Titration and pH Curves.

Weak Acid-Strong Base Titration Curves.

- Before the addition.
- Construct an "equilibrium" reaction table ONLY!
- $K_a = \frac{[A^-]\ [H_3O^+]}{[HA]}$ to obtain $[H_3O^+]$.
- Calculate the pH.

Weak Acid-Strong Base Titration Curves.

- Additions before the equivalence point.
- Construct a stoichiometry reaction table.
- Determine MOLES of *acid* in excess (not neutralized) and MOLES of *conjugate base* formed.
- Divide MOLES by the TOTAL VOLUME to obtain $[H_3O^+]$ and $[A^-]$.
- Construct an "equilibrium" reaction table.
- $K_a = \frac{[A^-]\ [H_3O^+]}{[HA]}$ and obtain $[H_3O^+]$.
- Calculate the pH.

Half equivalence point

- The equivalence point is when the moles or titrant are equal to the moles of analyte.
- At half the equivalence point, exactly half of the weak analyte will be shifted into it's conjugate.
- $HA \rightleftharpoons H^+ + A^-$, therefore $[HA] = [A^-]$
- $pH = pK_a + \log([A^-]/[HA])$
- At the half equivalence point
- $pH = pK_a$

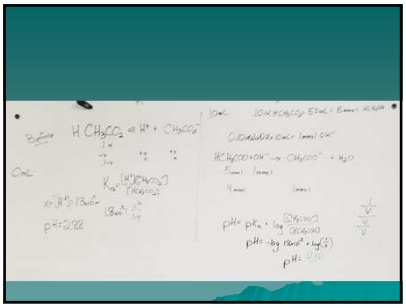
- Additions at the equivalence point.
- Construct a stoichiometry reaction table.
- Determine MOLES of *conjugate base* formed. Divide MOLES by the TOTAL VOLUME to obtain $[A^-]$. Calculate K_b
- ($K_a \times K_b = K_w$).
- Construct an "equilibrium" reaction table, reacting the conjugate base with water.
- $K_b = \frac{[OH^-]\ [BH^+]}{[B]}$ and obtain $[OH^-]$.
- Calculate the pOH, then the pH.
- The equivalence point is ALWAYS >7!

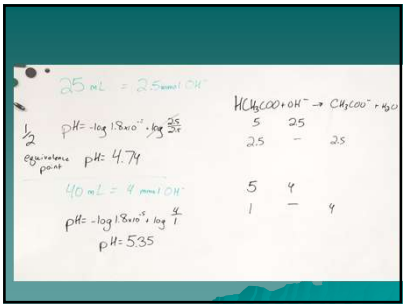
Additions beyond the equivalence point

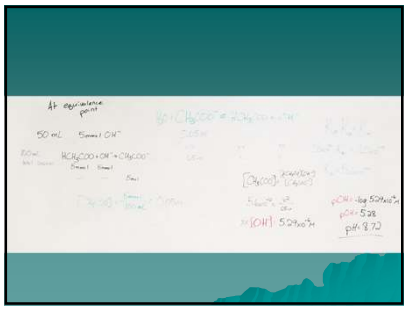
- Construct a "stoichiometry" reaction table.
- Determine MOLES of *base* in excess (not neutralized) and the MOLES of *conjugate base*.
- Divide MOLES by the TOTAL VOLUME,
- Because $[OH^-]_{excess} >> [OH^-]_{conj.\ base}$, use $[OH^-]_{excess}$ to calculate pOH, then the pH.

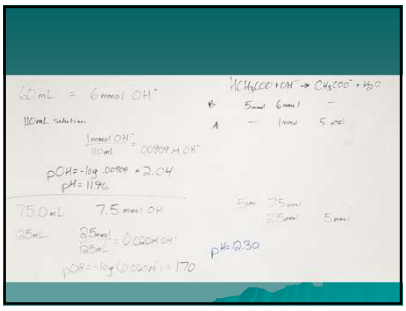
Problem

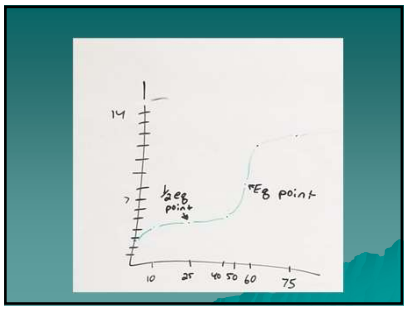
- 50.0 mL of 0.10 M CH_3COOH, acetic acid ($K_a = 1.8 \times 10^{-5}$) are titrated with 0.10 M NaOH. Calculate the pH after the additions of 0, 10.0, 25.0, 40.0, 50.0, 60.0, and 75.0 mL samples of NaOH.
- Then, construct a titration curve and label it properly.











Problem

- 50.0 mL of 0.20 M $HC_2H_5CO_2$, propanoic acid ($K_a = 4.4 \times 10^{-7}$) are titrated with 0.20 M NaOH.
- Calculate the pH after the additions of 0, 10.0, 25.0, 40.0, 49.0, 49.95, 50, 50.05, 51.0, 60.0, and 75.0 mL samples of NaOH.
- Then, construct a titration curve and label it properly.

Answer

- 0.0 mL = 3.53
- 10.0 mL = 5.75
- 25.0 mL = 6.36 ½ equivalence point
- 40.0 mL = 6.96
- 49.0 mL = 8.05
- 49.95 mL= 9.36
- 50.0 mL = 9.68
- 50.05 mL = 10.0
- 51.0 mL = 11.30
- 60.0 mL = 12.26
- 75.0 mL = 12.60