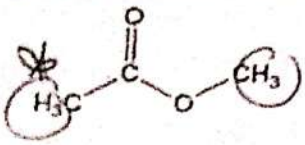
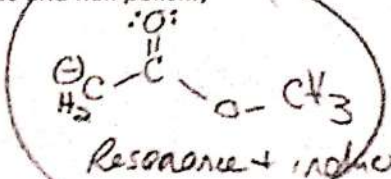
Name: Key Date: Pd:

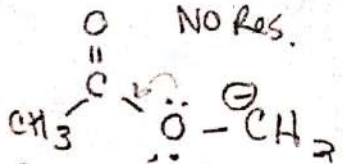
Organic Chemistry – Acid/Base Practice Problems #1

1. Which is most acidic group of protons on methyl acetate? Explain why. (This is a flammable liquid with a smell reminiscent of some glues and nail polish.)





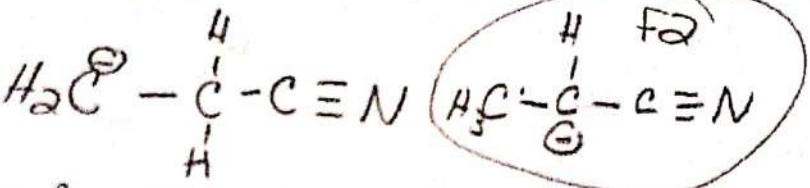
Resonance + induction



NO Res.

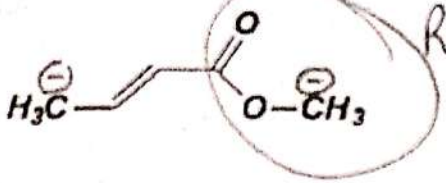
2. Draw the structures of the different conjugate bases that could result from the explicit hydrogens that are shown. Then, circle the hydrogen that would be the most acidic and explain why.

a.



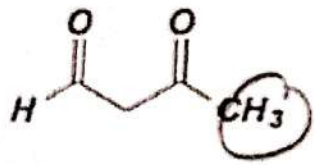
F2

b.

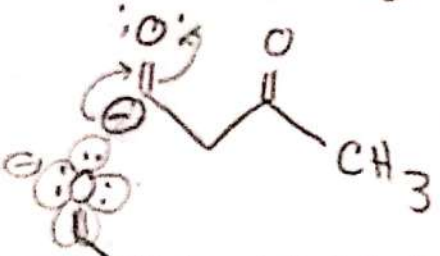


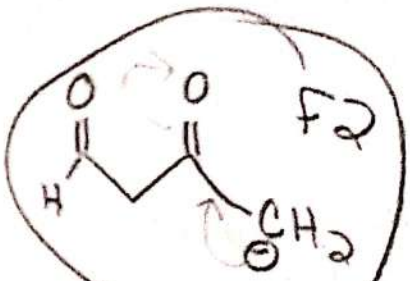
Resonance is better w/ O's

c.



NO Resonance

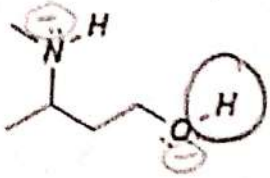




F2

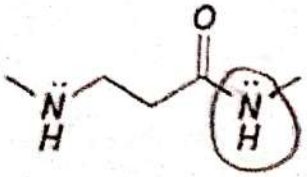
3. Circle the proton that would be the most acidic in each the following compounds. List the factor that would determine why.

a.



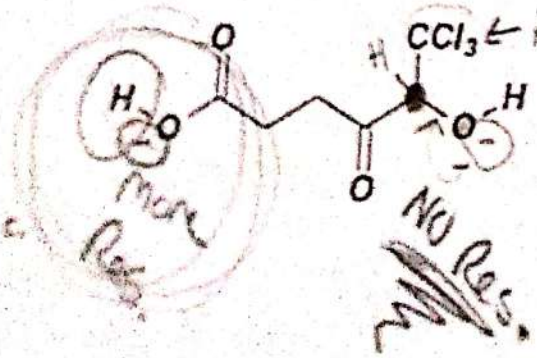
Factor(s): F1 (The atom O^- = more stable than N^-)

b.



Factor(s): F2 (the ⓡ N^- will have Res. w/ the O)

c.



CCl_3 ← induction

more Res.

NO Res.

Factor(s): F2 (more R w/ 2O's on the (L) side)

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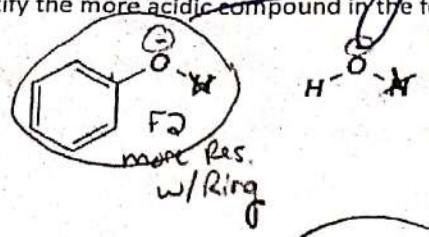
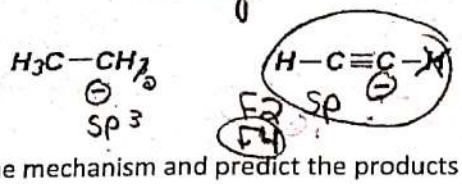
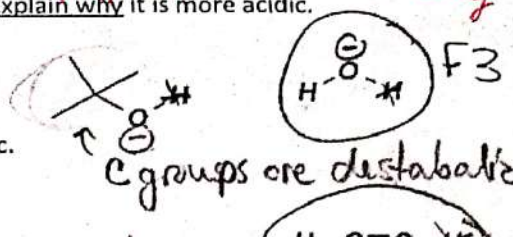
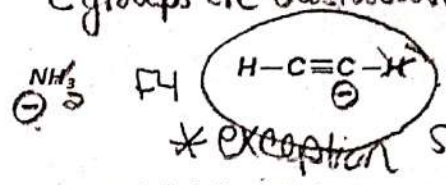
4. Identify the more acidic compound in the following pairs. Explain why it is more acidic.

alkyl groups = destabilizing

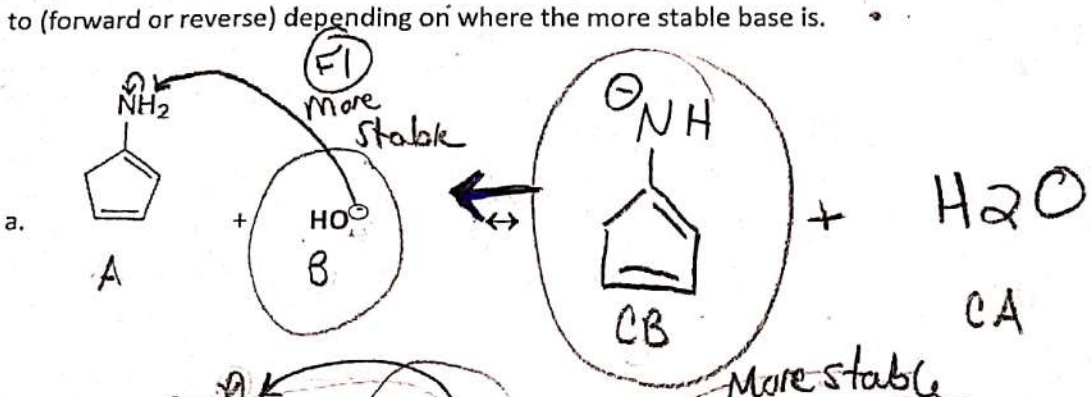
a. 

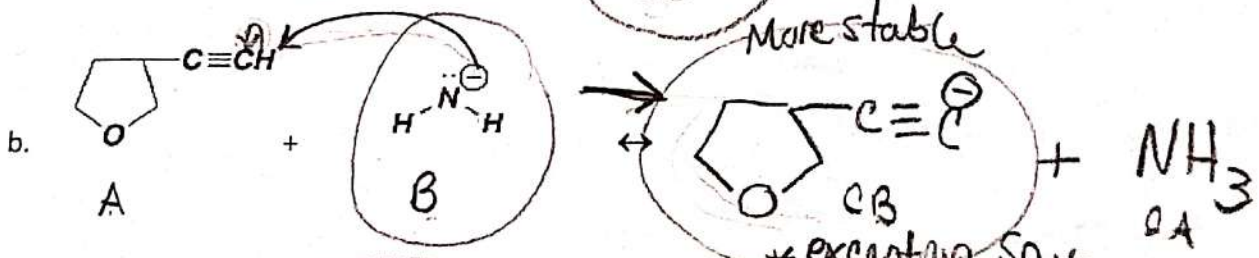
b. 

c. 

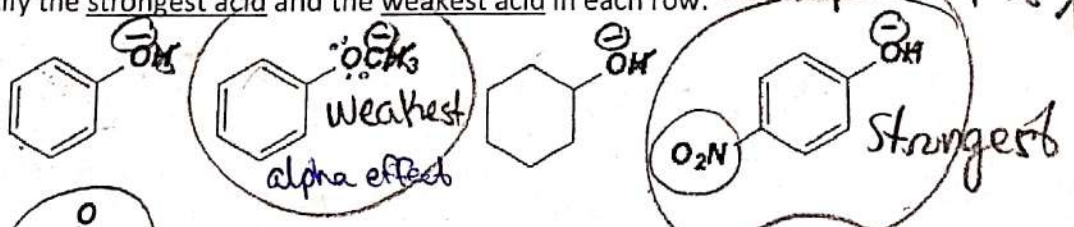
d. 

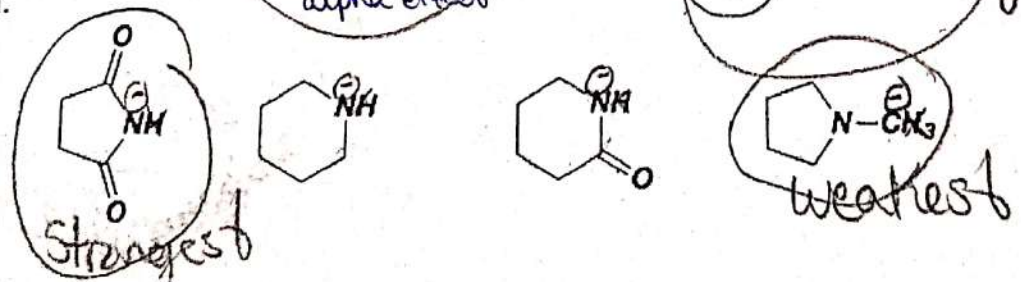
5. Draw the mechanism and predict the products for the following reactants. Label the acid, base, conjugate acid, and conjugate base (A, B, CA, CB). Make sure to include the direction that the equilibrium would shift to (forward or reverse) depending on where the more stable base is.

a. 

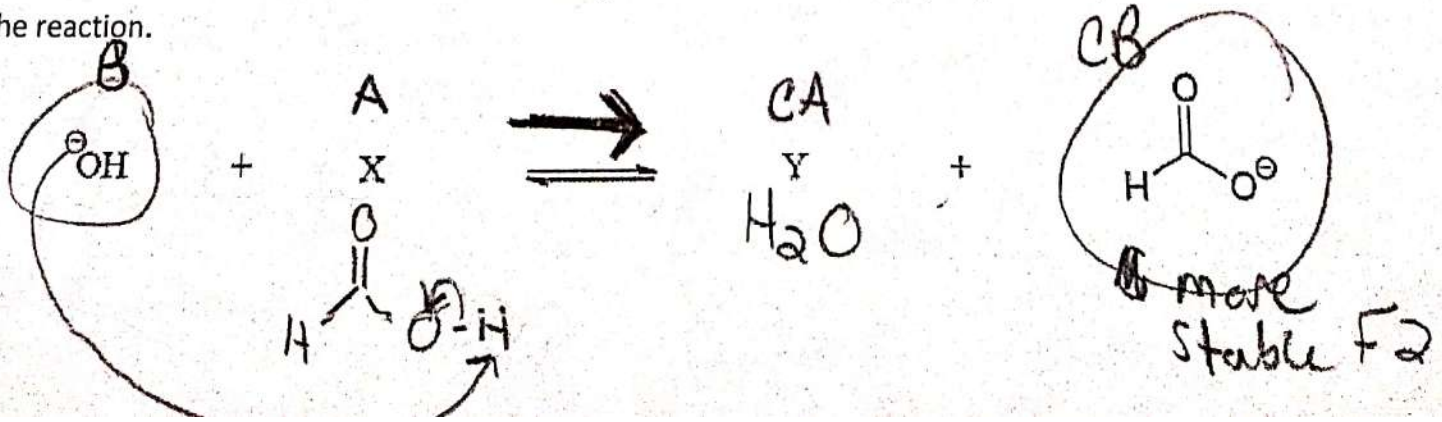
b. 

6. Identify the strongest acid and the weakest acid in each row:

a. 

b. 

7. Show the structures of X and Y in the following reaction. Label the A, B, CA, CB and predict the direction of the reaction.



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Name: Key Date: Pd:

Organic Chemistry – Acid/Base Practice Problems (#2)

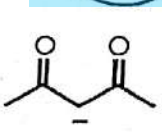
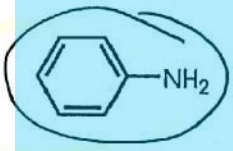
1. For each of the species below, identify the most acidic proton and provide the structure of the corresponding conjugate base. You might want to draw detailed Lewis formulas in some cases.

AKa: Take away H^+

HF	F^-	CH_3CH_3	$CH_3CH_2^-$
CH_3CH_2OH	$CH_3CH_2O^-$	CH_3CN	CH_2CN^-
H_3O^+	H_2O	$HC\equiv CH$	$HC\equiv C^-$
H_2O	OH^- (HO^-)	H_2	H^-

2. For each of the species below, identify the basic atom and provide the structure of the corresponding conjugate acid. You might want to draw detailed Lewis formulas in some cases.

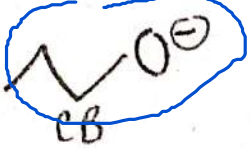
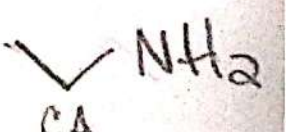
AKa: Add H^+

^-CN	HCN	$CH_3CH_2O^-$	CH_3CH_2OH
SO_4^{-2}	H_2SO_4 & HSO_4^-	OH^-	H_2O
CH_3CH_2OH	$CH_3CH_2OH_2^+$	$PhCOO^-$	PhCOOH
H_2O	H_3O^+	Br^-	HBr
			

3. Finish the acid- base reaction. Draw the mechanism. Label the A, B, CA, CB. Predict the direction of equilibrium.

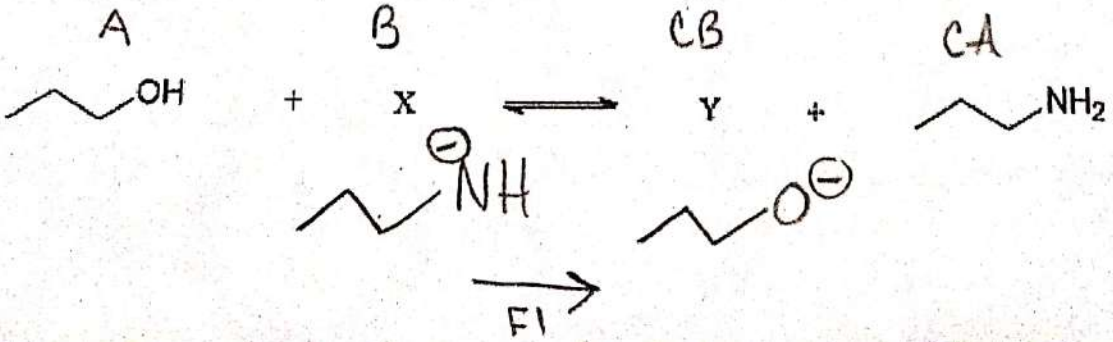
a. CH_3CH_2OH (A) + OH^- (B) ⇌ $CH_3CH_2O^-$ (CB) + H_2O (CA) — F3 ←, destabilizing

b. $CH_3CH_2NH_2$ (A) + CH_3O^- (B) ⇌ $CH_3CH_2NH^-$ (CB) + CH_3OH (CA) — F1 ←

c.  (A) + (B) ⇌  (CB) +  (CA) — F1 →

4. Show the structures of species X and Y in the following acid-base reactions.

A + B ⇌ CB + CA



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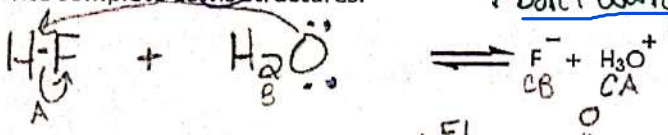
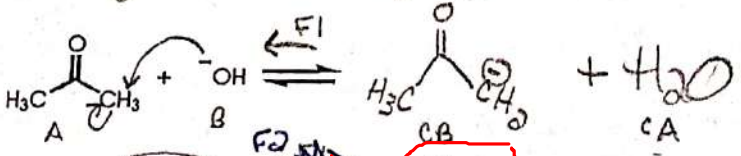
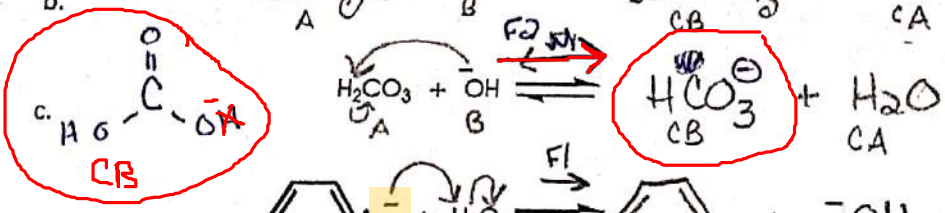
Key

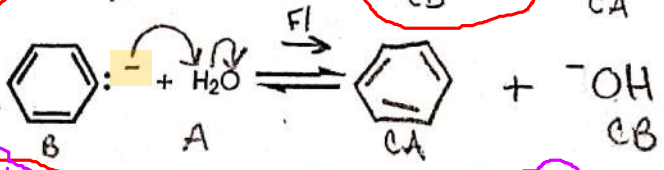
5. Fill in the reactants or products for the following acid-base reactions. Follow the labeling procedure used for number 3. Keep in mind that in bond-line hydrogens are not shown. When in doubt, write complete Lewis structures.

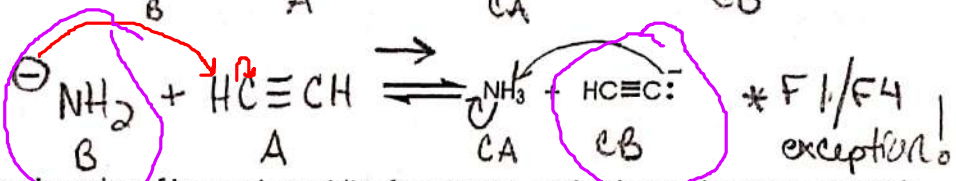
* Don't worry about eq. for "a"

a. 

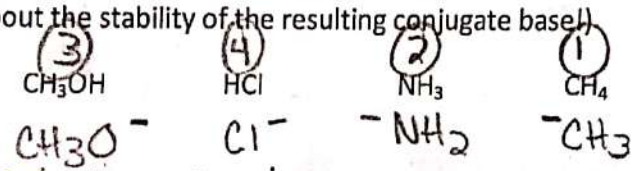
b. 

c. 

d. 

e. 

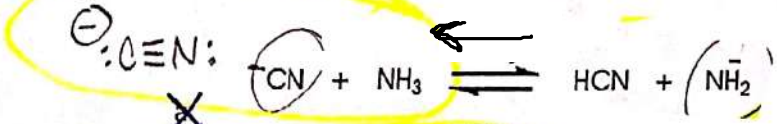
6. Rank the following in order of increasing acidity from 1 to 4, with 4 being the strongest acid: (Hint: think about the stability of the resulting conjugate base!)

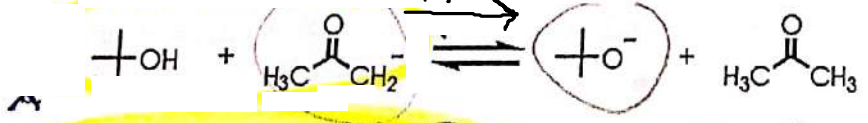


strongest acid will form the most stable product

7. Circle the side favored by equilibrium in the following acid-base r

F1/F4 exception





Factor 1 - the atom

(L) side is resonance stabalized

c. 

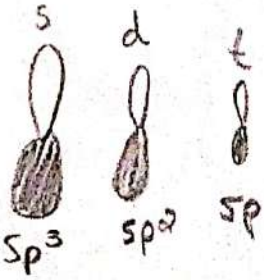
8. List out the four factors and their information to consider when looking at that factor:

a. Factor 1: Atom → electroneg. or ↓ size - stabalized more stable

b. Factor 2: Resonance

c. Factor 3: Induction — alkyl groups = destabalizing; "pull" of electroneg. atoms

d. Factor 4: Orbitals



* closer to nucleus = more stable

R: 2°'s = better than many C's

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Key O-Chem A-B #3

Practice Problems on Acid-Base Chemistry - Answers

1. For each of the following acid base reactions place one of the arrows inside the box to designate the extent of the reaction.

"R" "L"

neither side favored | product favored | reactant favored

a) HNO_3 ($pK_a = -1.3$) + $\ddot{N}H_3$ ⇌ NO_3^- + NH_4^+ ($pK_a = 9.24$)

b) HNO_2 ($pK_a = 3.29$) + HSO_4^- ⇌ NO_2^- + H_2SO_4 ($pK_a \approx -3.0$)

c) HSO_3Cl ($pK_a \approx -3.1$) + $Cl-CH_2-C(=O)-O^-$ ⇌ $^-SO_3Cl$ + $Cl-CH_2-C(=O)-OH$ ($pK_a = 2.86$)

d) $H_3C-C(=O^+H)-CH_3$ ($pK_a = -2.9$) + Cl^- ⇌ $H_3C-C(=O)-CH_3$ + HCl ($pK_a = -7.0$)

e) $H_3C-C(=O)-CH_3$ ($pK_a = 26.5$) + $^-\ddot{N}H_2$ ⇌ $H_3C-C(=O)-CH_2^-$ + $\ddot{N}H_3$ ($pK_a = 38$)

f) $H\ddot{S}^-$ + H_3O^+ ($pK_a = -1.74$) ⇌ $H_2\ddot{S}$ ($pK_a = 7.0$) + $H_2\ddot{O}$

g) HCN ($pK_a = 9.3$) + H_2O ⇌ CN^- + H_3O^+ ($pK_a = -1.74$)

* The equilibrium will shift toward the "weaker" side (it can't "push back")

* The LOWER the pka, the STRONGER the acid.

∴ the arrow will point towards the larger pka #

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