4/3/2019 Conceptual connection 17.2

HA

weak acid, $pK_a = 4.82$

need to make buffer w/ pH 4.25.

Will we need:

(*) A) $[HA] > [A^-]$

B) $[HA] < [A^-]$

C) $[HA] = [A^-]$ → $\frac{[base]}{[acid]} = 1$, $\log \frac{b}{a} = 0$, $pH = pK_a$

A^-

$$pH = pK_a + \log \frac{[base]}{[acid]}$$

HA

so, need $\log \frac{b}{a} < 0$

so, $\frac{b}{a} < 1$

$\Rightarrow a > b$

Calculating pH changes in a buffer when we add some acid/base.

Plan: (i) Calculating #mol of buffer components.

(ii) " " added acid/base. (strong)

(iii) Do stoichiometry! Assume added acid/base gets neutralized by our buffer. (LR problem)

↓ neut by: A^- ↘ neut by: HA

(iv) Use H-H

Ex: What's pH of a buffer if we add 0.10 mol HCl to a 2.00-L soln that is 1.00 M $HC_2H_3O_2(aq)$ and 1.25 M $NaC_2H_3O_2(aq)$

$K_a(HC_2H_3O_2) = 1.8\times10^{-5}$

i) $\#\text{mol } HC_2H_3O_2 = 2.00\,L \times \frac{1.00\,\text{mol } HC_2H_3O_2}{1\,L} = 2.00\,\text{mol } HC_2H_3O_2$

$\#\text{mol } C_2H_3O_2^- = 2.00\,L \times \frac{1.25\,\text{mol } C_2H_3O_2^-}{1\,L} = 2.50\,\text{mol } C_2H_3O_2^-$

ii) $\#\text{mol HCl (strong-acid)} = 0.10\,\text{mol HCl}$

$HCl \rightarrow H^+ + Cl^-$ // $HCl + H_2O \rightarrow H_3O^+ + Cl^-$

0.10_{mol} $0.10\,\text{mol}$

iii) Stoichiometry

LR; H^+

$H_3O^+(aq) + C_2H_3O_2^-(aq) \rightarrow HC_2H_3O_2(aq) + H_2O(l)$

(#mol)				
I	0.10	2.50	2.00	—
C	−0.10	−0.10	+0.10	—
Final	0	2.40 (Base)	2.10 (Acid)	—

iv) H-H $\quad pH = pK_a + \log\frac{[\text{base}]}{[\text{acid}]}$ (2dp)

$pK_a = -\log(K_a) = 4.744 + \log\left(\frac{2.40\,\text{mol} \div V_{TOTAL}}{2.10\,\text{mol} \div V_{TOTAL}}\right)$

$K_a = 1.8\times10^{-5}$ (2sf.) 2dp 3dp

$= 4.744 + 0.0580$

$= 4.80$ (2dp)

Q: What's orig buffer pH? (use H-H)

$pH = pK_a + \log\frac{b}{a} = 4.744 + \log\frac{1.25\,M}{1.00\,M} = 4.84$ (2d.p.)

Q: What would pH of 2.00 L pure H_2O change by if we added 0.10 mol HCl? (25.0 °C)

Pure water @ 25°C : 7.00.

$$pH = -\log[H_3O^+]$$

↑ ??

$$HCl + H_2O \xrightarrow{100\%} H_3O^+ + Cl^-$$

0.10 mol → 0.10 mol

$$[H_3O^+] = \frac{\#\text{mol}}{\#\text{L}} = \frac{0.10\text{ mol}}{2.00\text{ L}} = 0.050\text{ M}$$

$$pH = -\log[0.050] = 1.30$$

5.70 unit decrease.

vs.

0.04 for buffer!