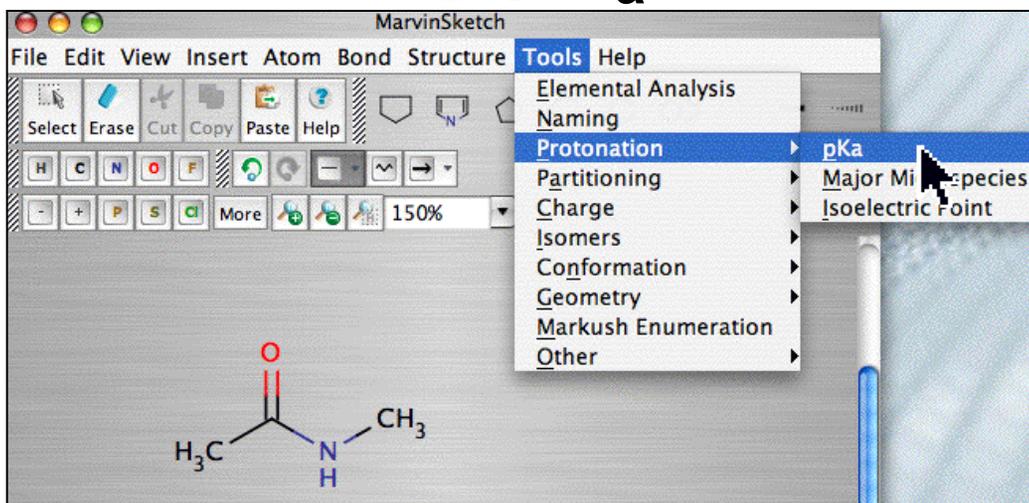


# Estimating pK<sub>a</sub> Values of Organic Structures

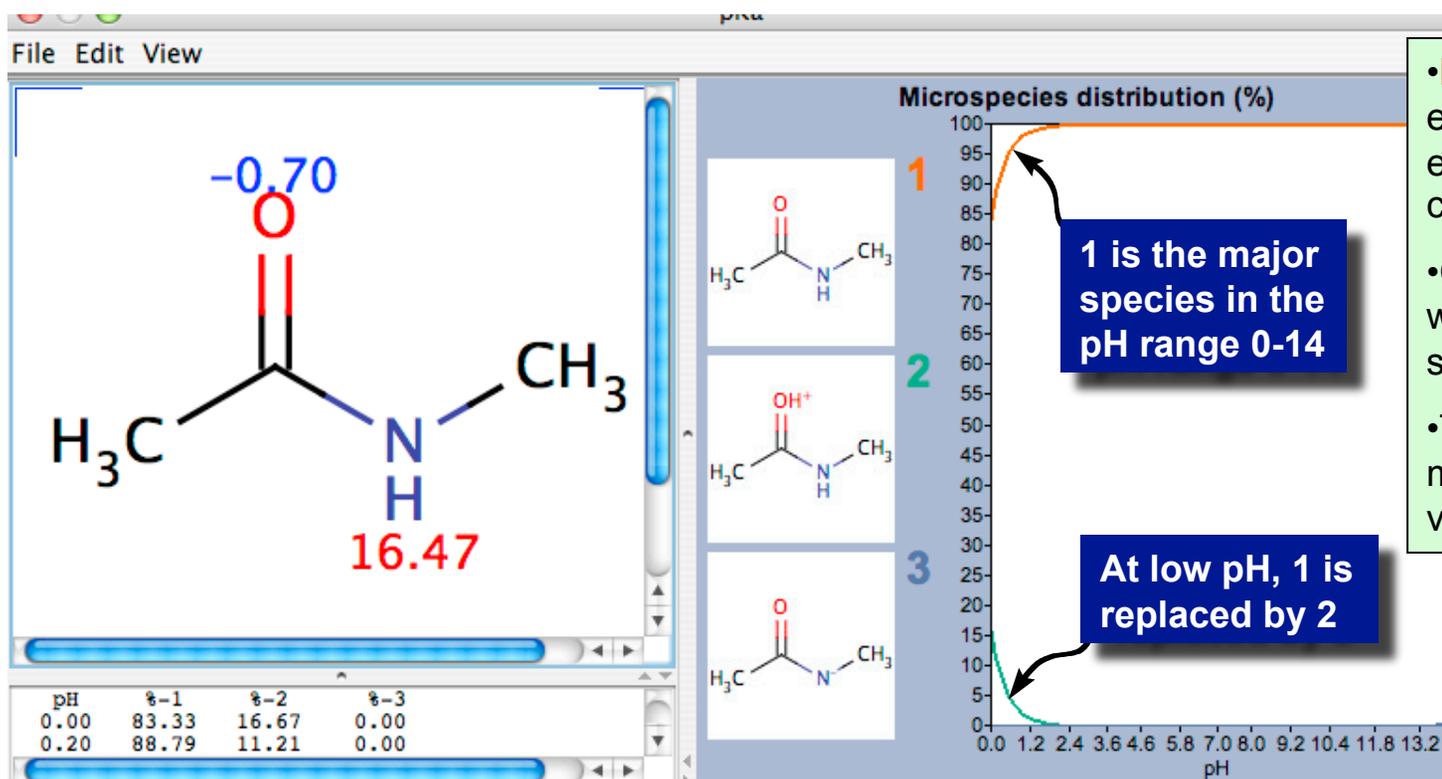


MarvinSketch has a very useful tool for estimating pK<sub>a</sub> values of organic molecules. Load MicroMarvinSketch:

<http://www.widgetbox.com/widget/micromarvin>

To determine the pK<sub>a</sub> of an organic structure (e.g., of methylacetamide)

- 1) draw the structure
- 2) Call pK<sub>a</sub> from Tools...protonation...
- 3) Accept default values and click OK



- **Red** values are pK<sub>a</sub> estimates; **blue** values are estimates of the pK<sub>a</sub> of the conjugate acid.

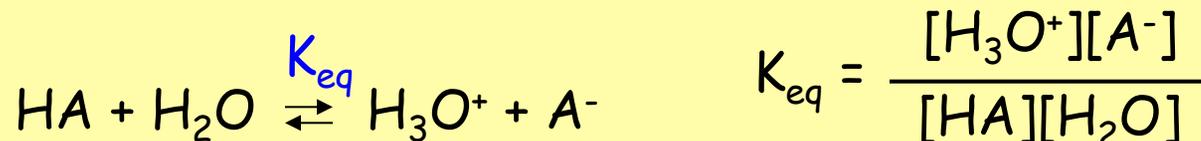
- Click the structures in windows labeled 1, 2, 3 to see various "microspecies".

- The plot shows how the microspecies concentrations vary with pH.



# Acid-Base Equilibria: Concepts & Definitions

Many protonation and deprotonation steps are reversible. The equilibrium can be expressed in terms of  $pK_a$ . Let's review the meaning of  $pK_a$ :



Assuming the  $[H_2O]$  to be constant (55.5 M) i.e.,  $[H_2O] \gg [H_3O^+]$ , we can define a new constant  $K_a = K_{eq}[H_2O]$  which allows us to drop water from the above equilibrium expression. This is the basis of the widely used  $pK_a$  convention:



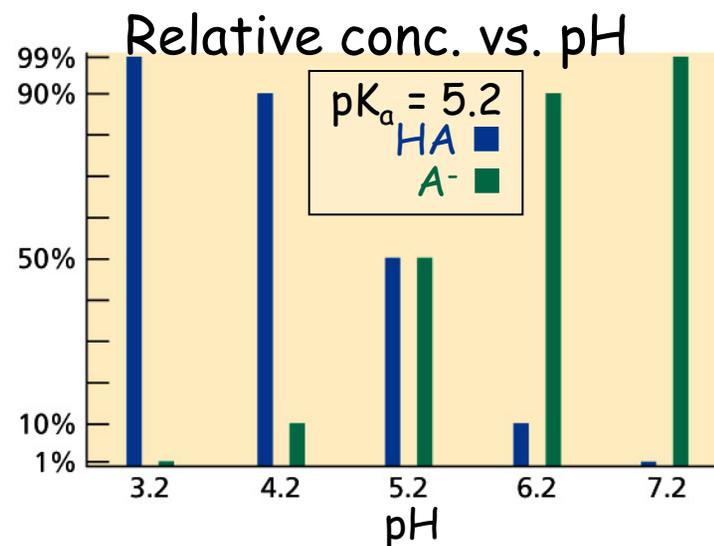
Or

$$\log K_a = \log [H^+] + \log \frac{[A^-]}{[HA]}$$

$$-\log K_a = -\log [H^+] + \log \frac{[HA]}{[A^-]}$$

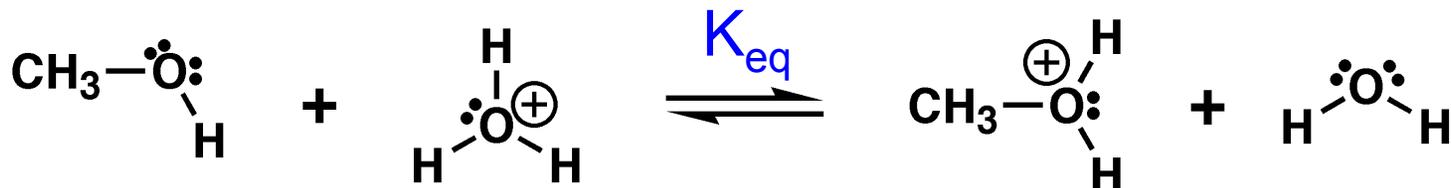
$$pK_a = pH + \log \frac{[HA]}{[A^-]}$$

Henderson-Hasselbalch eqn.

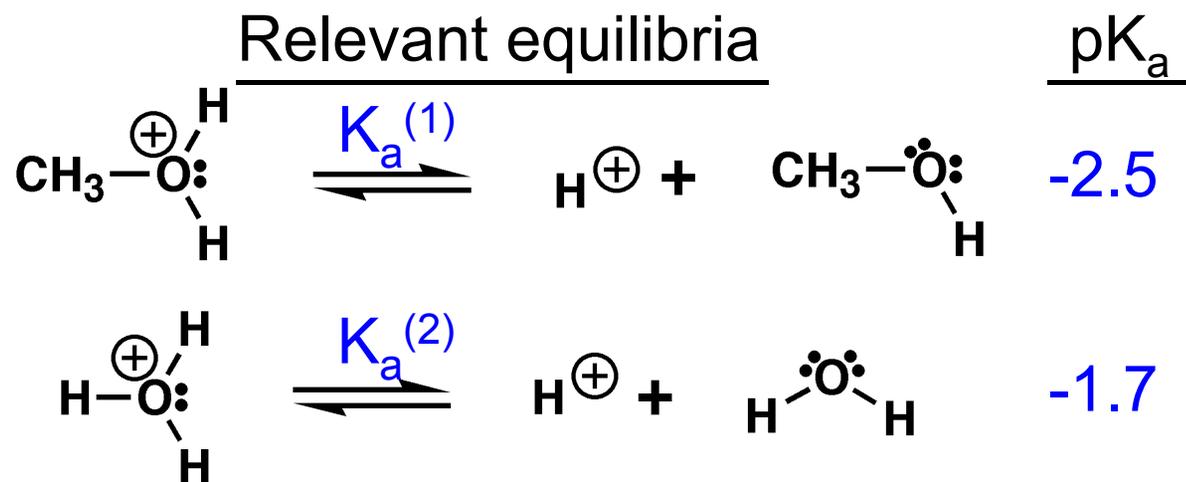


# Determining the Position of Equilibria

Based on the magnitude of  $K_{eq}$ , can we conclude that protonated alcohol is a reasonable species?



$K_{eq}$  can be calculated by analyzing this reaction as a sum of two acid / base equilibria



$$K_{eq} = \frac{1}{K_a^{(1)}} \cdot K_a^{(2)}$$

$$pK_a = -\log K_a$$

$$K_{eq} = \frac{10^{-(-1.7)}}{10^{-(-2.5)}} = 0.16$$