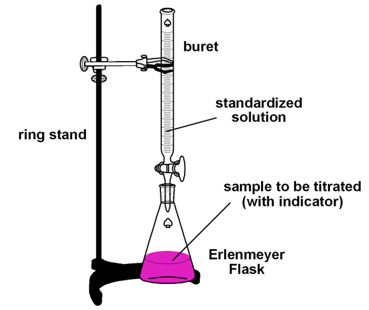
AP Chem- Notes-4-5
Ch. 4.7-4.8: Acid-Base & Redox Titrations

Titration: Process by which a solution of one reactant with known concentration **(titrant)** is slowly added to a sample of another reactant with unknown concentration/moles **(analyte).** Volume of titrant is measured using a buret.

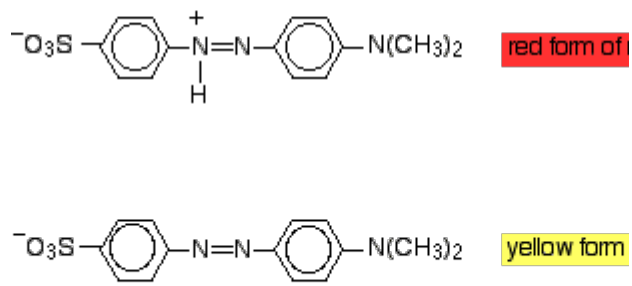


1) **Acid-Base Titrations**: Involve Acid-Base ("neutralization") reactions.

Equivalence point is the point in the titration when the exact stoichiometric mole ratio of reactants has been reached.

Acid-Base Indicator: Since acids and bases are both colorless, one needs to add an acid-base indicator to the solution, so that the solution will change color when the pH drastically changes.

- Most acid-base indicators are weak acids that change color upon the addition of base because when they react by losing an H^+
- Ex: phenolphathalein colorless form (acidic) to pink form(basic, pH > 8)
- Ex: Methyl Red: red (acidic) to Yellow (basic)



Endpoint: When one stops the titration because the indicator has changed color due to the addition of one drop of excess titrant.
(One can consider the "endpoint" to be the equivalence point even though officially, the titration has proceeded one drop past the equivalence point.)

Sample Calculation: What is the concentration of 10.0 mL of KOH solution if it takes 25.3 mL of 0.0503 M H_2SO_4 to reach the equivalence point?

$$H_2SO_4\,(aq) + 2\,KOH\,(aq) \rightarrow K_2SO_4\,(aq) + 2\,H_2O\,(l)$$

25.3 mL	10.0 mL
0.0503 M	? M
titrant	*analyte*

0.0253 mL

extra SF

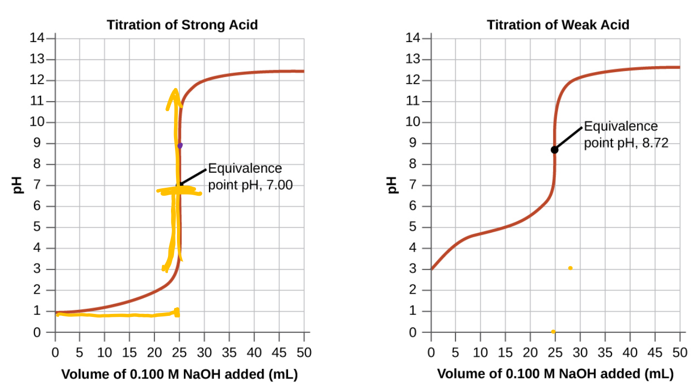
$$\text{mol KOH} = 25.3\text{ mL } H_2SO_4 \times \frac{0.0503\text{ mol } H_2SO_4}{1000\text{ mL } H_2SO_4} \times \frac{2\text{ mol KOH}}{1\text{ mol } H_2SO_4} = 0.002545\text{ mol KOH}$$

$$[KOH] = \frac{0.002545\text{ mol}}{10.0\text{ mL}} \times \frac{1\text{ mL}}{1\times10^{-3}\text{ L}} = 0.255\text{ M}$$

0.0100 L

Titration Curves:

- Just get a feel for what these curves look like.
- You are not yet responsible for understanding them. (chap 15!!)
- Note that the pH at the equivalence point is not always 7. Thus, the term, "neutralization" reaction, is somewhat of a misnomer.



(a) (b)

2) **Redox titrations:** Involve Redox reactions

Equivalence point is the point in the titration when the exact stoichiometric mole ratio of reactants has been reached.

Internal Indicator: If one of the reactants (titrant) has a color, it can be used as an internal indicator. When the colored reactant is all used up, or it is in slight excess, one will see a color change.

Common internal indicators:

a) $Cr_2O_7^{2-}$ → Cr^{3+}
orange/yellow *green*

b) MnO_4^- → Mn^{2+}
pink/purple *colorless*

Endpoint: When one stops the titration because the solution has changed color due to the addition of one drop of excess colored titrant.

Sample Calculation: How many grams of Sn^{2+} are present if it takes 25.6 mL of 0.01492 M $Cr_2O_7^{2-}$ $K_2Cr_2O_7^{2-}$ to reach the equivalence point? What is the percent Sn in the unknown sample if 0.8374 g of the sample was used?

$$3\ Sn^{2+}(aq) + Cr_2O_7^{2-}(aq) + 14\ H^+(aq) \rightarrow 3\ Sn^{4+}(aq) + 2\ Cr^{3+}(aq) + 7\ H_2O(\ell)$$

colorless	*orange*	*colorless*	*colorless*	*green*	*colorless*
? g	25.6 mL 0.01492 M				
analyte	*titrant*				

$$g\ Sn^{2+} = 25.6\ mL\ Cr_2O_7^{2-} \times \frac{0.01492\ mol\ Cr_2O_7^{2-}}{1000\ mL} \times \frac{3\ mol\ Sn^{2+}}{1\ mol\ Cr_2O_7^{2-}} \times \frac{118.7\ g\ Sn^{2+}}{1\ mol\ Sn^{2+}} = 0.1360\ g\ Sn^{2+}$$

$$\%\ Sn = \frac{0.1360\ g}{0.8374\ g} \times 100\% = \boxed{16.2\%\ Sn}$$

g