Announcements – Lecture XX – Tuesday, Nov 18th

1. **Final Lab – Saturday, November 22nd … 1-4pm … ISB 155/160 (A-E)**

   a) Print lab prior to coming to lab -- use the 'Print Friendly Version' located on the top left hand side of the page – this is the version that contains the 'Data Sheet' that you will hand in upon completing the lab.

   b) The pre-lab quiz associated with this lab is the 'TA Evaluation' that that can be found in your Class Owls. Completing this by Friday, December 5th is equivalent to a perfect quiz score.

2. **Third Exam – Tuesday December 2nd – 1:00-2:15pm – In Class**
   3 or 4 questions will be taken from Lab Owls 3, 4 and 5.

3. **No class on Tuesday, November 25th – I have an appointment in Boston.**

4. 

   iClicker:
   Choose any letter: A-E

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 $[OH^-]\uparrow$ ... $pOH = -\log_{10}[OH^-]$ will $\downarrow$

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

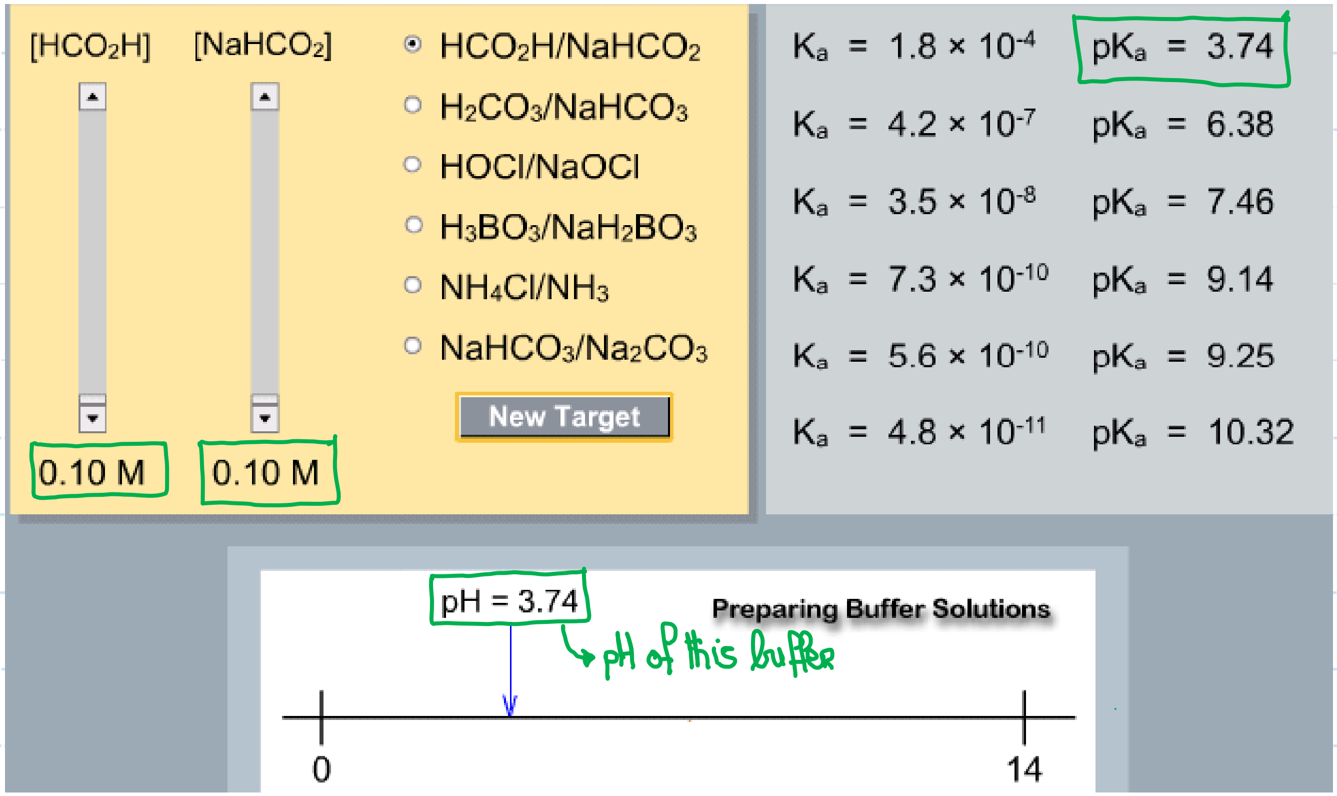
d) $[F^-]/[HF]$? 5 See (c) ... $[HF]\downarrow$, $[F^-]\uparrow$ ... $[F^-]/[HF]$, $\uparrow$

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

Acid C.Base (HCO_2^-)

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.

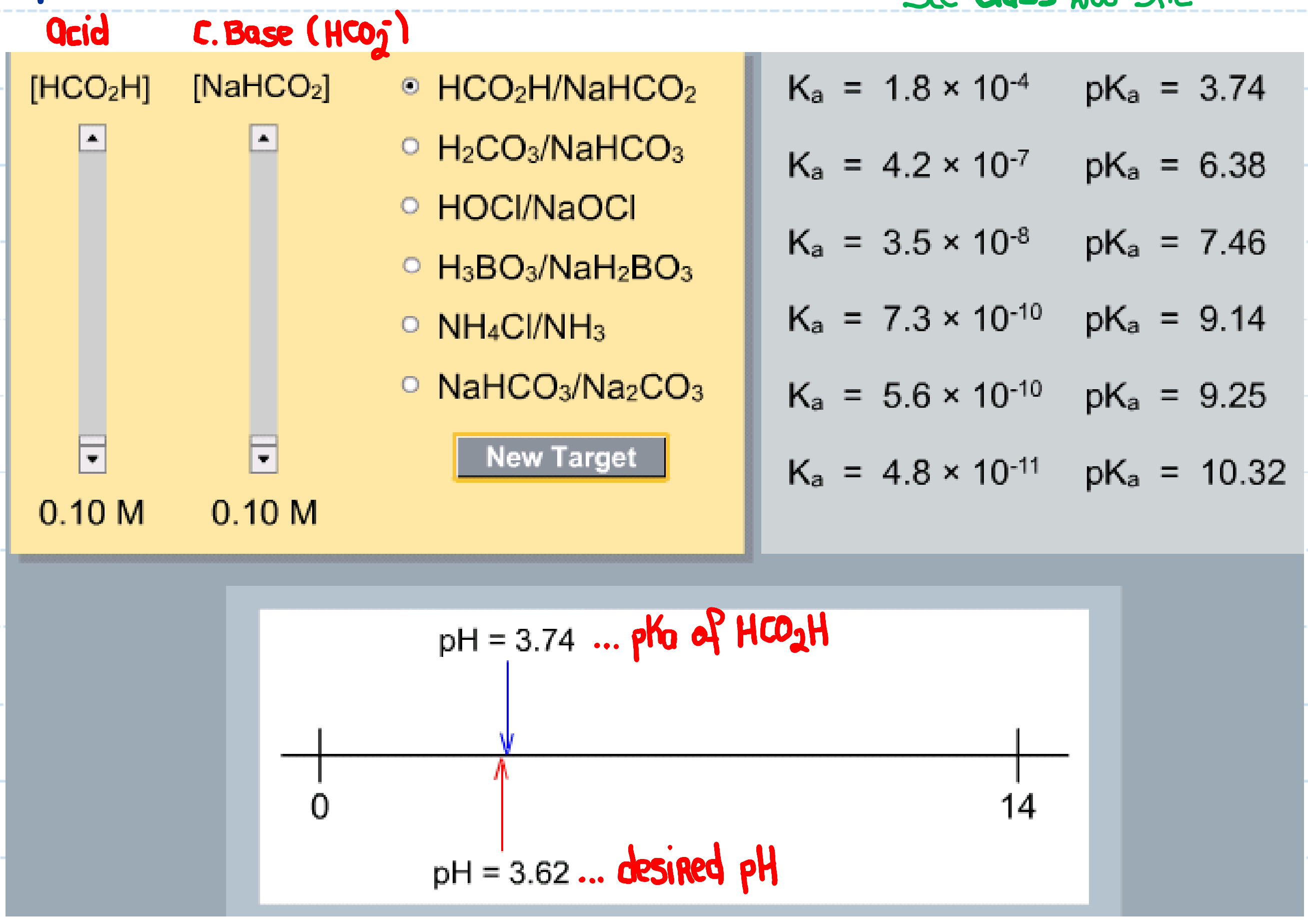
9.10 What Are Buffers? – Making an Optimal Buffer Solution

Adjusting the pH of a Buffer

See class web site

Optimal pH

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



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

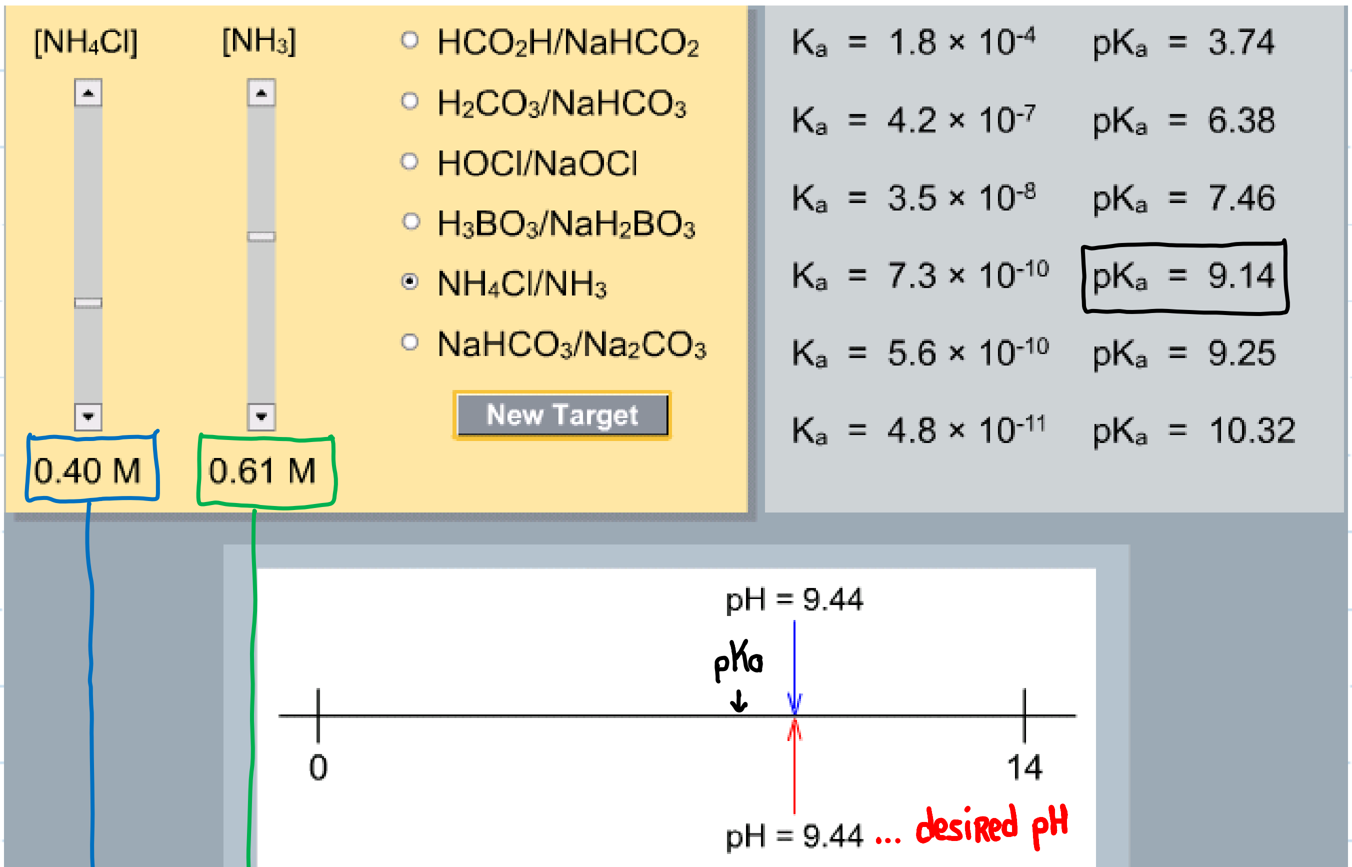
$[HCO_2H] \uparrow$, $pH \downarrow$

$[HCO_2^-] \uparrow$, $pH \uparrow$

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

8.10 What Are Buffers? – Identifying Buffer Solutions

How many of the following aqueous solutions are buffers? 3!

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 and its conjugate base

c) 0.27 M NH_4Br + 0.31 M NH_3 — ✓ ... Weak acid and its conjugate base

b) 0.34 M NH_4NO_3 + 0.39 M $NaNO_3$ — X ... NO_3^- is not the conjugate base of NH_4^+

d) 0.10 M HCl + 0.21 M NaF — ✓!

SA + WB = 100%

$H_3O^+ + F^- = H_2O(l) + HF(aq)$

0.1M   0.21M =   0.1M

0.11M

After reaction 0.1M HF and 0.11M F^- remain!

(d)

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 with the addion of H_3O^+ … 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 … pH will increase significantly.

8.11 How do We Calculate the pH of a Buffer?

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

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

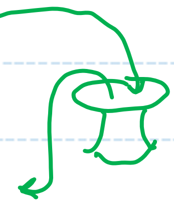
$$pH = -\log_{10}[H_3O^+]$$

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

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

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

$$pH = pK_a - \log_{10}[HA]/[A^-]$$



Math Magic!

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

HA = weak acid, A^- is HA's conjugate base

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

↳ HENDERSON-HASSELBACK EQUATION