A. Identify each chemical as either an "acid" or a "base" in the following reactions, and identify "conjugate" relationships.

-You should have one acid and one base on each side

-You should have two conjugate pairs

1. $CH_3CH_2OH + NaOH \rightleftharpoons CH_3CH_2ONa + H_2O$

2. $CH_3CH_2NHLi + CH_3OH \rightleftharpoons CH_3CH_2NH_2 + CH_3OLi$

3. $CH_3CH_2CO_2H + CH_3MgBr \rightleftharpoons CH_3CH_2CO_2MgBr + CH_4$

4. $CH_3OH + H_3O^+ \rightleftharpoons H_2O + CH_3OH_2^+$

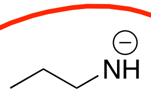
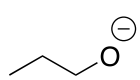
5. $CH_3CH_2NH_3^+ + CH_3OH \rightleftharpoons CH_3CH_2NH_2 + CH_3OH_2^+$

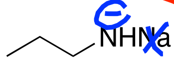
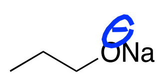
B. Choose the More **Basic** for Each of the Following Pairs (Single Variable). You can use stability to decide.

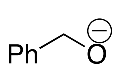
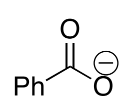
6. NH_3 $NaNH_2$

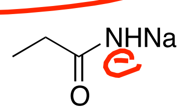
7. $NaOH$ H_2O

Keys:
1. Charge
2. Elecronegativity
3. Resonance

8.  

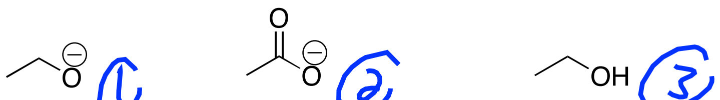
9.  

10.  

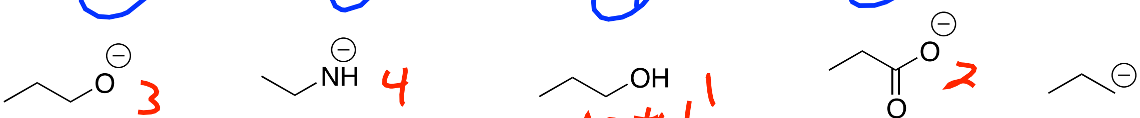
11.  

C. Rank the basicity of the following sets: Multiple Variable Problems

12. CH_3MgBr CH_3NHNa CH_3NH_2

13. 

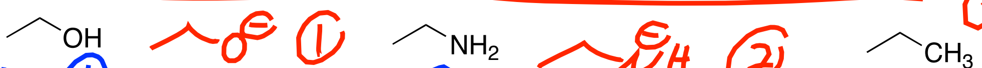
14. 

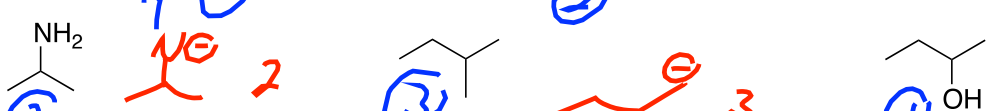
15. 

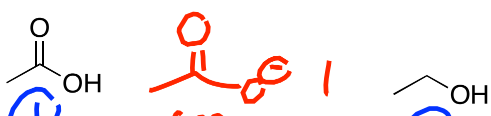
D. Choose the More Acidic for Each of the Following Pairs: Single Variable Problems

16. NH_3 $^{\oplus}NH_4$

17. 

18. 

19. 

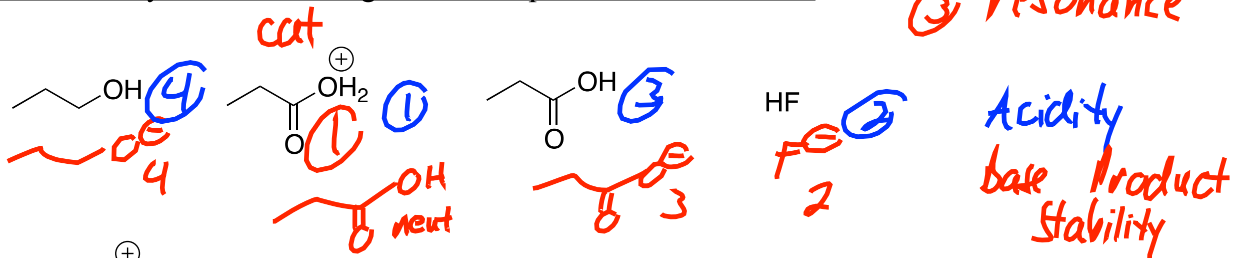
20. 

21. 

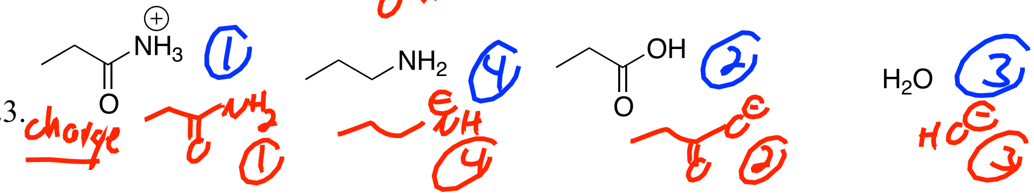
① charge
② eneg
③ resonance

E. Rank the acidity of the following sets: Multiple Variable Problems

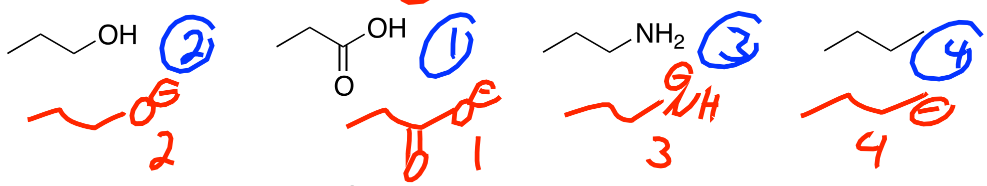
Acidity
base Product Stability

22.


Acidity
base Stability

23. charge


base Product Stability

24.


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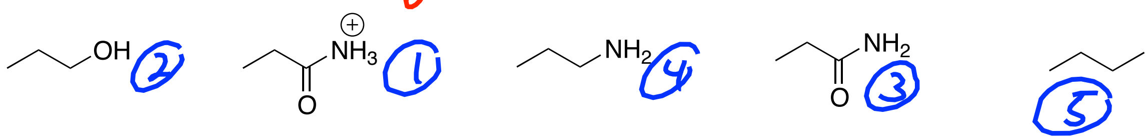

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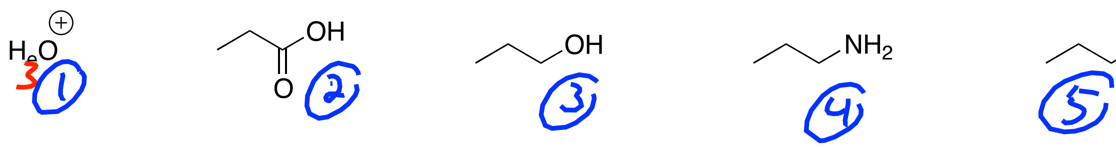
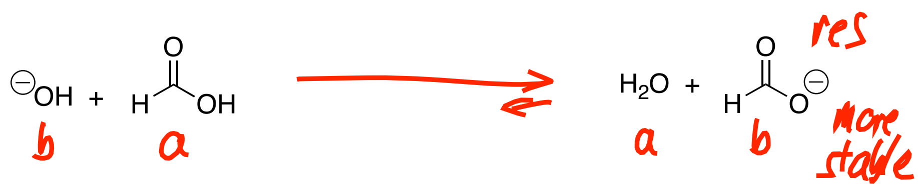


F. Draw arrow to show whether equilibrium favors products or reactants. (Why?)

Keys:
1. Charge
2. Elecronegativity
3. Resonance

Compare bases
More stable base favored

27.


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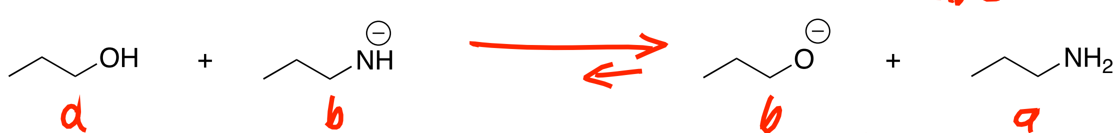
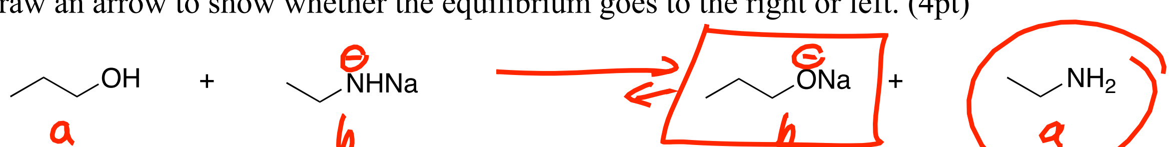


more stable
eneg

G. For the following acid-base reaction,

a. put a box around the weakest base in the reaction = more stable
b. put a circle around the weakest acid
c. draw an arrow to show whether the equilibrium goes to the right or left. (4pt)

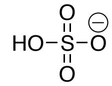
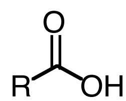
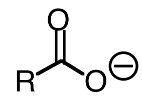
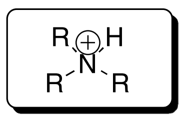
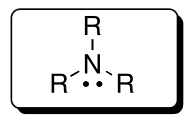
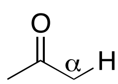
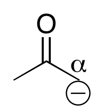
29.


more stable = weaker

weakest acid always on same side as weaker base

Acid-Base Chemistry (Section 1.13-18)

Acidity/Basicity Table

Entry	Class	Structure	Ka	Acid Strength	Base	Base Strength	Base Stability
1	Strong Acids	H-Cl, H_2SO_4	10^{2}		$Cl^{\ominus}$, 		
2	Hydronium	H_3O^+, ROH^+ cationic	10^{0}		H_2O, HOR neutral		
3	Carboxylic Acid		10^{-5}				
4	Ammonium Ion (Charged)	 Charged, but only weakly acidic!	10^{-12}		 Neutral, but basic!		
5	Water	HOH	10^{-16}		$HO^{\ominus}$		
6	Alcohol	ROH	10^{-17}		$RO^{\ominus}$		
7	Ketones and Aldehydes		10^{-20}				
8	Amine (N-H)	$(iPr)_2N$-H	10^{-33}		$(iPr)_2N^{\ominus}Li^{\oplus}$		
9	Alkane (C-H)	RCH_3	10^{-50}		$RCH_2^{\ominus}$		

Quick Checklist of Acid/Base Factors

1. Charge
2. **Electronegativity**
3. **Resonance/Conjugation**

1. Cations more acidic than neutrals; anions more basic than neutrals
2. Carbanions < nitrogen anions < oxyanione < halides in stability
3. resonance anions more stable than anions without resonance

- **When neutral acids are involved, it's best to draw the conjugate anionic bases, and then think from the anion stability side.**

- The above three factors will be needed this semester. The following three will also become important in Organic II.

4. Hybridization
5. Impact of Electron Donors/Withdrawers
6. Amines/Ammoniums

More Detailed Discussion of Acid/Base Patterns/Factors to remember

1. Charge Factor: central atom being equal, cations are more acidic than neutrals (H_3O^+ > H_2O, NH_4+ > NH_3), and anions more basic than neutrals (hydroxide > water).

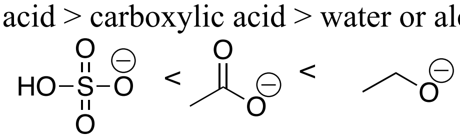
2. Electronegativity Factor:
    - Acidity — H-C < H-N < H-O < H-X (halogen)
    - Anion Stability — $C^{\ominus} < N^{\ominus} < O^{\ominus} < X^{\ominus}$
    - Basicity — $C^{\ominus} > N^{\ominus} > O^{\ominus} > X^{\ominus}$
    - Electronegativity — $C^{\ominus} < N^{\ominus} < O^{\ominus} < X^{\ominus}$

- Why: All neutral acids produce an anion after losing an H
- **The more stable the anion Z^- that forms, the more acidic the parent H-Z will be**. (The Product Stability/Reactivity principle).
- **The anion stability correlates the love for electrons (electronegativity).**
- Summary of Key Relationships:
    - ANION STABILITY and the ACIDITY of a neutral acid precursor.
    - ANION STABILITY and the BASICITY of the anion (inverse relationship)
    - ANION BASICITY and the ACIDITY OF THE CONJUGATE ACID are inversely related (the stronger the acidity of the parent acid, the weaker the basicity of the conjugate anion)
- KEY: WHEN THINKING ABOUT ACIDITY AND BASICITY, FOCUS ON THE STABILITY OF THE ANION.

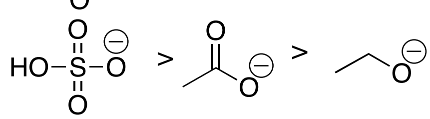
3. Resonance/Conjugation: Anion resonance is stabilizing, so **an acid that gives a resonance-stabilized anion is more acidic.** And an anion that forms with resonance will be more stable and less basic.

- Oxygen Series Examples:
  Acidity: sulfuric acid > carboxylic acid > water or alcohol

  Anion Basicity:



  Anion Stability:



- Note: Resonance is normally useful as a tiebreaker between oxygen anions, nitrogen anions, or carbon anions