Chem 116 Lecture 19
November 18, 2008 (LL)

Key points about acids and bases so far

- Pay attention to charge on the acid or base
- There is always an acid and base on the reactant side and their conjugate acid or base on the product side
- An increase in Ka causes a decrease in Kb
- A decrease in Ka causes an increase in Kb
- Ka= equilibrium constant, water + weak acid
  - When you have two different weak acids the larger the Ka the stronger the acid

Two clicker questions to practice what we went over in the previous lecture

A) HPO_4^{2-} base on reactant side
B) HCO_3^- acid on reactant side (has an H+)
C) CO_3^{2-} base
D) $H_2PO_4^-$ acid (has an H+ and one more H+ than HPO_4^{2-})

Ka Reaction
$HA (aq) + H_2O (l) \leftrightarrows A^- (aq) + H_3O^+ (aq)$
HA-Weak Acid
$Ka= [A^-] [H_3O^+] / [HA]$

Weak Acid
$H_2PO_4^- (aq) + H_2O (l) \leftrightarrows HPO_4^{2-} (aq) + H_3O^+ (aq)$
$H_2PO_4^-$ (aq)- acid loses H^+
H_3O^+ (aq)– base accepts H^+

Kb Reaction
$B(aq) + H_2O (l) \leftrightarrows HB^+ (aq) + OH^- (aq)$

H_2O (l)- acid loses and H^+ to OH^- (aq)
B (aq)- base , HB^+ gained the the H^+

$Kb= [Hb^+] [OH^-] / [B]$

Could $H_2PO_4^-$ be a weak base? Yes
$H_2PO_4^- + H_2O (l) \leftrightarrows OH^- (aq) + H_3PO_4$
$H_2PO_4^-$ = base , H_3PO_4 = accepts the H^+
H_2O (l) = acid in this case because it loses an H^+ and become OH^- on the product side

Could CO_3^{2-} be an acid? No
$CO_3^{2-} + H_2O \rightarrow ?$
-could not be an acid because there is no H^+ for the carbonate to give away

Could there be a Kb reaction for CO_3^{2-} ? Yes
$CO_3^{2-} + H_2O \leftrightarrows HCO_3^- + OH^-$

CO_3^2 – base
HCO_3 - accepts an H^+ from CO_3^2
H_2O – acid loses an H^+ to OH^-

Base:
HPO_4^{2-} $K_a = 3.6 \times 10^{-13}$ would be for its weak acid reaction, but we don't need K_a for it for this problem

Acids:
HCO_3^- $K_a = 5.61 \times 10^{-11}$
$H_2PO_4^-$ $K_a = 6.23 \times 10^{-8}$

The question was, does the equilibrium for the following rxn lie to the right or to the left:
HPO_4^{2-} (*aq*) + HCO_3^- (*l*) $\leftrightarrows$ CO_3^{2-} (*aq*) + $H_2PO_4^-$ (*aq*)

B) Equilibrium lies to left
- Need to look at the acid values to find which equilibrium constant for the acid is larger, and that's the stronger acid so it wins
- $K_a = 6.23 \times 10^{-8}$ is larger than $K_a = 5.61 \times 10^{-11}$, so $H_2PO_4^-$ is the stronger acid

What is the pH scale?
an increase in H^+ causes a decrease in pH'
a decrease in H^+ causes and increase in pH
the more acidic- the smaller the pH more H^+

What does pH scale mean mathematically?
Scale A- linear
Scale C- logarithmic
pH doesn't always have to be an integer

What you need to be good at?
Molarity= mols solute/ L solution (imp. during titrations)

Adding strong acid to strong base or 1 L of water
HCl = strong acid so it completely dissociates in water, into 1mol H^+ ions plus 1 mol Cl^- ions

H_2SO_4 = the first H^+ is strong, but the second one (on $HSO_4^–$) is weak acid doesn't dissociate very much, so when you have 1 mol of H_2SO_4, you get a little more than 1 mol H^+ , because you get 1 mol of H^+ from the first dissociation that is complete, and a tiny bit more H^+ from the dissociation of $HSO_4^–$ which is a weak acid so only a tiny bit of it dissociates. So, if you prepare a solution of 1 mol of H_2SO_4 in water, there will be lots of solutes in the solution:

- there will be no H_2SO_4
- there will be a little more than 1 mol of H^+
- there will be a little less than 1 mol of $HSO_4^–$
- there will be a tiny bit (much less than 1 mol) of SO_4^{2-}

NaOH = strong base, dissociates into 1 mol OH^- ions and 1 mol Na^+ ions

Example of strong base calculations

a) NaOH- strong base (arrhenius base)
   NaOH- when added to water completely dissociates
   1 mol NaOH 1 mol OH^-
   .0012 M NaOH solution:

   $[OH^-]$ = .0012 M
   pOH = -log(.0012) = 2.92
   pH = 14 - 2.92 = 11.08
   11.08: when take the log of something you get the significant digits after the decimal place (2 sig figs)

b) $Sr(OH)_2$ is a strong base
   pH= 10.46
   Goal: to find the concentration of $Sr(OH)_2$
   find the concentration of OH^- , get that from pOH, get pOH from pH

   1) pOH = 14 – pH
      pOH = 14 – 10.46
      pH = 3.54

   2) $[OH^-] = 10^{-pOH}$
      $= 10^{-3.57}$
      = .000288 M (keep more sig figs than needed, round back at the end)

   3) 0.000288 mol OH^- / 1L x 1 mol $Sr(OH)_2$ / 2 mol OH^-
      = .00014 M the $Sr(OH)_2$ concentration

How much does a weak acid or base dissociate?

Weak acids do not completely dissociate (they mostly stay whole and do not fully break apart into H^+ and the conjugate base), need to write an equilibrium table