**Acid/Base Titrations**

- Experimental procedure in which incremental amounts of a solution of known composition are added to a solution of unknown composition. The pH (or other) response provides information about the unknown composition.
- For addition of strong acid, a "real-life" implementation of the imaginary procedure used to determine the likely dominant species, except that the titration starts in the middle of the imaginary process (with some bases already protonated).
- Can equally well be carried out using a weak acid, or a strong or weak base, as the titrant.

**Titration with Strong Base**

- In a titration with base, each increment of titrant adds OH\(^-\) and inert salt. Some added OH\(^-\) remains "free", and some combines with H\(_3\)O\(^+\) and other acids to form their conjugate bases.

Because of the logarithmic relationship between [H\(^+\)] and pH, much more OH\(^-\) must be added for a given ΔpH at high or low pH than at near-neutral pH.

**Titration with Strong Acid or Base**

- Consider two solutions that are identical, except that one contains TOTA of a weak acid/base pair

- If pH is in range where speciation of the TOTA is almost constant, the two solutions will have almost identical responses to titrant additions
- If pH is in range where speciation of the TOTA is changing rapidly, the acid/base will react with much of the added OH\(^-\)/H\(^+\), and pH will change more slowly in the system with TOTA
Titration with Strong Acid or Base

When plotted as pH vs. conc'n of strong acid or base added, titration curves have “flat” regions in the vicinity of the pKᵢ of each conjugate acid/base group in the solution. The extra width in the flat region indicates the concentration of H⁺ released (or acquired) by the group as it is converted from acid to conjugate base (or vice versa).

The additional amounts of strong acid or base needed to achieve a given ΔpH (compared to a control system with no weak acids or bases) are additive, considering all the weak acid/base groups in the system.

Because all reactions are reversible, titrations with strong acid can be exactly reversed by titrations with strong bases (except for changes in activity coefficients induced by the salt addition).

The amount of strong acid or base needed to change pH from one value to another equals the difference in TOTH of the solution at the two pH values, where TOTH can be computed using any consistent set of components.
Titration with Strong Acid or Base

\[ \text{pH} \]

\[ 10^{-3} \text{ M HCl} + 10^{-3} \text{ M H}_{2}\text{CO}_3 \]