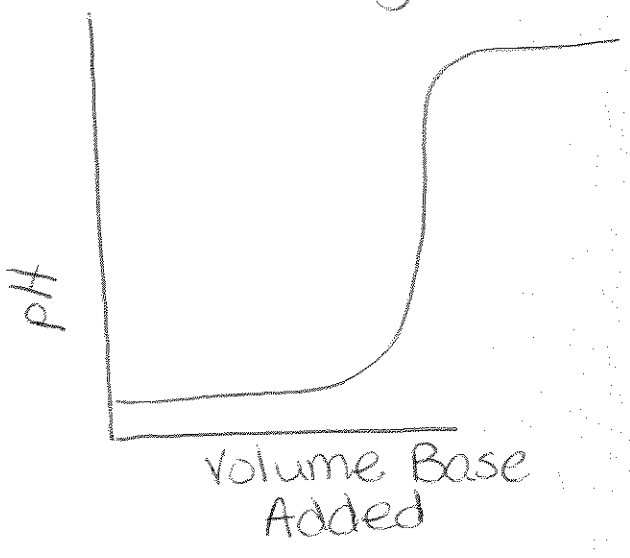
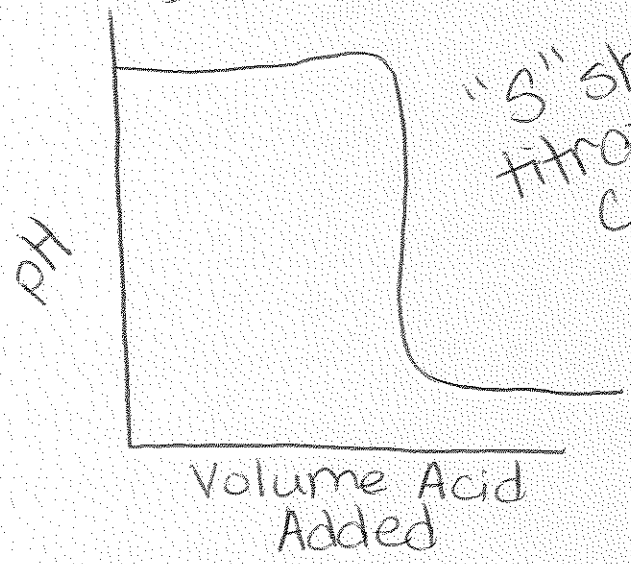
Titration Curve Notes

- Titration - procedure used to determine amount of acid or base in solution
  - Solution of known concentration (titrant) is delivered to a solution being analyzed (analyte) to find its concentration
  - Acid base indicators used to signal the endpoint of the titration
  - Equivalence point: moles acid = moles base
    - *Determined by stoichiometry
- Indicators are weak acids that undergo a color change at a known pH
  - An indicator that undergoes a color change closest to the pH at the equivalence point is selected
- Titration curve - plot of pH versus volume during a titration
  - Shape of curve makes it possible to find equivalence point, K_a, or K_b
  - pH at the equivalence point is not always 7 and is determined by the acid base properties of the conjugate present
- 3 Types of Titration
  1) Strong Acid - Strong Base ex. $NaOH + HCl$
  2) Strong Base - Weak Acid ex. $NaOH + HC_2H_3O_2$
  3) Strong Acid - Weak Base ex. $HCl + NH_3$

Strong Acid + Strong Base





"S" shape titration curve

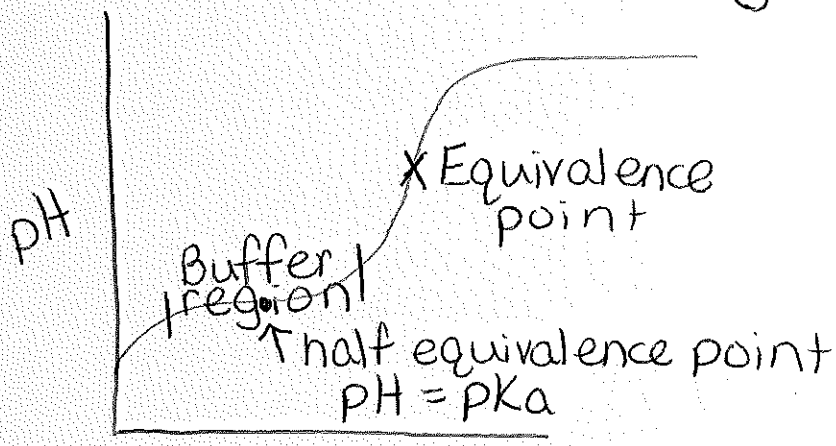
For adding base to acid:

- Before base is added, pH given by strong acid soln so $pH < 7$

$$pH = -\log[H^+]$$

- Adding base before equivalence point, pH given by amount of strong acid in excess
- At equivalence point, amount of base is stoichiometrically equivalent to amount of acid originally present; pH determined by the salt solution.
- Usually use phenolphthalein as an indicator
  - colorless in acid
  - pink in base
- Equivalence point equal amounts of acid and base
- End point - observed point
- Titration error = equivalence point - end point
- After equivalence point, pH determined by amount of strong base in excess

Weak Acid + Strong Base



curve would be inverted for weak base + strong acid

ex. $HC_2H_3O_2$ titrated with NaOH

- Before base is added, solution contains only weak acid, so pH found by ICE table
- As strong base is added, the acid is neutralized and its conjugate base is formed creating a buffer
  - ex. $HC_2H_3O_2(aq) + OH^-(aq) \rightarrow C_2H_3O_2^-(aq) + H_2O(l)$
  - pH calculated with Henderson-Hasselbalch
- At equivalence point, acid and base are neutralized but conjugate base hydrolyzes with water so pH ≠ 7

  $A^-(aq) + H_2O(l) \leftrightarrow HA(aq) + OH^-(aq)$ pH > 7
- After equivalence point, strong base in excess determines pH

Titration with PolyProtic Acid

- For a polyprotic acid, each ionizable proton dissociates in steps, and the graph shows an equivalence point for each step