

NAME (Print): _____

SIGNATURE: _____

Chemistry 610A/618A
Dr. Brent Iverson
1st Exam
Oct. 1, 2003

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. **I recommend saving questions marked "challenge" until you are finished with all of the other questions.**

RELAX, TAKE A DEEP BREATH, THINK ABOUT SOMETHING PEACEFUL AND BEGIN. NERVES AND PANIC ONLY HURT YOU, JUST ASK A SCUBA DIVER, FIGHTER PILOT OR SWORD SWALLOWER !

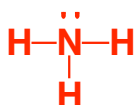
Page	Points
1	(18)
2	(14)
3	(18)
4	(20)
5	(34)
6	(32)
7	(26)
8	(24)
9	(32)
10	(22)
11	(34)
12	(24)
Total	(298)
T Score	

1. (6 pts) In the space provided, state the most important question in chemistry.

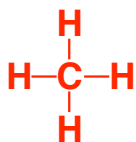
Where are the electrons?

2. (3 pts each) Draw an acceptable line Lewis structure for the following molecular formulas. Write all atoms, use lines for all bonds and show all lone pairs of electrons as dots. Show all formal charges. Note we require complete Lewis structures here, we will not accept line angle drawings for this problem.

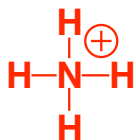
A. NH_3



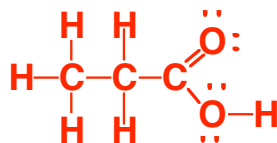
B. CH_4



C. NH_4

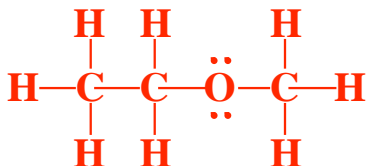


D. $\text{CH}_3\text{CH}_2\text{COOH}$

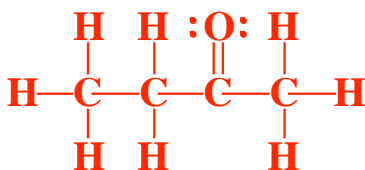


2 (continued). (3 pts each) Draw an acceptable line Lewis structure for the following molecular formulas. Write all atoms, use lines for all bonds and show all lone pairs of electrons as dots. Show all formal charges. Note we require complete Lewis structures here, we will not accept line angle drawings for this problem.

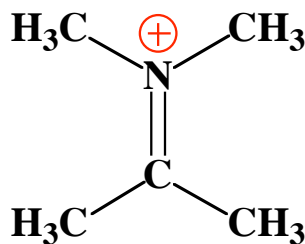
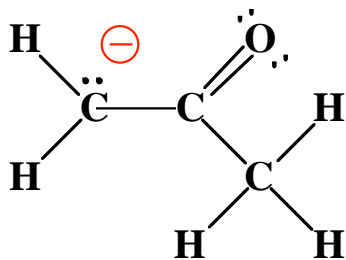
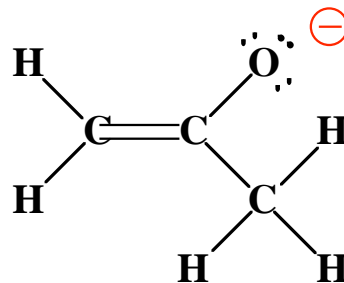
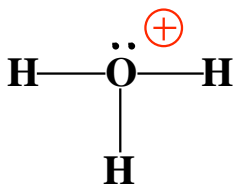
E. $\text{CH}_3\text{CH}_2\text{OCH}_3$



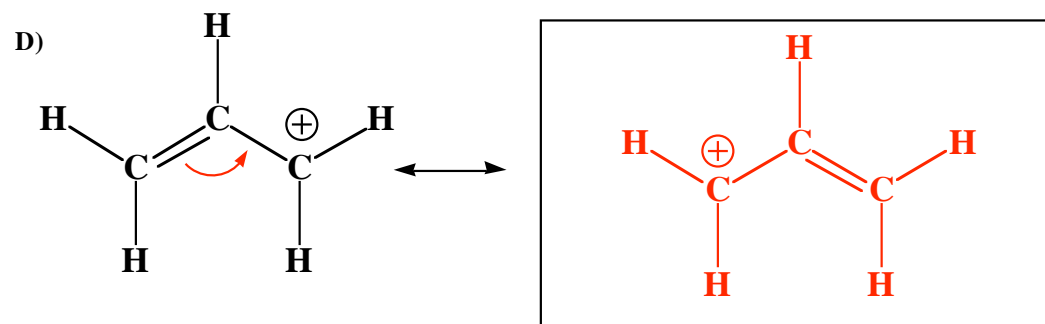
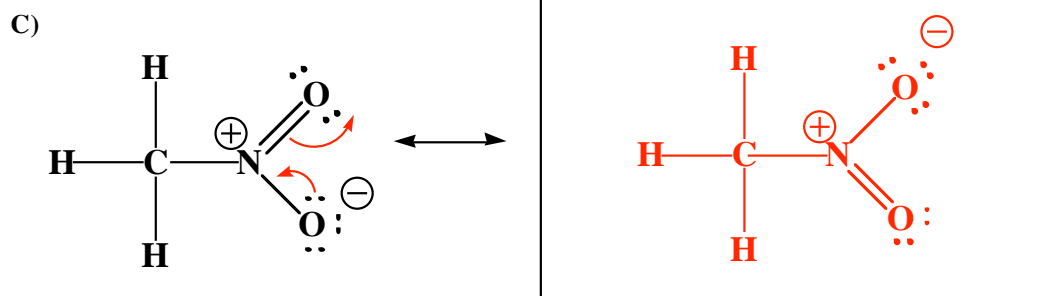
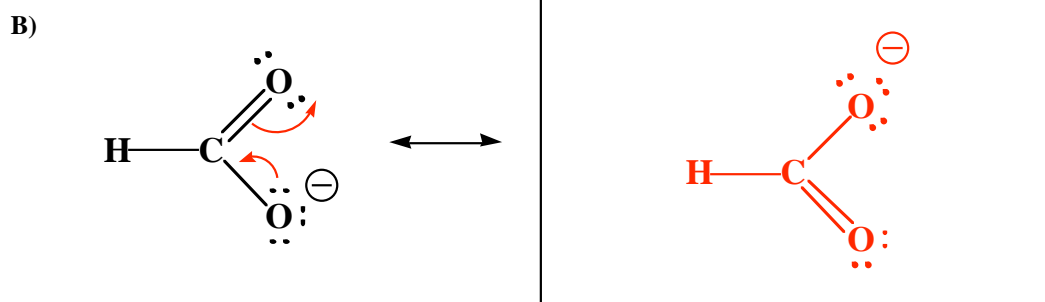
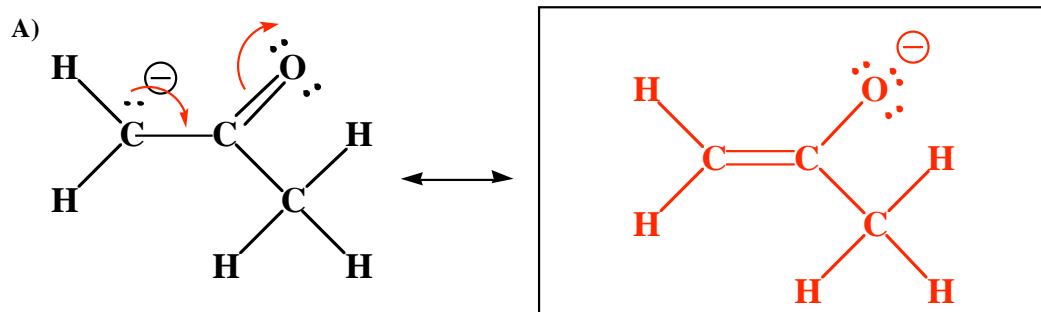
F. $\text{CH}_3\text{CH}_2\text{COCH}_3$



3. (2 pts each) Add all the formal charges next to the appropriate atoms.



5. (5 pts each) Following is drawn one contributing structure to a resonance hybrid. In the space provided, draw another contributing structure that makes an EQUAL OR GREATER CONTRIBUTION to the overall resonance hybrid. Use arrows on the structures we have drawn on the left to indicate the movement of electrons that leads to the structure you have drawn. Make sure to show all pairs of electrons as either bonds (lines) or lone pairs (dots) and ALL FORMAL CHARGES.



5. (2 pts 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 do not represent equilibrating structures, rather the hybrid (blending) of them is the true molecular representation.

B. Resonance contributing structures represent equilibrating structures.

C. When drawing contributing structures you generally move atom nuclei and sigma bonds.

D. When drawing contributing structures you generally move lone pairs and pi bonds.

E. Arrows drawn on contributing structures show how atom nuclei and charges move.

F. Arrows drawn on contributing structures show how electron pairs move.

G. A resonance hybrid is a more accurate representation of a molecule than any one contributing structure.

H. When deciding which resonance contributing structure makes the major contribution to the resonance hybrid; full octets are favored, fewer charges are favored, and a negative charge on the more electronegative atom is favored.

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

J. Electron density location is best described by wave mechanics (i.e. a three-dimensional wave) and a wave equation called the Schrödinger equation.

K. In molecular orbital theory, combination of n atomic orbitals in a molecule or ion forms n molecular orbitals, each of which extends over the entire molecule or ion.

L. A molecular orbital can hold up to four electrons.

M. In the valence bond approach, for elements more complicated than hydrogen, it is helpful to combine (hybridize) the valence atomic orbitals on a given atom before looking for overlap with orbitals from other atoms.

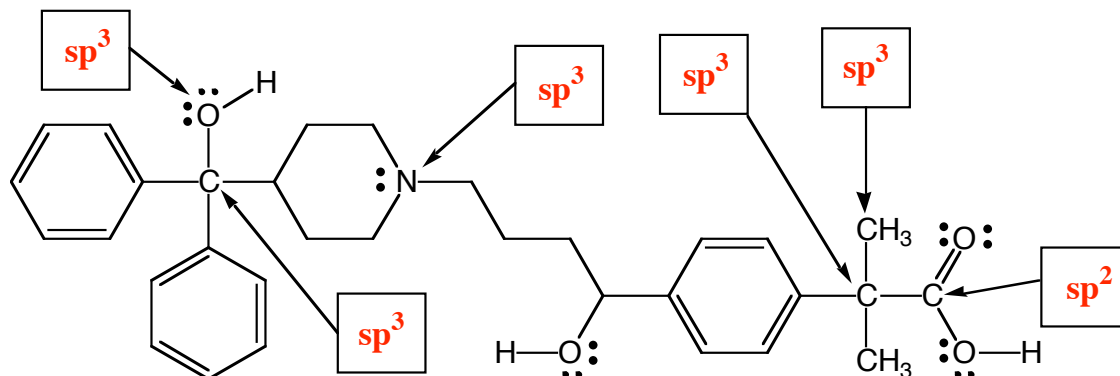
N. An sp^2 hybrid orbital results from the combination of one $2s$ orbital with three $2p$ orbitals.

O. An sp^3 hybrid orbital results from the combination of one $2s$ orbital with three $2p$ orbitals.

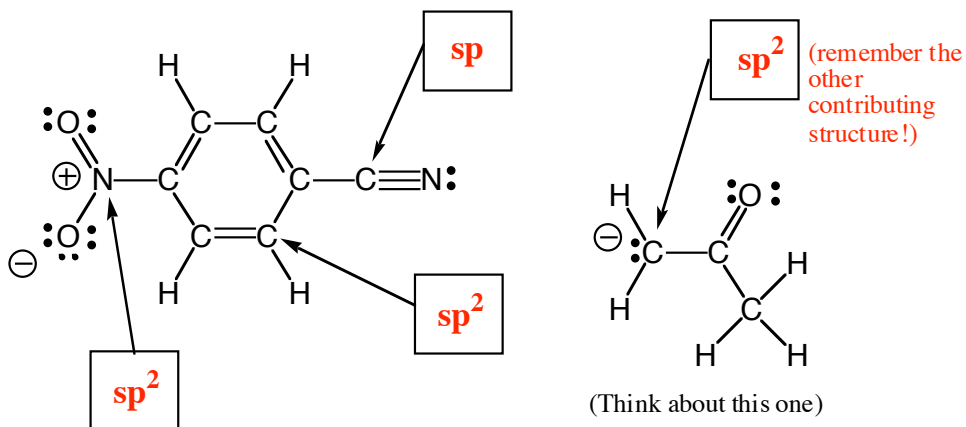
P. The sigma bond between carbon atoms of the $H_2C=CH_2$ molecule is formed from overlap of two sp^3 hybrid orbitals.

Q. The pi bond between carbon atoms of the $H_2C=CH_2$ molecule is formed from overlap of two $2p$ orbitals.

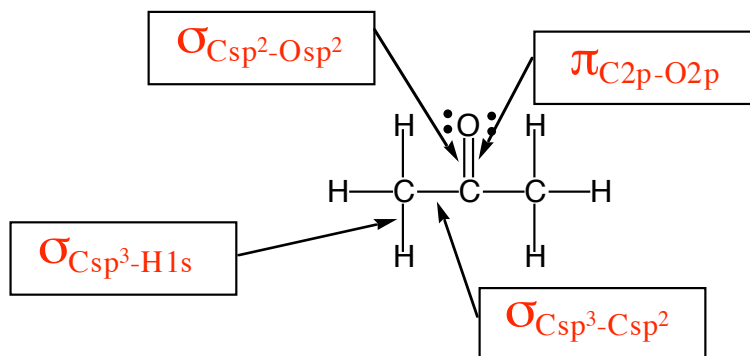
6. (2 pts each box) For the following two molecules, IN THE BOX PROVIDED, STATE THE **HYBRIDIZATION STATE** OF EACH ATOM INDICATED WITH AN ARROW.



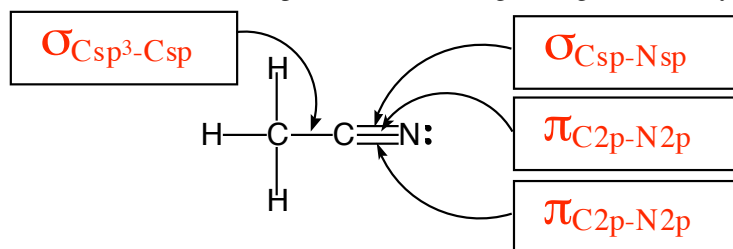
Allegra (an antihistamine)



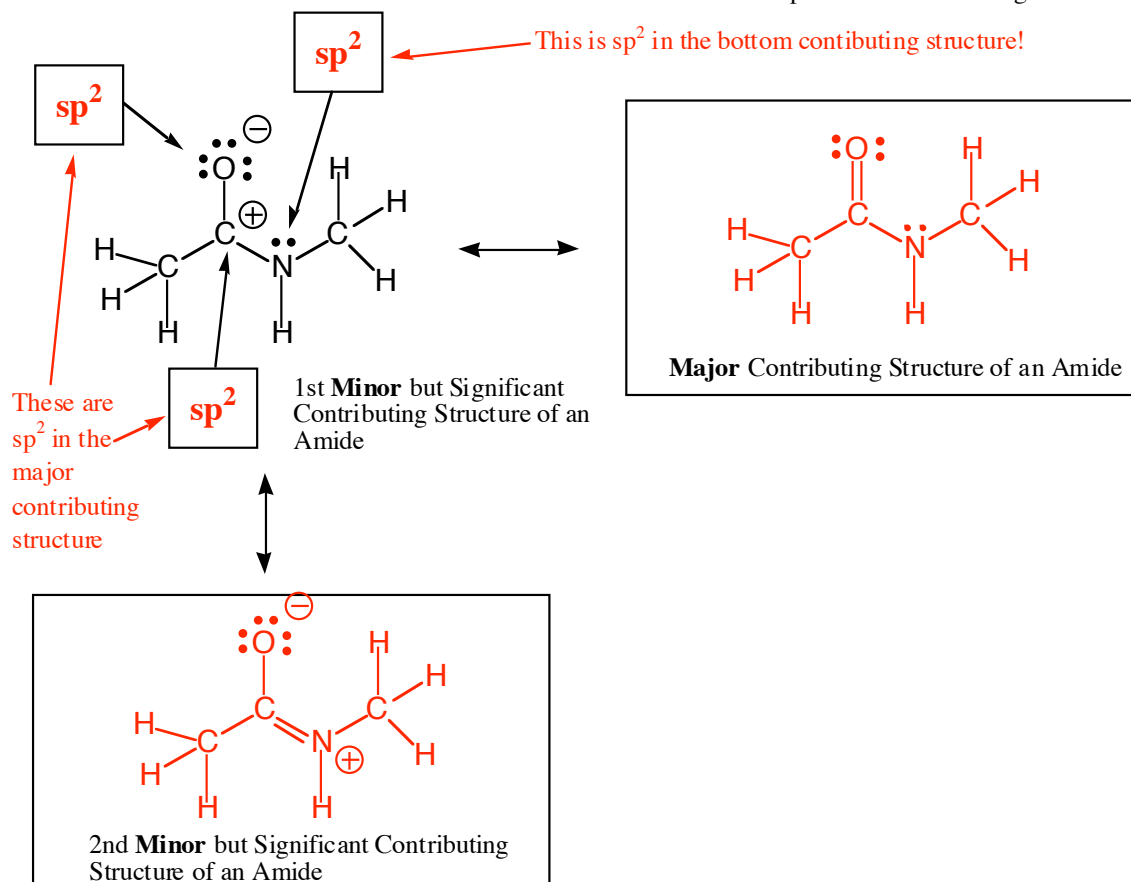
7. (3 pts each) For the following two molecules, IN THE BOX PROVIDED, STATE THE BOND TYPE (σ OR π) AND WHAT HYBRIDIZED ORBITALS OVERLAP TO MAKE EACH BOND INDICATED WITH AN ARROW. For example, an answer for a given sigma bond may be: $\sigma_{\text{Csp}^3\text{-Csp}^2}$



7 (cont.). (3 pts each) For the following two molecules, IN THE BOX PROVIDED, STATE THE BOND TYPE (σ OR π) AND WHAT HYBRIDIZED ORBITALS OVERLAP TO MAKE EACH BOND INDICATED WITH AN ARROW. For example, an answer for a given sigma bond may be: $\sigma_{\text{Csp}^3\text{-Csp}^2}$



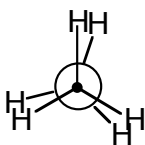
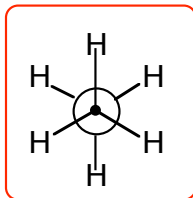
8. (14 pts) **SAVE THIS UNTIL LAST** This is an "apply what you know" challenge problem, but if you keep your wits about you, you will be able to figure it out. An amide is a very important functional group in proteins. The following contributing structure makes a minor but still significant contribution to the resonance hybrid of an amide. IN THE SPACE PROVIDED TO THE RIGHT, DRAW THE MOST IMPORTANT (i.e. DOMINANT) CONTRIBUTING STRUCTURE FOR THIS AMIDE. THEN IN THE BOXES BELOW, DRAW ONE MORE MINOR CONTRIBUTING STRUCTURE FOR THIS AMIDE. THEN IN THE BOXES PROVIDED, STATE THE **HYBRIDIZATION STATE** OF EACH ATOM INDICATED WITH AN ARROW. YOU DO NOT HAVE TO DRAW ARROWS ON THE ORIGINAL STRUCTURE TO SHOW MOVEMENT OF ELECTRONS. Remember to show all lone pairs and formal charges.



10. (4 or 6 pts each) For each pair of structures, **circle the one that has less strain** and **on the line provided state which of the three kinds of strain** (torsional, angle, non-bonded interaction) **is(are) significantly different for the two different structures.**

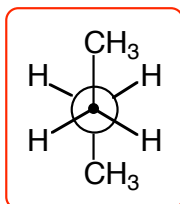
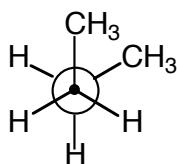
Type(s) of Strain

A.



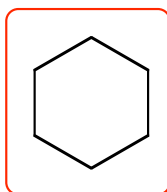
Torsional Strain

B.



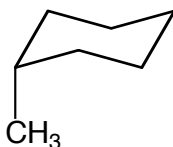
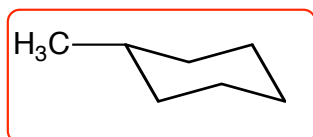
Non-bonded Interaction Strain

C.



**Angle Strain
Torsional Strain**

D.



Non-bonded Interaction Strain

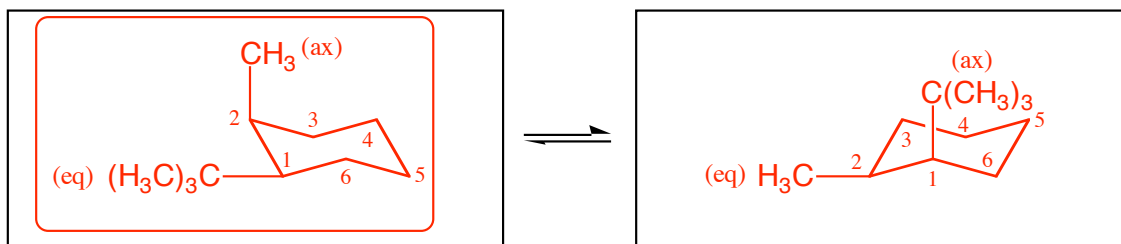
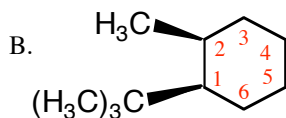
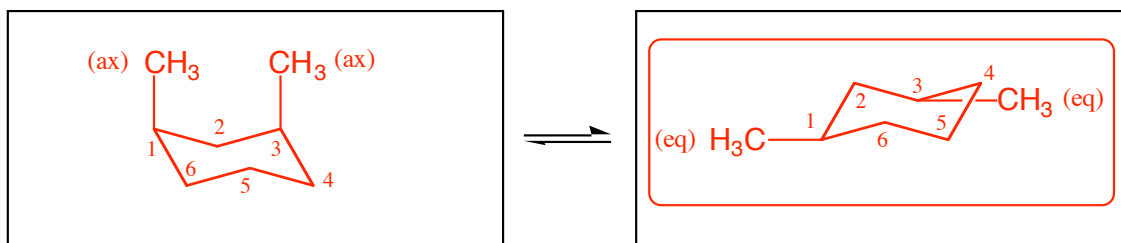
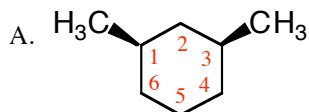
11. (3 pts.) A) In ONE sentence describe the physical basis of torsional strain.

Torsional strain is the result of bonding electron pairs repelling each other through space, so there is more strain when bonding electron pairs are closer to each other (i.e. eclipsed).

B) (3 pts.) In ONE sentence describe the physical basis of non-bonded interaction (steric) strain.

Non-bonded interaction (steric) strain is the result of atoms crunching into each other.

12. (10 pts each) For each molecule, draw the two chair conformations, and circle the one that is lower in energy, i.e. predominates at equilibrium. You do not need to show all of the hydrogen atoms on the ring, but you may if it helps. Make sure your drawing clearly indicates which groups are equatorial and which are axial. If we cannot interpret your drawing we will have to mark it wrong.



13. (2 pts each) CIRCLE ALL OF THE TRUE STATEMENTS

A. Constitutional isomers are molecules with the same molecular formula, but the atoms are connected to each other differently.

B. Stereoisomers are molecules with the same molecular formula, but the atoms are connected to each other differently.

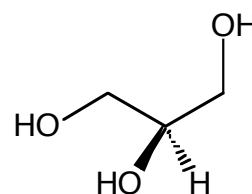
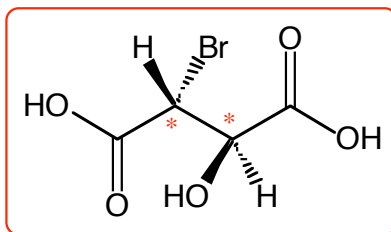
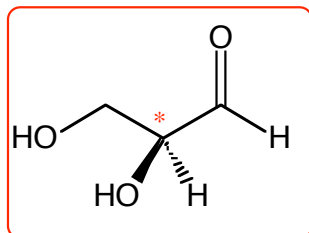
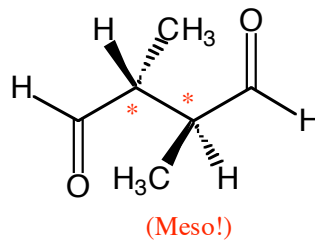
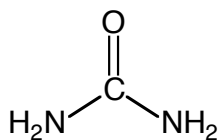
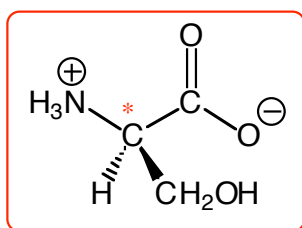
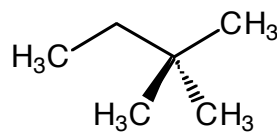
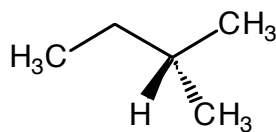
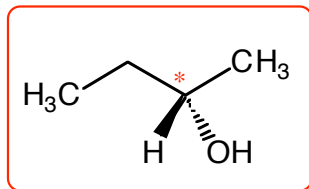
C. Constitutional isomers have the same connectivity, but the atoms are arranged differently in space.

D. Stereoisomers have the same connectivity, but the atoms are arranged differently in space.

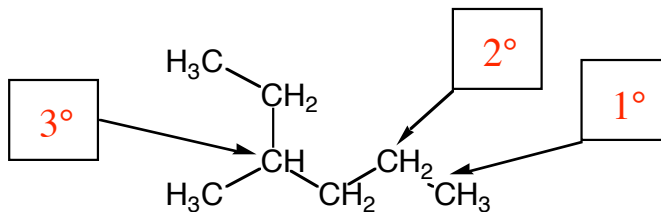
E. An object or molecule cannot be chiral if it has a plane of symmetry.

F. An object or molecule cannot be chiral if it has a mirror plane.

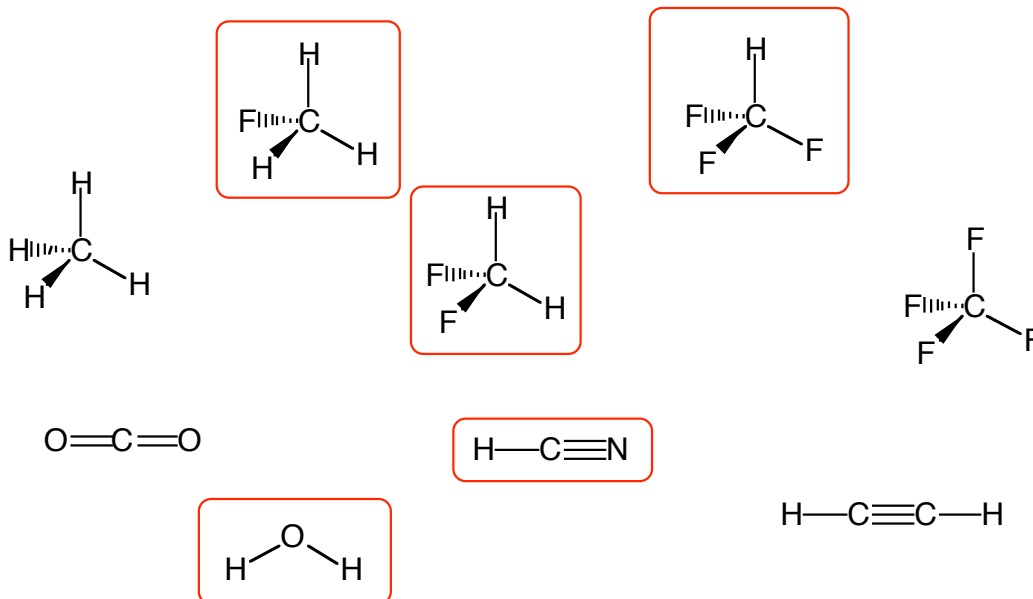
14. (16 pts) Draw a circle around each chiral molecule. Place an asterisk (*) next to each stereocenter. Note that a single molecule can have more than one stereocenter.



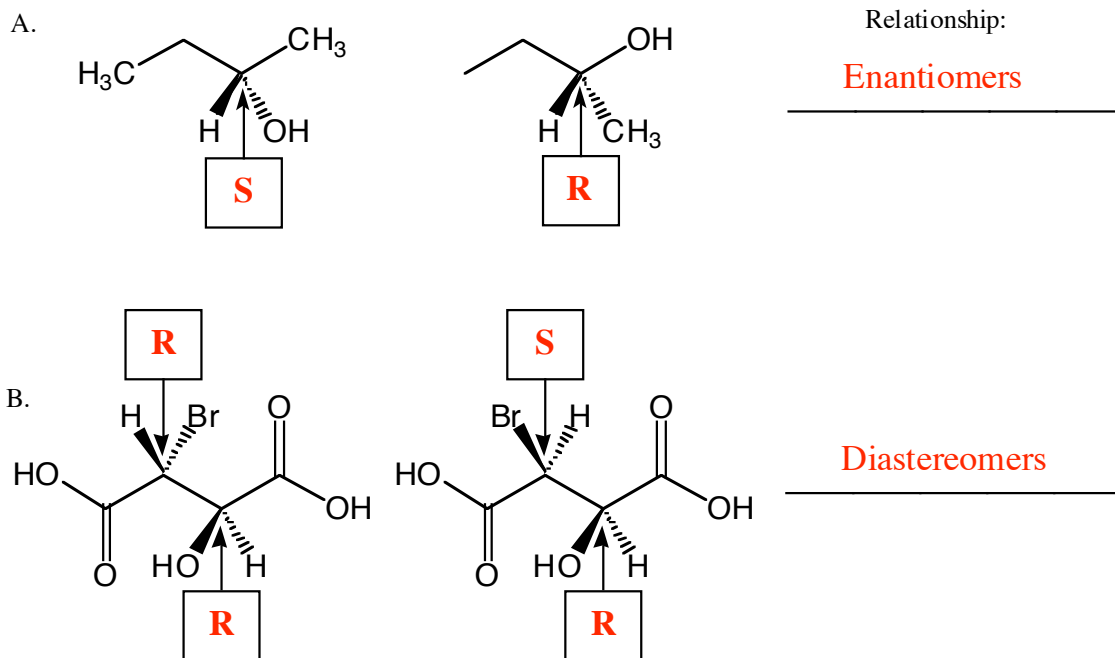
15. (2 pts each) In the boxes provided, label the indicated carbon atom as either primary (1°), secondary (2°), tertiary (3°), or quaternary (4°).



16. (2 pts each) DRAW A CIRCLE AROUND ALL THE MOLECULES WITH A PERMANENT MOLECULAR DIPOLE MOMENT.

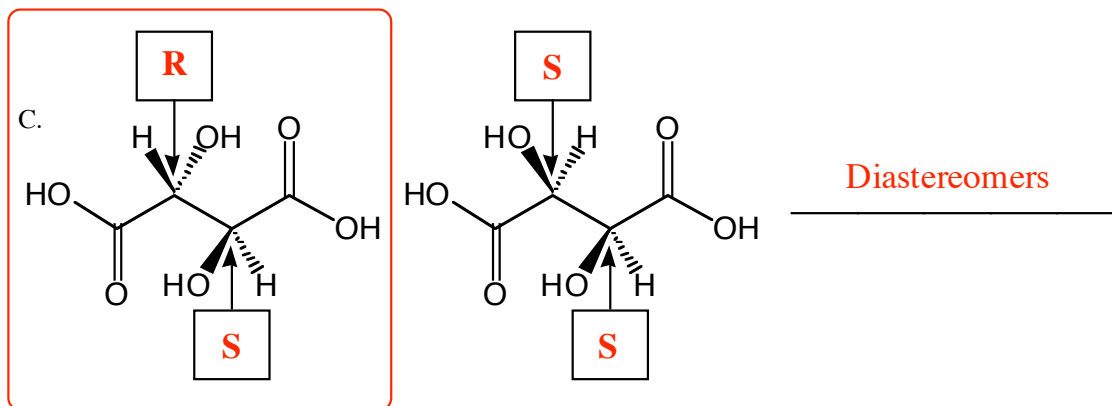


17. (6 or 10 pts each) Label each stereocenter as "R" or "S" and on the line provided state whether the pair of molecules represent two enantiomers, two diastereomers, or the same compound. Draw a circle around any meso compound.



17 (cont.). (12 pts) Label each stereocenter as "R" or "S" and on the line provided state whether the pair of molecules represent two enantiomers, two diastereomers, or the same compound. Draw a circle around any meso compound.

Relationship:



Meso!

18. (12 pts) Challenge! Save until the end! For the molecules below, DRAW A CIRCLE AROUND THE STEREOISOMER THAT IS DIFFERENT FROM THE OTHER TWO, THEN FOR THE REMAINING TWO, DRAW A BOX AROUND THE MOLECULE THAT HAS LESS STRAIN (i.e. IS LOWER IN ENERGY). I asked the TA if he thought this was too hard and he said, "No, it is nice that they see something **new, man.**" This was a hint to consider drawing Newman projections to help figure out which S conformation had the least strain!

