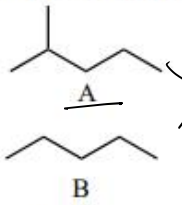
I. A. (8 pts) Physical properties. (No explain = no credit.)

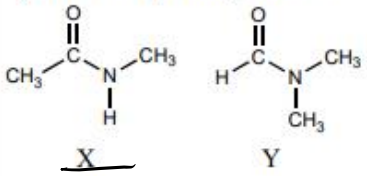
a) Which compound (A or B or neither) has the higher boiling point? Explain briefly.



diff MC

more C → more MW
A has higher BP

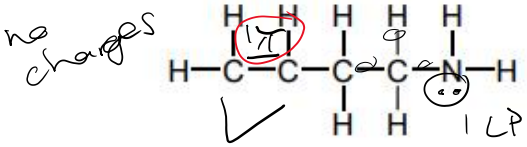
b) Which compound (X or Y or neither) has the higher boiling point? Explain briefly.



X has N–H directly bonded and interacting so it will have ↑ MW

B. (10 pts)

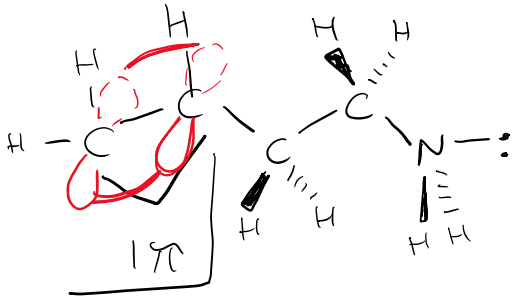
a) Complete the Lewis structure for the following molecule (only sigma bonds are shown).
b) Provide a 3-D sketch for this molecule (only the best resonance form). Remember to locate the maximum number of atoms in the plane of the page.



no charges

missing bond

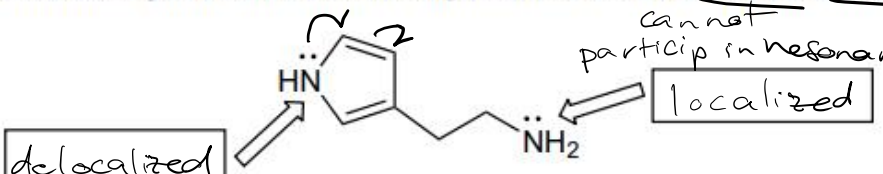
1 LP



1 π

draw close to linear because of the π bond

C. (4 pts) For the *lone pair on each indicated nitrogen atom*, describe it as **localized** or **delocalized.**



delocalized

allylic

cannot particip in resonance

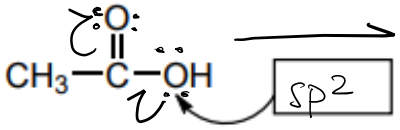
localized

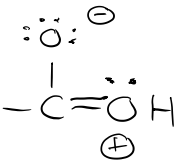
can have & particip in resonance

II. (23 pts) Short Answer.

LP is allylic, next to π bond

A) (2 pts) Identify the **hybridization** of the indicated atom (place answer in box).





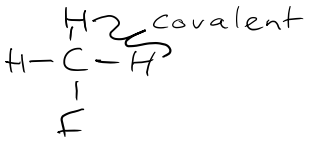
resonance

B) (2 pts) Indicate your choice (**A**, **B** or **C**) for whether the following compound involves:

A) covalent bonding only
B) ionic bonding only ~~metal & nonmetal~~
C) both covalent and ionic bonding

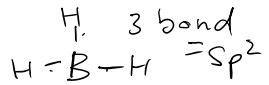
CH_3F | A

all nonmetal



C) (5 pts) For the given compound, identify the **hybridization** of the central atom and the molecular **geometry**.

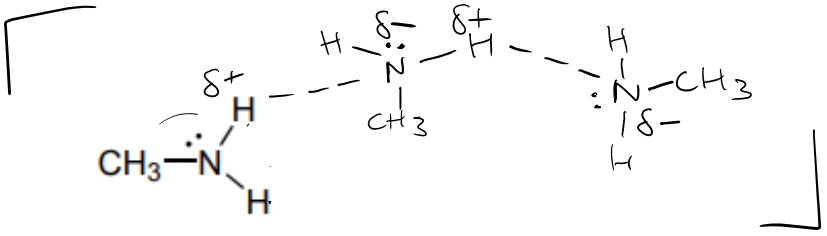
BH_3



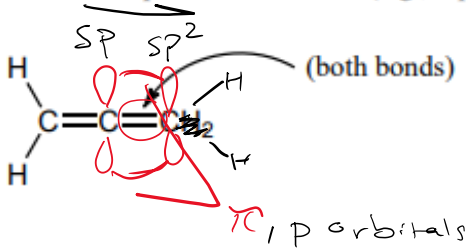
no more LP

hybridization?	geometry?
sp^2	trigonal planar

D) (5 pts) Illustrate the hydrogen bonding that occurs among **three molecules** of CH_3NH_2. The first molecule has been drawn below. (Please note that there is more than one correct illustration possible!).



E) (4 pts) For each of the two indicated bonds, describe type of bond (*e.g.*, ionic, σ, π) and the orbitals that overlap to form the bond (e.g., *s, p, sp, sp²*, *sp³*). Put responses in provided boxes.

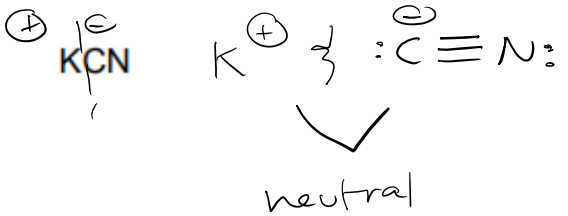


(both bonds)

bond 1	σ, sp — sp^2
bond 2	π, p — p

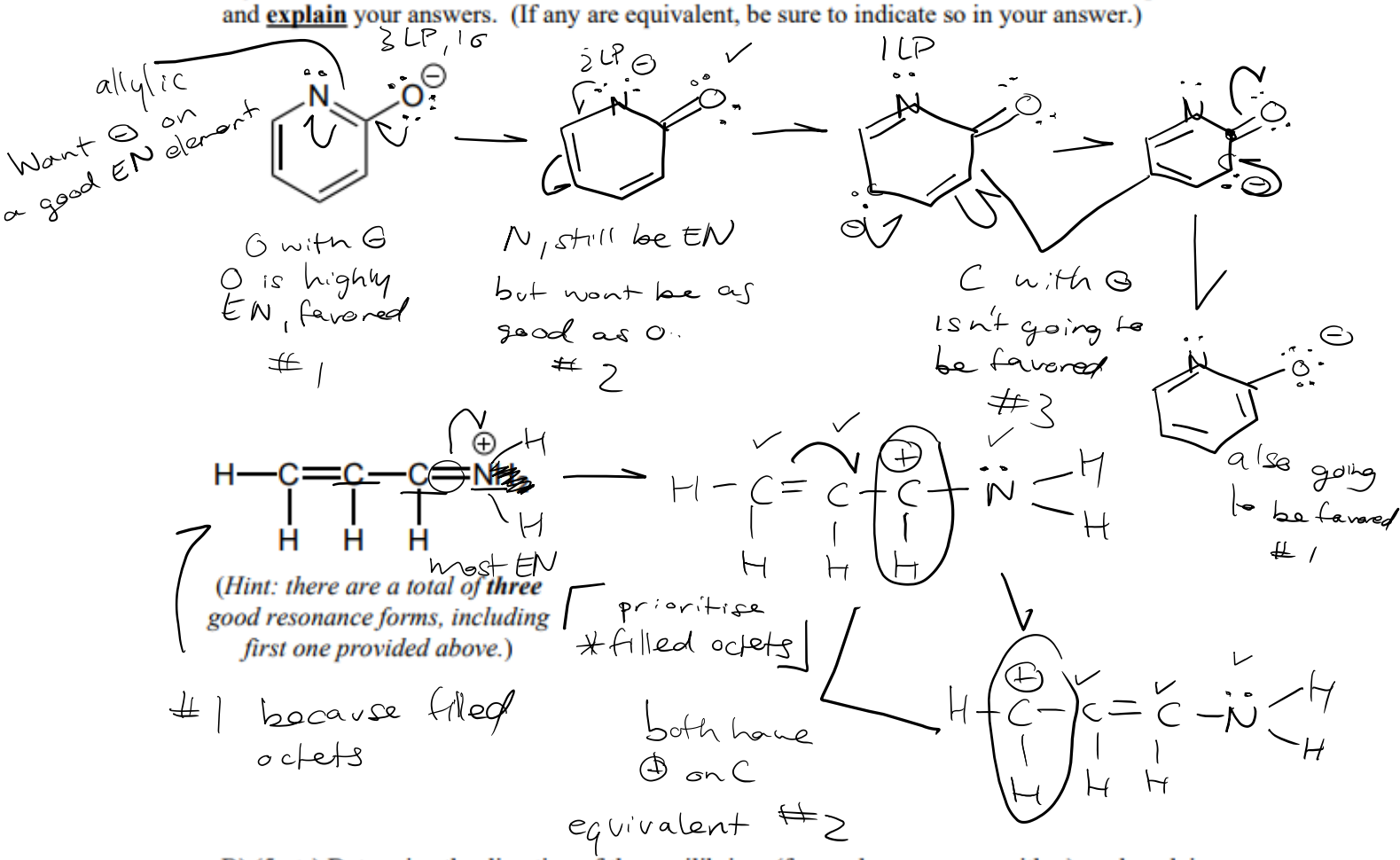
π, p orbitals interacting

F) (5 pts) Provide a complete Lewis structure for the following compound.

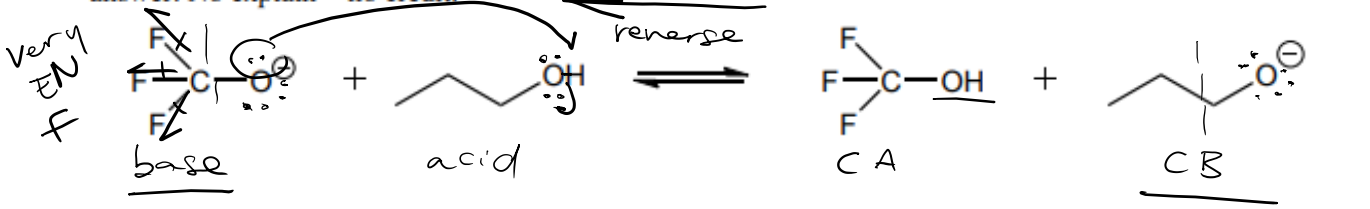


neutral

III. A) (14 pts) For the Lewis structures given below, **supply any missing lone pairs** and **draw any significant resonance forms**. **Rank each of the resonance contributors** in order of importance and **explain** your answers. (If any are equivalent, be sure to indicate so in your answer.)



B) (5 pts) Determine the direction of the equilibrium (forward, reverse, or neither), and explain your answer. No explain = no credit.



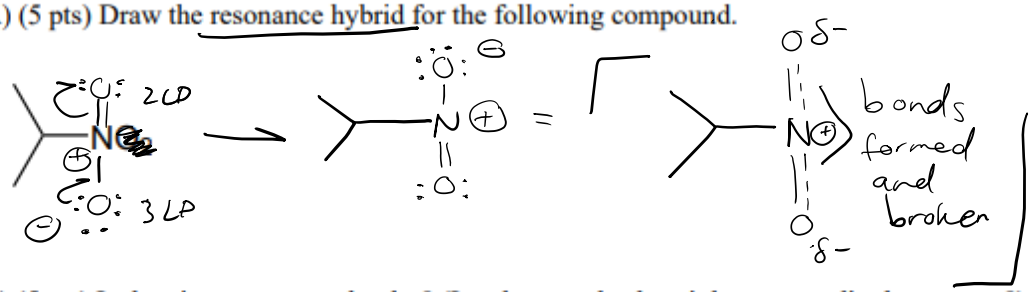
Induction via F stabilize the ⊖
more stable = less rxtv = weaker base

reactants on left are weaker

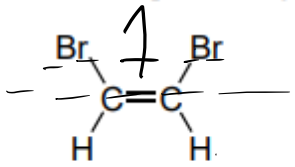
v rxtv = v un = v strong

IV. (22 points)

A) (5 pts) Draw the resonance hybrid for the following compound.

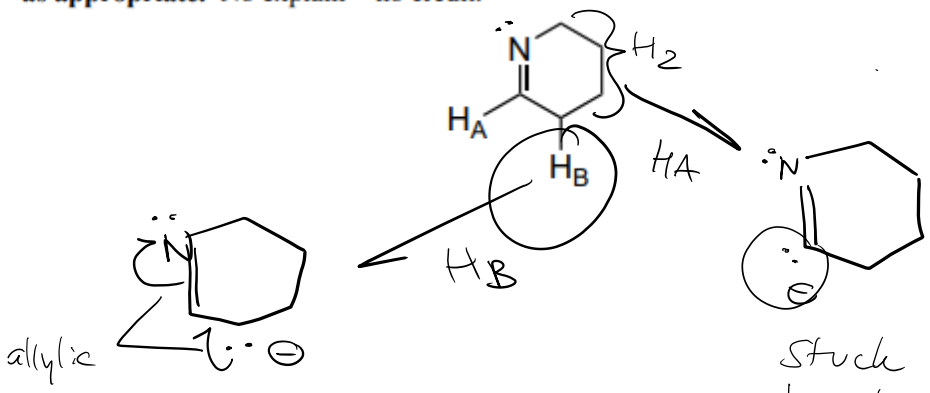


B) (5 pts) Is the given compound polar? (In other words, does it have a net dipole moment?) **Explain, using drawings as appropriate**. No explain = no credit.



Do have net DPM, Br's EN gives polarity that doesn't cancel out → produces net polarity.

C) (12 pts) Which is the more acidic proton (H_A, H_B or neither)? **Explain, using drawings as appropriate.** No explain = no credit.

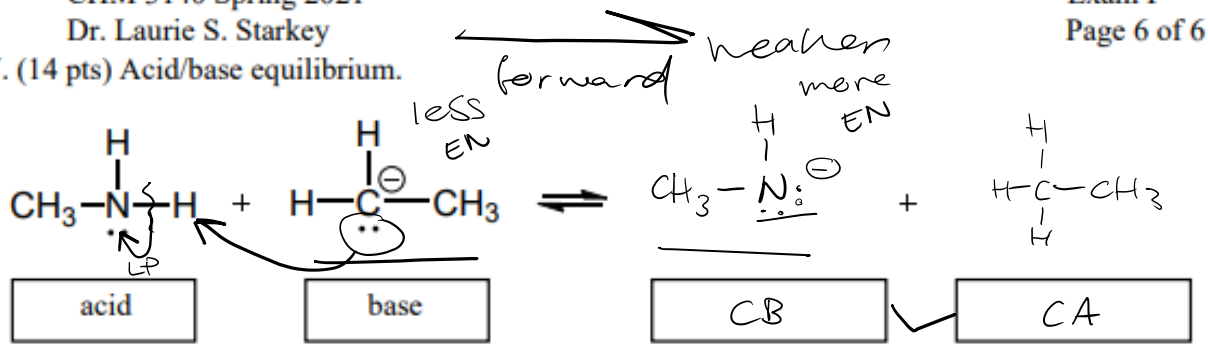


allylic

engage in resonance = more stability = less rxtv = weaker CB → stronger acidic proton

Stuck here localized bc on sp² = no reson = less stable = more rxtv = stronger CB = weak acid

V. (14 pts) Acid/base equilibrium.



pair is weaker

a) **Predict the products** expected for the above Bronsted-Lowry acid/base reaction.

b) In the boxes provided, **label** each of the above products. (e.g., acid, base, conj. acid, conj. base)

c) **Use curved arrows** to show the reaction mechanism.

d) To which side does the equilibrium lie (R or L)? **Explain fully**.

Compare base since they have ⊖ charge

Δ in ⊖ charge, want more EN carrying ⊖ → ⊖ charge does better on N than O is more stable = less rxt = weaker base on Right side

I. A. (5 pts) **No explain = no credit.**

a) Which compound (A or B or neither) has the higher boiling point? Explain briefly.

$CH_3CH_2CH_2OCH_3$ H bond = higher BP

A

$CH_3CH_2CH_2CH_2OH$

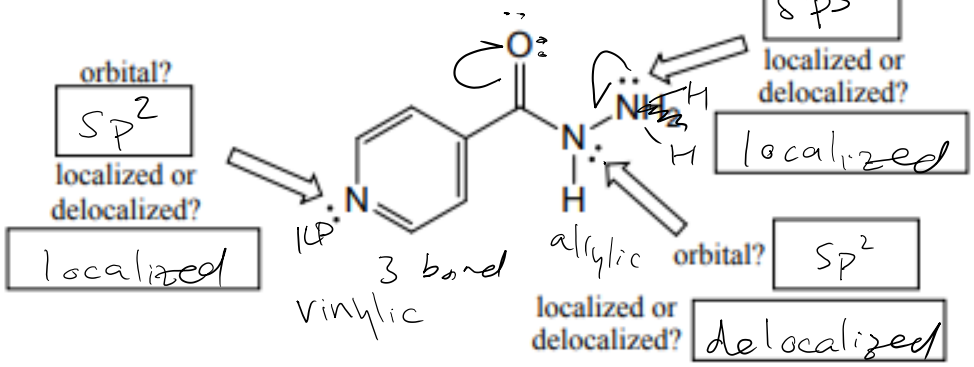
B

B. (6 pts) For each, indicate your choice (**A**, **B** or **C**) for whether it involves:
A) covalent bonding only; **B**) ionic bonding only; **C**) both covalent and ionic bonding

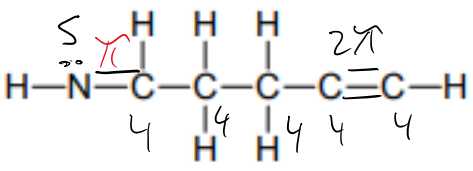
HNO_3 — A

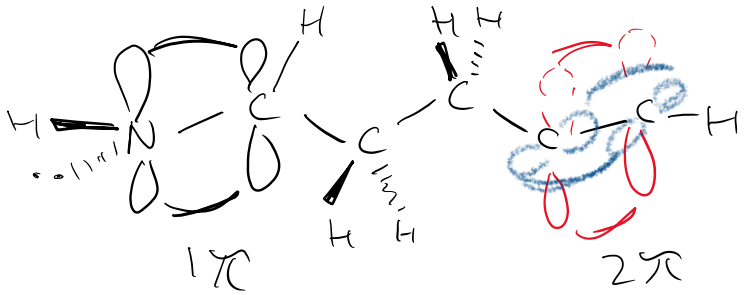
$NaOCH_3$ — C

C. (9 pts) For the *lone pair on each indicated nitrogen atom*, provide the **orbital** it is in and describe it as **localized** or **delocalized.**



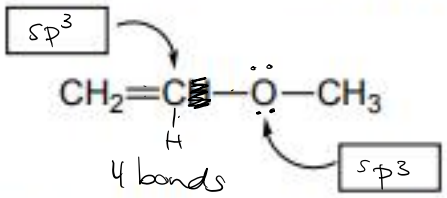
D. (9 pts) a) Complete the Lewis structure for the following molecule (only sigma bonds are shown).
b) Provide a 3-D sketch for this molecule (only the best resonance form). Remember to locate the maximum number of atoms in the plane of the page.



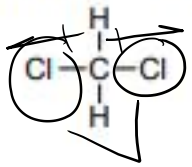


II. (25 pts) Short Answer.

A) (4 pts) Identify the hybridization of the indicated atoms (place answers in boxes).



B) (5 pts) Is the given molecule polar? Explain, using drawings as appropriate.

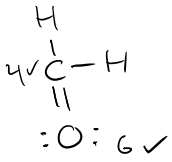


Completely cancel out since oppositely pulling

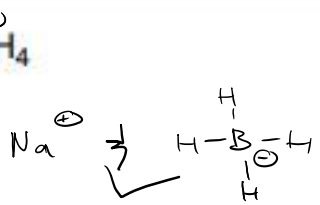
equally pulling, cancel out

C) (10 pts) Provide a complete Lewis structure for each of the following.

CH_2O

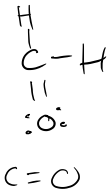


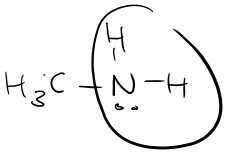
$NaBH_4$

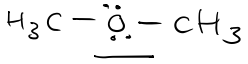


D) (6 pts) Which of the following pure compounds can form hydrogen bonds? (yes/no)

CH_2O	CH_3NH_2	CH_3OCH_3
no	yes	no

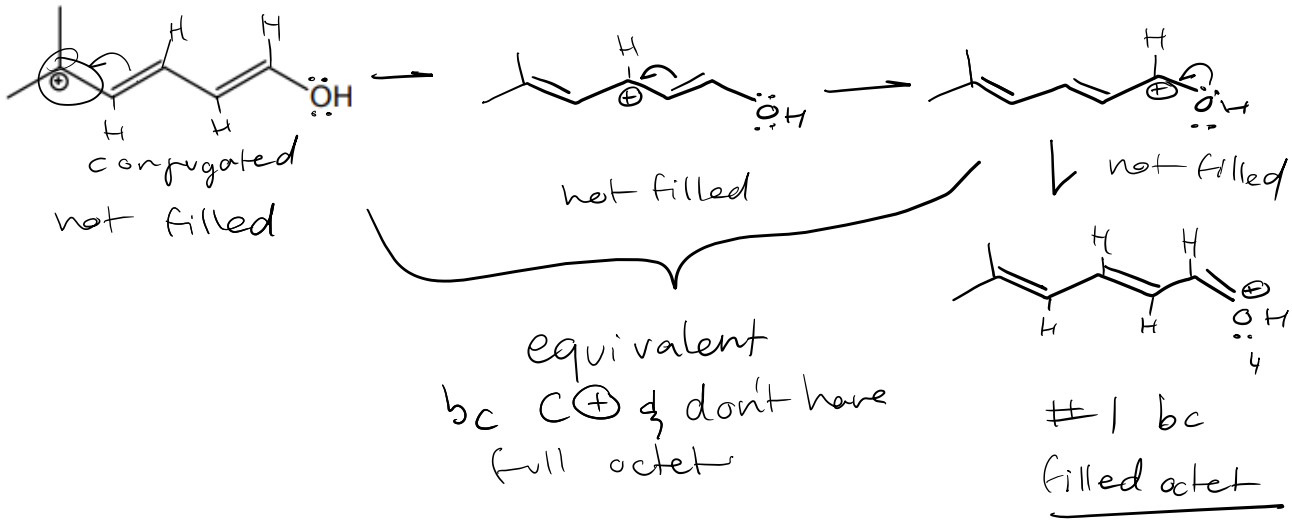




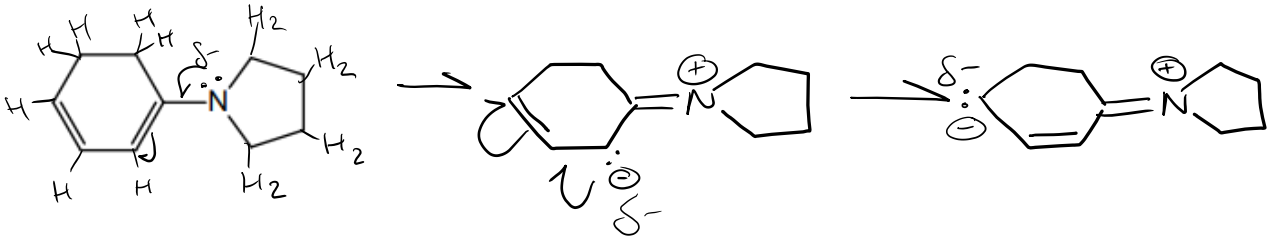


III. (16 pts)

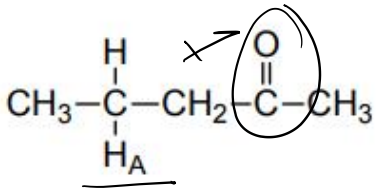
A) For the Lewis structure below, **supply any missing lone pairs** and draw any significant resonance forms. Rank each of the resonance contributors in order of importance and explain your answers. (If any are equivalent, be sure to indicate so in your answer.)



B) For the Lewis structure below, **supply any missing lone pairs** and draw any significant resonance forms. Based on the compound's resonance, determine which site(s) are electron-rich. Indicate any electron-rich site on the provided structure using a δ- symbol. No explanation is needed.

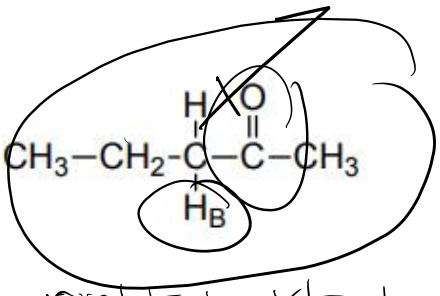


IV. (15 pts) Which is the more acidic proton (H_A, H_B or neither)? Explain, using drawings as appropriate.



further from most EN element in struct

farther = less stable = more rxtv = stronger CB → weaker acidic proton

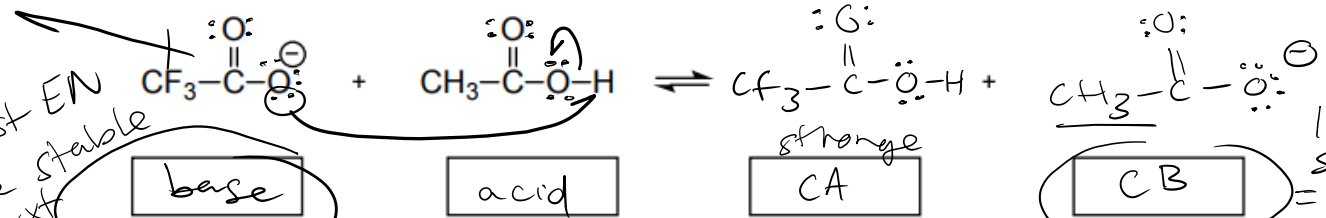


right next to most EN elem in structure

more induction → more stable → less rxtv → weaker CB → stronger acidic proton

V. (15 pts) Acid/base equilibrium.

rev rxnt



F is most EN
more stable
= less rxtv
= weaker base

strongest

less stable = more rxtv = stronger

a) **Complete the Lewis structures** given (add missing lone pairs) and predict the products expected for the above Bronsted-Lowry acid/base reaction.

b) In the boxes provided, **label** each of the products drawn. (e.g., acid, base, conj. acid, conj. base)

c) Using the structures given above, use **curved arrows** to show the reaction mechanism.

d) To which side does the equilibrium lie, Right/forward or Left/reverse (or neither)? **Explain fully**.

Strong induction from F_3 on base causes stabilization & less reactivity → weaker = want to go to that side!

left