

Acid/Base titrations: Determination of the equivalence point is characterized by a pH level that is a function of the acid/base strengths and concentrations of the analyte & titrants.

Strong Acid + Strong Base = neutral (7)

Strong Acid + weak base = still slightly Acidic

weak Acid + Strong base = still slightly Basic

$$M_A V_A = M_B V_B$$

if acid is in excess

$$[H^+] = \frac{\text{moles } H^+}{\text{total volume}} = \frac{M_A V_A - M_B V_B}{V_A + V_B}$$

if base is in excess

$$[OH^-] = \frac{\text{moles } OH^-}{\text{total volume}} = \frac{M_B V_B - M_A V_A}{V_A + V_B}$$

The end Point can be found by:

1. Indicator
2. pH probe
3.  $\Delta$  temp. (thermometric)

Standardizing Titrant: Standardization is accomplished by titrating a known amount of acid or base standard.

Common Acid Standards: HCl, HClO<sub>4</sub> and H<sub>2</sub>SO<sub>4</sub>

Common Base Standard: NaOH

Metal - Ligand Complexation Reaction: (aka: Complexation Titration)

A titration in which the reaction between the analyte & the titrant form a metal-ligand complex.

A ligand - a molecule with an unshared pair of electrons that attract a metal ion.

$$\text{Formation Constant} = K_f = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

$$\text{Dissociation Constant} = K_d = \frac{[A]^a [B]^b}{[C]^c [D]^d}$$

Common titrant (ligand) = EDTA (ethylene diamine tetraacetic acid)  
an aminocarboxylic acid  
a zwitter ion

Forms strong 1:1 complexes with many metal ions.

it has 6 (six) bonding sites: 2 amino bond sites and 4 acid bonding sites.

The equivalence point happens when the concentration of the metal ion and the ligand are stoichiometrically equal. This may be found by locating the inflection point on a titration curve.

- ② Visual indicator of the endpoint is a metallochromatic (organic dye) solution that yields a color change when it goes from complexed to uncomplexed. The ligand used must have a higher activity so that it can release the metal from the dye and bind with it. Many of the metallochromatic indicators are pH sensitive and reaction conditions must be adjusted.
- ③ The equivalence point may also be determined by a change in absorbance.

## Redox Reaction Titrations:

a titration in which the reaction between the analyte + titrant is a redox reaction.

LEO-GER      OIL-RIG

Common oxidizing titrants:  $MnO_4^-$  +  $Cr_2O_7^{2-}$

Common reducing titrants:  $Fe^{2+}$  +  $S_2O_3^{2-}$

For a redox titration it is common to monitor the electrochemical potential. (Nernst Equation). The Nernst equation relates the voltage of a cell ( $E$ ) to the activities of the reactants + products.

$$E = E^\circ - \frac{RT}{nF} \ln Q$$

where:  $F$  = Faraday constant

$E^\circ$  = cell voltage when activities are in unity

$Q$  = reaction quotient

$R$  = gas laws constant

$T$  = temp

A matrix dependent formal potential is used - that is the potential of a redox reaction for a specific set of solution conditions - such as pH and ionic composition.

Precipitation Titration: a titration reaction between the analyte + titrant that forms a precipitant.

The titration curve can be developed as a change in either the analyte or titrants concentration as a function of the titrant.

- End point can be determined using visual indicators or potentiometers.
- Visual indicators work to indicate an excess of either analyte or titrant.
  - potentiometers are ion-selective electrodes that measure change in concentration.