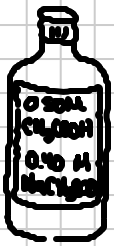
Lecture 14.2: Determination of Buffer pH

Note Title 2/25/2012



$[CH_3COOH] = 0.50M$

$[CH_3COO^-] = 0.40M$

$[Na^+] = 0.40M$ (spectator)

Det. pH

	CH_3COOH	$+ H_2O$	$\rightleftharpoons$	H_3O^+	$+$	CH_3COO^-
i	0.50M	~	shift →	0.0M		0.40M
C	$-x$			$+x$		$+x$
e	$0.50 - x$			x		$0.40 + x$

Not here

L.M.A. $\dfrac{(x)(0.40+x)}{(0.50-x)} = K_a = 1.76\times10^{-5}$ (2SF; $x=0$; 3SF)

small. favors reactants

x & small $\approx x=0$ assumption.

$$\frac{(x)(0.40)}{(0.50)} = 1.76\times10^{-5}$$

$$x = 2.2\times10^{-5}M = [H_3O^+]$$

$[H_3O^+] = 2.2\times10^{-5}M \Rightarrow pH = -\log(2.2\times10^{-5})$

$pH = 4.66$

5% rule: $\dfrac{2.2\times10^{-5}M}{0.40M}\times100 = 0.0055\% < 5\%$ ☺

Henderson Hasselbalch Equation (Shortcut) ... assumes 5% works (valid)

$$pH_{buffer} = pK_a + \log_{10}\left(\frac{[conj\ base]}{[conj\ acid]}\right)$$

$$pH_{buffer} = -\log(1.76\times10^{-5}) + \log\left(\frac{0.40M}{0.50M}\right)$$

$pH_{buffer} = 4.66$! ☺ agrees with ICE

Check 5% validity | $\dfrac{[H_3O^+]}{[acetic\ acid]}\times100\% = \dfrac{10^{-pH}}{0.40M}\cdot100 = \dfrac{10^{-4.66}}{0.40M}\cdot100 = 0.0055\%$ ☺ $< 5\%$