Acids, Bases & Salts

I. Acids - begin with H (ex. HCl)
- A. Arrhenius' theory - an acid is a substance that yields hydrogen ions in aqueous solution
  1. Turn blue litmus red
     a. colorless in phenolphthalein
  2. Have a pH less than 7
  3. react with metals above Hydrogen on Table J to form salt and H_2 gas
  4. React with Metallic oxides to form salts and water
  5. React with bases to form a salt and water (neutralization reaction)
  6. Tastes sour
  7. Conduct electricity in relation to the degree of their ionization
     a. strong electrolyte - strong acids (top of Table M)
     b. Contain more H^+ (H_3O^+) than OH^-
  8. Binary Acids – Hydrogen and a nonmetal that is more electronegative
  9. Ternary Acids (oxyacids) – Hydrogen with a polyatomic ion containing oxygen

II. Bases - end in OH (ex. NaOH)
- A. Arrhenius' theory - a base is a substance that yields hydroxide ions in aqueous solution
  1. All bases dissociate except for NH_3(aq) which ionizes
  2. Turn red litmus blue
     a. pink in phenolphthalein
  3. Has a pH greater than 7
  4. Reacts with acids to form salt and water (neutralization reaction)
  5. Tastes bitter
  6. Feels slippery
  7. Emulsifies fats and oils
  8. Conducts electricity in relation to their solubility
     a. more soluble, the more free ions, and the better the conductivity
     b. contain more OH^- than H^+ (H_3O^+)

III. Salts - do not begin with H or end in OH (ex. NaCl, MgS)
1. Form in neutralization reactions of an acid with a base

Acid + base « salt + water

- B. Non electrolytes - will not conduct electricity when melted, vaporized or dissolved in water
  1. Organic compounds - begin with C and contain H

III. Bronsted-Lowry Theory (Alternate Theory)
- A. An acid is any species (molecule or ion) that can donate a proton to another species (loses H^+)
- B. A base is any species (molecule or ion) that can accept a proton (gains H^+)
- C. Formation of Conjugate Acid-Base Pairs

ex. $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

- D. ***The strongest acid has the largest K_a value (and the smallest pH value)***

E. ***The weakest acid has the smallest K_a value***

F. ***As conjugate acid strength decreases, conjugate base strength increases***

G. ***Conjugate acid-base pairs differ by H^+***

1. ***NH_3 and NH_4^+ H_2O and OH^-***

H. ***Amphoteric (amphiprotic) substances act as either an acid or base***

1. ***(ex. H_2O)***

IV. Acid - Base Reactions

A. Neutralization (Titration)

1. Acid - Base titration - determining the molarity of an unknown acid (base) by slowly combining it with a base (acid) of known molarity until the solution is neutralized
   a. neutralization is called the "equivalence point"
   b. Steps to determining the molarity of an unknown
      1. write the balanced equation (determines the molar ration of reactants and products)
      2. determine the # of moles of standard solution needed to neutralize the unknown
         a. Moles of known solute = volume of solution (L) X molarity
      3. use molar ratios to determine moles of unknown solution
         a. L of known x M of known = L of unknown x M of unknown
         b. or M_A X V_A (#H) = M_B X V_B (#OH)

V. ***Ionization constant of water***

1. ***Use this expression to find either the H^+ or OH^- for any water solution***
   a. ***acid, base, salt, or pure water***
   b. ***$[H_3O^+][OH^-] = 1 \times 10^{-14} = K_w$ = ionization constant of H_2O at 25° C***
2. ***pure water $H_3O^+ = 1 \times 10^{-7}$***
3. ***Pure water $OH = 1 \times 10^{-7}$***

VI. Determining pH of a solution

A. pH scale is 1-14

1. 1-6 is acidic
2. 7 is neutral
3. 8-14 is basic
4. 1 step of pH change (1à 2 eg.) is a 10X change in concentration

B. ***$pH = -\log [H^+]$***

1. ***ex. $1.0 \times 10^{-7} = pH\ 7$***
   a. ***pH = 7 is neutral***
   b. ***pH > 7 is base***
   c. ***pH < 7 is acid***
2. ***ex. Find pH of .001 M HCl .001 M = $1.0 \times 10^{-3} = pH\ 3$***
3. ***ex. Find pH of .10 M NaOH $OH^- = 1.0 \times 10^{-1}$ $H_3O^+ = 1.0 \times 10^{-13}$ pH = 13***

C. ***$pOH = -\log [OH^-]$***

D. ***$pH + pOH = 14$***

VII. ***Monoprotic and Polyprotic Acids – determined by the number of H^+ that can be donated by a substance***

A. ***Dissociation constant of second and third H^+ ions is relatively insignificant***

VIII. Hydrolysis of a salt (reverse of a neutralization reaction)

1. Hydrolysis - reaction with water
2. Dissolving of salt in water can produce a basic or acidic solution
    a. ***4 Types of Reactions***
        1. ***Salt of strong acid and strong base = neutral solution (pH 7)***
            a. ***ex. $NaCl + H_2O$ ® $HCl + NaOH$***
        2. ***Salt of weak acid and strong base = basic solution (pH > 7)***
            a. ***$NaC_2H_3O_2 + H_2O$ ® $HC_2H_3O_2 + NaOH$***
        3. ***Salt of strong acid and weak base = acidic solution (pH < 7)***
            a. ***$NH_4Cl + H_2O$ ® $HCl + NH_4OH$***
        4. ***Salt of weak acid and weak base = variable depending on ionization constants***
            a. ***$NH_4C_2H_3O_2 + H_2O$ ® $HC_2H_3O_2 + NH_4OH$***