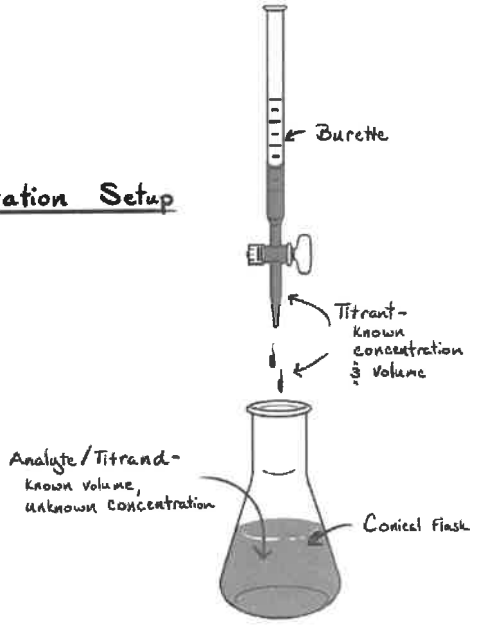
Acid-Base Titration

Titration is a process where a known property of one solution is used to infer an unknown property of another solution.

In an acid-base titration, the sample in the receiving flask may be an acid or a base. If the sample is a base, the titrant is an acid (or vice versa).

The goal of the acid-base titration is to neutralize the base (or vice versa).

Titration Setup



Strong Acid + Strong Base → Water + Salt

- This is a special type of double displacement reaction known as a **neutralization reaction**.
- After the reaction, the salt solution is neutral, meaning it contains equal moles of H^+ and OH^- ions.

Example: $HCl_{(aq)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + NaCl_{(aq)}$

Equivalence Point

The point in which the acid and base are mixed in exactly the right proportions to neutralize each other is known as the equivalence point.

The equivalence point occurs when the number of moles of base is neutralized by equal number of moles of acid.

$$\#\text{ moles of } H^+ = \#\text{ moles of } OH^-$$

By knowing the volumes of acid and base used, and the concentration of the titrant used, we can determine the concentration of the unknown solution.

Since: $M = \frac{mol}{L}$ $mol = M \cdot L$ moles H^+ = moles OH^-

$M_A \cdot L_A = M_B \cdot L_B$

$$M_A V_A = M_B V_B$$

Example 1: During a titration, 75.8 mL of 0.100 M $HCl_{(aq)}$ is titrated to equivalence point with 100.0 mL of NaOH solution with an unknown concentration. What is the concentration of the NaOH?

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + NaCl_{(aq)}$

Given: $V_A = 75.8mL$
$M_A = 0.100M$
$V_B = 100.0mL$

Need: M_B

$M_AV_A = M_BV_B$

$M_B = \frac{M_AV_A}{V_B} = \frac{0.100M \cdot 75.8mL}{100.0mL} = 0.0758M$

notice the 1:1 mole ratio
$H^+ : OH^-$

Example 2: A 20.0 mL solution of strontium hydroxide, $Sr(OH)_2$, is titrated with 25.0 mL of 0.0500M $HCl_{(aq)}$. What is concentration of the base?

Solution: $\_ Sr(OH)_{2(aq)} + \underline{2} HCl_{(aq)} \rightarrow \_ SrCl_{2(aq)} + \underline{2} H_2O_{(l)}$

notice 2 moles H^+ : 1 mole OH^- ; the coefficient switches sides

$M_AV_A = 2M_BV_B$

$M_B = \frac{M_AV_A}{2V_B} = \frac{0.05M \cdot 25mL}{2 \cdot 20mL} = 0.0313M$

Example 3: If it takes 50.0 mL of 0.50 M potassium hydroxide solution to completely neutralize 125 mL of sulfuric acid solution, what is the concentration of the acid?

Solution: $\underline{2} KOH_{(aq)} + \_ H_2SO_{4(aq)} \rightarrow \underline{2} H_2O_{(l)} + \_ K_2SO_{4(aq)}$

1 mol H^+ : 2 mol OH^-

$2M_AV_A = M_BV_B$

$M_A = \frac{M_BV_B}{2V_A} = \frac{0.50M \cdot 50mL}{2 \cdot 125mL} = 0.10M$