

2. (6 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.

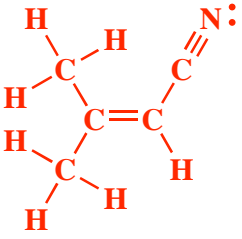
A) $(CH_3)_3CCH_2CH_2CO_2H$



B) $H_2CCHCH_2CHCH_2$

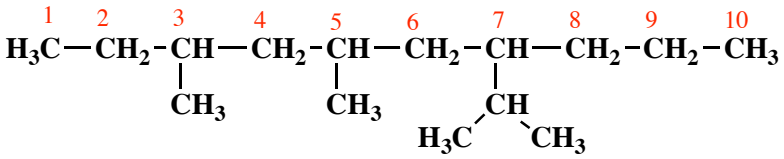


C) $(CH_3)_2CCHCN$



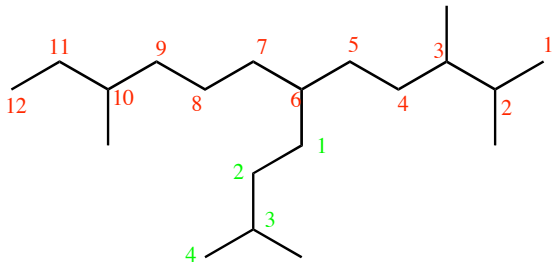
3. (4 pts each) Provide an acceptable IUPAC name for the following molecules. You can ignore R and S for this one.

A)



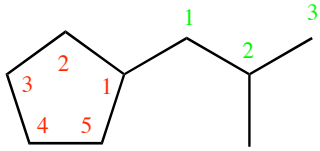
7-isopropyl-3,5-dimethyldecane

B)



2,3,10-Trimethyl-6-(3-methylbutyl)dodecane OR 6-isopentyl-2,3,10-trimethyldodecane

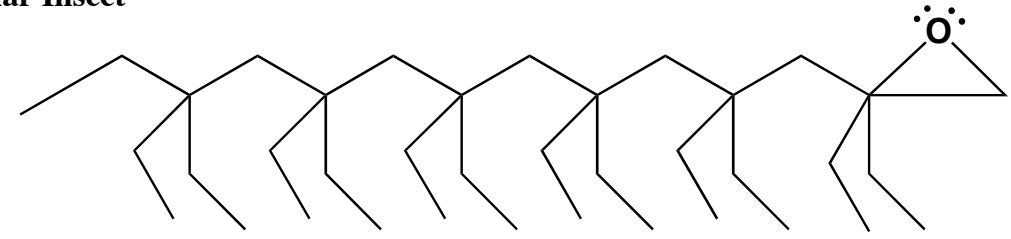
C)



Note that when there is only one group on a cycloalkane you do not need to write the number 1.

(2-methylpropyl)cyclopentane OR isobutylcyclopentane

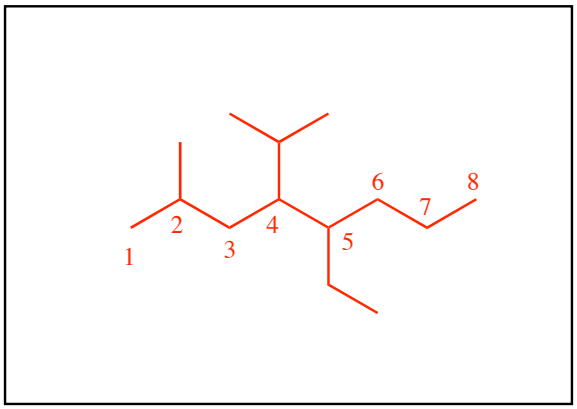
Molecular Insect



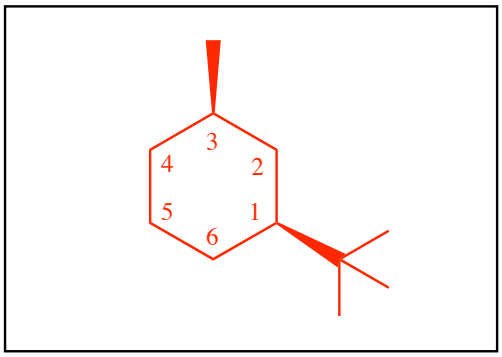
(You don't need to name this one!)

5. (3 pts each) For the following IUPAC names, draw the appropriate line angle drawing (you can ignore R and S for this).

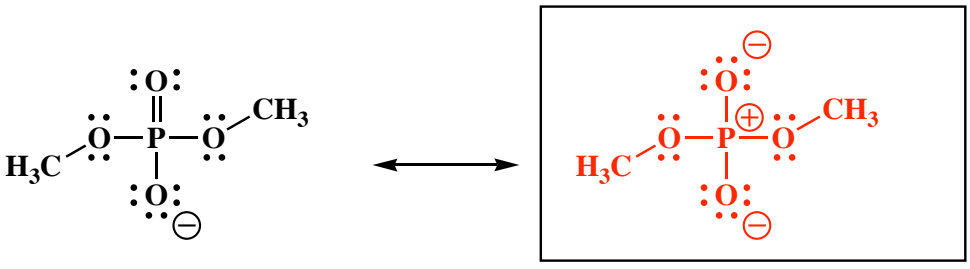
A) **5-ethyl-4-isopropyl-2-methyloctane**

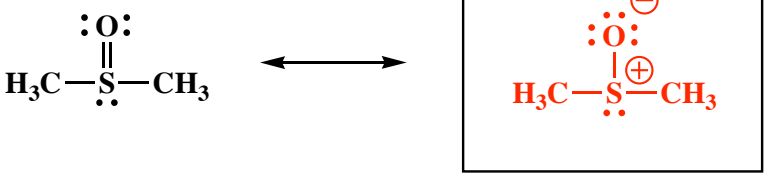


B) ***cis*-1-*tert*-butyl-3-methylcyclohexane**



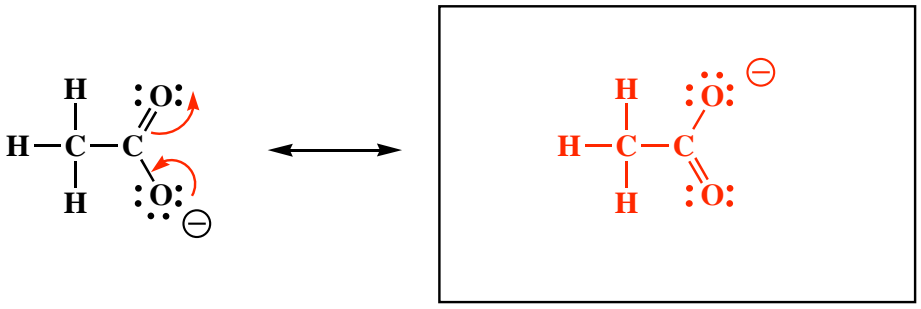
6. (3 pts each) Each structure shown below is drawn in the form nomally used in textbooks and the scientific literature. However, as discussed in class, there are structures that better represent the actual electronic distribution of each species. In the box provided, draw the structures that better represent the true situations.



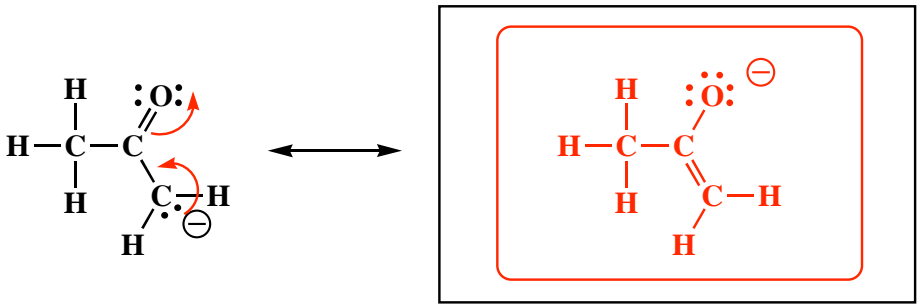


7. (5pts each) The following molecules are best represented as the hybrid of contributing structures. **Draw the second important contributing structure** in the space provided, including all lone pairs and formal charges. **For the structure on the left, use arrows to indicate the movement of electrons 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.

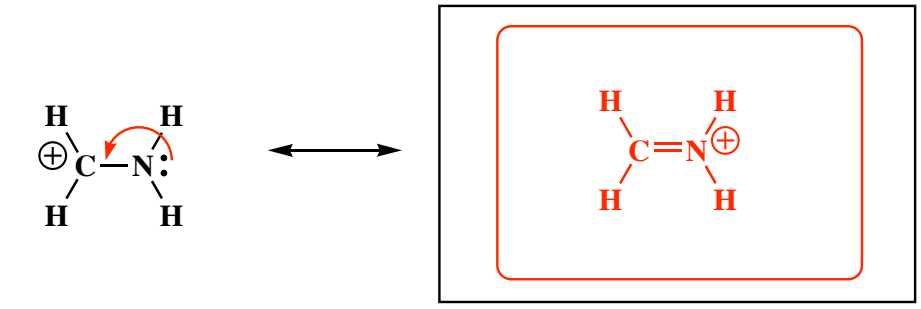
A.



B.

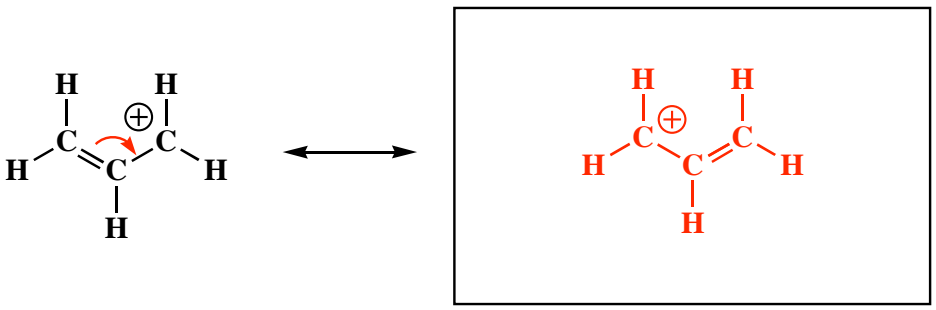


C.



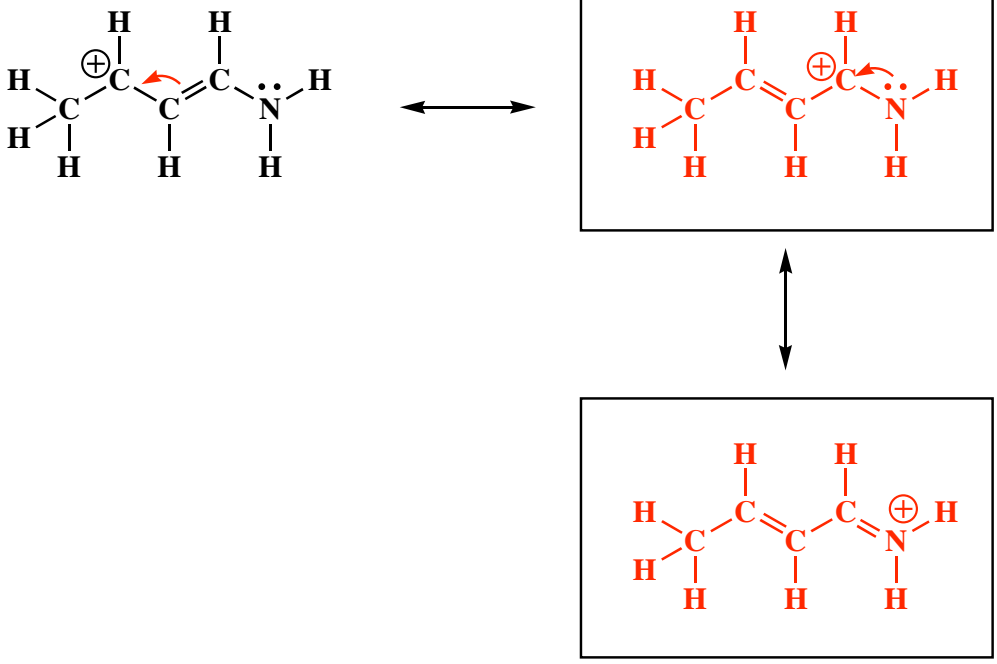
Although the positive charge is on themore electronegative atom, the structure on the right has all filled valences and more covalent bonds.

D.

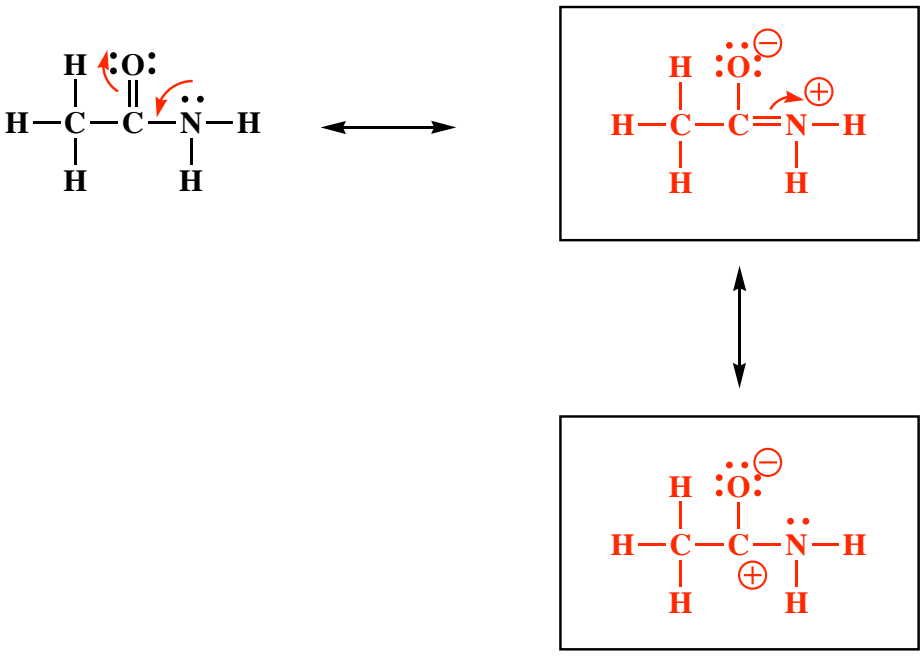


8. (10 pts each) The following molecules are best represented as the hybrid of three contributing structures. **Draw the second and third important contributing structures** in the spaces provided, including all lone pairs and formal charges. **For the two structures on the left in each problem, use 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 strucures**. You might want to read these directions again to make sure you know what we want.

A.



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. This page is worth a lot of points, so take your time.

A. Resonance contributing structures are used when more than one structure are required to describe accurately how the electrons and charges are distributed in a molecule

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. Equivalent resonance contributing structures make equal contributions to the resonance hybrid.

F. For unequal resonance contributing structures: full octets are favored, more covalent bonds are favored, fewer charges are favored, and a negative charge on more electronegative atom (also positive charge on less electronegative atom) are favored.

G. Electrons have certain properties of particles and certain properties of waves.

H. For organic chemistry, it is best to think of electron density as particles, described by Newton's laws.

I. For organic chemistry, it is best to think of electron density as waves, described by wave equations.

J. 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.

K. An sp^3 hybridized carbon atom has only two major hybridized orbitals, arranged in a bent geometry.

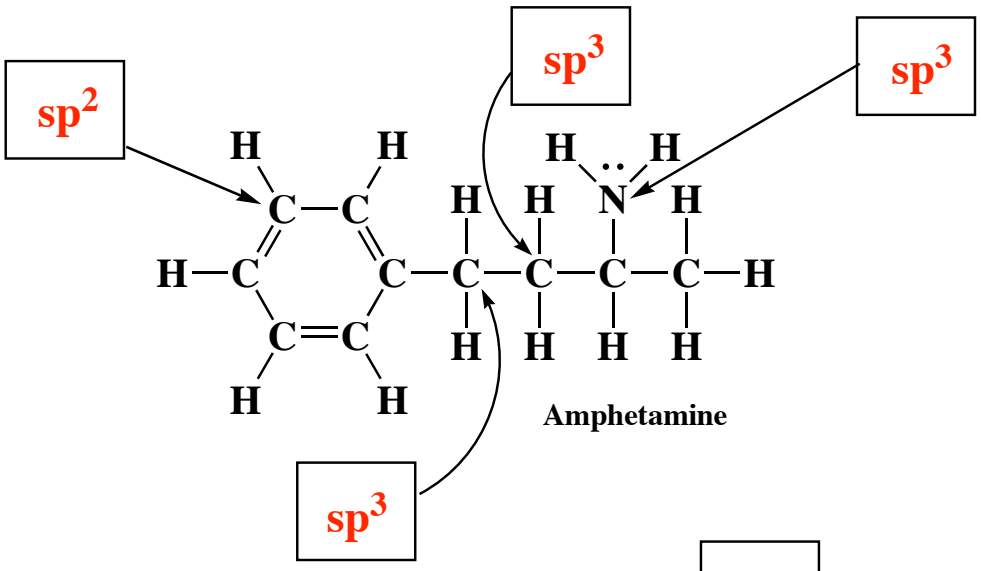
L. An sp^3 hybridized carbon atom has only one major hybridized orbital.

M. An sp^3 hybridized carbon atom has four major hybridized orbitals, arrangened in a tetrahedral geometry.

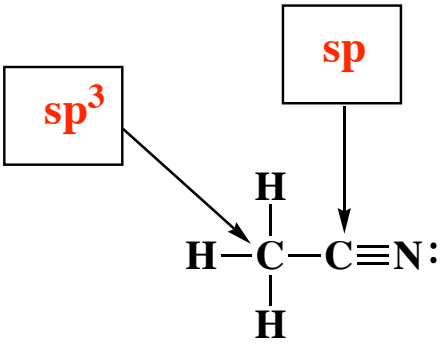
N. A sigma bond occurs when the majority of the electron density is found on the bond axis.

O. A pi bond occurs when the majority of the electron density is found on the bond axis.

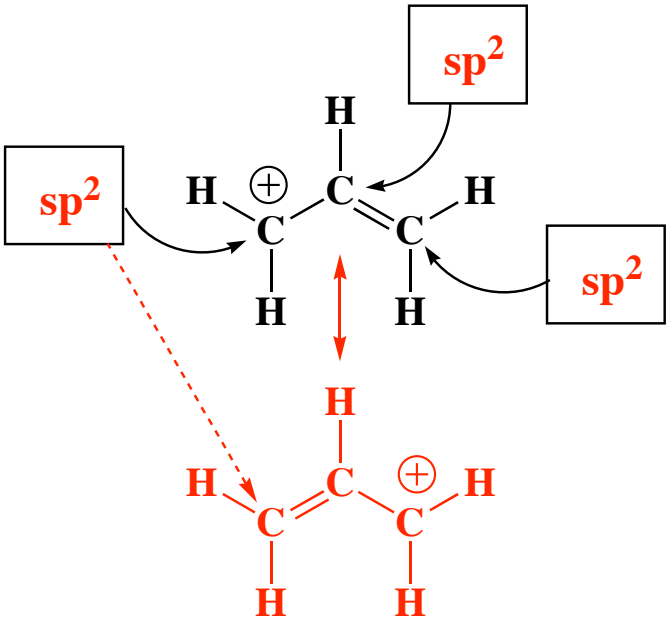
10. (11 pts) In the box provided, write the hybridization state (sp^3, etc.) of the atom indicated by the arrow.

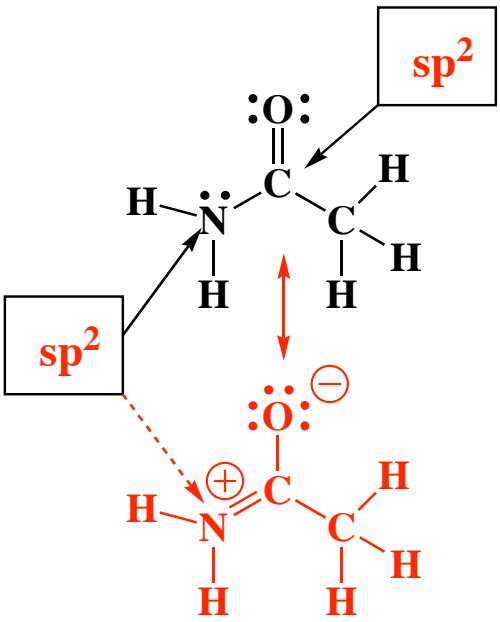


Amphetamine

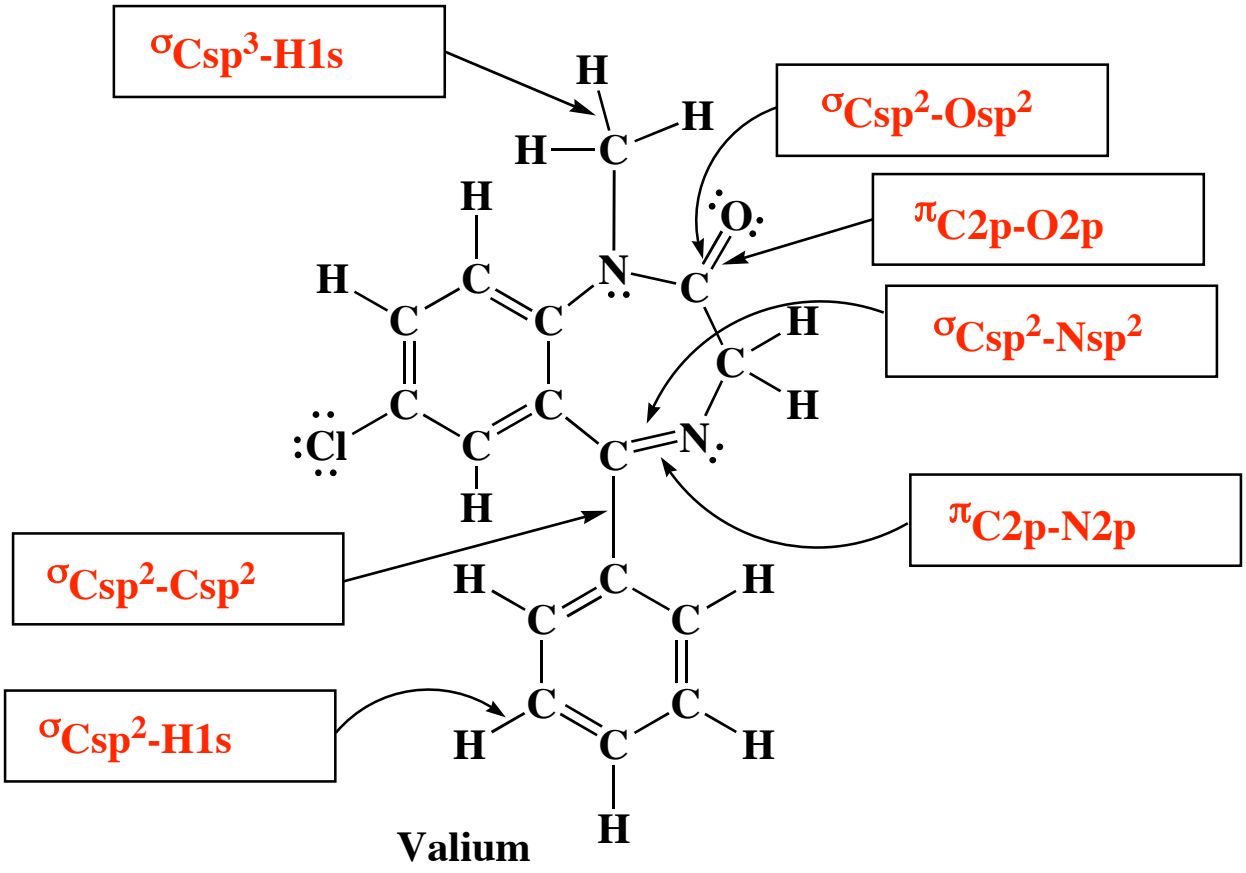


Acetonitrile (a solvent)

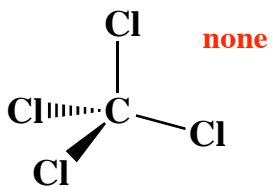


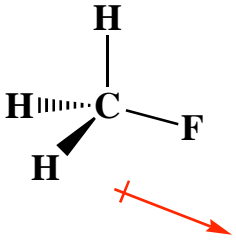


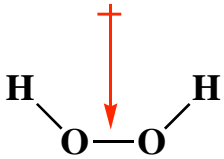
11. (14 pts) You knew this was going to be on the test. In the spaces provided, indicate the type of bond, and the hybridized orbitals that overlap to form the bond.
For example, one answer could be: $\sigma Csp^3\text{-}H1s$



12. (3 pts each) For the following molecules, use the dipole moment symbol ⟶ to show the direction of the molecular dipolemoment 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,

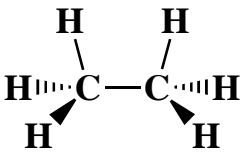
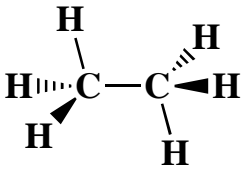
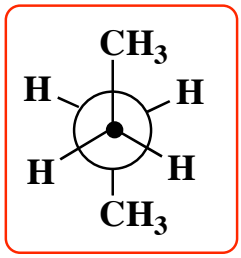
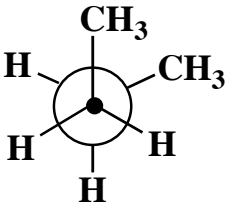
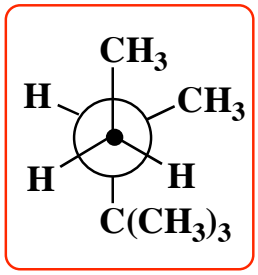
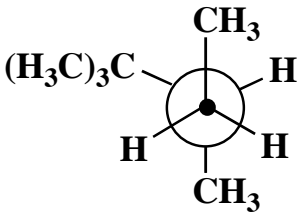
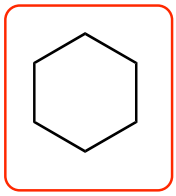
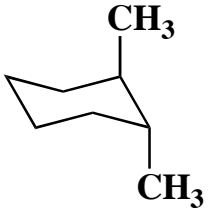
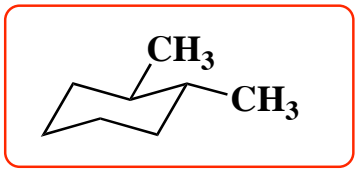
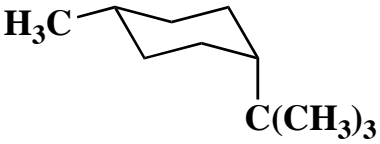
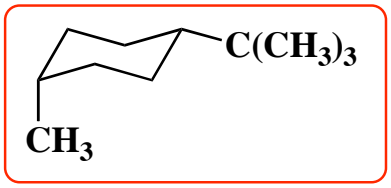






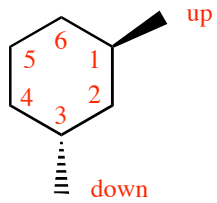
For the molecule above list the molecular dipole for the conformation shown.

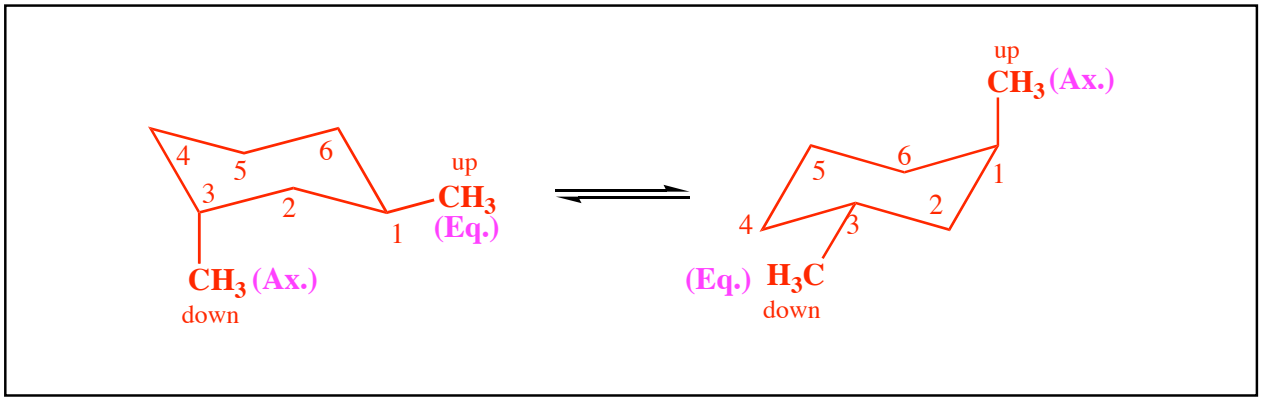
13. (4 pts each) For each pair of molecules, circle the one that has LESS STRAIN, then put an "X" in the box under all the types of strain that explain(s) your answer:

			Angle strain	Torsional strain	Steric strain
	vs.		☐	X	☐
	vs.		☐	☐	X
	vs.		☐	☐	X
☐	vs.		X	X	☐
	vs.		☐	☐	X
	vs.		☐	☐	X

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.

A)





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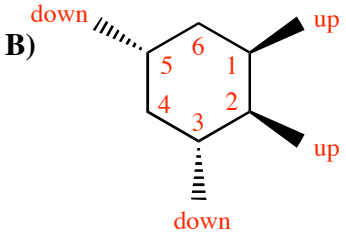
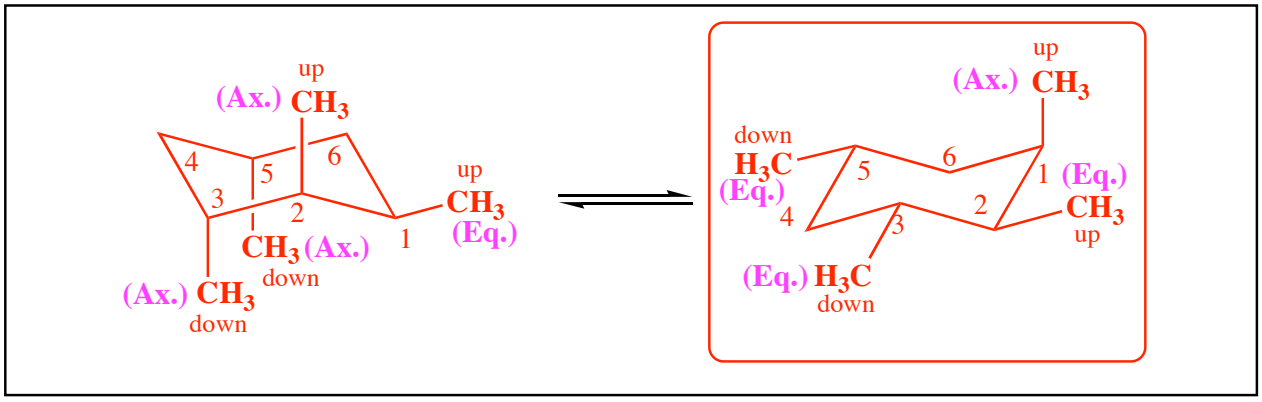
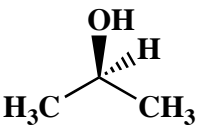




15. (2 pts each) Examine the following structures. For each molecule with a chiral center, assign the stereochemistry then write "R" or "S" as appropriate in the box provided below each structure. For all molecules that have no chiral centers, leave the box blank.



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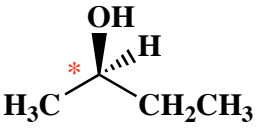
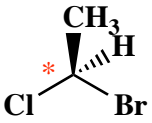
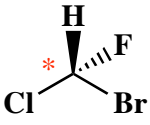


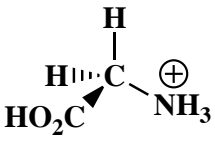
R



R



S



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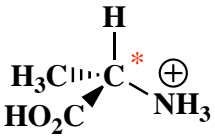
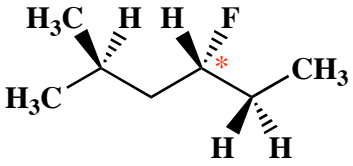
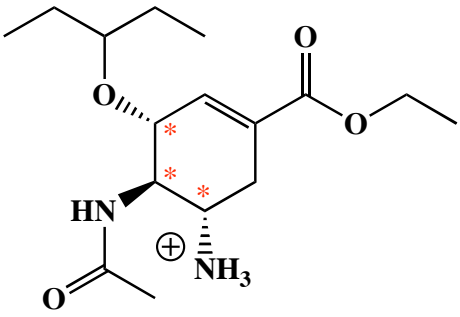


S

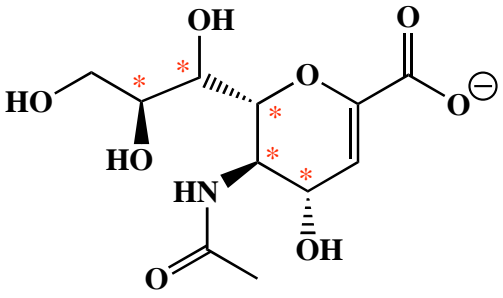


R

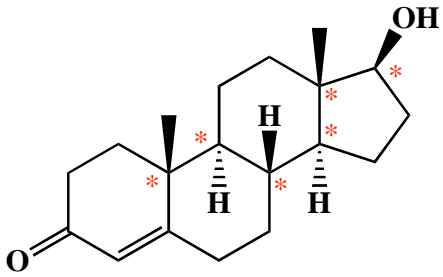
16. (14 pts) For the following molecules,identify all the chiral centers. Put an asterisk next to all chiral centers you find.



Tamiflu
(anti-flu medication)

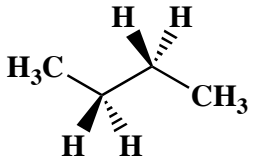


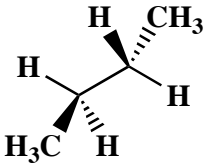
Relenza
(anti-flu medication)



Testosterone

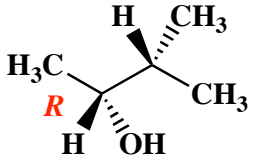
17. (3 pts each) For each pair of molecules, on the line provided state whether they are (1) **enantiomers**, (2) **diastereomers**, (3) **consitutional isomers**,or (4) **different conformations of the same molecule.** Each pair of molecules will best be described by one of these four terms.

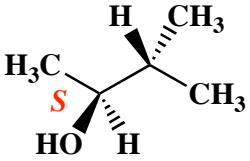




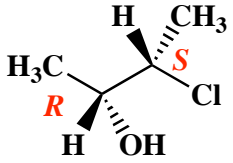
Relationship:

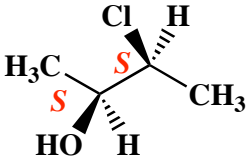
different conformations of the same molecule



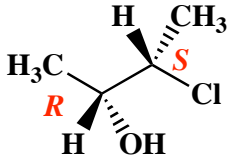


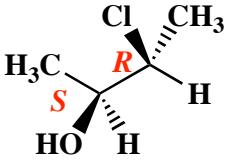
enantiomers



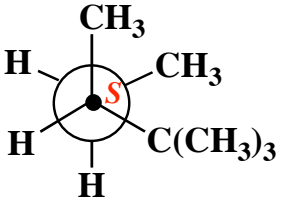


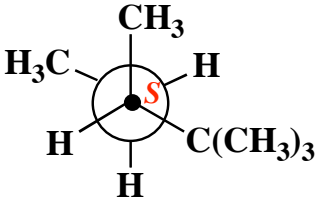
diastereomers



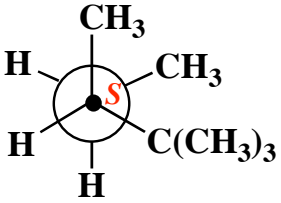


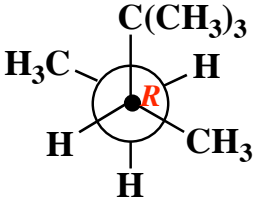
enantiomers



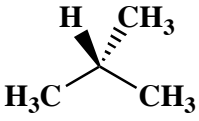


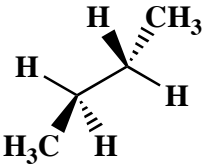
different conformations of the same molecule





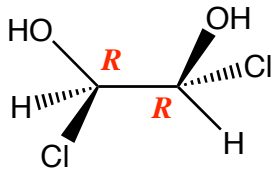
enantiomers

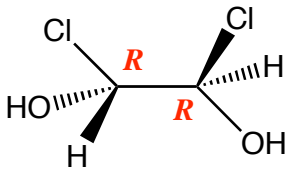




constitutional isomers

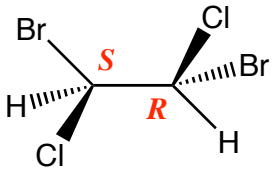
17. (continued) (3 pts each) For each pair of molecules, on the line provided state whether they are (1) **enantiomers**, (2) **diastereomers**, (3) **consitutional isomers**,or (4) **different conformations of the same molecule.** Each pair of molecules will best be described by one of these four terms.

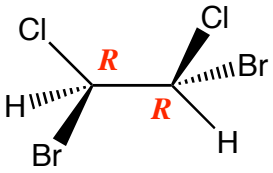




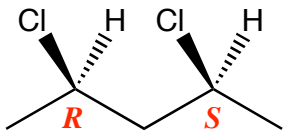
Relationship:

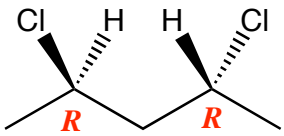
different conformations of the same molecule



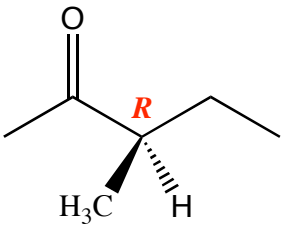


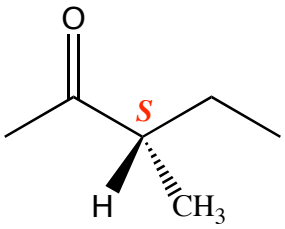
diastereomers





diastereomers





enantiomers

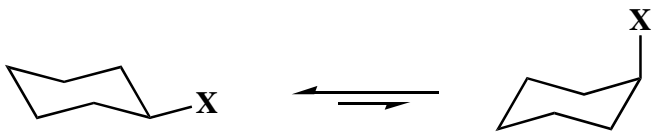
18. (2 pts. each) Fill in the blanks with the word or number that best completes the following statements.

A. A molecule with 3 chiral centers will have a maximum of _____**8**_____ possible stereoisomers.

B.. Diastereomers are _____**stereoisomers**_____ that are not _____**enantiomers**_____.

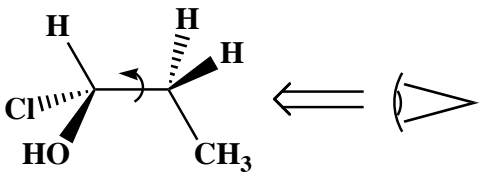
C. A mirror plane will not be found in even the most symmetric conformation of a _____**chiral**_____ molecule, although enantiomers arenon-identical _____**mirror**_____ images of each other.

19. Here is an "apply what you know" problem. The following monosubstituted cyclohexane derivatives have been analyzed and they exhibit the equatorial to axial ratios shown.

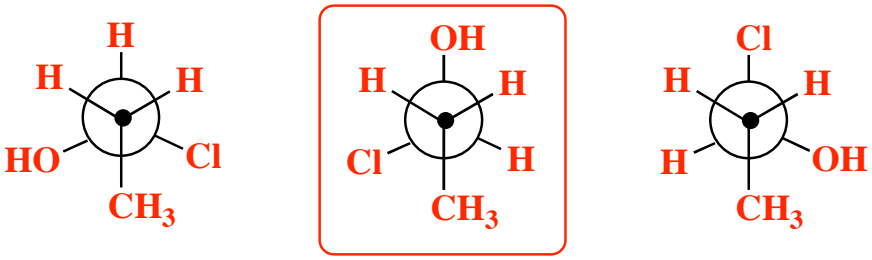


	observed ratio of equatorial : axial
X = CH_3	19 : 1
X = Cl	2.4 : 1
X = OH	4.8 : 1

Use the information about the three cyclohexane derivatives to analyze the staggered conformations of the following molecule:



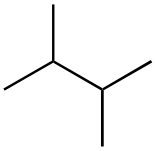
A. (9 pts) On the templates provided below, draw Newman projections of all three of the staggered conformations of the above molecule (from the perspective indicated) as the central bond rotates.



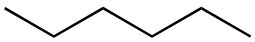
B. (8 pts) On the above Newman projections, draw a circle around the staggered conformation that is lowest in energy (has the least strain) and in the space provided below briefly explain your answer.

The equatorial : axial ratios observed with cyclohexane derivatives are based on steric strain, with smaller groups causing less strain, resulting in smaller equatorial : axial ratios. From the ratios provided in the first part of the problem, it is clear that Cl groups are smaller than an -OH group, leading to the smallest equatorial : axial ratio of 2.4:1. For this reason, in the three staggered conformations drawn, the lowest energy (least steric strain) will occur when only the smaller Cl atom is gauche with respect to the methyl group.

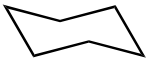
20. Here is another "apply what you know" problem. Following are three six carbon alkanes along with their boiling points



2,3-Dimethylbutane
bp 58°C



Hexane
bp 69°C



Cyclohexane
bp 81°C

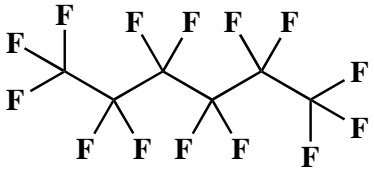
A. (6 pts) Given what you know about attraction between alkanes, explain why hexane has a higher boiling point than 2,3-dimethylbutane.

Attraction between alkane molecules is due to dispersion or van der Waals forces, which are directly proportional to the surface area of contact between molecules. Unbranched alkanes have more surface area available for contact, so they "stick" together better, increasing their boiling points relative to branched isomers. Put another way, branching decreases boiling points by decreasing surface area available to interact with other molecules.

B. (6 pts) Given what you know about attraction between alkanes, explain why cyclohexane has a higher boiling point than hexane.

Cyclohexane has no branches, but rather a ring structure that restricts conformations to the two equilibrating chair structures. These chair structures will pack together well and offer a great deal of available surface area with which to interact. Straight cyclohexane also has no branching, but when the bonds rotate it creates a variety of bent shapes, some of which cannot interact with a great deal of shared surface area contact. The cyclohexanes thus can interact over more of their surface area, leading to a higher boiling point.

C. (6 pts) Given that tetradecafluorohexane has a lower boiling point than hexane, what can you surmise about fluorine atoms compared to hydrogen atoms.



Tetradecafluorohexane
bp 59°C

The induced, transient dipoles in the fluorine atoms are of lower magnitude than the induced, transient dipoles of the hydrogen atoms. As a result, the dipsersion (van der Waals) forces holding the molecules are of less strength, meaning the fluorinated molecule has a lower boiling point (despite its significantly higher molecular weight).

As a side note, reduced dipersion forces for fluorine are the reason the Teflon family of polymer coatings (which are fluorine containing polymers) do not stick to molecules such as grease or oil and are used as non-stick coatings on pots and pans.