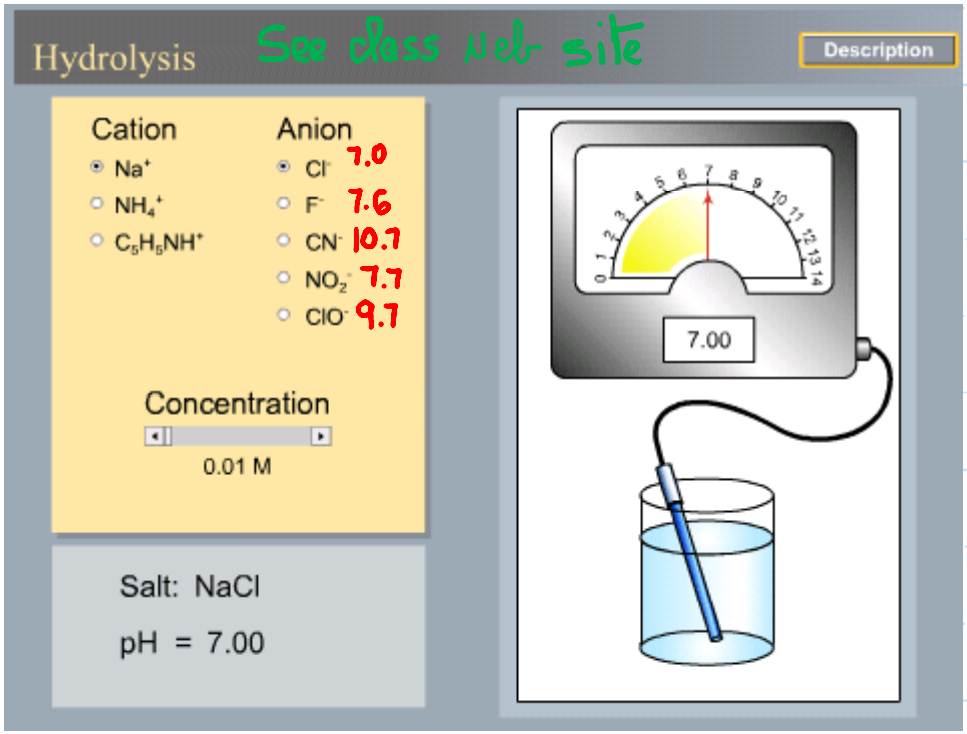
Class Announcements

8.3 What Are Conjugate Acid–Base Pairs? – Consequences



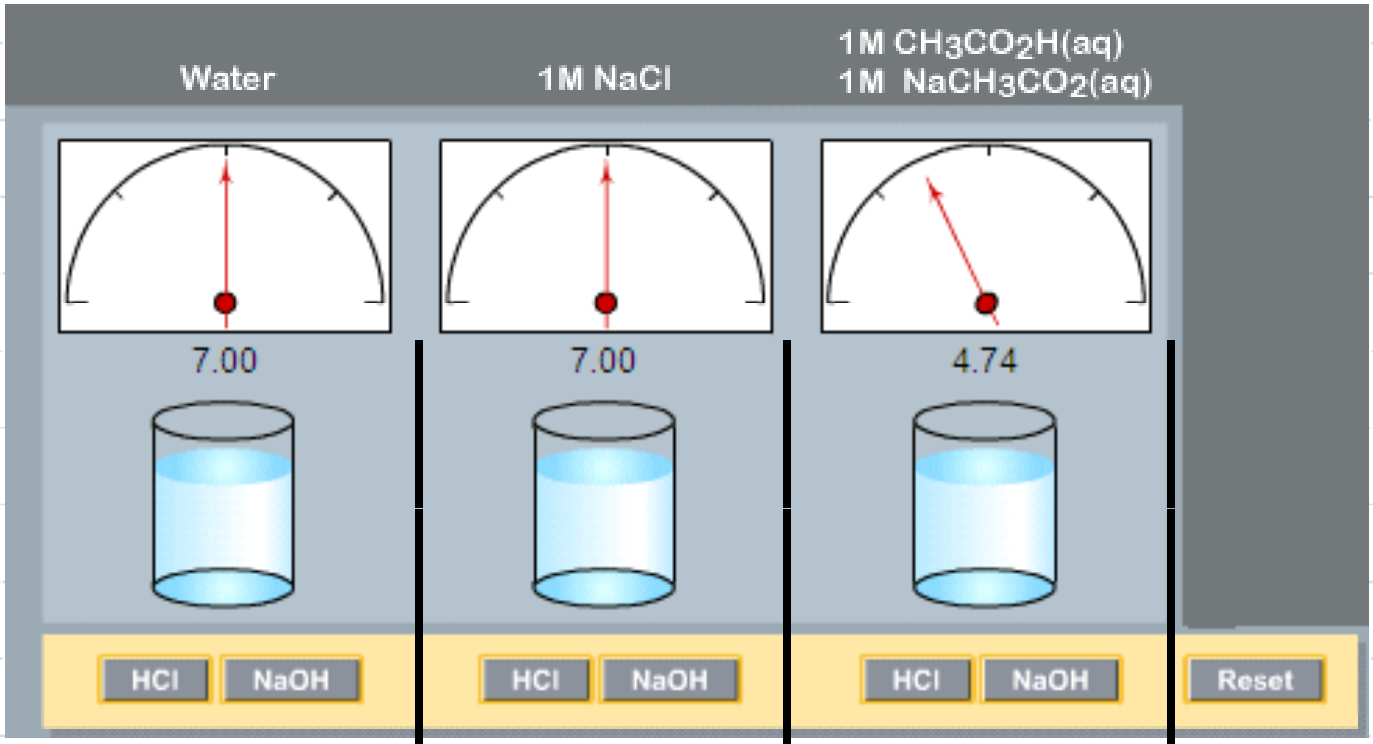
Base	Conjugate acid	
Cl^-	HCl	… strong acid
F^-	HF	all weak acids
CN^-	HCN	
NO_2^-	HNO_2	
ClO^-	HClO	

$CN^- + H_2O(l) \Leftrightarrow HCN(aq) + OH^-$

pH Up … Sodium carbonate … Washing Soda

↳ $CO_3^{2-} + H_2O(l) \Leftrightarrow HCO_3^- + OH^-$

8.10 What Are Buffers?



pH	7.00	7.00	4.74	INITIAL
pH	1.04	1.04	4.65	ADD H_3O^+
pH	12.96	12.96	4.83	Add OH^-

large pH change

small pH change

CH_3CO_2H ... acid

$CH_3CO_2^-$ ... base ... conjugate base of CH_3CO_2H !

8.10 What Are Buffers? – How Do They Resist Drastic pH Changes

Addition of Strong Acid – H_3O^+

1M CH_3CO_2H / 1M $CH_3CO_2^-$

acid — conjugate base

SA + WB = 100%

H_3O^+

$$H_3O^+ + CH_3CO_2^- = H_2O(l) + CH_3CO_2H(aq)$$

OVERALL CHANGES

$[CH_3CO_2^-]$: ↓ ... Reacted with the added H_3O^+.

$[CH_3CO_2H]$: ↑ ... a product of the reaction that removed the H_3O^+.

$[H_3O^+]$: ↑ ... not by much ... a result of $[CH_3CO_2H]$↑.

pH : ↓ ... not by much.

8.10 What Are Buffers? – How Do They Resist Drastic pH Changes

Addition of Strong Base – OH^-

1M CH_3CO_2H / 1M $CH_3CO_2^-$

Acid — Conjugate base

↕ OH^-

WA + SB = 100%

$$OH^- + CH_3CO_2H(aq) = CH_3CO_2^- + H_2O(l)$$

Overall Changes:

$[CH_3CO_2H]$: ↓ ... Reacted with the added OH^-

$[CH_3CO_2^-]$: ↑ ... a product of the reaction that removed the OH^-

$[OH^-]$: ↑ ... not by much ... a result of $[CH_3CO_2^-]$↑ ... a base

pH : ↑ ... not by much

8.10 What Are Buffers? – How Do They Resist Drastic pH Changes

A buffer solution made from HF and KF has a pH = 2.84.
Addition of OH- will cause –

1. Increase significantly
2. Increase slightly
3. Decrease significantly
4. Decrease slightly
5. Increase
6. Decrease

a)  pH ? 2 Adding base ... solution will become more basic

b)  pOH ? 4 $[OH^-]$ ↑ ... $pOH = -\log_{10}[OH^-]$ will ↓

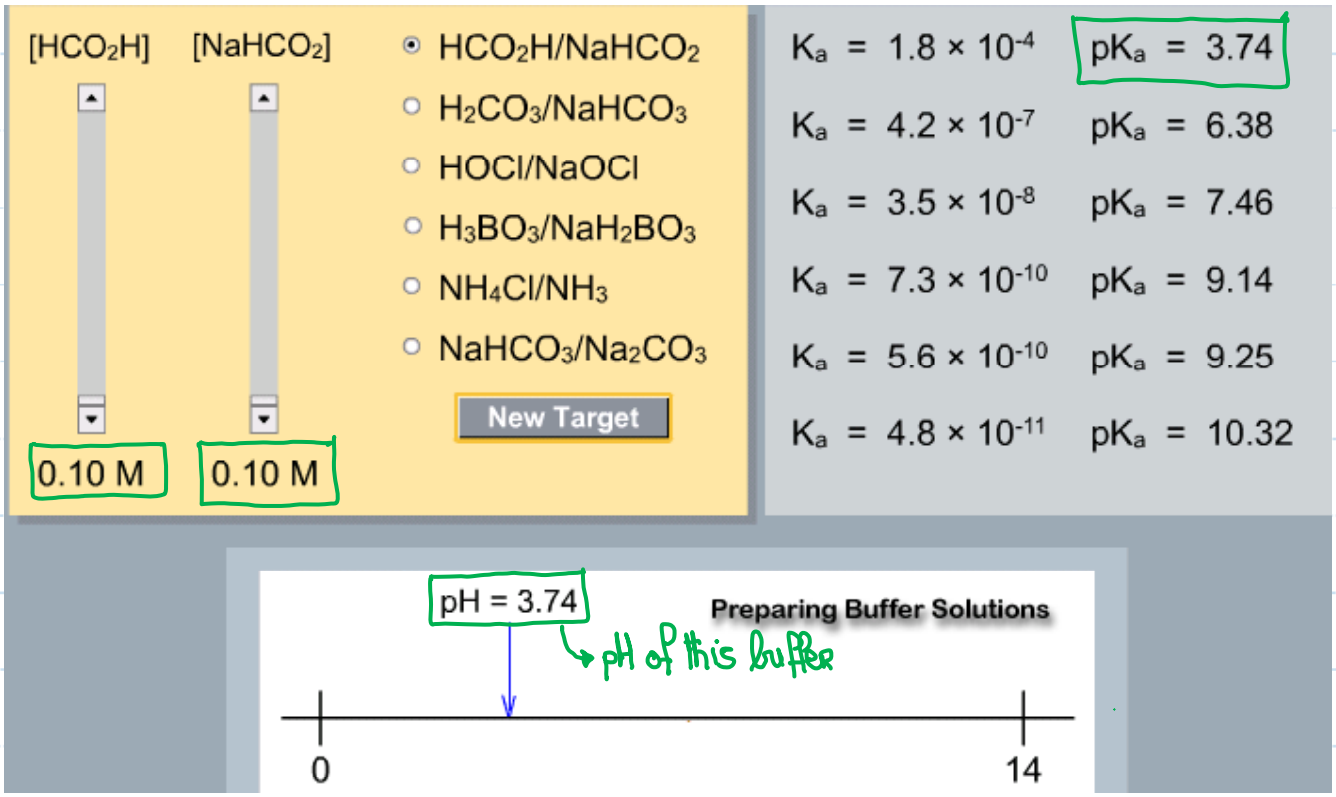
c)  $[HF]$? 6 $HF(aq) + OH^- = H_2O(l) + F^-$

d)  $[F^-]/[HF]$? 5 See (c) ... $[HF]$↓, $[F^-]$↑ ... $[F^-]/[HF]$, ↑

8.10 What Are Buffers? – Making an Optimal Buffer Solution – pH and pKa

See class web site to see whether this holds true for other buffer systems

When [Acid] = [C.Base], the pH of the buffer is equal to the pKa of the acid.



When choosing a buffer system one usually selects one whose pKa is closest to the desired pH.

9.10 What Are Buffers? – Making an Optimal Buffer Solution

Adjusting the pH of a Buffer

See class web site

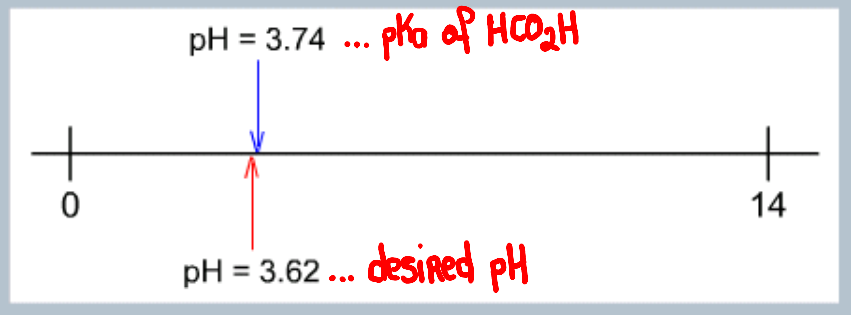
Acid C. Base (HCO_2^-)

[HCO_2H]	[$NaHCO_2$]		
0.10 M	0.10 M	◉ $HCO_2H/NaHCO_2$	$K_a = 1.8 \times 10^{-4}$ $pK_a = 3.74$
		○ $H_2CO_3/NaHCO_3$	$K_a = 4.2 \times 10^{-7}$ $pK_a = 6.38$
		○ $HOCl/NaOCl$	$K_a = 3.5 \times 10^{-8}$ $pK_a = 7.46$
		○ H_3BO_3/NaH_2BO_3	$K_a = 7.3 \times 10^{-10}$ $pK_a = 9.14$
		○ NH_4Cl/NH_3	$K_a = 5.6 \times 10^{-10}$ $pK_a = 9.25$
		○ $NaHCO_3/Na_2CO_3$	$K_a = 4.8 \times 10^{-11}$ $pK_a = 10.32$

New Target

Optimal pH

$\frac{[Acid]}{[C.Base]} \approx 0.1$ to 10



Since the desired pH is more acidic than the pKa ... increase the [ ] of the acid.

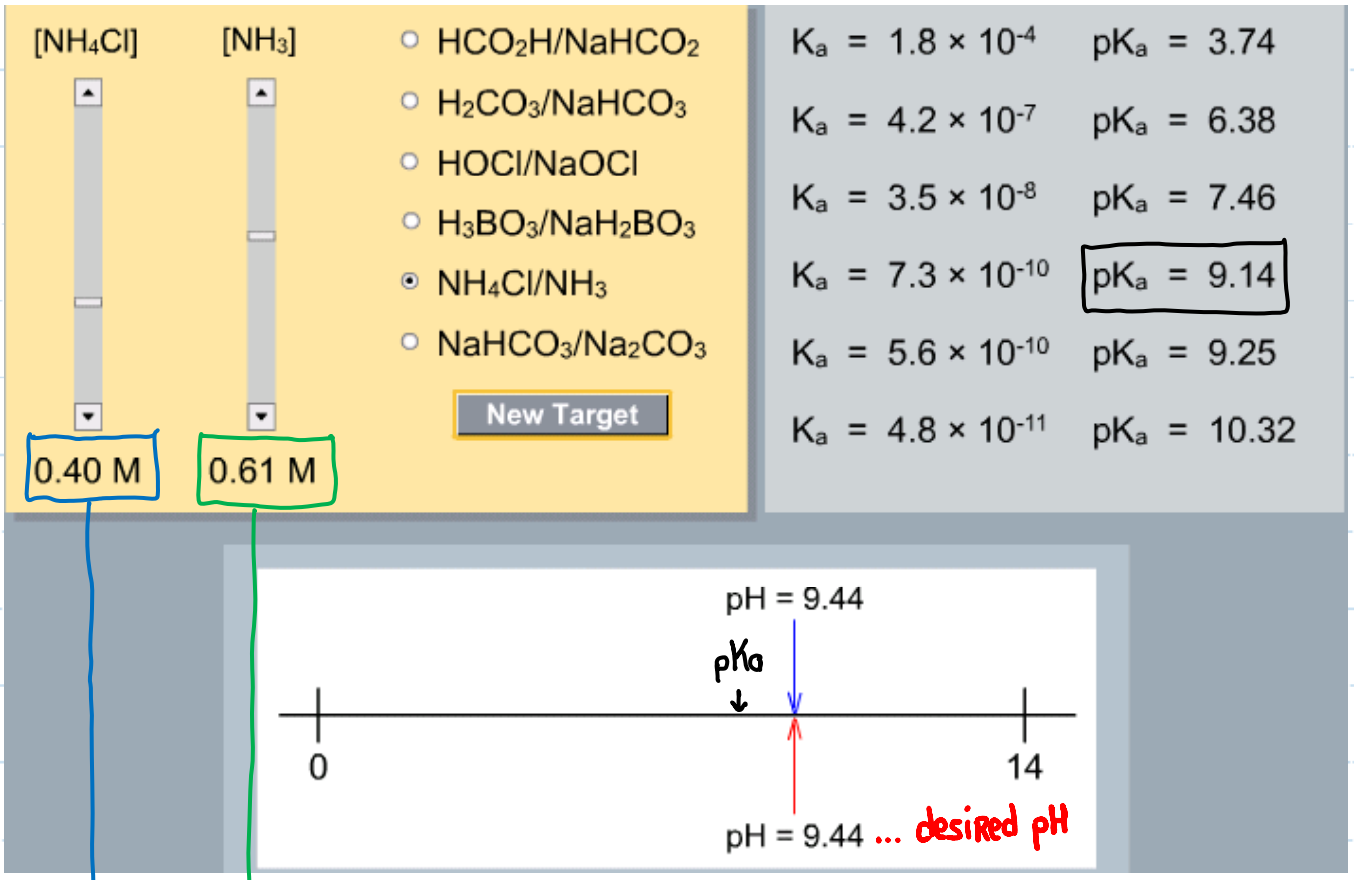
$[HCO_2H] \uparrow$, pH ↓

$[HCO_2^-] \uparrow$, pH ↑

8.10 What Are Buffers? – Making an Optimal Buffer Solution

Buffer Capacity

NH_4^+ (acid) C. Base



→ Maximum concentration of OH^- that can be removed.

↳ Maximum concentration of H_3O^+ that can be removed