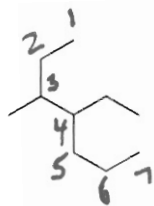
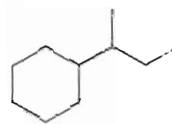


1. (6 points) Provide IUPAC accepted names for the following compounds.

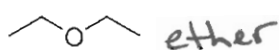
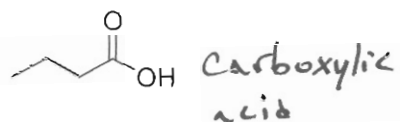
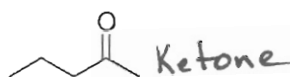


4-ethyl-3-methylheptane

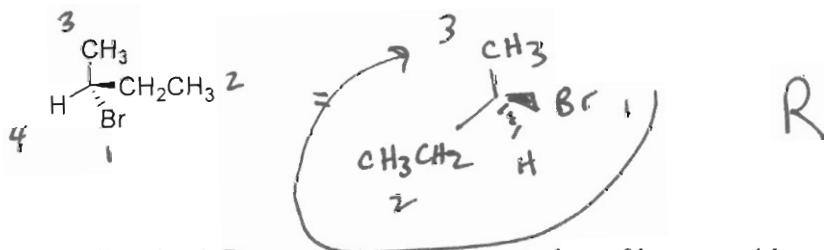


sec-butylcyclohexane

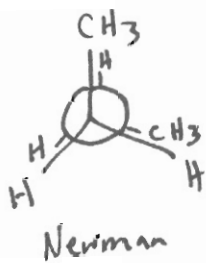
2. (10 points, 2 each) What functional group is present in each of the following molecules?



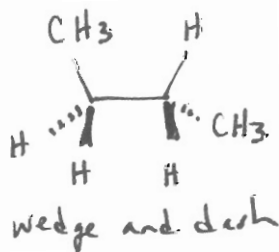
3. (3 points) Determine the absolute configuration of the stereocenter in the following molecule. Show your reasoning for full credit.



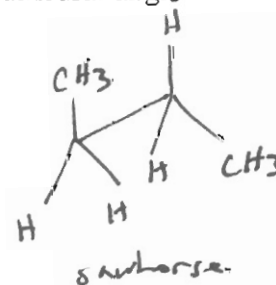
4. (3 points) Draw any 3-D representation of butane with a C-C-C-C dihedral angle of 120° .



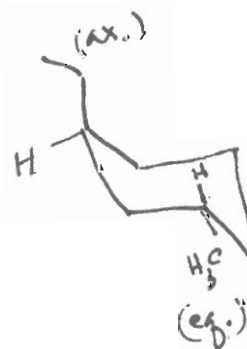
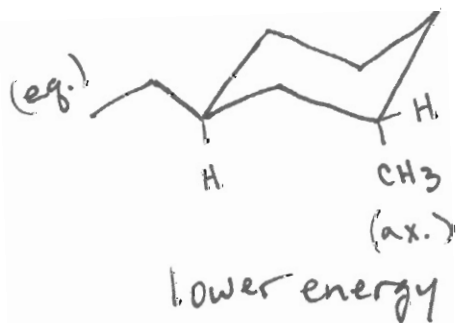
or



or



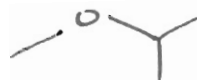
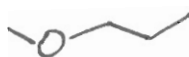
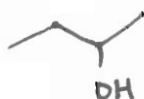
5. (6 points) Draw both chair conformations of trans-1-ethyl-3-methylcyclohexane. Clearly label the alkyl substituents as axial or equatorial. (You do not need to show all the hydrogens.) Which conformer is lower energy?



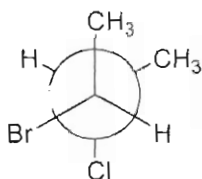
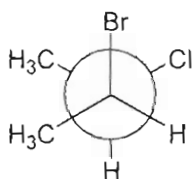
6. (2 points) How many units of unsaturation are present in a molecule with the molecular formula $C_8H_{10}Cl_2Br_2O$?

$$\frac{8(2) + 2 - 10 - 2 - 2}{2} = 2$$

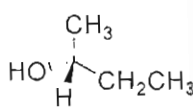
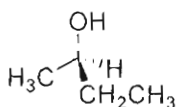
7. (10 points) Draw 5 of the 7 constitutional isomers of $C_4H_{10}O$. Be careful not to duplicate structures.



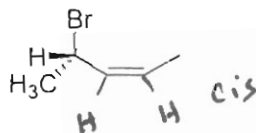
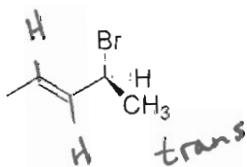
8. (12 points, 4 each) Determine if each of the following pairs of compounds represent enantiomers, diastereomers, constitutional isomers, or two molecules of the same compound.



back = same
front = mirror
diastereomers

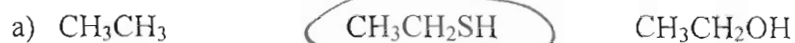


both (R)-2-butanol
same

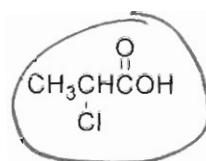
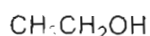
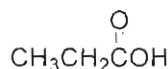
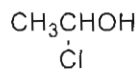


diastereomers

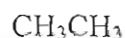
9. (4 points, 2 each) Circle the strongest acid in each set.



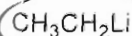
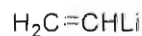
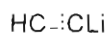
b)



10. (4 points, 2 each) Circle the strongest base in each set.



b)

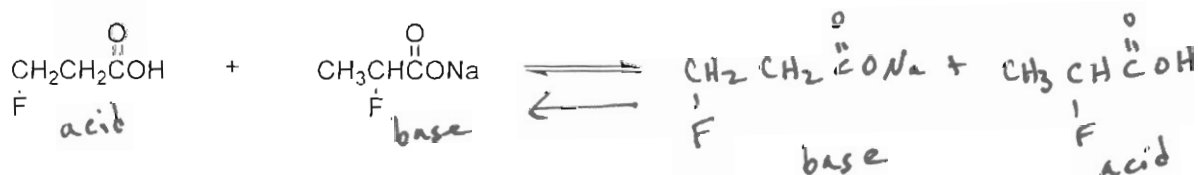
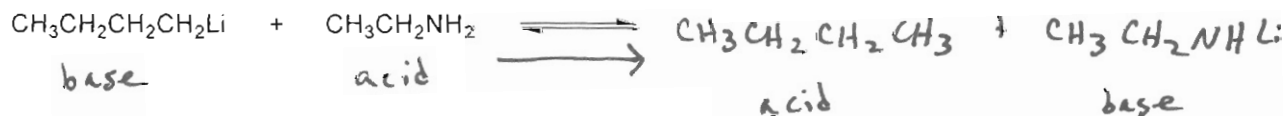


11. (15 points, 5 each) For each of the following Bronsted-Lowry acid/base reactions

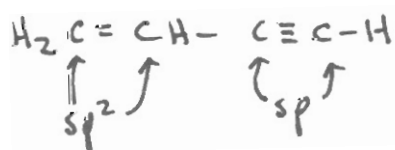
a) provide products that would form if the reaction proceeds as written. 2 pts

b) label the acid and base on each side of the reaction. 1 pt

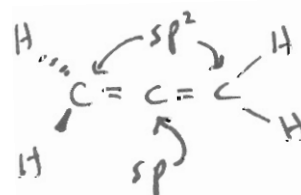
c) draw an arrow indicating which way the equilibrium actually lies. 2 pts



12. (3 points) Draw a molecule that contains at least one sp -hybridized carbon and at least 1 sp^2 -hybridized carbon. Label those two carbons (one sp - and one sp^2 -hybridized.)



or



13. (3 points) What criteria must be met for a nucleus to be visible in nuclear magnetic resonance spectroscopy?

The nucleus must have an odd number of protons, or an odd number of neutrons, or both.

14. (4 points) How, specifically, could you distinguish the following compounds from each other using NMR?



A

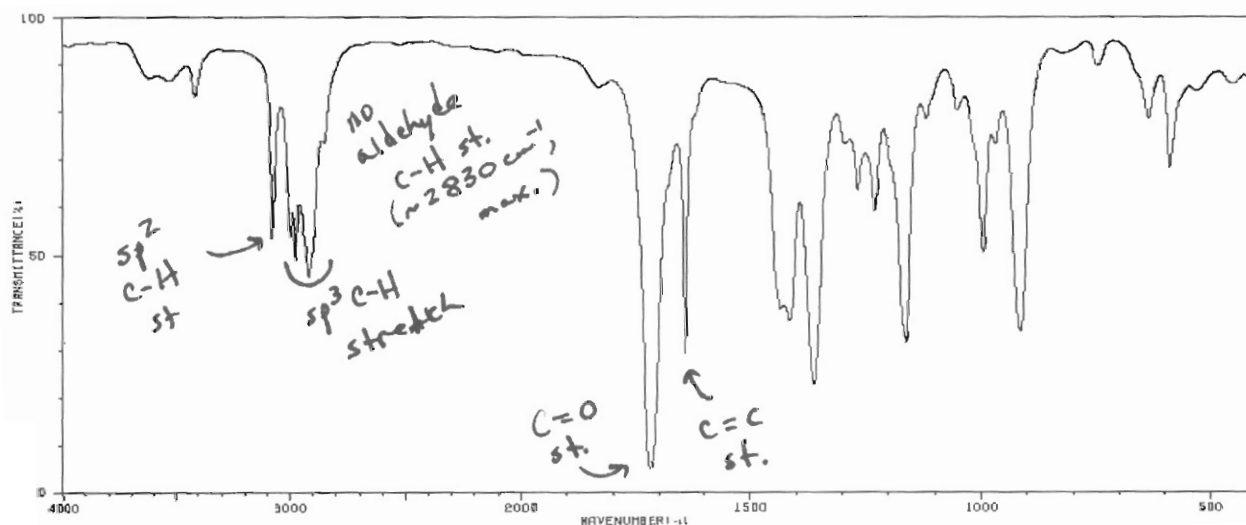
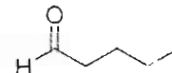
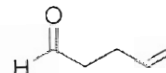
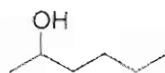
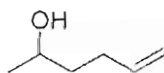
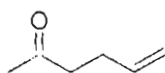
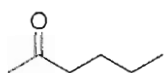


B

^{13}C NMR A gives 3 signals. B gives 1.

^1H NMR A gives 4H triplet, 4H quartet and 2H triplet. B gives a singlet only (all 8 H's).

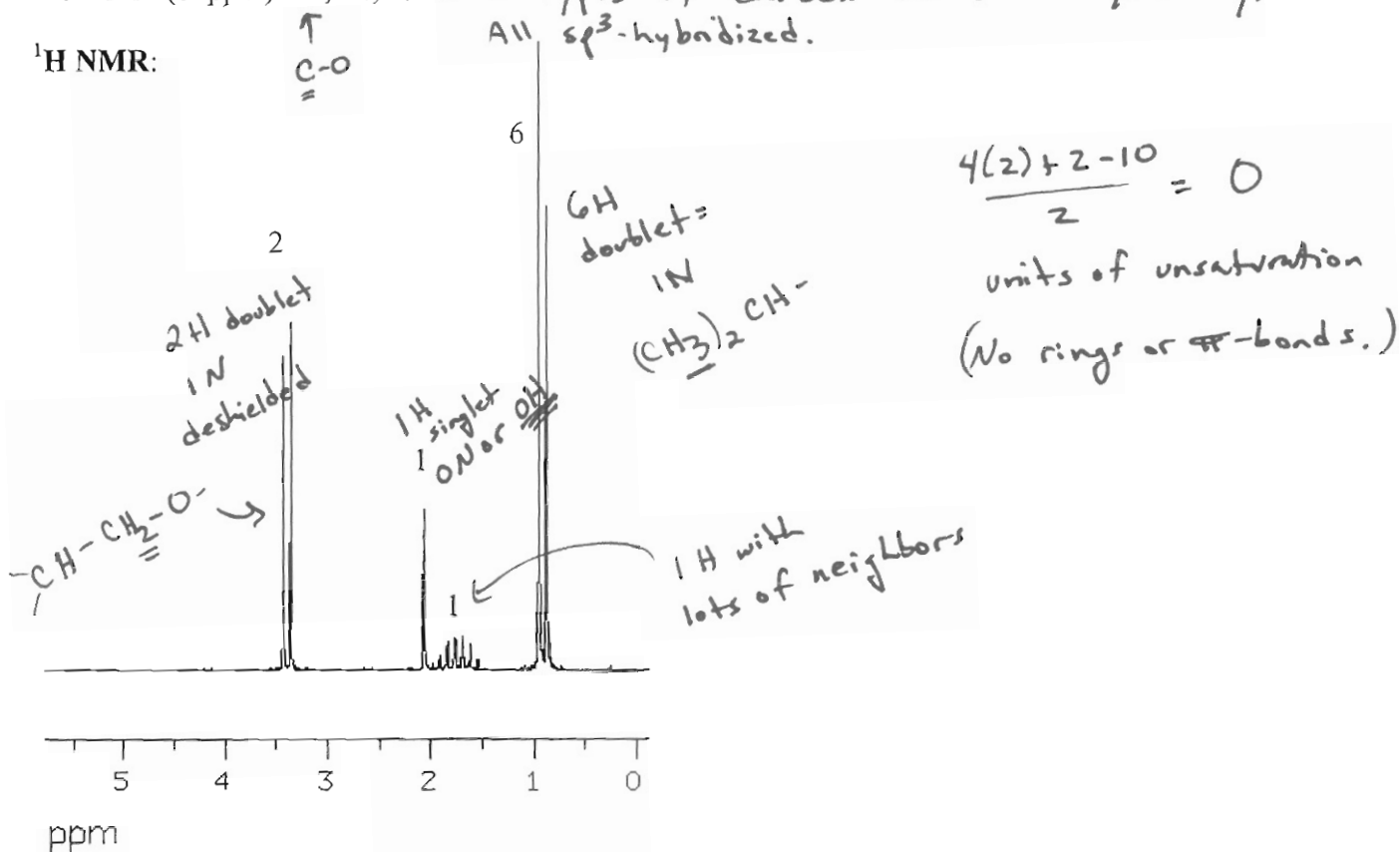
15. (5 points) Match the given IR spectrum to one of the following compounds. Label several peaks (or absence thereof) in the IR that allow you to conclusively identify the compound.



16. (10 points) Determine the structure of the following C₄H₁₀O compound. Partial credit will be awarded if you solve pieces of the final structure and show your reasoning.

¹³C NMR (δ, ppm): 69, 31, 19 ← 3 types of carbon so some symmetry.

¹H NMR:



IR:

