

Announcements

- Turn on the Clicker (the red LED comes on).
- Push “Join” button followed by “20” followed by the “Send” button (switches to flashing green LED if successful).
- Exam 3 on chapters 15, 16 and 17 is one week from today.
- Sample exam and answer key to last section will be posted today or tomorrow.

Review

- Brønsted-Lowry
 - acid = a proton donor
 - base = a proton acceptor
- Lewis
 - acid=electron pair acceptor
 - base = electron pair donor
- Conjugate pairs
 - Acids and bases which interconvert during an acid-base reaction.
 - Conjugate bases of weak acids are strong bases.
 - Conjugate acids of weak bases are strong acids.
- Acid dissociation equilibria just like any other.
 - $\text{HA}(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{A}^-(\text{aq})$ $-K_a = [\text{H}^+][\text{A}^-]/[\text{HA}]$
 - Given numerical value for K_a and initial $[\text{HA}]$ can find final equilibrium concentrations.
- Likewise for bases
 - $\text{MOH}(\text{aq}) \rightleftharpoons \text{M}^+(\text{aq}) + \text{OH}^-(\text{aq})$ $-K_b = [\text{M}^+][\text{OH}^-]/[\text{MOH}]$

Review Con't

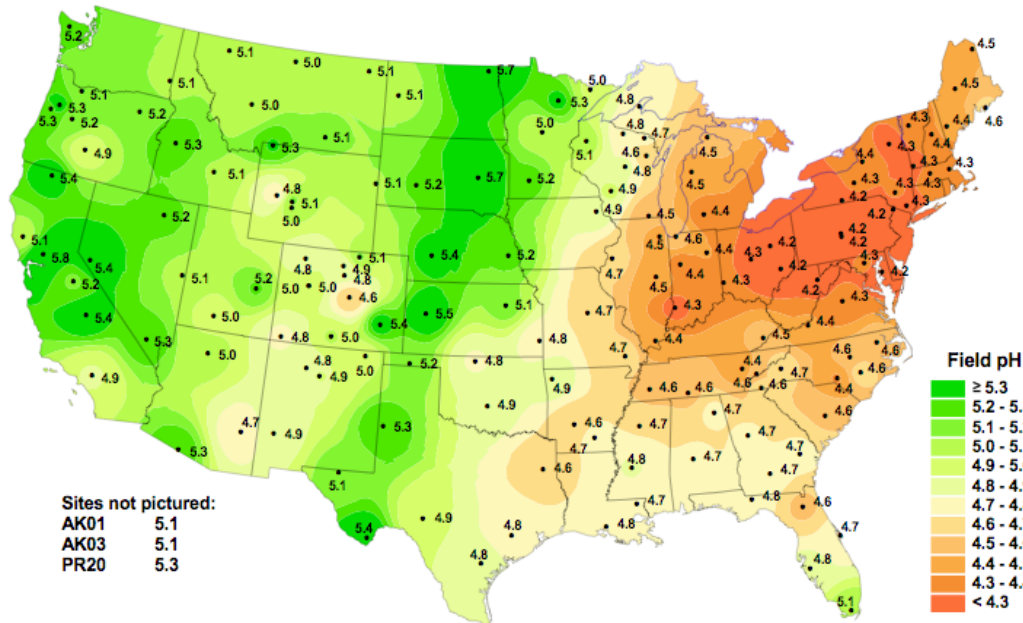
- Acid Rain (pH < 5.3)
 - Multiple coupled acid dissociation equilibria
 - Large K_{a1} , assume first dissociation goes to completion and then equilibrate second step (K_{a2}).
 - Small K_{a1} , equilibrate first dissociation, use result to as start to equilibrate second dissociation, then iterate. You are not expected to iterate, but must show that second step change is small enough that you do not need to.
 - Acids causing acid rain H_2SO_4 , HNO_3 , HNO_2 .
 - Natural rain slightly acidic from carbonic acid (H_2CO_3) equilibria. The carbonic acid comes from dissolved CO_2 .
- Judging relative strength of oxo and halogen acids. (More oxygen on conjugate base = more acidic, for halogens acids stronger as go down group).
- $pH = -\log_{10}[H^+] = -\log_{10}[H_3O^+]$ (pH < 7 = acid, pH > 7 = base)

pH, pOH, pK_w

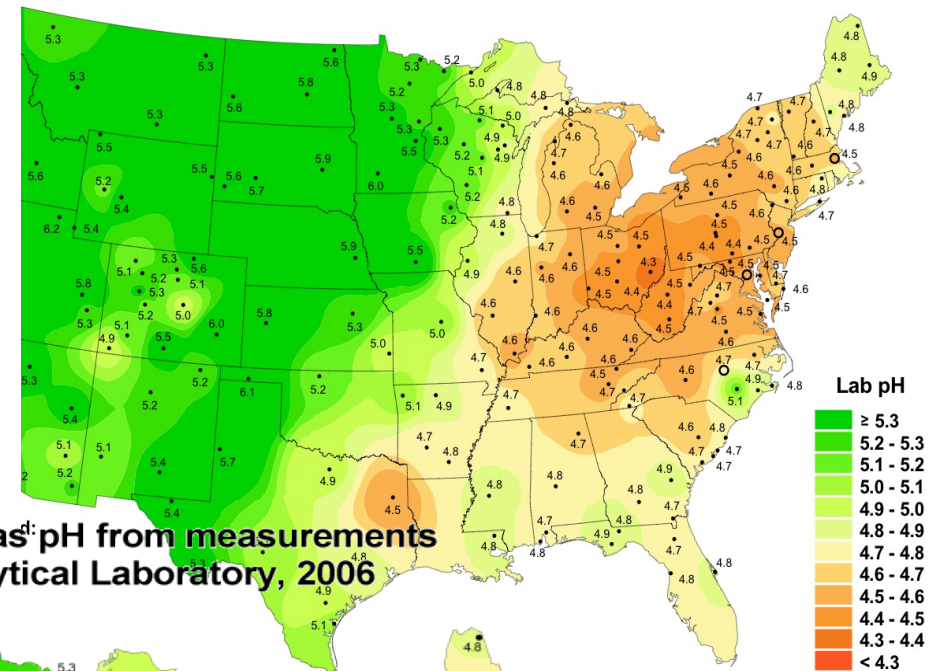
- $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$
 - $K_w (25^\circ\text{C}) = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14}$
 - in pure water $[\text{H}^+] = [\text{OH}^-] = x$
 - $x^2 = 1.0 \times 10^{-14}$
 - $x = 1.0 \times 10^{-7} = [\text{H}^+] = [\text{OH}^-]$
- $\text{p}K_w = -\log(1.0 \times 10^{-14}) = 14.00$
 - $\text{p}K_w = -\log[\text{H}^+][\text{OH}^-] = -\log[\text{H}^+] + -\log[\text{OH}^-]$
 $= \text{pH} + \text{pOH} = 14.00$
 - For conjugate pairs: $K_a K_b = K_w$ or $\text{p}K_a + \text{p}K_b = \text{p}K_w$

Acid Rain 1994-2006

Hydrogen ion concentration as pH from measurements made at the field laboratories, 1994



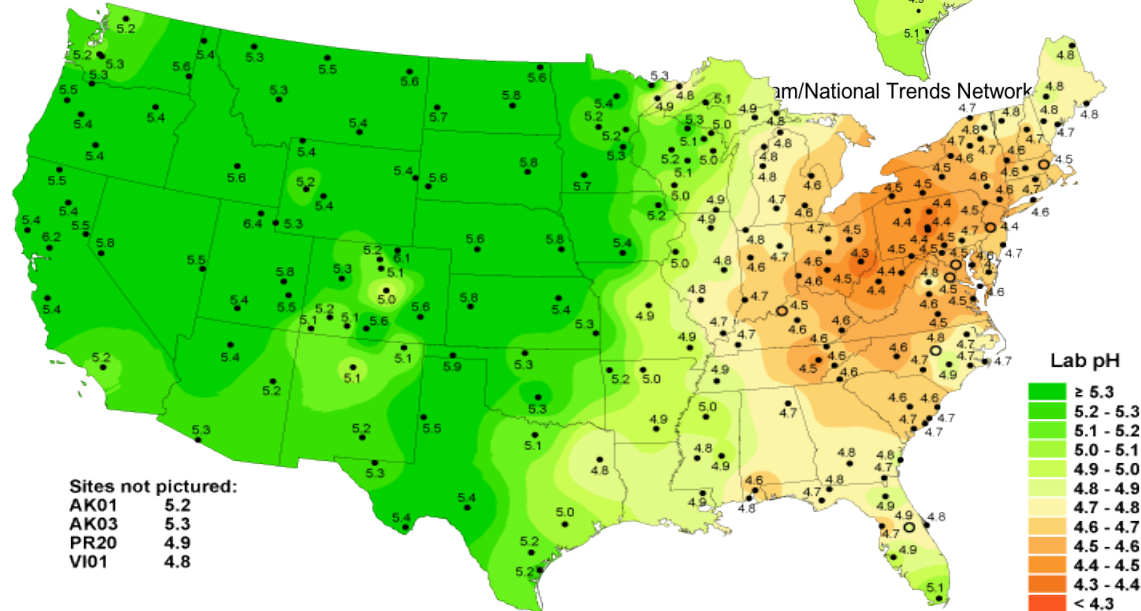
Hydrogen ion concentration as pH from measurements made at the Central Analytical Laboratory, 2005



Sites not pictured:
 AK01 5.1
 AK03 5.1
 PR20 5.3

National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

Hydrogen ion concentration as pH from measurements made at the Central Analytical Laboratory, 2006



Sites not pictured:
 AK01 5.2
 AK03 5.3
 PR20 4.9
 VI01 4.8

National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

Buffers

- Buffer = a solution that resists a change in its pH when either an acid or base is added.
- Buffers consist of a weak acid + the salt of its conjugate base. (alternately weak base + salt of its conjugate acid)
- Can calculate pH using standard equilibrium calculations
- If [salt] and [acid] reasonably high easier to use Henderson-Hasselbach: $\text{pH} = \text{pK}_a + \log\left(\frac{[\text{base}]}{[\text{acid}]}\right)$