

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.



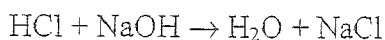
1 mol base = 1 mol acid at equivalence point



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]?

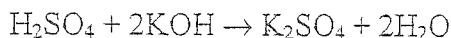


$$\text{Moles HCl} = M \times L = (0.300 \text{ M})(0.075 \text{ L}) = 0.0225 \text{ moles}$$

$$\text{At equiv. point: moles HCl} = \text{moles NaOH} = 0.0225 \text{ moles}$$

$$[\text{NaOH}] = 0.0225 \text{ mol} / 0.150 \text{ L} = 0.150 \text{ M}$$

ii) **Example:** 300 mL of unknown [H₂SO₄] is titrated with 600 mL of 0.400 M KOH. What is the [H₂SO₄]?



$$\text{Moles KOH} = M \times L = (0.400 \text{ M})(0.6 \text{ L}) = 0.24 \text{ moles}$$

$$\text{At equiv. point: 1 mole H}_2\text{SO}_4 = 2 \text{ mole KOH}$$

$$0.24 \text{ moles KOH} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol KOH}} = 0.12 \text{ moles H}_2\text{SO}_4$$

$$[\text{H}_2\text{SO}_4] = 0.12 \text{ moles} / 0.3 \text{ L} = 0.4 \text{ M}$$

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

oxalic acid
 $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

Basic Primary Standard

sodium carbonate
 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