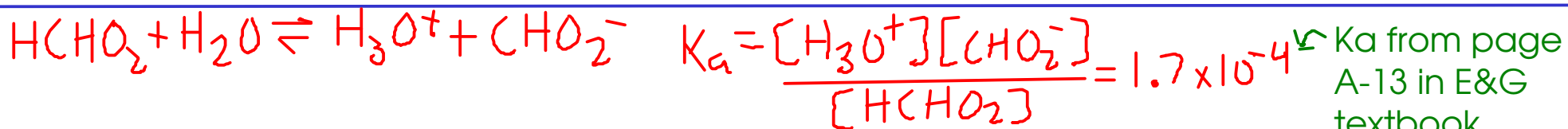


Find the pH and the degree of ionization for an 0.10 M solution of formic acid:  $\text{HCHO}_2$



↙  $K_a$  from page A-13 in E&G textbook...

Species	[Initial]	$\Delta$	[Equilibrium]
$\text{H}_3\text{O}^+$	0	+X	X
$\text{CHO}_2^-$	0	+X	X
$\text{HCHO}_2$	0.10	-X	0.10 - X

Let "x" equal the increase in hydronium ion concentration.

$$\frac{(x)(x)}{(0.10 - x)} = 1.7 \times 10^{-4}$$

$$\frac{x^2}{0.10 - x} = 1.7 \times 10^{-4}$$

- ↓
- 1) Assume  $x \ll 0.10$
  - 2)  $0.10 - x = 0.10$

$$\frac{x^2}{0.10} = 1.7 \times 10^{-4}$$

$$x = 0.0041231056 \text{ M} = [\text{H}_3\text{O}^+]$$

$$\text{pH} = 2.38$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+]$$

What about DEGREE OF IONIZATION? Degree of ionization (DOI) is the FRACTION of a weak acid or base that ionizes in water. So ...

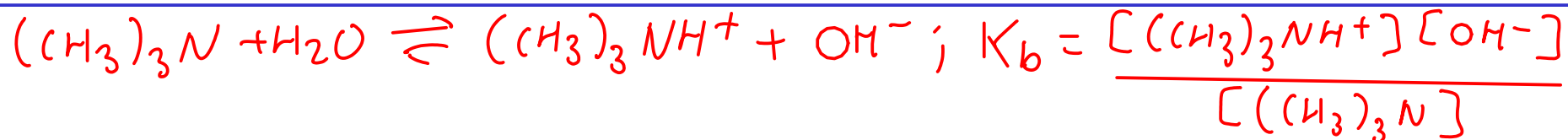
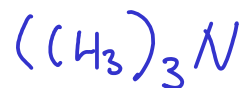
$$\frac{[\text{CHO}_2^-]}{[\text{HCHO}_2]_{\text{initial}}} = \frac{[\text{H}_3\text{O}^+]}{[\text{HCHO}_2]_{\text{initial}}} = \frac{0.0041231056 \text{ M}}{0.10 \text{ M}} = \boxed{0.041 = \text{DOI}}$$

Sometimes, we express DOI in terms of a percentage, which we just call "percent ionization":

$$\% \text{ ionization} = \text{DOI} \times 100 \quad 0.041 \times 100 = \boxed{4.1\% \text{ ionized}}$$

When you do Experiment 16A. By Le Chateleur's Principle, adding water to the equilibrium should force it to the right - meaning that more acid will ionize - even as the pH goes up!. Therefore, the degree of (or percent) ionization should INCREASE as the concentration of the acid DECREASES. Check this with your experiment 16A data on acetic acid.

An aqueous solution of 0.25 M trimethylamine has a pH of 11.63. What's the experimental value of  $K_b$ ?



Start with an equilibrium chart, just like we normally do for weak acid/base equilibrium.

Species	[Initial]	$\Delta$	[Equilibrium]
$(\text{CH}_3)_3\text{NH}^+$	0	+x	x
$\text{OH}^-$	0	+x	x
$(\text{CH}_3)_3\text{N}$	0.25	-x	0.25 - x

Let "x" equal the increase in trimethylammonium ion concentration.

Plug into equilibrium expression.

$$\frac{(x)(x)}{0.25 - x} = K_b$$

$$\boxed{\frac{x^2}{0.25 - x} = K_b}$$

We'll need to use the information we know about pH to find "x". Once we know "x", we can plug in and we'll have  $K_b$ . Remember that if you know pH, you can calculate BOTH hydronium and hydroxide concentrations!

$$\frac{x^2}{0.25 - x} = K_b \quad ; \text{pH} = 11.63$$

Find pOH ...

$$\text{pOH} = 14.00 - 11.63 \left( \text{pH} + \text{pOH} = 14.00 \right)$$

$$\text{pOH} = 2.37 \quad \left( [\text{OH}^-] = 10^{-\text{pOH}} \right)$$

$$[\text{OH}^-] = 10^{-2.37} = 0.0042657952$$

$$\text{So, } x = [\text{OH}^-] = 0.0042657952$$

Now, plug "x" back into the Kb expression...

$$\frac{(0.0042657952)^2}{0.25 - 0.0042657952} = K_b$$

$$7.4 \times 10^{-5} = K_b$$

Species	[Equilibrium]
$(\text{H}_3)_3\text{NH}^+$	x
$\text{OH}^-$	x
$(\text{H}_3)_3\text{N}$	$0.25 - x$