11. Acid/Base Titration – The Basics (IV.16)

a) The Technique

i) The Purpose – to find out concentration of an unknown acid or base.

ii) Titration – means to slowly and accurately add known [acid] to an unknown [base] (or vice versa) using a buret, until base is exactly neutralized ("*equivalence point*").

iii) Equivalence Point – when proportion of acid = proportion of base described by the reaction.

Example: $NaOH + HCl \rightarrow NaCl + H_2O$

1 : 1

1 mol base = 1 mol acid at equivalence point

Example: $3NaOH + H_3PO_4 \rightarrow Na_3PO_4 + 3H_2O$

3 : 1

3 mol base = 1 mol acid at equivalence point

a) Strong Acid and Strong Base

i) Example: 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 [NaOH]?

$HCl + NaOH \rightarrow H_2O + NaCl$

Moles HCl = M x L = (0.300 M)(0.075 L) = 0.0225 moles

At equiv. point: moles HCl = moles NaOH = 0.0225 moles

[NaOH] = 0.0225 mol / 0.150 L = **0.150 M**

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

$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$

Moles KOH = M x L = (0.400 M)(0.6L) = 0.24 moles

At equiv. point: 1 mole H_2SO_4 = 2 mole KOH

$$0.24 \text{ moles KOH} \times \frac{1 \text{ mol } H_2SO_4}{2 \text{ mol KOH}} = 0.12 \text{ moles } H_2SO_4$$

[H_2SO_4] = 0.12 moles / 0.3 L = **0.4 M**

c) Accuracy

i) Volume

- all titrations are repeated until two volumes are within ± 0.1 mL
- discard results from any titration that is outside this range
- use average of best results in calculations

Example: Volume of HCl added

1st titration	41.75 mL
2nd titration	41.32 mL
3rd titration	41.34 mL

Thus, volume HCl added = (41.32 + 41.34)/2 = **41.33 mL**

ii) Standard Solutions

What is it?

A solution with a very accurately known concentration

How do we make one?

① Use a very pure (99.9%) substance and dissolve an accurate mass in water. Called a **Primary Standard**

Acidic Primary Standard	Basic Primary Standard
oxalic acid	sodium carbonate
$H_2C_2O_4 \cdot 2H_2O$	Na_2CO_3

② Titrate a solution *with* a primary standard to accurately find the concentration of the solution.

~~Do Questions: #108-120 page 162-163; #121-123 page 165~~

Read p. 154-159, 164-165
#94-107, 121-123