

## Lecture 5 – Volumetric Analysis/Titrations

### Methods for Establishing Concentration of Standard Solutions

1. Direct – carefully weighed out sample into a volumetric flask
2. Standardization - solution is standardized by:
  - a. titration with a weighed quantity of a primary std
  - b. weighed quantity of secondary std
  - c. or measured volume of another std solution

### Stoichiometric Calculations in Volumetric Analysis

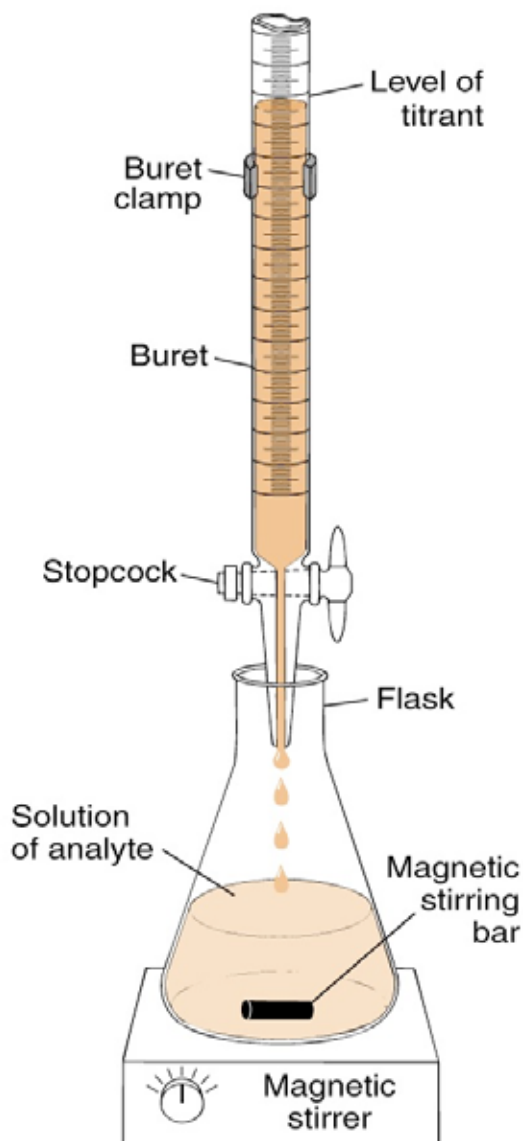
$$1. \text{ amount A} = \# \text{ mol A} = \frac{wtA(g)}{fwA(g/mol)}$$

$$2. \text{ amount A} = \# \text{ mol A} = V \text{ (L)} \times C_A \text{ (mol A /L)}$$

\* Solution preparation – lecture 1

\* When primary std's not available, use standardization method

Volumetric titration – addition of a standardized solution (titrant) from a buret (or other volumetric device) to a solution of analyte until reaction completed (equivalence point).



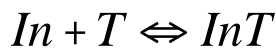
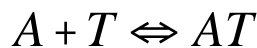
Key: Relate # moles of titrant to moles of analyte

## Titration Curves in Titrimetric Methods (precipitation)

End point = some physical change that occurs near the equivalence point of a titration

Equivalence point - reaction b/t titrant and analyte is complete.

Color change – most recognizable indicator  
(p.367)



For change -  $\frac{[InT]}{[In]}$  change by 1-2 orders of magnitude

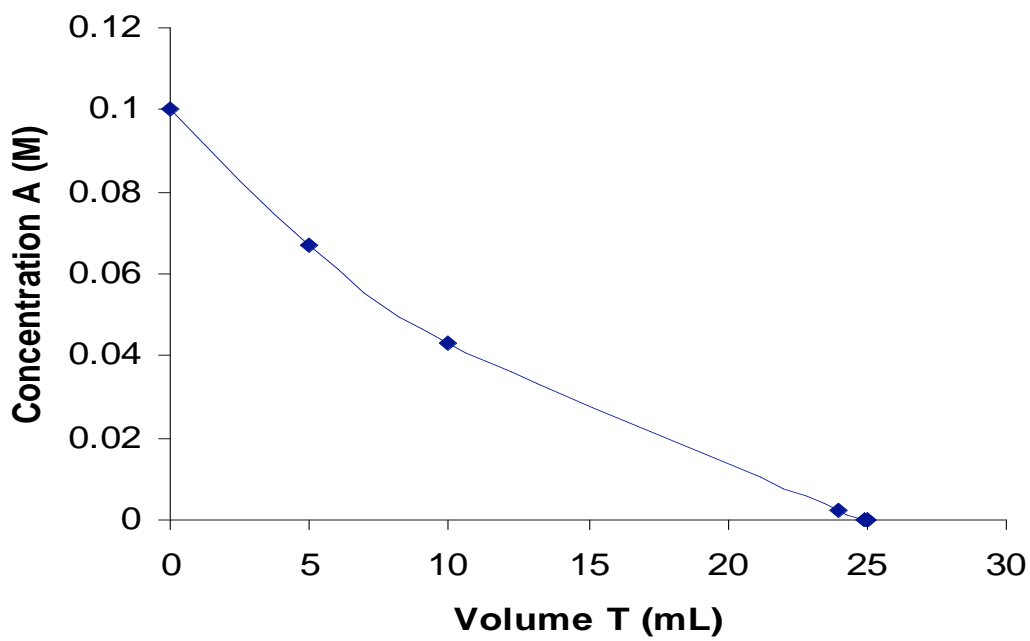
Titration curves – allow understanding of the basis of end points and titration errors.

1. Sigmoidal – small region (0.1-0.5 mL) surrounding the equivalence point
2. Linear – measurements made on both sides of the equivalence point.

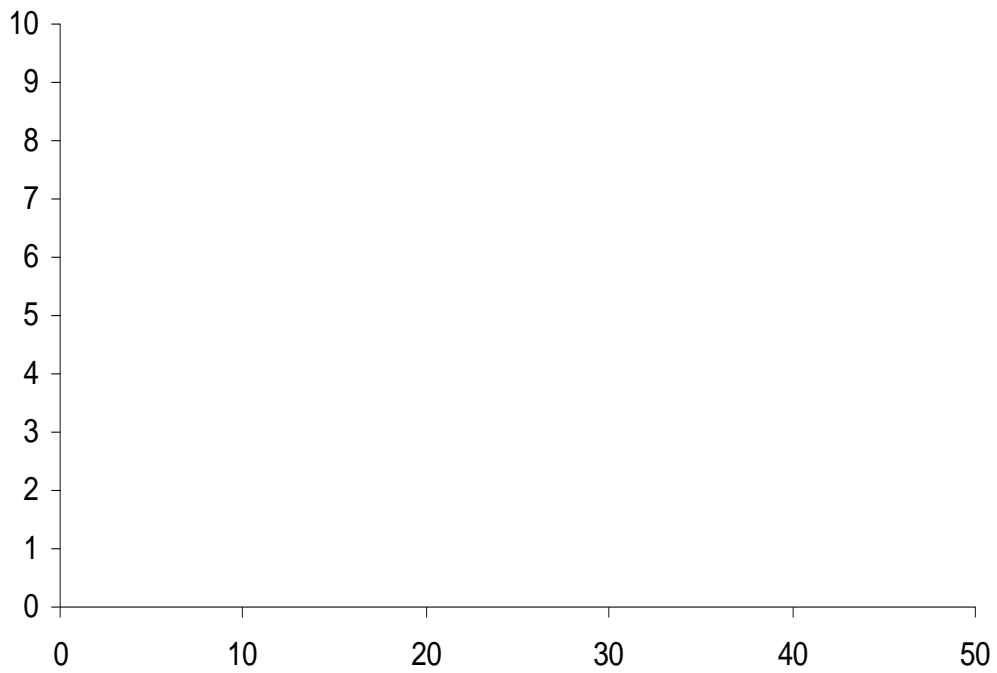
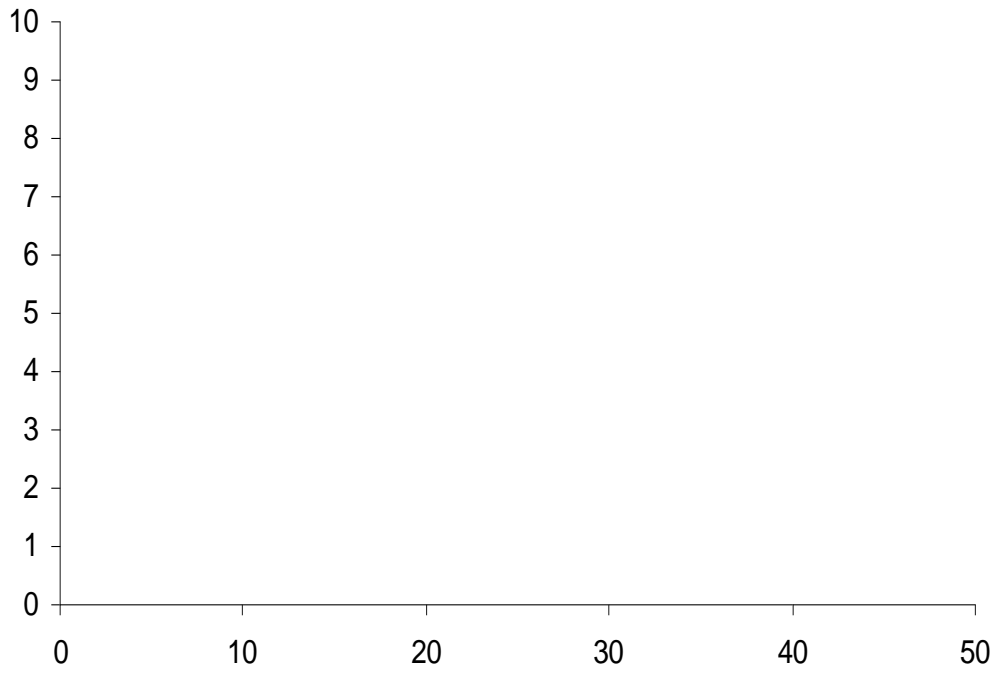
## Using data near the equivalence point

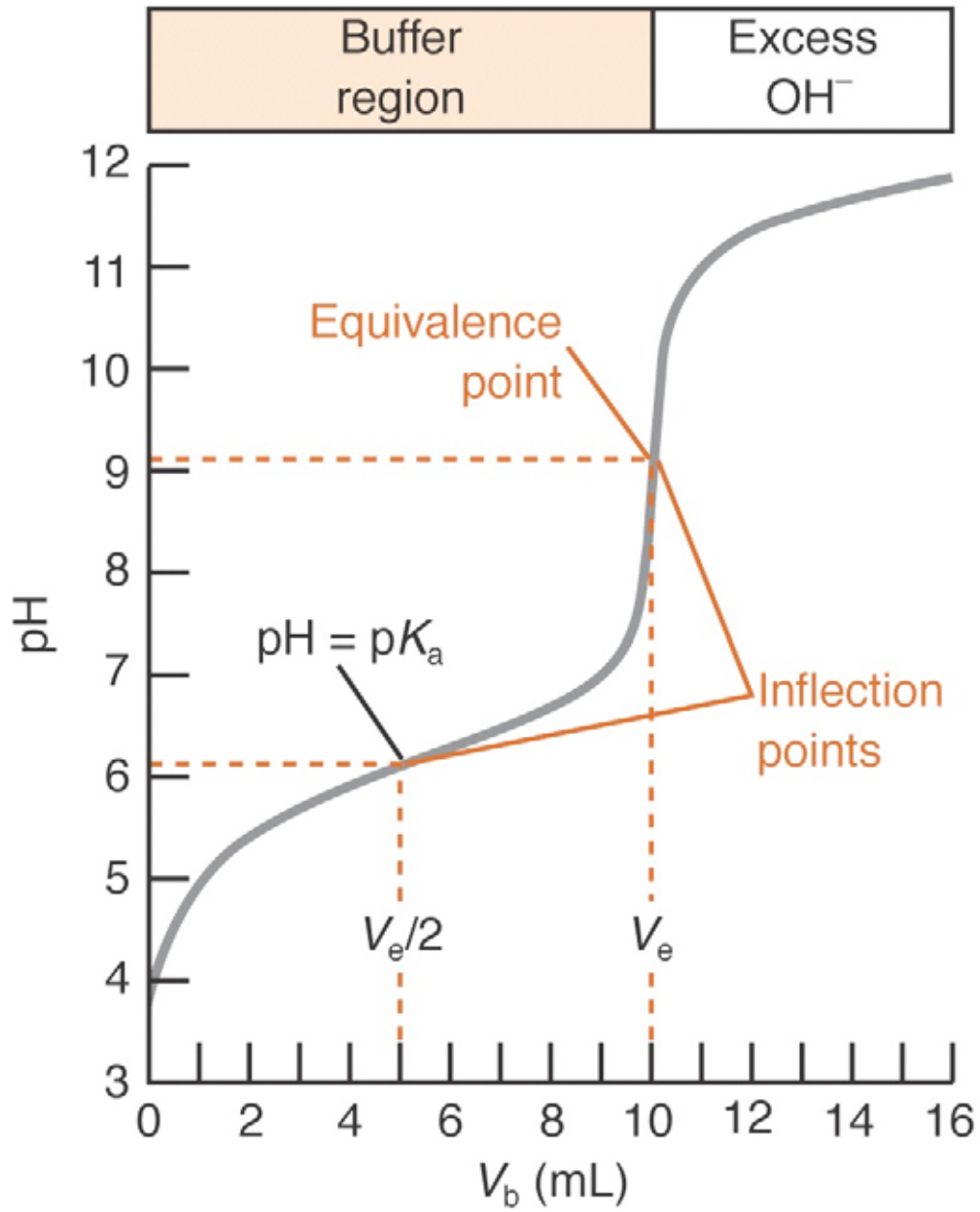
### Concentration changes during titration

Vol 0.1000 T (mL)	Conc. A (mol/L)	pA
0	$1.00 \times 10^{-1}$	1.00
5.00	$6.67 \times 10^{-2}$	1.18
10.00	$4.29 \times 10^{-2}$	1.37
24.00	$2.04 \times 10^{-3}$	2.69
24.90	$2.00 \times 10^{-4}$	3.70
24.99	$2.00 \times 10^{-5}$	4.70
25.00	$2.24 \times 10^{-6}$	5.65
25.01	$2.50 \times 10^{-7}$	6.60
25.10	$2.50 \times 10^{-8}$	7.60
26.00	$2.50 \times 10^{-10}$	9.60
40.00	$1.67 \times 10^{-10}$	9.78
45.00	$1.25 \times 10^{-10}$	9.90
50.00	$1.00 \times 10^{-10}$	10.00



# Graphs of titration curves

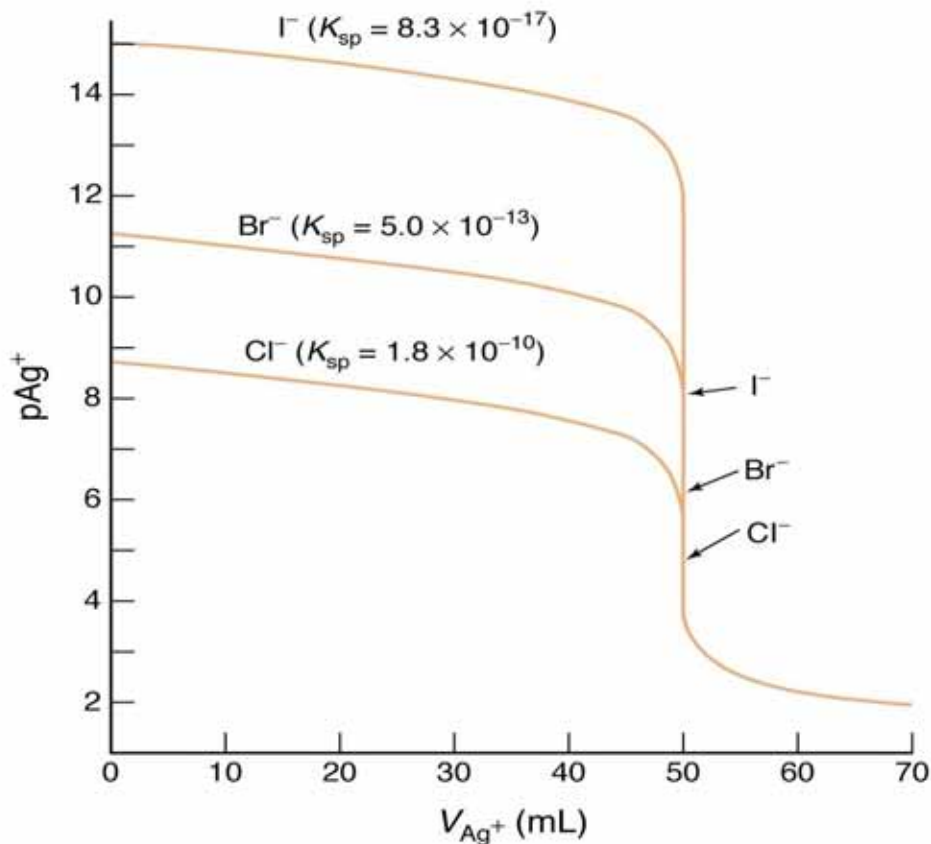




## Factors Influencing Endpoints

1. Concentrations- increases in analyte and reagent concentrations enhance the change in pA (equivalence region). Rule: change of 2 in p-function.
2. Reaction completeness – end points improve as reaction becomes more complete.  
-product solubility large factor

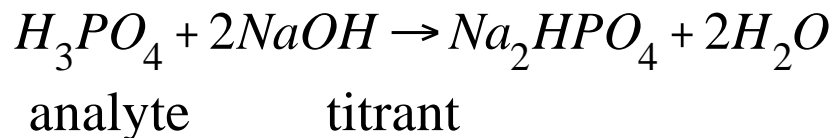
### Titration curves of mixtures



## Direct Titration

-titrant reacts directly with the analyte:

*amount analyte = amount titrant (moles or mmoles) x  
reacting ratio*



Stoichiometric ratio: 2 moles NaOH needed to  
react with 1 mole H<sub>3</sub>PO<sub>4</sub>

$$\text{amt of } H_3PO_4 \text{ (mmol)} = \text{amt NaOH (mmol)} \times \frac{1H_3PO_4}{2NaOH}$$

$$\text{wt } H_3PO_4 = \text{amt } H_3PO_4 \times \text{fw } H_3PO_4$$

$$\% H_3PO_4 = \frac{\text{wt } H_3PO_4}{\text{wt sample}} \times 100$$

**\*\*\*IN Class Calculations to Follow!**