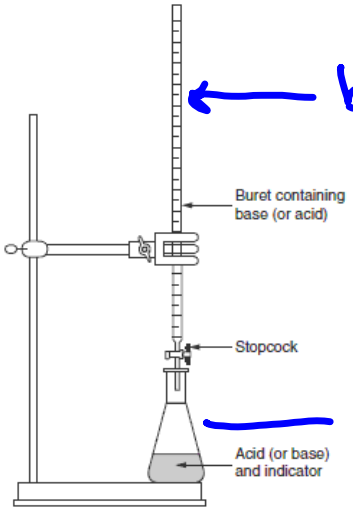
Titrations

Titration: adding a *known amount of solution of known concentration* to a *solution with an unknown concentration*

****Goal: To determine the unknown concentration****



buret (known acid or base) → M

Erlenmeyer flask (unknown acid or base) → M

Figure 19.3 General acid–base titration set-up

Equivalence Point

Endpoint: the point of neutralization in a titration

Equivalence point: the point where the moles of H^+ and OH^- are equal -- usually close to the endpoint (not always at pH = 7)

- *strong acid and strong base, equivalence point pH around 7*
- *strong acid and weak base, equivalence point pH less than 7*
- *weak acid and strong base, equivalence point pH greater than 7*

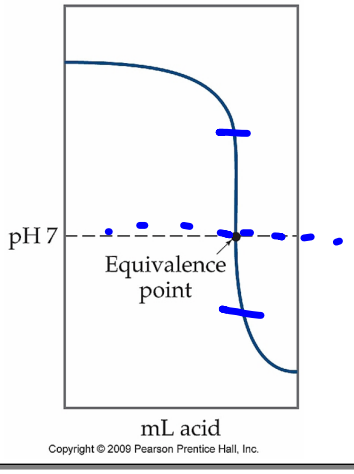
Equivalence Point

How do we know we reached the endpoint in a titration?

We can use an indicator and look for a color change!

OR

We use a graph.



Titration

Titration Calculations

After we do the experiment, how do we determine the concentration of the known???

--- STOICH!!

Steps:

1. Write and balance the equation.
2. List what you know (vol of acid, vol of base, conc of standard, mole ratio)
3. Begin with the volume (L) of the standard solution
4. Set up dimensional analysis to determine the number of moles of the unknown (Use the known molarity and the mole to mole ratio as conversion factors)
5. Divide by the volume (L) of the unknown to find molarity of the unknown

Titration Calculations

Practice #1

20.0 mL of 0.100 M HCl are titrated with 19.5 mL of an NaOH solution. What is the molarity of the NaOH solution?

1. Write and balance the equation. List what you know and don't know.

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

20.0mL 19.5mL
0.100M x M

2. Set up dimensional analysis to find moles for the substance of unknown concentration. (NaOH)

3. Divide the number of moles of NaOH by the volume of NaOH to find molarity.

Titration Calculations

Practice #1

20.0 mL of 0.100 M HCl are titrated with 19.5 mL of an NaOH solution. What is the molarity of the NaOH solution?

1. Write and balance the equation. List what you know and don't know.

$$\underset{\substack{20.0mL \\ 0.100M}}{HCl} + \underset{\substack{19.5mL \\ x\ M}}{NaOH} \longrightarrow NaCl + H_2O$$

REMEMBER: M = mol/L

2. Set up dimensional analysis to find moles for the substance of unknown concentration. (NaOH)

$$20.0mL \times \frac{1L}{1000mL} \times \frac{0.1\ mol\ HCl}{1L\ HCl} \times \frac{1\ mol\ NaOH}{1\ mol\ HCl} = 0.002\ mol\ NaOH$$

3. Divide the number of moles of NaOH by the volume of NaOH to find molarity.

Titration Calculations

Practice #1

20.0 mL of 0.100 M HCl are titrated with 19.5 mL of an NaOH solution. What is the molarity of the NaOH solution?

1. Write and balance the equation. List what you know and don't know.

$HCl + NaOH \rightarrow NaCl + H_2O$

20.0 mL, 0.100 M = mol/L, 19.5 mL, X M = mol/L

2. Set up dimensional analysis to find moles for the substance of unknown concentration. (NaOH)

$$20.0\text{mL} \times \frac{1\text{L}}{1000\text{mL}} \times \frac{0.1\text{ mol HCl}}{1\text{L HCl}} \times \frac{1\text{ mol NaOH}}{1\text{ mol HCl}} = 0.002\text{ mol NaOH}$$

3. Divide the number of moles of NaOH by the volume of NaOH to find molarity.

$$19.5\text{mL} \times \frac{1\text{L}}{1000\text{mL}} = 0.0195\text{L}$$

$$\frac{0.002\text{ mol NaOH}}{0.0195\text{L}} = 0.0103\text{M}$$

Titration Calculations

Practice #2

In a titration, 33.21 mL of 0.3020 M strontium hydroxide ($Sr(OH)_2$) solution is required to exactly neutralize 20.00 mL of hydrofluoric acid solution (HF). What is the molarity of the hydrofluoric acid solution?

1. Write and balance the equation. List what you know and don't know.

2. Set up dimensional analysis to find moles for the substance of unknown concentration. (NaOH)

3. Divide the number of moles of NaOH by the volume of NaOH to find molarity.

Titration Calculations

Practice #2

In a titration, 33.21 mL of 0.3020 M strontium hydroxide ($Sr(OH)_2$) solution is required to exactly neutralize 20.00 mL of hydrofluoric acid solution (HF). What is the molarity of the hydrofluoric acid solution?

1. Write and balance the equation. List what you know and don't know.

$Sr(OH)_2 + 2HF \rightarrow SrF_2 + 2HOH$

*33.21 mL, 0.3020 M = mol/L, 20.0 mL, x M

2. Set up dimensional analysis to find moles for the substance of unknown concentration. (NaOH)

$33.21\,mL \times \frac{1\,L}{1000\,mL} \times \frac{0.3020\,mol\,Sr(OH)_2}{1\,L\,Sr(OH)_2} \times \frac{2\,mol\,HF}{1\,mol\,Sr(OH)_2} = 0.0201\,mol\,HF$

3. Divide the number of moles of NaOH by the volume of NaOH to find molarity.

$20.0\,mL \times \frac{1\,L}{1000\,mL} = 0.0200\,L$

$M = \frac{mol}{L} = \frac{0.0201\,mol}{0.0200\,L}$

$= 1.0\,M$