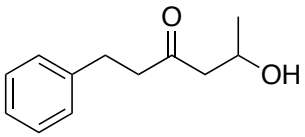
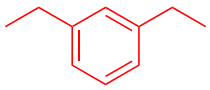
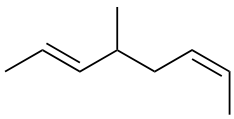
Part	A	B	C	Total
Points	10 (+2)	20	20	50 (+2)
Mark				
TA				

Part A – 1 or 2 points per question

1. (5 pts) Give the line structure or the IUPAC names for the following compounds:

STRUCTURE	NAME
	5-hydroxy-1-phenyl-3-hexanone
	*m*-diethylbenzene
	(2E,6Z)-4-methyl-2,6-octadiene

2. (0.5 pt) In valence bond theory, which atomic orbitals overlap to form the $\sigma_{C\text{-}H}$ molecular orbitals of ethane, CH_3CH_3?

   a. C 2*p* + H 1*s*

   b. C 2*sp* + H 1*s*

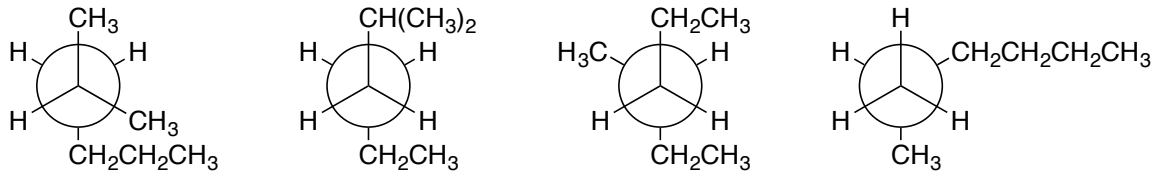
   c. C $2sp^2$ + H 1*s*

   d. C $2sp^3$ + H 1*s*

3. (0.5 pt) The two chair conformers of *cis*-1,2-dibromocyclohexane are of equal stability.

TRUE FALSE

4. (0.5 pt) Which of the following Newman projections represents 3-methylhexane?



A B C D

5. (0.5 pt) Which of the following is *not* true regarding the properties of alkanes?

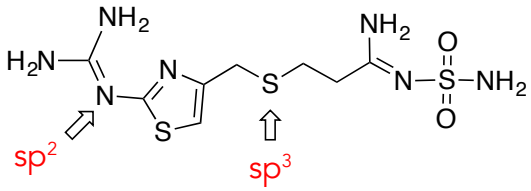
   a. alkanes are nonpolar

   b. alkanes burn in air to give H_2O and CO_2

   c. alkanes are highly miscible with water

   d. the strongest intermolecular force between alkane molecules are van der Waals interactions

6. (3 pts) The molecule shown below is known as Pepcid, a drug used to reduce gastric acid production. State the hybridization, geometry, and approximate bond angles of the indicated atoms.

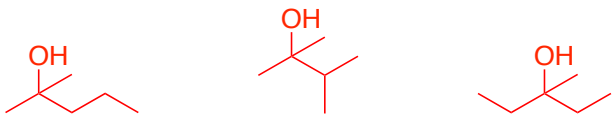


sp^2
trigonal planar
120°

sp^3
tetrahedral
109.5°

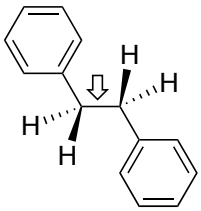
BONUS (+1.5 pts)

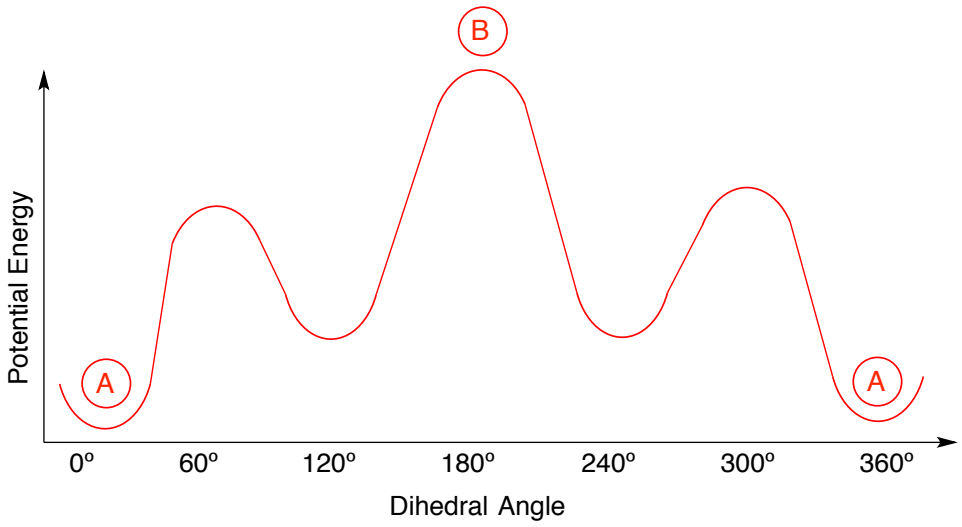
7. Draw line structures of three tertiary alcohols that have the formula $C_6H_{14}O$.

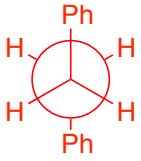


Part B

8. (5 pts) Consider the various conformers of following molecule along the indicated bond. On the following axes, sketch the potential energy diagram (as accurately as possible) as the bond is rotated. Draw and name the Newman projections for the highest and lowest energy conformers and label them on your graph.

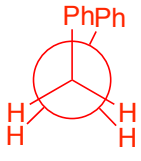






A

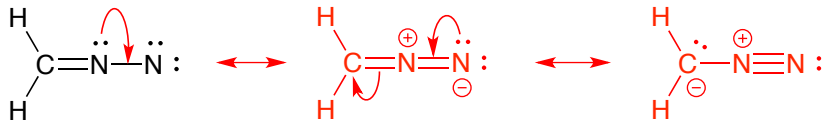
LOWEST ENERGY
ANTI-STAGGERED



B

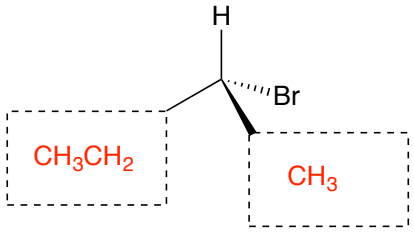
HIGHEST ENERGY
ECLIPSED

9. (5 pts) Draw the two other possible resonance structures for the following species, using electron-pushing arrows to show the conversion between resonance forms. Label the most stable resonance form.

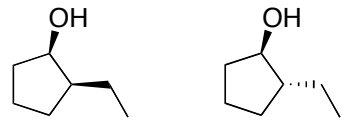
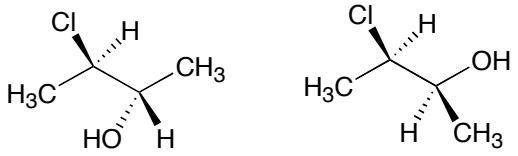


MOST STABLE

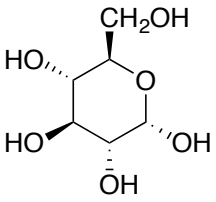
10. (2 pts) Complete the following diagram so that it represents (*R*)-2-bromobutane.

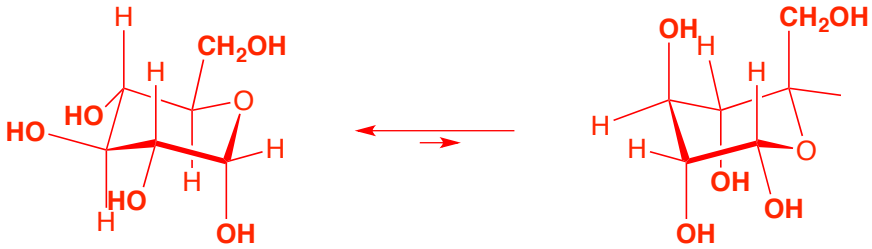


11. (3 pts) Clearly indicate the specific relationship (structural isomers, conformers, enantiomers, etc.) between the following pairs of molecules.

	DIASTEREOMERS
	STRUCTURAL ISOMERS
	CONFORMERS

12. (5 pts) The molecule below is glucose, an important carbohydrate. Draw the two chair conformers of this compound and indicate the more stable conformer (if applicable).

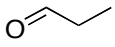


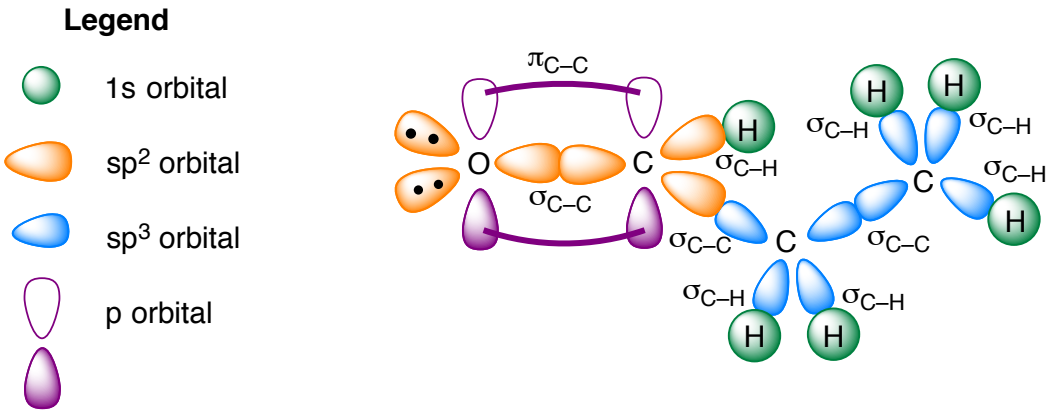


MORE STABLE

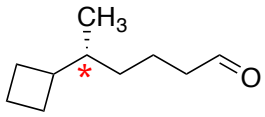
Part C

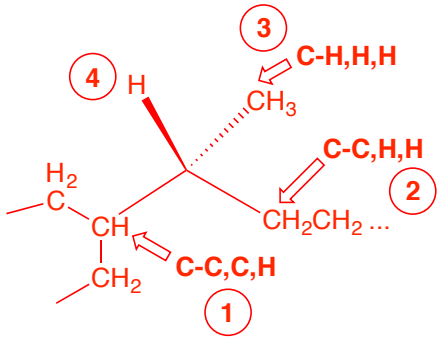
13. (6 pts) Draw the following molecule using the LCAO (hybridization) method. Label all the orbitals (p, sp, sp^2, or sp^3) and the bonds (σ or π). Include a legend if you're using different colours.





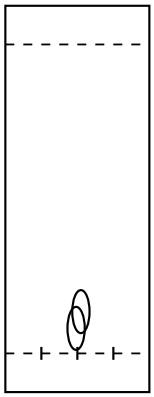
14. (4 pts) For the following molecule, identify any stereocentres with an asterisk (*). Give the full name of the molecule (including any relevant stereochemistry). To receive full marks, show all your work.





R-5-cyclobutylhexanal

15. (5 pts) You are attempting to separate pentanal and 2-pentanol using TLC. In your first attempt, you use hexane as your mobile phase, and unfortunately obtained the resulting TLC at right (note that I've shown the spots as oval shapes).



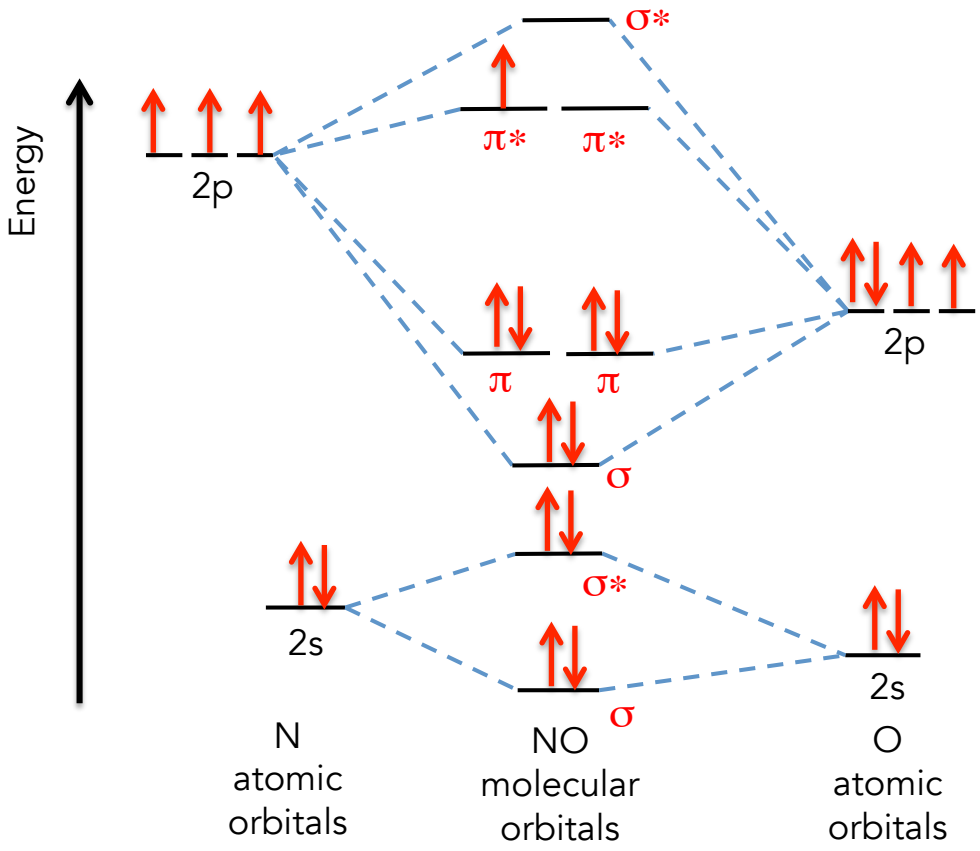
    a. Why did this separation not work? Explain in one or two sentences.
    b. What modification would you make in your second attempt? Why?
    c. If you achieved a good separation on your second attempt, which compound would have the larger R_f value?

a). Hexane is too non-polar a solvent to use as a mobile phase: the solutes (an aldehyde and an alcohol, both polar substances) instead have strong intermolecular forces with the very polar stationary phase, and thus do not migrate appreciably.

b). I'd try increasing the polarity of the mobile phase, perhaps by mixing hexane with something like ethyl acetate (ideally, a range of mixtures, of increasing polarity, might be needed to find the best possible separation).

c). larger R_f = PENTANAL

16. (5 pts) Using the template below, complete the molecular orbital diagram of NO by adding electrons and completing the appropriate labels. What is the bond order in this species? Why are the atomic orbitals of oxygen shown at a lower energy than nitrogen?



Bond Order = (8 – 3)/2 = 2.5

Oxygen's atomic orbitals appear at a lower energy (relative to nitrogen) due to the higher electronegativity of the atom.