What makes a buffer?

2 components:

LiF
NaF
CH_3CO_2Na

HF/F^- $\quad$ $CH_3CO_2H/CH_3CO_2^-$

(A) 1. weak acid + 2. Its conj. base

OR

(B) 1. weak base + 2. Its conj. acid.

NH_3 / NH_4^+

neutral

$NH_4Cl \xrightarrow{H_2O} NH_4^+ + Cl^-$:)

$NH_4NO_3 \rightarrow NH_4^+ + NO_3^-$:)

$NH_4F \rightarrow NH_4^+ + F^-$:(

basic

Why do we need both things present?

Consider a buffer: CH_3CO_2H / CH_3CO_2Na ($CH_3CO_2^-$)

→ it can neutralize added base! $CH_3CO_2H + OH^- \rightarrow H_2O + CH_3CO_2^-$

→ it can neutralize added acids! $CH_3CO_2^- + H^+ \rightarrow CH_3CO_2H$

Why don't they neutralize each other?

$CH_3CO_2H + CH_3CO_2^- \xrightarrow{H^+} CH_3CO_2^- + CH_3CO_2H$

$NaCl / HCl$ ✗

HF / LiF ✓

$HNO_3 / NaNO_3$ ✗

NH_3 / NH_4Br ✓

$HC_2H_3O_2 / NaBr$ ✗

Calculations... 1. what's pH (25°C) of a buffer that's 1.0M CH_3CO_2H / 1.5M CH_3CO_2Na

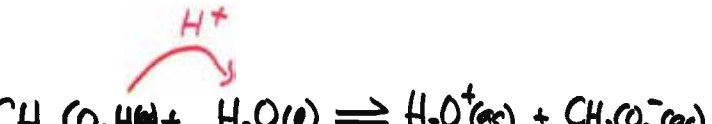
2. If we add 0.20mol NaOH to 2.0-L of this buffer, what will pH be?
   - assume no vol change.

3. If 10.0mL of 2.0M HCl (aq) is added 120.0mL of our buffer, pH = ? Assume vols are additive.

$K_a(CH_3CO_2H) = 1.8\times10^{-5}$ @ 25°C. pH ?

1. 1.0M CH_3CO_2H / 1.5M CH_3CO_2Na

K_a rxn?



I	1.0M	—	≈0	1.5M
C	−x	—	+x	+x
E	(1.0−x)	—	(x)	(1.5+x)

$$K_a = \frac{[H_3O^+][A^-]}{[HA]} \Rightarrow 1.8\times10^{-5} = \frac{(x)(1.5+x)}{(1.0-x)}$$

if $x \ll 1$, then $1.8\times10^{-5} = \frac{(x)(1.5)}{(1.0)}$

$$x = \frac{1.8\times10^{-5}(1.0)}{(1.5)} = 1.2\times10^{-5}$$

<5%

$$pH = -\log[H^+] = 4.92$$

2. Let's add 0.20 mol NaOH to 2.0-L of buffer. pH = 4.92

$[CH_3CO_2H] = 1.0M$, $[CH_3CO_2^-] = 1.5M$

I	0.20 mol	2.0 mol	—	3.0 mol
C	−0.20 mol	−0.20 mol	—	+0.20 mol
E	0	1.8 mol	—	3.2 mol

[ ], P (mol)

$$[CH_3CO_2H] = \frac{1.8\text{ mol}}{2.0\text{ L}} = 0.90M$$

$$[CH_3CO_2^-] = \frac{3.2\text{ mol}}{2.0\text{ L}} = 1.6M$$

ICE it!

	CH_3CO_2H	+ H_2O	$\rightleftharpoons$	$CH_3CO_2^-$	+ H_3O^+
I	0.90 M	—		1.6 M	≈ 0
C	$-x$	—		$+x$	$+x$
E	$(0.90-x)$	—		$(1.6+x)$	(x)

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

$x \ll 0.90$

$$1.8\times10^{-5} = \frac{(x)(1.6+x)}{(0.90-x)} \approx \frac{(x)(1.6)}{(0.90)}$$

$$x = 1.0\times10^{-5}$$

$pH = 5.00$ (compare to orig pH = 4.92)