Chapter 16: Acid - Base Titration and pH

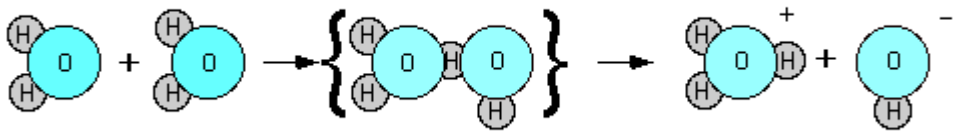
16-1 Aqueous Solutions and the Concept of pH

I. Hydronium Ions and Hydroxide Ions

A. Self-Ionization of Water

1. Autoprotolysis

$$H_20(l) + H_20(l) \rightarrow H_30^+(aq) + OH^-(aq)$$



2. Molarity at 25°C
   a. 1.0×10^{-7} moles H_30^+ per liter of solution
   b. 1.0×10^{-7} moles OH^- per liter of solution

B. Ionization Constant for Water (K_W)

1. $K_W = [H_3O^+][OH^-] = (1.0 \times 10^{-7}M)(1.0 \times 10^{-7}M) = 1.0 \times 10^{-4}M^2$
2. K_W is a constant at ordinary ranges of room temperatures

C. Neutral, Acidic, and Basic Solutions

1. Neutral
   a. $[H_3O^+] = [OH^-]$
2. Acidic
   a. $[H_3O^+] > [OH^-]$
3. Basic
   a. $[H_3O^+] > [OH^-]$

D. Calculating $[H_3O^+]$ and $[OH^-]$

1. $\left[H_3O^+\right] = \frac{1.0x10^{-14}M^2}{\left[OH^-\right]}$
2. $\left[OH^-\right] = \frac{1.0x10^{-14}M^2}{\left[H_3O^+\right]}$
3. Assume that strong acids and bases are completely ionized in solution
   a. 1.0 M H_2SO_4 = 2.0 M H_3O^+
   b. 1.0 M $Ba(OH)_2$ = 2.0 M OH^-

II. The pH Scale

A. pH

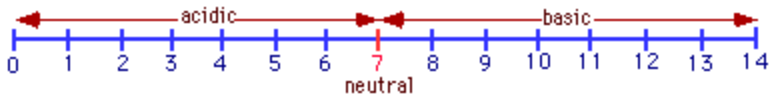
1. The negative of the common logarithm of the hydronium ion concentration
   a. pH = - log $[H_30^+]$

B. pOH

1. The negative of the common logarithm of the hydroxide ion concentration
   a. pOH = - log $[OH^-]$

pH + pOH = 14.0

C. The pH Scale



III. Calculations Involving pH

A. Calculation of pH from [H_30^+] Concentration
See worksheet on logarithms

B. Calculation of [H_30^+] and [OH^-] Concentration from pH
See worksheet on antilogs

C. pH Calculations and the Strength of Acids and Bases
1. Weak acids and weak bases cannot be assumed to be 100% ionized
2. [H_30^+] and [OH^-] cannot be determined from acid and base concentrations, and must be determined experimentally

16-2 Determining pH and Titrations

I. Indicators and pH Meters

A. Acid-Base Indicators
1. Compounds whose colors are sensitive to pH

B. Transition Interval
1. pH range over which an indicator color change occurs
2. Indicators are useful when they change color in a pH range which includes the endpoint of the reaction

C. Choosing Indicators

Acid-Base Indicator Selections		
Combination	*Endpoint*	*Indicator(s)*
Strong acid - strong base	endpoint pH is 7	Litmus Bromthymol blue
Strong acid - weak base	endpoint is less than 7	Methyl orange Bromphenol blue
Weak acid – strong base	endpoint is greater than 7	Phenolphthalein Phenol red
Weak acid – weak base	endpoint pH can fall in a wide range	No single indicator is suitable

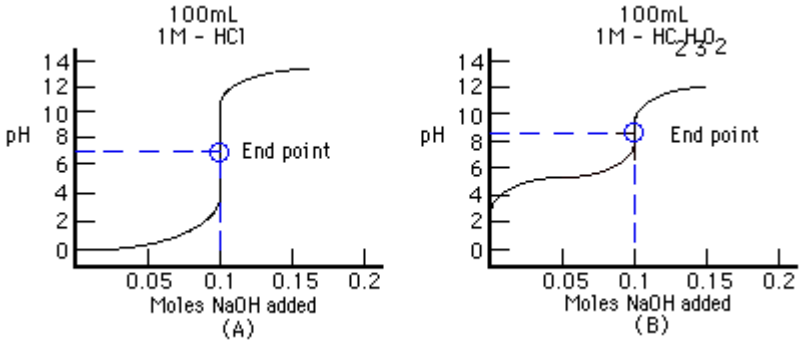
D. pH meter
1. Measures voltage difference between two electrodes

II. Acid-Base Titration

A. Titration
   1. Controlled addition of the measured amount of a solution of a known concentration required to react completely with a measured amount of sol'n of unknown concentration

B. Equivalence Point
   1. The point at which the solutions used in a titration are present in chemically equivalent amounts

C. Titration Curves
   1. End point
      a. the point in a titration at which the rxn is just completed



III. Molarity and Titration

A. Standard Solution
   1. A solution that contains the precisely known concentration of a solute, used in titration to find the concentration of the solution of unknown concentration

B. Primary Standard
   1. A highly purified solid compound used to check the concentration of the known solution in a titration

C. Calculations with Molar Titrations
   1. Start with the balanced equation for the neutralization reaction and determine the chemically equivalent amounts of the acid and base
   2. Determine the moles of acid (or base) from the known solution used during the titration
   3. Determine the moles of solute of the unknown solution used during the titration
   4. Determine the molarity of the unknown solution