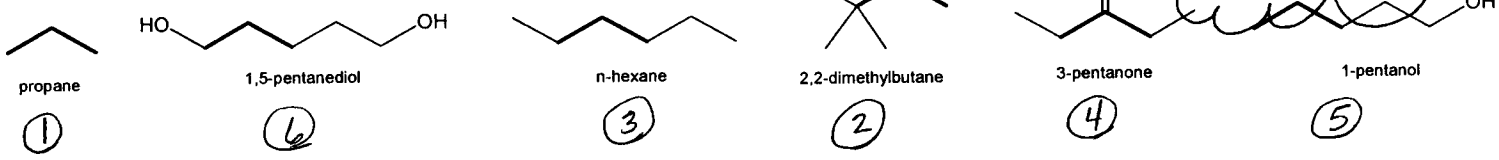
KEY

1. a. (6 pts) Number the following structures in order of increasing boiling point, with 1 being the lowest boiling and 6 being the highest boiling.

Solomons Review 2.27

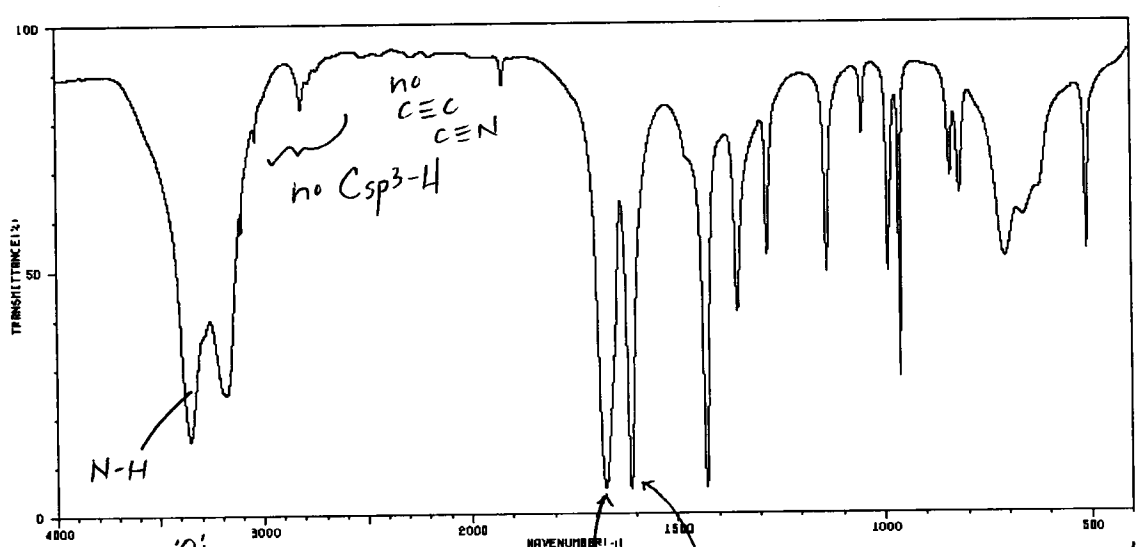


propane (1) | 1,5-pentanediol (6) | n-hexane (3) | 2,2-dimethylbutane (2) | 3-pentanone (4) | 1-pentanol (5)

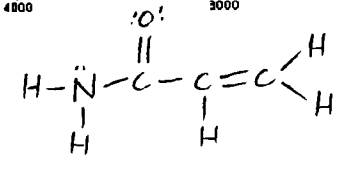
b. (5 pts) What is the relationship between *n*-hexane and 2,2-dimethylbutane. Account for the difference in boiling point of these two molecules.

constitutional isomers. n-hexane has more surface area than 2,2-dimethyl-butane. more surface area = more London dispersion forces = more energy required to increase distance betw molecules = higher bp

2. (10 pts) Use the following IR data to derive a reasonable structure for unknown compound **GRIO**, C_3H_5NO.

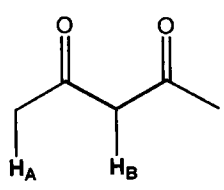


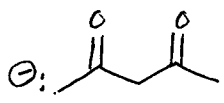
IHD = $\frac{(2(3)+2+1)-5}{2}$ = 2



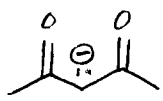
other reasonable structures possible.

3. (12 pts) Predict whether H_A or H_B has the lower pK_a. Justify your answer. Your answer must include a combination of words and relevant structures.

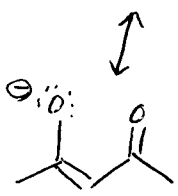




vs.

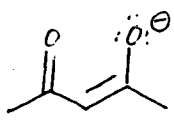


this conjugate base more stable



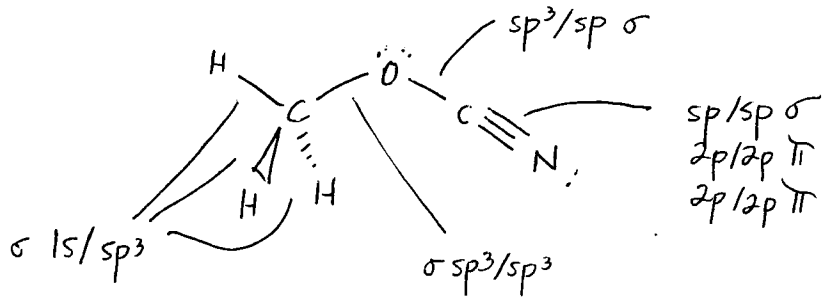
(1) the ⊖ is closer to both C=O so is stabilized more by the e⁻ withdrawing inductive effect.

(2) the ⊖ is stabilized by 2 additional resonance structures.

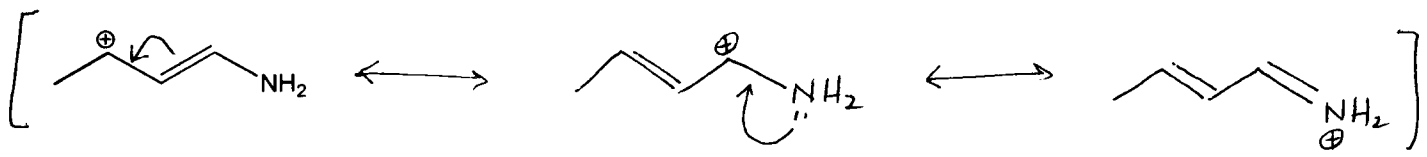


So pka of H_B is lower

4. (10 pts) For the molecule CH_3OCN, draw a <u>three dimensional</u> Lewis structure, including all lone pairs. On your Lewis structure, clearly <u>label all orbitals</u> that overlap to form each of the bonds in the molecule.



5. (15 pts) For the species below, (a) Draw two additional resonance structures that are at least as stable as the structure shown below, including formal charges and lone pairs where necessary. (b) Evaluate which structure is the major contributor. Briefly explain.

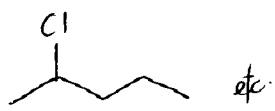


a C lacks octet

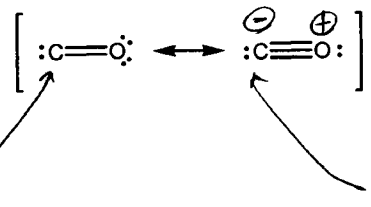
major
all atoms = octet

Solomons 1.35c

6. (3 pts) Draw the structure of any secondary haloalkane that contains a total of 5 carbons.



7. (8 pts) Two resonance structures (shown below) are required to describe carbon monoxide, CO. (a) Include formal charges on the resonance structures if necessary. (b) Briefly explain why the carbon atom in carbon monoxide is capable of acting as a Lewis acid. Be specific. (c) Briefly explain why the carbon atom in carbon monoxide is capable of acting as a Lewis base. Be specific.



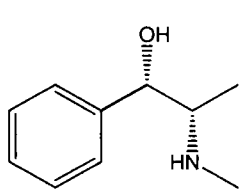
(b)

C is e⁻ deficient (6 valence e⁻) So would like to accept an e⁻ pair

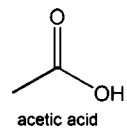
(c)

C is negative and has a lone pair available for donation

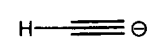
8. (16 pts) In the US, a salt form of pseudoephedrine is manufactured by Johnson & Johnson and sold under the name Sudafed. Pay close attention to the alcohol and amine functional groups and consider their relative acidities.



Pseudoephedrine



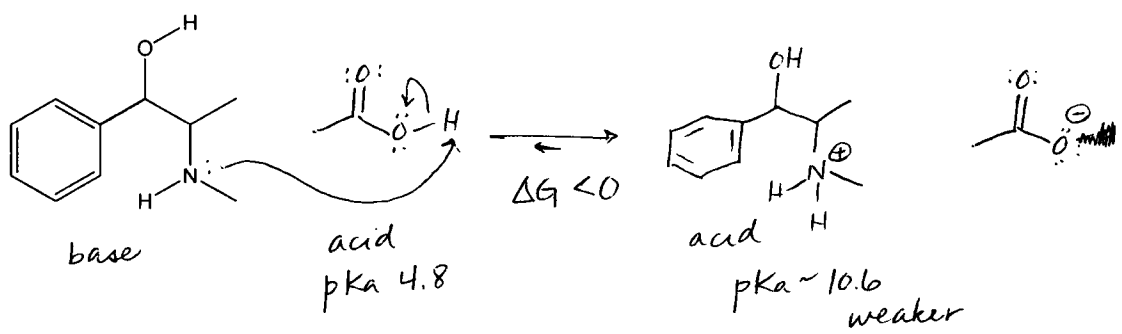
acetic acid



acetylide anion

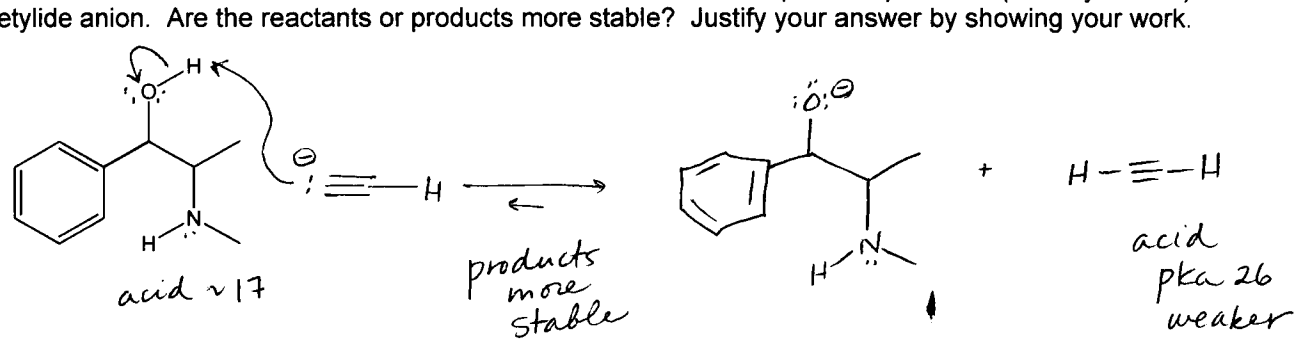
a. Use curved arrows to draw the balanced acid/base reaction of pseudoephedrine (already shown) and acetic acid. Is the ΔG for this reaction >0 or <0? Justify your answer by showing your work.

N stronger base than O

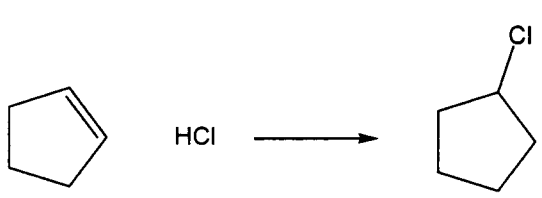


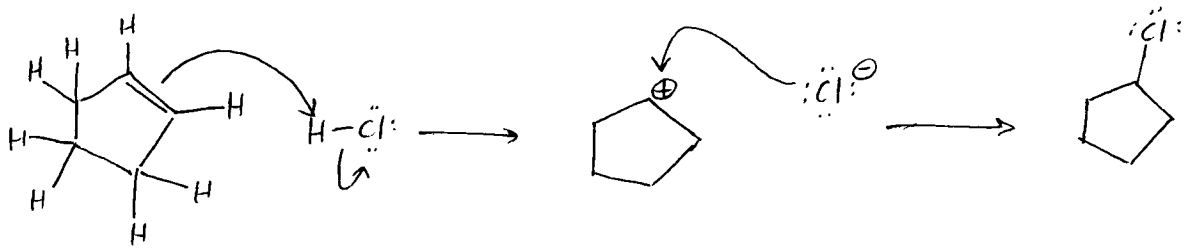
b. Use curved arrows to draw the balanced acid/base reaction of pseudoephedrine (already shown) with acetylide anion. Are the reactants or products more stable? Justify your answer by showing your work.

OH stronger acid than NH



9. (15 pts) The reaction shown below is a reaction **THAT YOU HAVE NEVER SEEN BEFORE. DON'T PANIC.** (a) Draw complete Lewis structures of the two reactants. (b) Propose a reasonable mechanism for the reaction by drawing curved arrows to show the movement of electrons. HINT: This reaction requires two separate LA/LB reactions. Focus on drawing the arrows and products of the first, then move on to the second.





OR