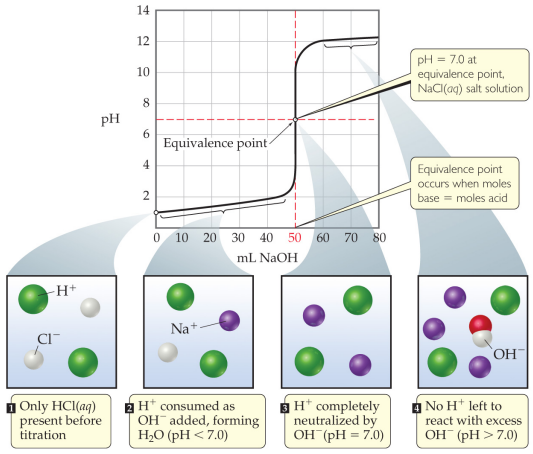
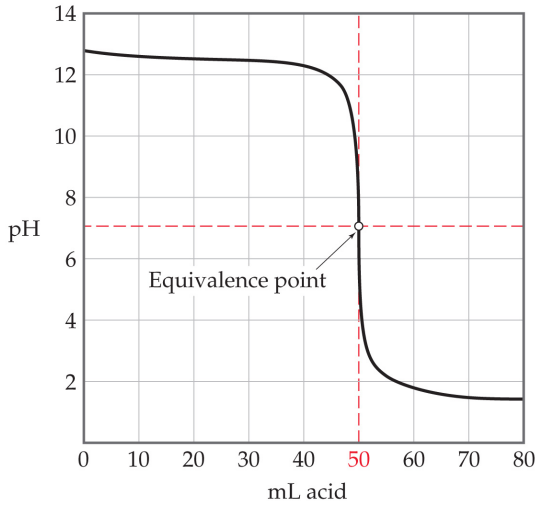
- **Titration**
  - The titrant (acid/base of known concentration) is added to the analyte (a base/acid unknown concentration).
  - An indicator (or pH meter) is used to determine when the solution has reached the **equivalence point**, where moles acid = moles base.

- **Titration of Strong Acid with Strong Base**
  - 50 mL 0.100 M HCl is titrated with 0.100 mL NaOH. What happens to the pH during the titration?
    - $HCl\ (aq) + NaOH\ (aq) \rightarrow NaCl\ (aq) + H_2O\ (l)$
    - $H^+\ (aq) + OH^-\ (aq) \rightarrow H_2O\ (l)$
    - Assume complete rxn for a strong acid, strong base
    - No NaOH added
      0.1 M HCl = 0.1 M H^+
      pH = -log H^+ = 1.0
    - 10mL NaOH added
      0.1*0.05 = 0.005 M H^+
      0.1*0.01 = 0.001 M OH^-
      Mol H^+ eq = mol H^+ c - mol OH^- c = 0.005 – 0.001 = 0.004 mol
      $[H^+]$ = 0.004/0.060 = 0.067M
      pH = -log 0.067 = 1.18
    - 25mL NaOH added
      Mol H^+ eq = mol H^+ c - mol OH^- c = 0.005 – 0.1*0.025 = 0.0025
      $[H^+]$ = 0.0025/0.075 = 0.033M
      pH = -log 0.033 = 1.48
    - 50mL NaOH added
      Equivalent point
      For strong acid & strong base, pH = 7
    - 100mL NaOH added
      Approaching 13
      Mol OH^- eq = mol OH^- c - mol H^+ c = 0.1*0.1 – 0.005 = 0.005
      $[OH^-]$ = 0.005 / 0.15 = 0.033 M
      pOH = 1.5, pH = 14 – 1.5 = 12.5

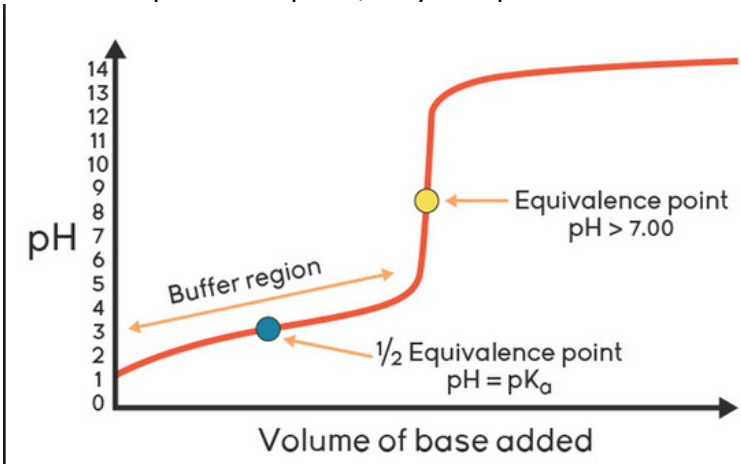
  - Initially, the pH goes up slowly.
    $[H^+] = \frac{(H^+ \text{ mol})_o - (OH^- \text{ mol})}{\text{total volume}}$
  - Just before the equivalence point, the pH rises rapidly.
  - At the equivalence point, pH = 7.
  - After the equivalence point, the pH goes up rapidly but then levels off.
    $[OH^-] = \frac{(OH^- \text{ mol}) - (H^+ \text{ mol})_o}{\text{total volume}}$



- Titration curve looks similar to the strong acid being titrated by strong base, but it is "flipped over."
- pH during the titration:
- high pH initially
- pH = 7 at equivalence point
- low pH at end



- **Titration: Weak Acid + Strong Base**
  - Initially, only HA is present.
  - Up to the equivalence point, both HA and A^- are present (**buffer region**).
  - After the equivalence point, only A^- is present.



  - 50mL 0.1M acetic acid + 0.1M NaOH

$Ka = x^2 / 0.1-x = 1.8 * 10^{-5}$

$x^2 / 0.1 = 1.8 * 10^{-5}$

$x = 1.34 * 10^{-3}$ M H^+

pH = 2.87