AP CHEMISTRY

TOPIC 7: ACIDS & BASES, PART E, EXAMPLES, PART II

Day 87:

- Buffers

Practice Problem:

a.) A buffered solution (at equilibrium) contains 2.55 *M* benzoic acid, ($HC_7H_5O_2$, $K_a = 6.52 \times 10^{-5}$) and 1.37 *M* potassium benzoate, $KC_7H_5O_2$. Calculate the pH of this solution.

	[$HC_7H_5O_2$]	$\rightleftharpoons$	[H^{+1}]	+	[$C_7H_5O_2^{-1}$]
I	2.55 *M*		~ 0		1.37 *M*
C	- *x*		+ *x*		+ *x*
E	2.55 - *x*		*x*		1.37 - *x*

$$\frac{\left[H^{+1} \right]\left[C_7H_5O_2^{-1} \right]}{\left[HC_7H_5O_2 \right]} = \frac{(x)(1.37 + x)}{2.55 - x} = \frac{(x)(1.37)}{2.55} = 6.52\times10^{-5}$$

$$x = \frac{(2.55)(6.52\times10^{-5})}{1.37} = \left[H^{+} \right]$$

$$1.21 \times 10^{-4} = \left[H^{+} \right] \; ; \; pH = -\log 1.21 \times 10^{-4} = 3.92$$

b) Calculate the change in pH that occurs when 0.85 moles of solid NaOH is added to 1.0 L solution is added to one liter of the buffered solution (from part a, assume the volume change is negligible). Before you begin the problem, what would you expect to happen? Will the pH stay relatively close to the above value?

$$0.85\ M\ \ NaOH \rightarrow 0.85\ M\ \ Na^{+1} + 0.85\ M\ \ OH^{-1}$$

	[$C_7H_5O_2^{-1}$]	+	[H_2O]	$\rightleftharpoons$	[$HC_7H_5O_2$]	+	[OH^{-1}]
I	1.37 *M*		-		2.55 *M*		0.85
C	+ 0.85		-		- 0.85		- 0.85
E	1.37 + 0.85 = 2.22		-		2.55 - 0.85 = 1.70		~ 0

$$K_b = \frac{K_w}{K_a} = \frac{1.00\times10^{-14}}{6.52\times10^{-5}} = 1.53\times10^{-10} = \frac{\left[HC_7H_5O_2\right]\left[OH^{-1}\right]}{\left[C_7H_5O_2^{-1}\right]}$$

$$\frac{(1.70)\left[OH^{-1} \right]}{2.22} = 1.53\times10^{-10} \; ; \; \frac{(2.22)(1.53\times10^{-10})}{1.70} = \left[OH^{-1}\right] = 1.998\times10^{-10}$$

$pH = 14 - \left(-\log 1.998\times10^{-10} \right) = 4.30$ **;** The addition of hydroxide ions changed the pH by + 0.38

Let's think about this… The system took on quite a bit of hydroxide ions, and the system reacted to the addition of the hydroxide ions very well. If the weak acid would not have been present – the solution would have a pH well within the BASIC range…

$$pH = 14 – (- \log [OH^{-1}]) = 14 – (- \log 0.85) = 13.93$$