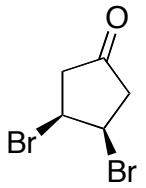
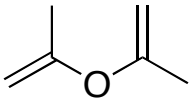
Part A – 1 or 2 points per question

1. Give the IUPAC names for the following compounds.



cis-3,4-dibromocyclopentanone



di isopropenyl ether

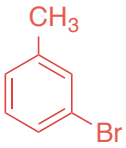
2. Draw an arrow indicating the dipole moment in the following molecule: C–O

3. Which of the following is/are an exception(s) to the octet rule? Circle the exception(s).

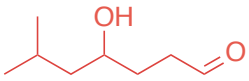
CH_4 $\bullet CH_3$ CH_3^+ CH_3^-

4. Draw the line structure for the following compounds.

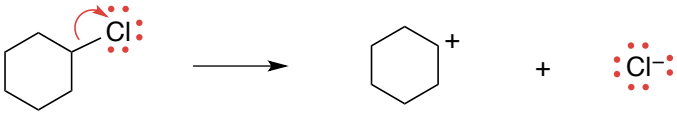
   a. *meta*-bromotoluene



   b. $(CH_3)_3CCH_2CHOHCH_2CH_2CHO$

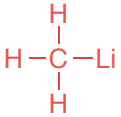


5. Include *all* lone pairs of electrons and add electron-pushing arrows as needed to the following reaction:



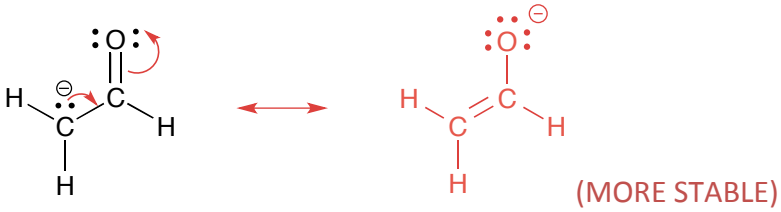
6. Draw the full Lewis structure of CH_3Li. Indicate clearly which bonds are ionic or covalent.

C–H: ΔEN = 2.5 – 2.1 = 0.4 (covalent)
C–Li: ΔEN = 2.5 – 1.0 = 1.5 (polar covalent)

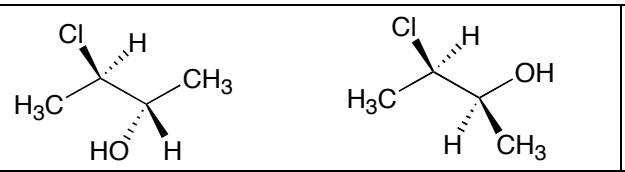
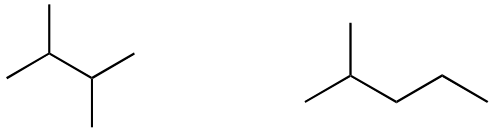
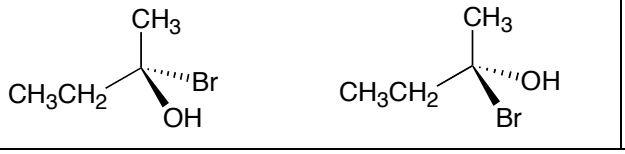


Part B

7. (3 pts) Draw the possible resonance structures for the following species, using electron-pushing arrows to show the conversion between resonance forms. Label the more stable resonance form.

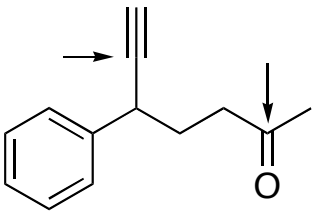


8. (3 pts) Indicate the relationship between the following pairs of molecules. Be as specific as possible. (*e.g.* conformers, diastereoisomers, enantiomers…)

	CONFORMERS
	STRUCTURAL ISOMERS
	ENANTIOMERS

9. (6 pts) State the hybridization, geometry, and approximate bond angles of the indicated atoms.

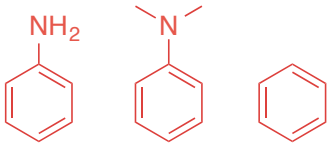
sp
linear
180º



sp^2
trigonal planar
120º

10. (3 pts) From the following set of molecules, circle the compound that would have the smallest R_f on silica gel. In a few sentences, explain your choice.

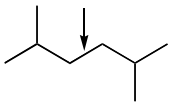
aniline *N,N*-dimethylaniline benzene



The molecular structures of each are at right. Smaller R_f values correspond to molecules that have stronger intermolecular interactions with the solid phase (the silica gel). Of these three substances, aniline is capable of the strongest interaction (Hydrogen-Bonding) with the silica gel, and so its progress up the TLC plate will be slowest.

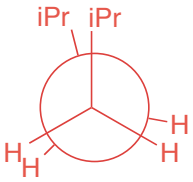
Part C

11. (4 pts) Consider the Newman projection of the following molecule along the C3-C4 bond.



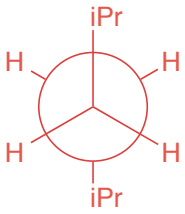
a. Draw and name the Newman projection of the least stable conformation.

Let "iPr" represent the iso-propyl groups attached to C3 and C4:



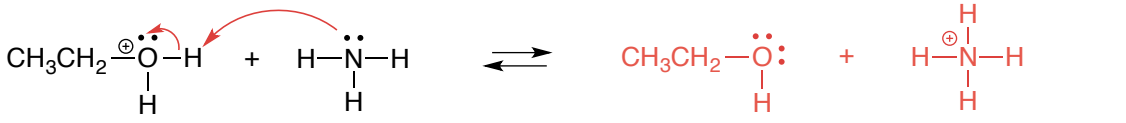
ECLIPSED

b. Draw and name the Newman projection of the most stable conformation.



ANTI-STAGGERED

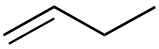
12. (4 pts) For the *acid-base* reaction below:
    a. Draw a mechanism and the expected products.
    b. Identify the acid, base, conjugate acid, and conjugate base.
    c. Does the equilibrium favour the starting materials or products? Justify your answer.

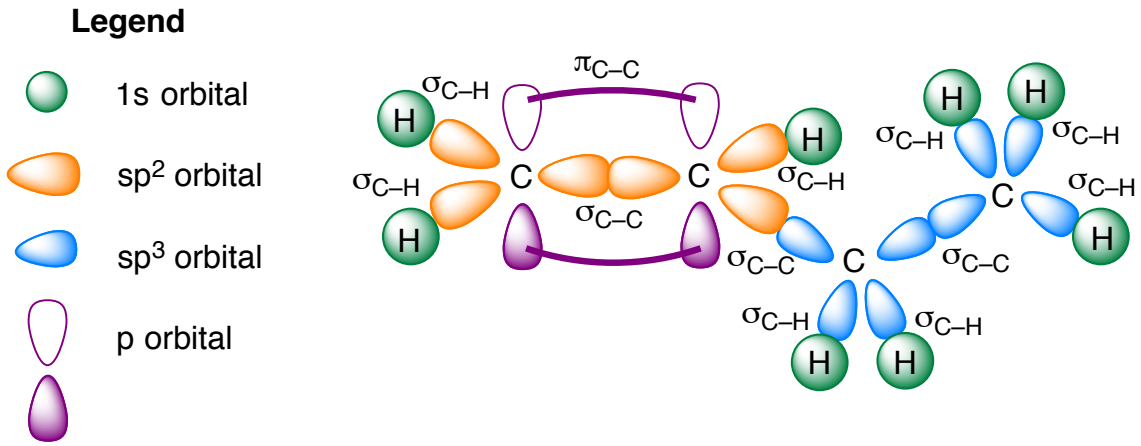


ACID pKa ~ –2 | BASE | CONJUGATE BASE | CONJUGATE ACID pKa ~ 9.2

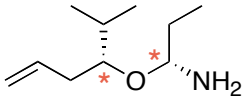
The reaction goes towards products, because the protonated alcohol is a stronger acid than the ammonium ion.

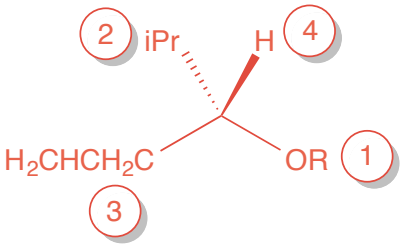
13. (6 pts) Draw the following molecule using the LCAO method. Label all the orbitals (p, sp, sp^2, or sp^3) and the bonds (σ or π).



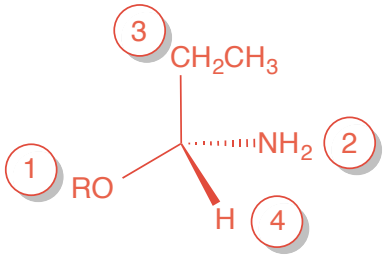


14. (4 pts) For the following molecule, identify the stereocentres with an asterisk (*) and assign the stereochemistry of each centre as *R* or *S*. Show your reasoning to obtain full marks.





This chiral centre is R.

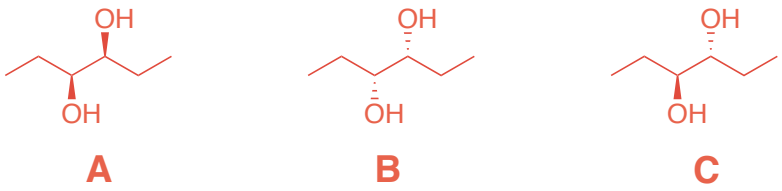


This chiral centre is R.

15. (7 pts) Draw the structures for all possible stereoisomers of the molecule below. Clearly identify which structures are enantiomers, diastereomers, or meso compounds.

$CH_3CH_2CHOHCHOHCH_2CH_3$

There are three stereoisomers in total:



A and B are enantiomers.

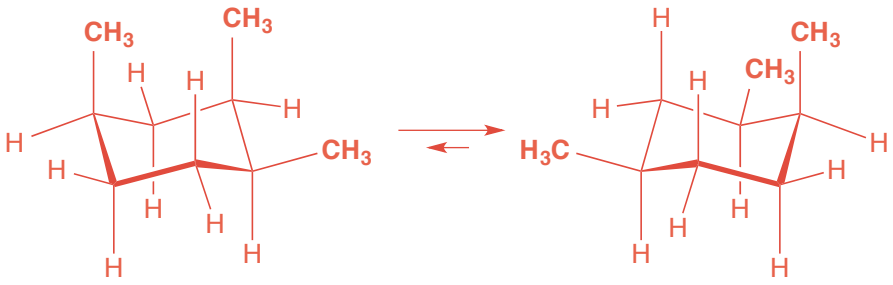
C is a meso compound.

A and C are diastereoisomers.

B and C are diastereoisomers.

Bonus (2 pts):

16. Draw the line structures for the two chair conformers of all-*cis*-1,3,4-trimethylcyclohexane and label the more stable conformer.



2 CH_3's are axial
1 CH_3 is equatorial

1 CH_3 is axial
2 CH_3's are equatorial

MORE STABLE