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).~~

NO CLICKER QUESTIONS TODAY

- VOTE TODAY!!!

- You should have got e-mailed to you suggested reading and problems for chapter 16.
- Quiz in discussion will cover through 16.2.

Review

- Quadratic in solving equilibria
- T dependence of K
  - $K = \exp(-\Delta G^o/(RT))$
  - $\ln(K_2/K_1)=(-\Delta H^o/R)(1/T_2 - 1/T_1)$
- Heterogeneous equilibria
  - pure solids and solvents do not appear in mass action expression.

Chapter 16-Solution Equilibria

- Brønsted-Lowry vs Lewis acids and Bases
- Conjugate pairs
- Equilibria and Acid Rain
- Equilibria and Bases
- Structure-acidity relations
- pH
- pH of salt solutions
- Buffers
- Indicators
- titration
- solubilities of solids (K_{sp})
- Complex ions

Brønsted-Lowry Model

- acid = a proton donor • base = a proton acceptor
- $HNO_3(aq) + H_2O(aq) \longleftrightarrow NO_3^-(aq) + H_3O^+(aq)$

  acid base

- $Na^+(aq) + OH^-(aq) + H_2O(aq) \longleftrightarrow Na^+(aq) + H_2O(aq) + OH^-(aq)$

  base acid

Lewis Model (does not require water)

- acid = electron pair acceptor • base = electron pair donor
- $H_3P: + Cu^{2+} \longleftrightarrow H_3P{-}Cu^{2+}$

  base acid coordinate covalent bond

- $H_3N: + H{-}O{-}H \longleftrightarrow H_3N{-}H^+ + OH^-$

  base acid

Conjugate Acid-Base Pairs

- Acids and bases which interconvert during an acid base reaction.

- $NH_3 + H_2O <--> NH_4^+ + OH^-$

- $HNO_3 + H_2O <--> NO_3^- + H_3O^+$

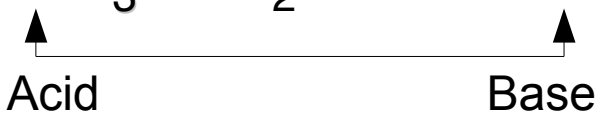


Figure 16.8

Bisulfate Equilibrium

$H_2SO_4(aq) \longleftrightarrow H^+(aq) + HSO_4^-(aq)$ $K_{a1} >> 1$ like HNO_3
$HSO_4^-(aq) \longleftrightarrow H^+(aq) + SO_4^{2-}(aq)$ $K_{a2} = 1.2 \times 10^{-2}$

Assume: $[H_2SO_4]_i = 0.050$ M

	$HSO_4^-(aq)$	<—>	$H^+(aq)$	+	$SO_4^{2-}(aq)$
i	0.050		0.050		0
Δ	-x		+x		+x
eq	0.050-x		0.050 +x		+x

$\Rightarrow 1.2 \times 10^{-2} = (0.050 + x)x/(0.050 - x)$

solve using quadratic: x = 0.0085 or -0.071(not possible).
So $[H^+] = 0.050 + 0.0085 = 0.059$ M
$[HSO_4^-] = 0.050\text{-}x = 0.041$ M

Carbonic Acid & Bicarbonate Equilibrium

	$H_2CO_3(aq) \longleftrightarrow$	$H^+(aq)$	+	$HCO_3^-(aq)$	$K_{a1}=4.3 \times 10^{-7}$
i	1.3×10^{-5}	0		0	
Δ	-x	+x		+x	
eq	$1.3 \times 10^{-5} - x$	x		x	

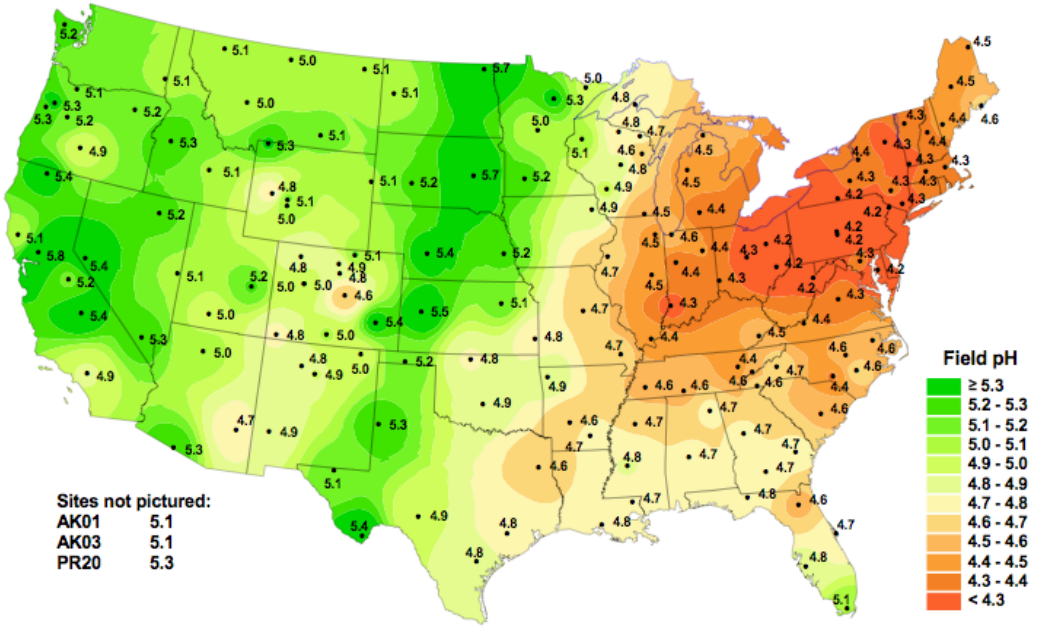
$4.3 \times 10^{-7} = x^2/(1.3 \times 10^{-5} - x)$

Second equilibrium: $HCO_3^-(aq) \longleftrightarrow H^+(aq) + CO_3^{2-}(aq)$

$K_{a2} = 4.7 \times 10^{-11}$

Acid Rain 1994-2005

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



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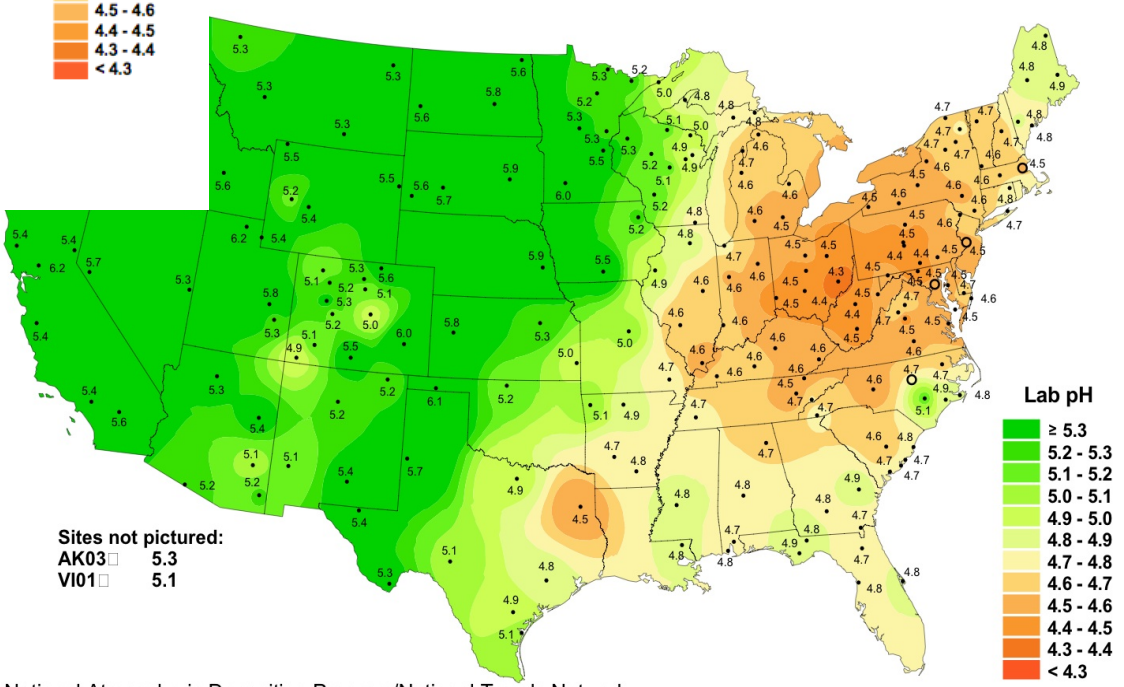

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