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

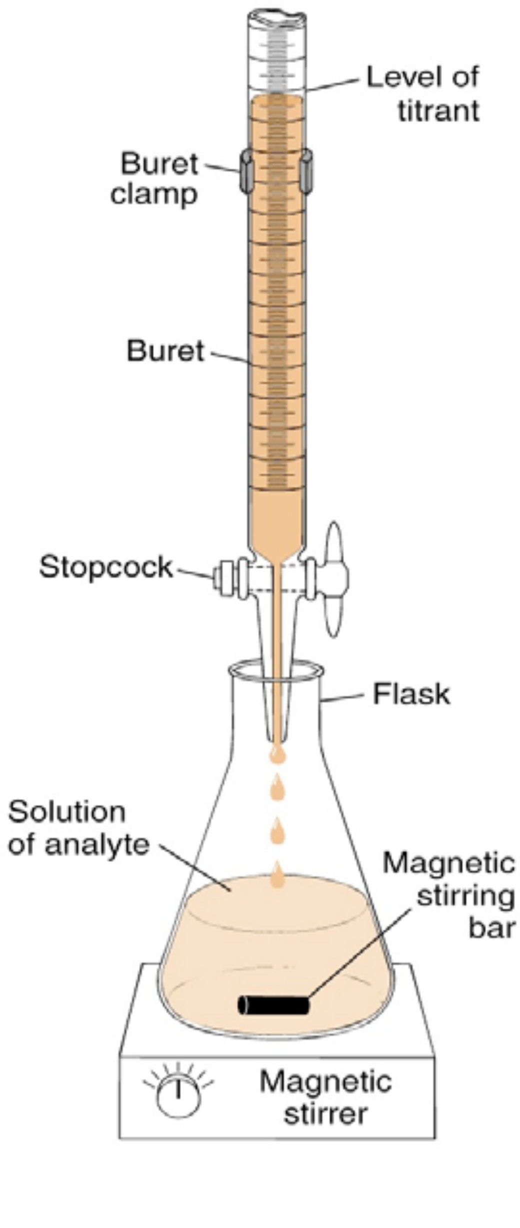
1. amount A = # mol A = $\frac{wtA(g)}{fwA(g/mol)}$

2. amount A = # mol A = V (L) x C_A (mol A /L)

* Solution preparation – lecture 1

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

<u>Volumetric titration</u> – 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)

$$A + T \Leftrightarrow AT$$

$$In + T \Leftrightarrow InT$$

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

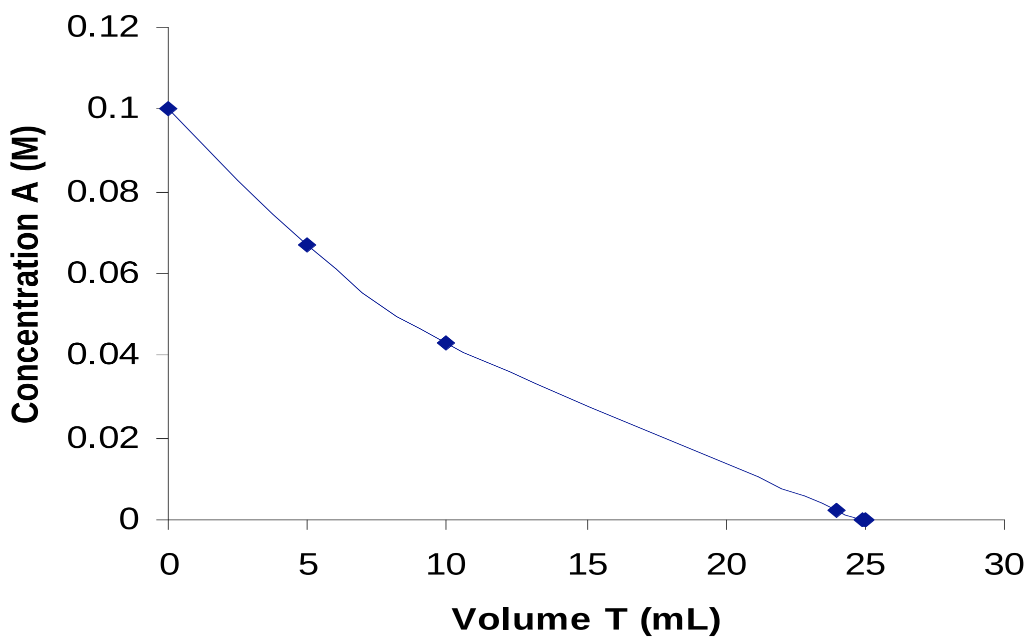
Titration curves – allow understanding of the basis of end points and titration errors.

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

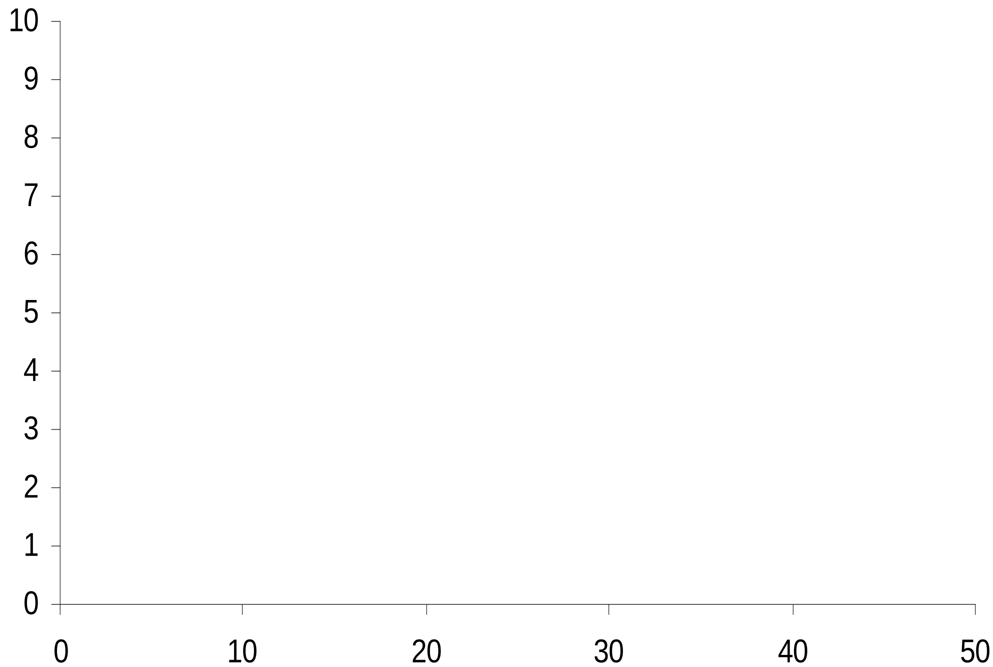
Using data near the equivalence point

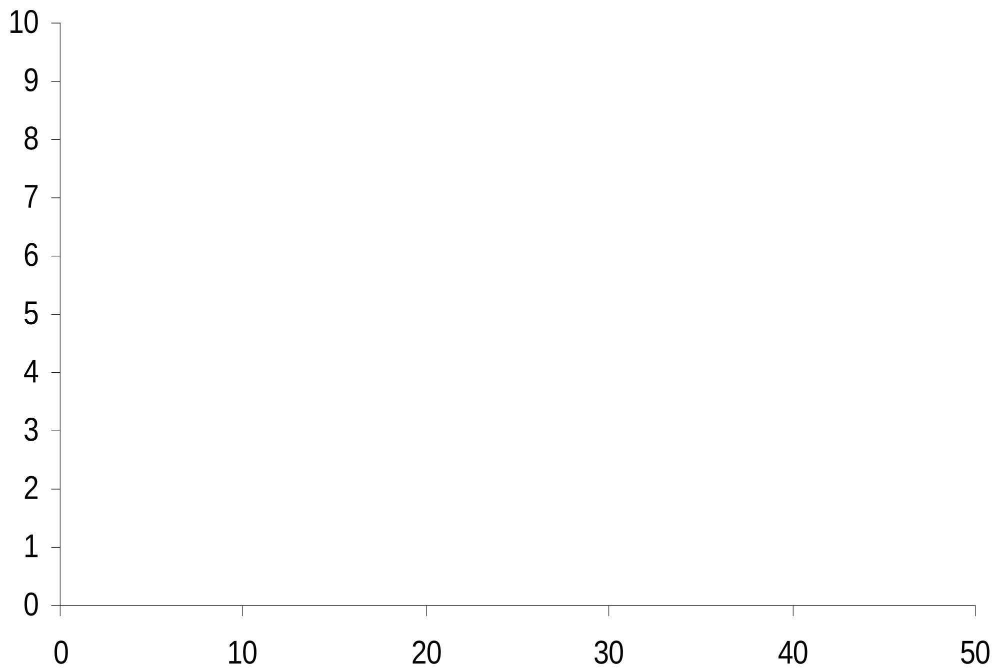
Concentration changes during titration

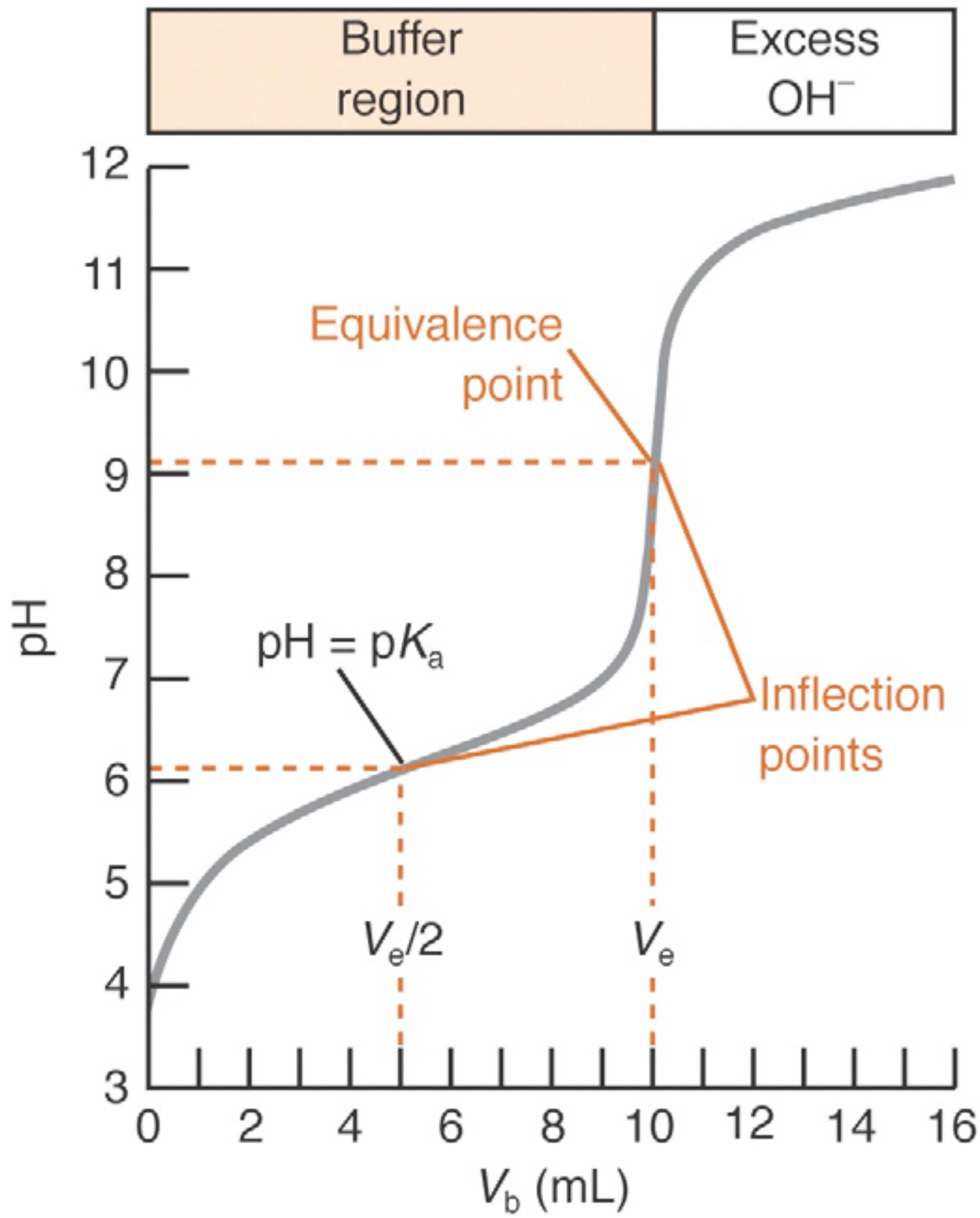
Vol 0.1000 T (mL)	Conc. A (mol/L)	pA
0	1.00×10^{-1}	1.00
5.00	6.67×10^{-2}	1.18
10.00	4.29×10^{-2}	1.37
24.00	2.04×10^{-3}	2.69
24.90	2.00×10^{-4}	3.70
24.99	2.00×10^{-5}	4.70
25.00	2.24×10^{-6}	5.65
25.01	2.50×10^{-7}	6.60
25.10	2.50×10^{-8}	7.60
26.00	2.50×10^{-10}	9.60
40.00	1.67×10^{-10}	9.78
45.00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



Graphs of titration curves







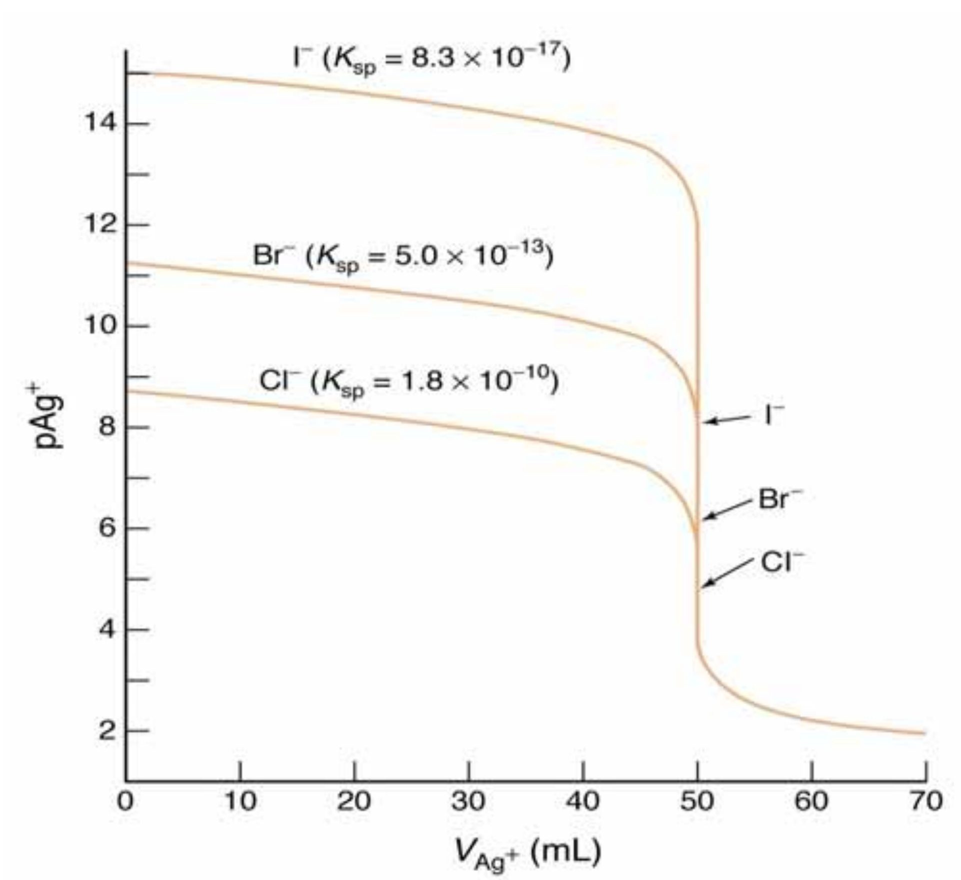
Buffer region
Excess OH⁻
Equivalence point
pH = pKa
Inflection points
Ve/2
Ve
pH
Vb (mL)
12
11
10
9
8
7
6
5
4
3
0
2
4
6
8
10
12
14
16

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*

$$H_3PO_4 + 2NaOH \rightarrow Na_2HPO_4 + 2H_2O$$

analyte titrant

Stoichiometric ratio: 2 moles NaOH needed to react with 1 mole H_3PO_4

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

wt H_3PO_4 = amt H_3PO_4 x fw H_3PO_4

$$\% H_3PO_4 = \frac{wtH_3PO_4}{wt\,sample} x100$$

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