17.2 Buffers

Buffer pH – The Henderson–Hasselbalch Equation

$$HA_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+ + A^-$$

'Buffer Acid' 'Buffer Base'

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

$$[H_3O^+] = K_a\left(\frac{[HA]}{[A^-]}\right)$$

$$= K_a\left(\frac{[\text{Weak acid}]}{[\text{Conjugate base}]}\right)$$

$$= K_a\left(\frac{[\text{Buffer Acid}]}{[\text{Buffer Base}]}\right)$$

$$-\log_{10}[H_3O^+] = -\log_{10} K_a - \log_{10}\frac{[\text{Buffer Acid}]}{[\text{Buffer Base}]}$$

$$pH = pK_a - \log_{10}\frac{[\text{Buffer Acid}]}{[\text{Buffer Base}]}$$

$$pH = pK_a + \log_{10}\frac{[\text{Buffer Base}]}{[\text{Buffer Acid}]} \quad *$$

* BEWARE :- This formula works only if :
[Buffer Base] > 100 K_a and ;
[Buffer Acid] > 100 K_a.
Yet at no stage is this checked.

The ICE method is much safer as it checks the above to see if you can use the approximation short cut or whether you need to solve the quadriatic.

17.2 **Buffers**

Buffer pH – The Henderson–Hasselbalch Equation

Calculate the pH of a buffer solution made from 1.00 L of a 0.133 M hydrofluoric acid and 0.243 mol of sodium fluoride.
Ka HF = 7.2×10^{-4}

$$pH = pK_a + \log_{10}\frac{[\text{Buffer Base}]}{[\text{Buffer Acid}]}$$

[Buffer Base] = $[F^-]$ = 0.243 ; [Buffer Acid] = [HF] = 0.133

$$pH = -\log_{10}(7.2\times10^{-4}) + \log_{10}\left(\frac{0.243}{0.133}\right)$$

$$= 3.143 + \log_{10}(1.827)$$

$$= 3.143 + 0.262$$

$$= 3.40$$

17.2 Buffers

Making Buffer Solutions

$pH = pK_a + \log_{10}\frac{[\text{Buffer Base}]}{[\text{Buffer Acid}]}$

but when [Buffer Base] = [Buffer Acid]

$pH = pK_a + \log_{10}(1)$

$pH = pK_a$

Preparing Buffer Solutions

$[HCO_2H]$	$[NaHCO_2]$	
0.10 M	= 0.10 M	◉ $HCO_2H/NaHCO_2$
		○ $H_2CO_3/NaHCO_3$
		○ $HOCl/NaOCl$
		○ H_3BO_3/NaH_2BO_3
		○ NH_4Cl/NH_3
		○ $NaHCO_3/Na_2CO_3$

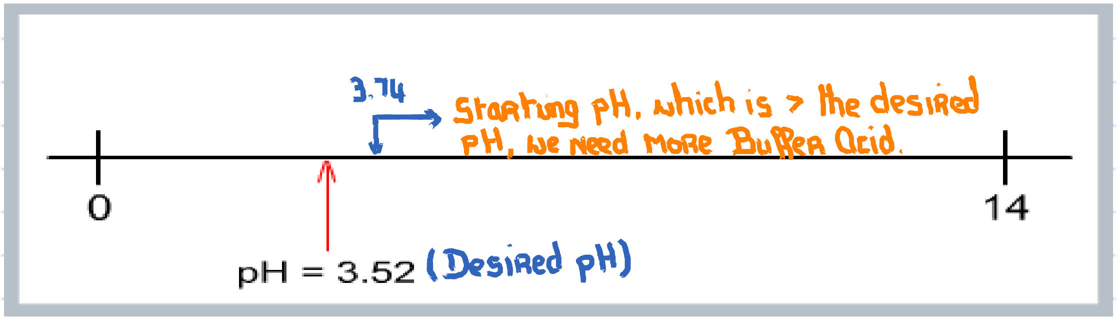
New Target

See Class Web Site.

$K_a = 1.8 \times 10^{-4}$	$pK_a = 3.74$
$K_a = 4.2 \times 10^{-7}$	$pK_a = 6.38$
$K_a = 3.5 \times 10^{-8}$	$pK_a = 7.46$
$K_a = 7.3 \times 10^{-10}$	$pK_a = 9.14$
$K_a = 5.6 \times 10^{-10}$	$pK_a = 9.25$
$K_a = 4.8 \times 10^{-11}$	$pK_a = 10.32$

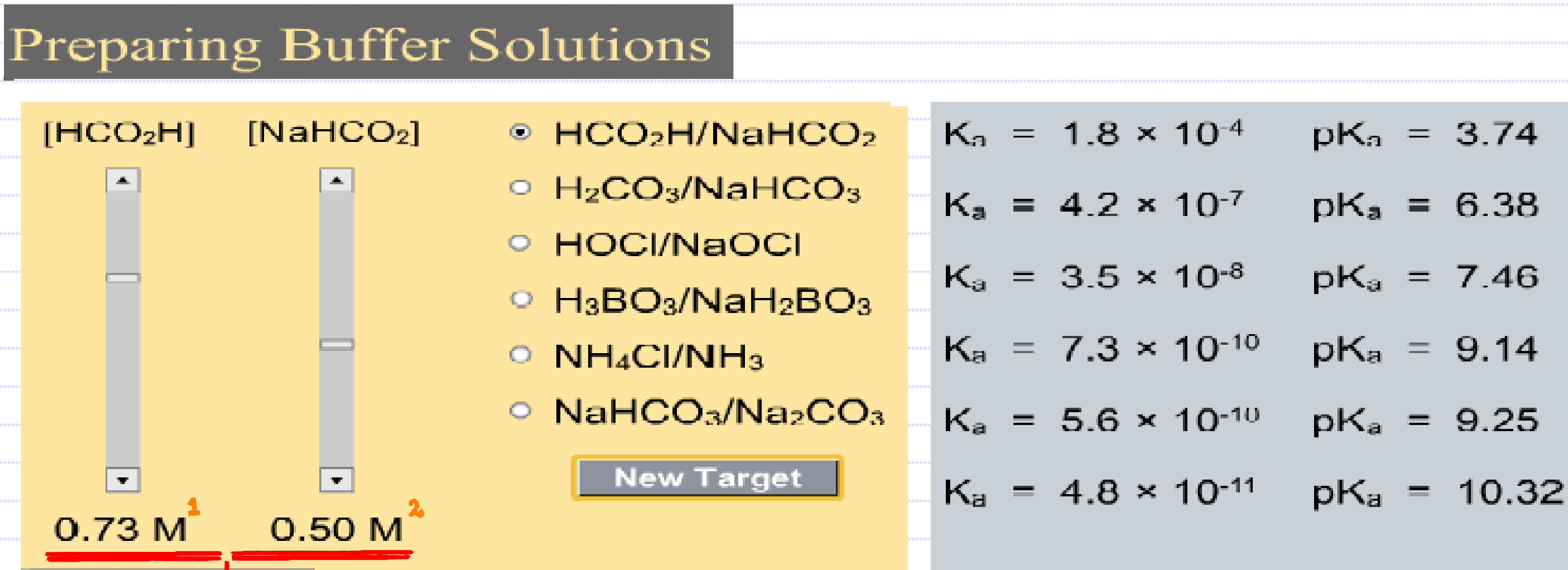
1) Chose an acid/base combination whose acid pKa is closest to the desired pH.

2) Adjust the acid or base concentration to get the desired pH.



17.2 Buffers

Buffer Capacity



Buffer Capacity

1. Maximum amount of OH^- that can be removed = $[HCO_2H]$ = 0.73 M

2. Maximum amount of H_3O^+ that can be removed = $[HCO_2^-]$ = 0.50 M