Announcements – Lecture XXI – Thursday, Dec 1st

1. Lab 5 – Saturday, December 3, 1-4pm

2. Exam III – Thursday, December 8th – In Class
   Three or Four questions will be taken from Lab Owls 3 and 4.
   No questions will be taken from Lab Owl 5.

3. iClicker:

Choose any letter: A-E

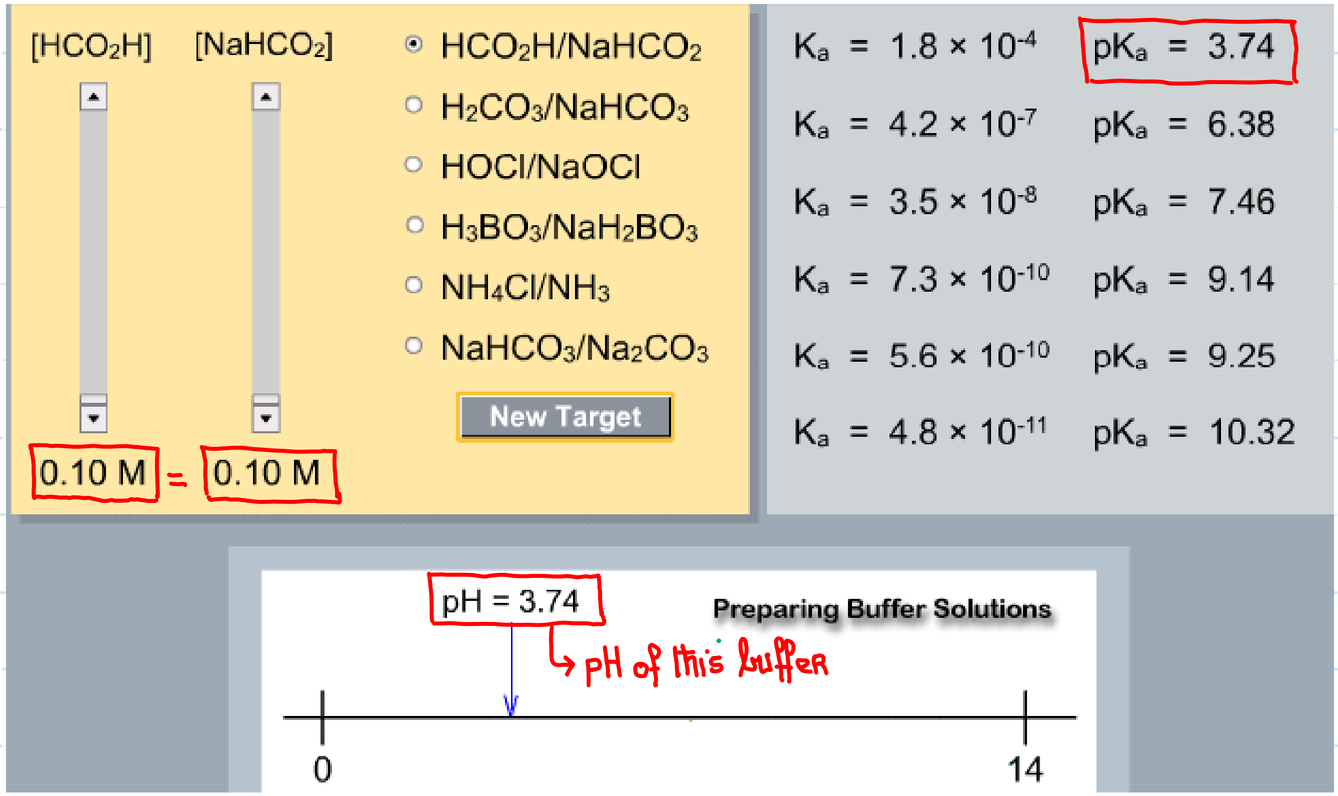
8.10 What Are Buffers? – Making an Optimal Buffer Solution – pH and pKa

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

HCO_2^-

Acid C. Base

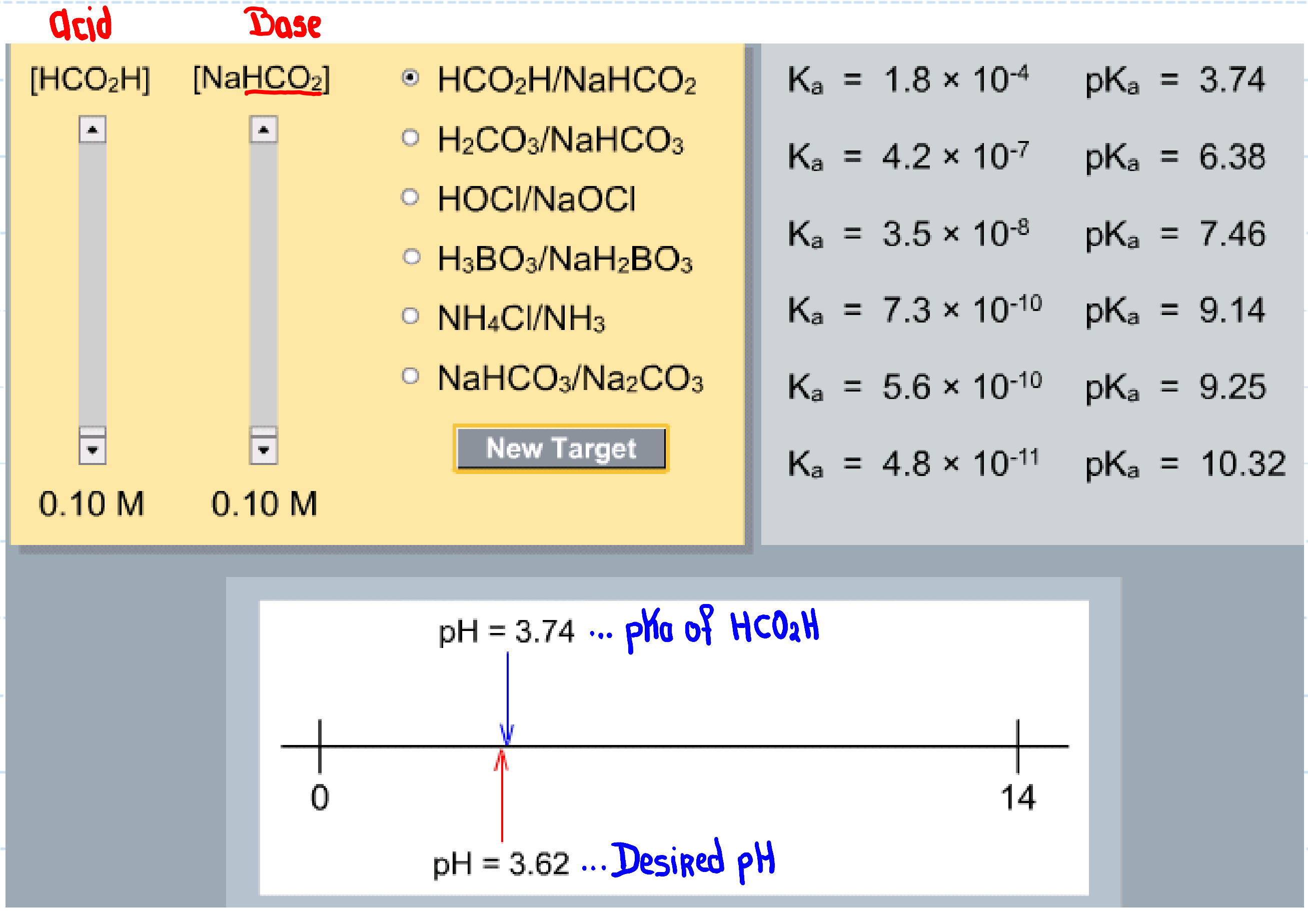
When [Acid] = [C.Base], the pH of the buffer is equal to the pKa of the buffer acid.



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



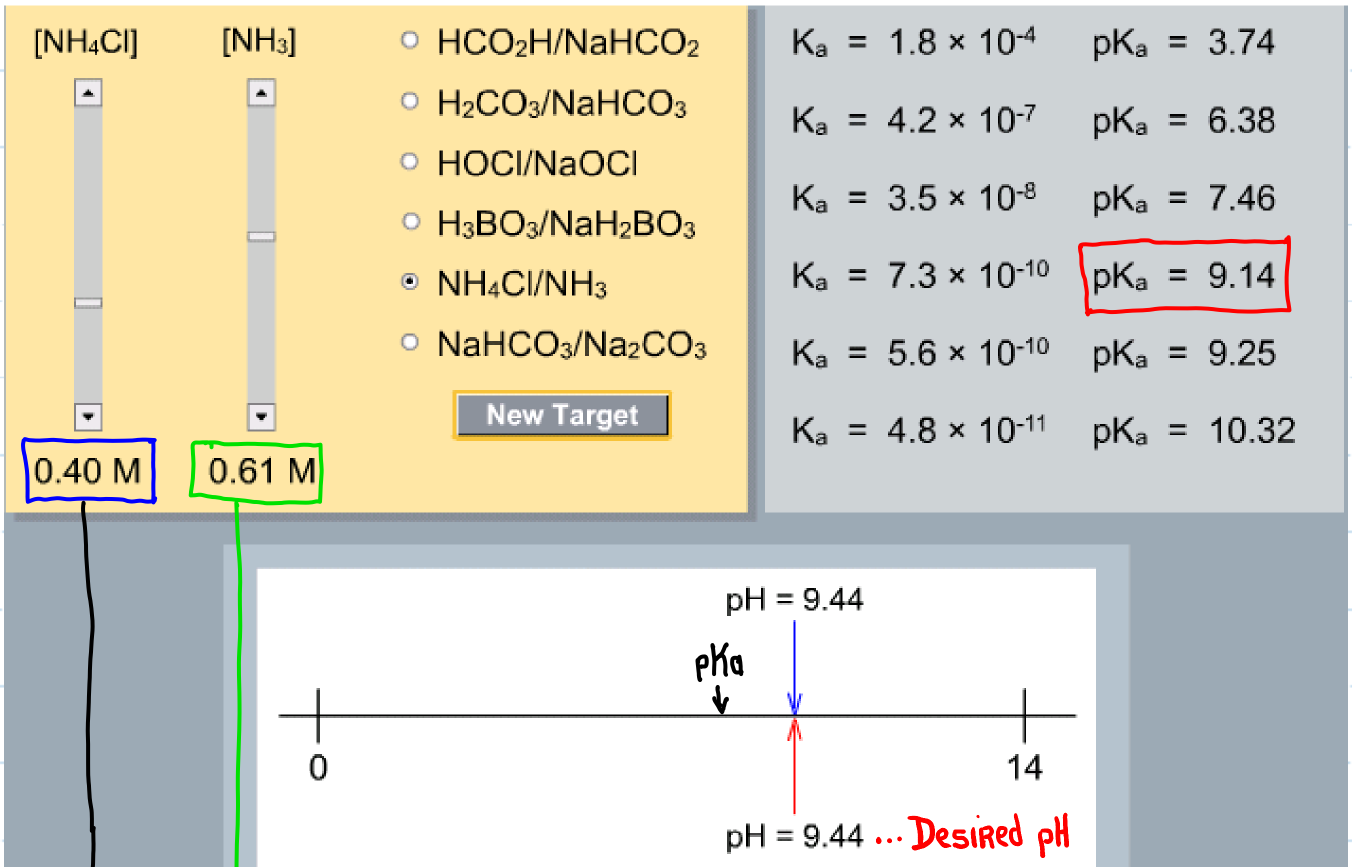
Since the desired pH is more acidic than the pKa ... increase the concentration of the buffer acid

[HCO_2H] ↑, pH ↓

[HCO_2^-] ↑, pH ↑

8.10 What Are Buffers? – Making an Optimal Buffer Solution
Buffer Capacity

Acid: NH_4^+ Base: NH_3



↳ Maximum amount of OH^- that can be removed.
↳ Maximum amount of H_3O^+ that can be removed

} Buffer Capacity.

8.10 What Are Buffers? – Identifying Buffer Solutions

How many of the following aqueous solutions are buffers? 2

a) 0.24 M HI + 0.18 M NaI	X : HI is a strong acid.
d) 0.10 M CH_3COOH + 0.18 M CH_3COOK	✓ : Weak acid, CH_3COOH / Conjugate base, CH_3COO^-
c) 0.27 M NH_4Br + 0.31 M NH_3	✓ : Weak acid, NH_4^+ / Conjugate base, NH_3
b) 0.34 M NH_4NO_3 + 0.39 M $NaNO_3$	X : NO_3^- is not the conjugate base of NH_4^+

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

A 1L solution contains 0.25 mol of NaCN and 0.15 mol of HCN.

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

a) Addition of 0.1 mol of HCl will case the [HCN] to – 5.

$H_3O^+ + CN^- = HCN(aq) + H_2O(l)$

b) Addition of 0.1 mol of HCl will case the pOH to – 2.

pH ↓ slightly … pH + pOH = 14 … pOH ↑ slightly.

c) Addition of 0.1 mol of NaOH will case the [HCN] to – 6.

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

d) Addition of 0.2 mol of NaOH will case the pH to – 1.

Buffer capacity exceeded … [HCN] = 0.15 … $[OH^-]$ = 0.2

8.11 How do We Calculate the pH of a Buffer?

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

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

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

$$\log_{10}[H_3O^+] = \log_{10}K_a + \log_{10}[HA] - \log_{10}[A^-]$$

$$-\log_{10}[H_3O^+] = -\log_{10}K_a + \log_{10}[A^-] - \log_{10}[HA]$$

$$pH = pK_a + \log_{10}\left([A^-]/[HA]\right)$$

HA = Weak acid = Buffer acid.

A^- = Conjugate base = Buffer base.

Buffer pH: $$pH = pK_a + \log_{10}\frac{[\text{Buffer base}]}{[\text{Buffer acid}]}$$

↳ Henderson-Hasselback Equation.

8.11 Buffers – A Summary

a) Buffer : Buffer acid + Buffer base — Weak acid plus its conjugate base.

b) [Buffer acid] = [Buffer base] — pH of Buffer = pKa of the Buffer acid.

c) Buffer Capacity — = concentration of the Buffer acid or Buffer base.

d) How a Buffer works — $OH^- +$ Buffer acid $= H_2O(l) +$ Buffer base.

$H_3O^+ +$ Buffer base $= H_2O(l) +$ Buffer acid.

e) Buffer pH — $pH = pK_a + \log_{10}\left(\frac{[\text{Buffer base}]}{[\text{Buffer acid}]}\right)$