Organic Chemistry I, CHM 3140
Dr. Laurie S. Starkey, Cal Poly Pomona
Chapter 3 Acid-Base Reactions (Proton Transfer), Part 1 – Practice Problems

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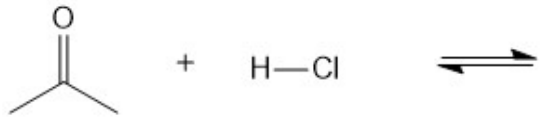
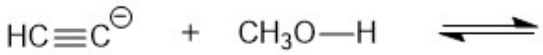
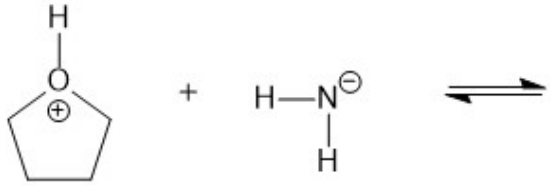
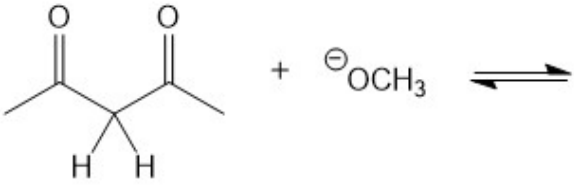
1 **Group work:** *protonate* each compound with the given acid (add missing lone pairs, draw curved arrows to show mechanism, draw the products and label them C.A. and C.B.).





2 **Group work:** *deprotonate* each compound with the given base (add missing lone pairs, draw curved arrows to show mechanism, draw the products and label them C.A. and C.B.).

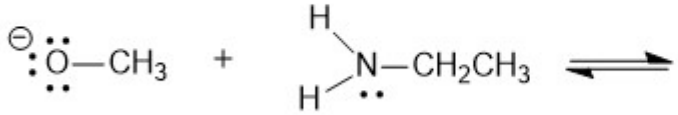




3 Draw the conjugate acid or conjugate base, as directed, for each.

conjugate base of	conjugate acid of	conjugate acid of
NH_3	H_2O	$H:^{\ominus}$

4 **Group work:** Predict the products, use curved arrows to show the mechanism for the proton transfer reaction, determine the favored direction of equilibrium, and explain your choice.

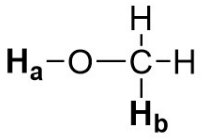


base acid

5 Which is the stronger acid? Explain briefly.

H_2O H_2S

6 What is the most acidic proton in methanol, CH_3OH (H_a or H_b)? Explain briefly.



Acid Dissociation Constant, K_a, and pK_a are measures of acid strength (3.3) *(from lecture notes page 3-7*

K_{eq} is the equilibrium constant

$$K_{eq} = \frac{[\text{products}]}{[\text{reactants}]}$$

if HA is a STRONG acid

if HA is a WEAK acid

K_a is the acid dissociation constant

$$K_a = \frac{[H_3O^+]\,[A^-]}{[HA]}$$

since K_a is often VERY large or VERY small, it's easier to work with pK_a

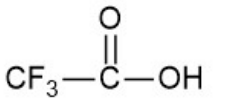
$$pK_a = -\log(K_a)$$

if K_a is a LARGE number (>1), then the acid is stronger weaker

if an acid is stronger, then the pK_a is higher lower

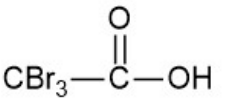
for example, sulfuric acid (H_2SO_4) has a K_a of ~1.6×10^5 and a pK_a of -5.2
acetic acid (CH_3CO_2H) has a K_a of 1.8×10^{-5} and a pK_a of 4.75

7 What predictions can you make about the relative K_a and pK_a values of the two acids shown below? Justify your answers.



trifluoroacetic acid

X



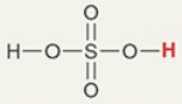
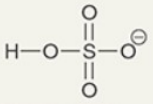
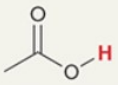
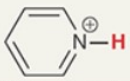
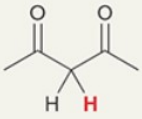
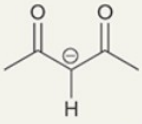
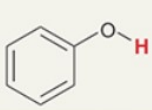
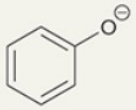
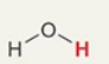
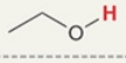
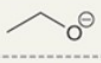
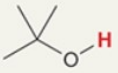
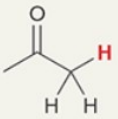
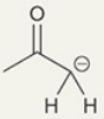
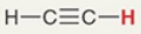
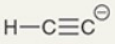
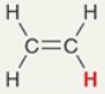
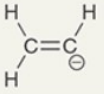
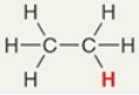
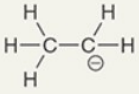
tribromoacetic acid

Y

Klein Table 3.1 pK_a Values of Various Acids

TABLE 3.1

pK_a VALUES OF COMMON COMPOUNDS AND THEIR CONJUGATE BASES

	ACID	pK_a	CONJUGATE BASE	
Strongest acid		−9		Weakest base
		−7.3		
		−7		
		−1.74		
		4.75		
		5.3		
		9.0		
		9.9		
		15.7 (see margin note)		
		16.0		
		18.0		
		19.2		
		25		
		38		
		44		
Weakest acid		50		Strongest base