IV. 16 & IV.18: Acid-Base Titrations

You will be able to:

- Design, perform, and analyze a titration experiment of: strong acid + strong base, strong base + weak acid, and strong acid + weak base.
- Explain the difference between the equivalence point of a SA-SB titration and the equivalence point of a WA/WB-SB/SA titration
- Interpret titration curves plotted from experimental data
- Select indicators whose transition point coincides with the equivalence point of the titration reaction
- Calculate the concentration of an acid or base using titration data or similar data (ex. grams or moles)
- Calculate the volume of an acid or base of known molarity needed to completely react with a given amount of acid or base
- Calculate the pH of a solution formed when a strong acid is mixed with a strong base

Review of titrations

TITRATION: _____

_____

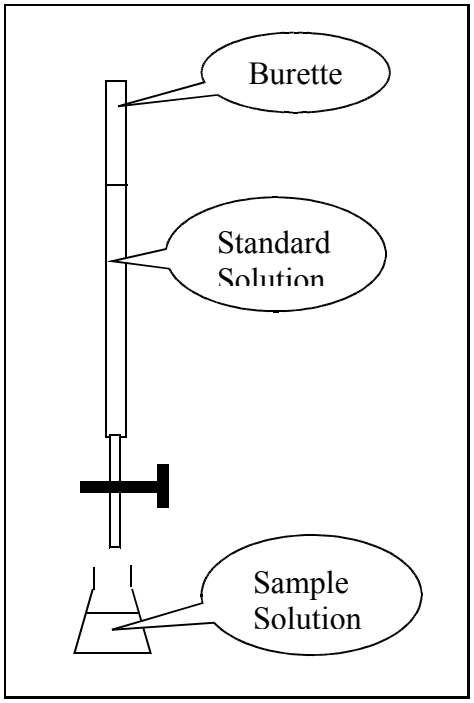
_____

- **STANDARD** solution (**TITRANT**) = _____
- **SAMPLE** solution = _____ concentration.
- **EQUIVALENCE POINT** (or "stoichiometric point") is _____

  _____

- **INDICATOR** signifies the _____

The <u>best</u> indicator will have the pH at equivalence point withing their transition range.



<u>Important info in titration problems:</u>

- concentration of acid — concentration of base — base/acid mole ratio
- volume of acid — volume of base

I. Titration of STRONG ACID and STRONG BASE

Example 34: We have 150 mL of NaOH at an unknown concentration. 75 mL of 0.300 M HCl must be added to reach the equivalence point. What is the [NaOH]?

Step 1: Write out the reaction equation.	
Step 2: Calculate moles of standard solution used to reach equivalence point (mol = CV)	
Step 3: Use molar ratio to	

convert to moles of sample solution	
Step 4: Use volume of sample solution to find [NaOH] (C = mol/V)	

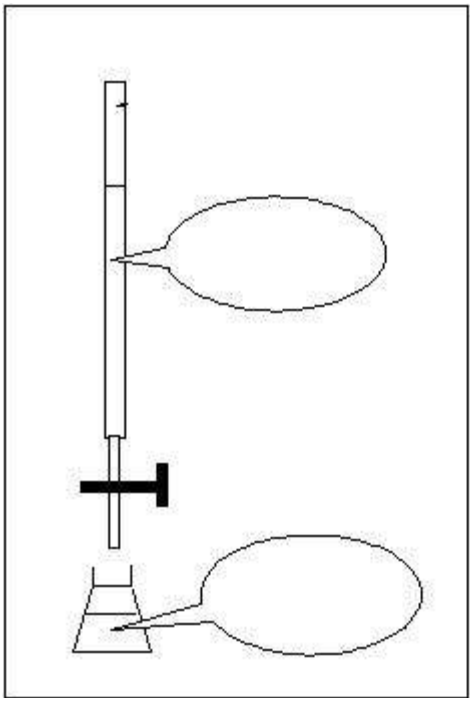
Example 35: 300 mL of unknown [H_2SO_4] is titrated with 600 mL of 0.400 M KOH. What is the [H_2SO_4]?

Step 1: Write out the reaction equation.	
Step 2: Calculate moles of standard solution used to reach equivalence point (mol = CV)	
Step 3: Use molar ratio to convert to moles of sample solution	
Step 4: Use volume of sample solution to find [H_2SO_4] (C = mol/V)	

TITRATION CURVES

Titration Story:

A base of known concentration (ex: 0.01 M NaOH) is slowly added to a measured volume of an acid of known concentration (25.0 mL of 0.01M HCl). Meanwhile, the pH of the mixture is monitored by a pH meter. The results can be plotted in a graph of *pH vs. volume of base* added.

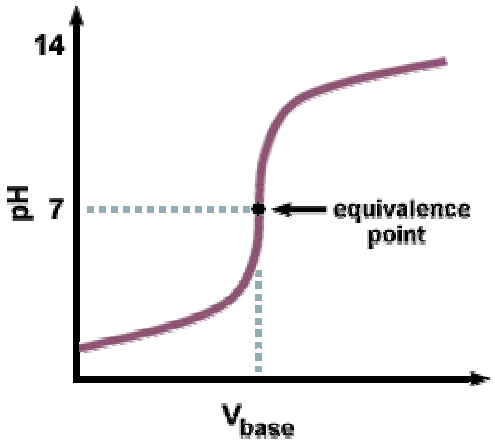


The curve on the graph that results from this is called a **TITRATION CURVE**.

We can calculate the pH of the mixture in the beaker throughout the titration. *There are 4 stages:*

1. Acid before any base is added
2. Based added but acid in excess
3. Equivalence point
4. Base in excess

STRONG ACID-STRONG BASE TITRATION CURVE



Remember: **SA** + **SB** → SALT + H_2O

Therefore: The *SALT* formed from a **SA-SB** titration is ALWAYS _____
Since there is no SA, no SB and just H_2O and a NEUTRAL salt, the pH of the solution formed will be **7.00**

Conclusion: _____

A good **INDICATOR** for this titration would be _____.

Do Hebden set 31 p. 158 #94-97, p. 167 #24

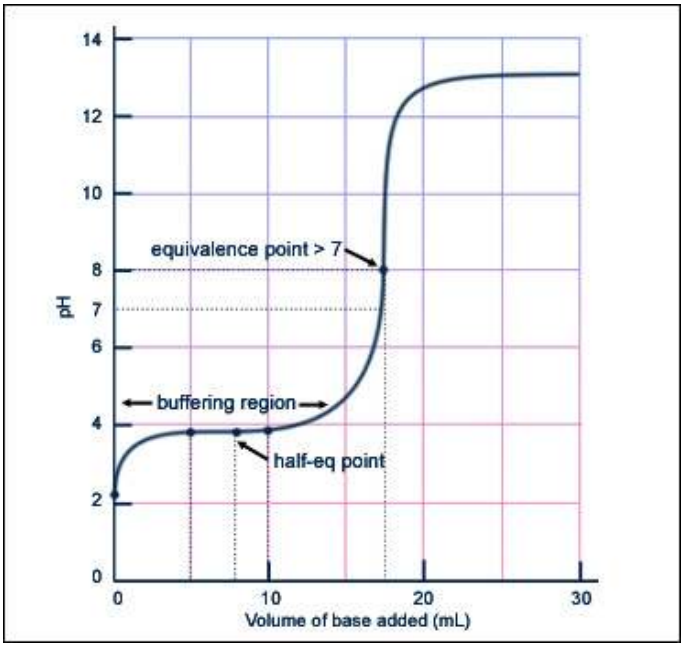
Read p. 155-157 examples "Partial Neutralization", "% Purity" and "Molar Mass", then try p. 158 #98-107

II. Titration of STRONG BASE and WEAK ACID

Example 36: 150 mL of unknown [CH_3COOH] is titrated with 220 mL of 0.250 M NaOH to reach the equivalence point. What is the [CH_3COOH]? **Calc the same as SB-SA**

Step 1: Write out the reaction equation.	
Step 2: Calculate moles of standard solution used to reach equivalence point (mol = CV)	
Step 3: Use molar ratio to convert to moles of sample solution	
Step 4: Use volume of sample solution to find [CH_3CHOOH] (C = mol/V)	

STRONG BASE-WEAK ACID Titration Curve



Conclusion: _____

_____

A good **INDICATOR** would be _____

_____

Calculating the K_a and concentration of the weak acid: *(summary of p. 169-170)*

$pH_{1/2}$ = _____ = pKa (**K_a** = antilog(-pKa))

$$[WA]_{EQ} = \frac{[H_3O^+]^2}{K_a}$$ <-- from initial pH

$$[WA]_{INT} = [WA]_{EQ} + X$$

III. Titration of a STRONG ACID and WEAK BASE

***NOTE*:** Graph gives pH values, but need pOH for all calculations! So, **FIRST convert pH to pOH**.

Conclusion: _____

_____

A good **INDICATOR** would be _____

_____