

# Titration

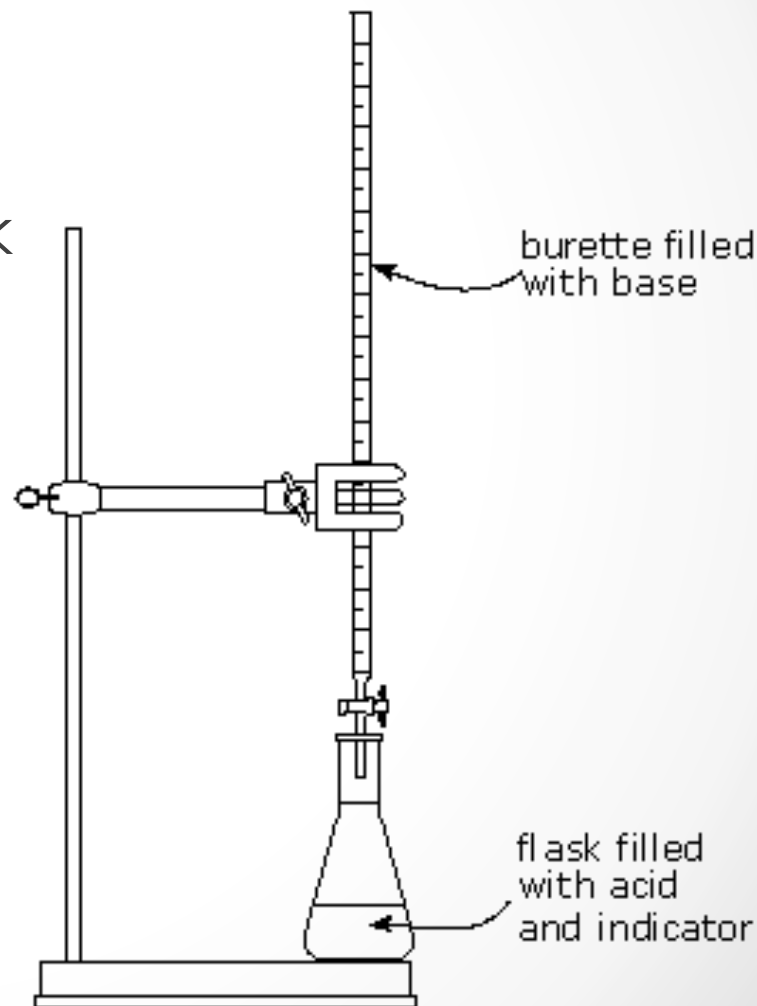
Section 9.9

# Titration

- Used to determine unknown concentrations of acids or bases
- Centered around the idea of neutralization
- When a solution is neutral, **moles<sub>acid</sub> = moles<sub>base</sub>**

# Set Up

- Base goes in buret
- Acid and indicator go in flask
- Indicator: phenolphthalein
  - Lightest pink is neutralized



# Set Up

a.



b.



c.



# Shortcut

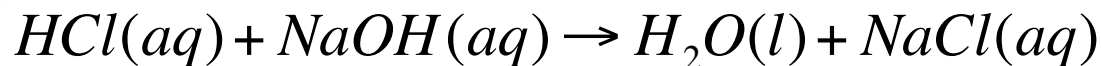
- When molar ratios of acid and base are 1:1, you can use  $M_A V_A = M_B V_B$
- Recall,  $M_1 V_1 = M_2 V_2$  from dilution, same concept
- Only when molar ratios are 1:1
- If not, use regular stoichiometry flow chart

# Example #1

What is the molarity of an HCl solution if 25.5 mL of a 0.24 M NaOH solution are needed to neutralize 15.0 mL of the sample?

# Example #1 Solved

- First, write out a balanced equation



- Second, if you can use short cut, identify variables

- $M_A = x$   $M_B = 0.24 \text{ M NaOH}$

- $V_A = 15.0 \text{ mL}$   $V_B = 25.5 \text{ mL}$

- Solve equation for unknown variable

- $(x)(15.0\text{mL}) = (0.24\text{M})(25.5\text{mL})$

- $x = \mathbf{0.41 \text{ M HCl}}$

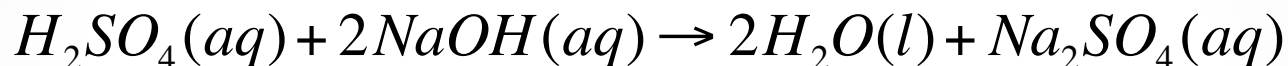
# Example #2

How many milliliters of 2.0 M NaOH are needed to neutralize 5.0 mL of a 6.0 M  $\text{H}_2\text{SO}_4$  solution?



# Example #2 Solved

- First, write out a balanced equation



- Second, if you can't use shortcut, set up flow chart

$$5.0mLH_2SO_4 \times \frac{1L}{1000mL} \times \frac{6.0molH_2SO_4}{1L} \times \frac{2molNaOH}{1molH_2SO_4} \times \frac{1L}{2.0molNaOH} \times \frac{1000mL}{1L} = 30.mLNaOH$$

The diagram illustrates the unit conversion process for the calculation. Five vertical arrows point upwards from labels below to specific units in the equation above:

- A blue arrow points from "Need L" to the "1L" in the first fraction.
- A green arrow points from "Molarity" to the "6.0molH<sub>2</sub>SO<sub>4</sub>" in the second fraction.
- An orange arrow points from "Molar ratio" to the "2molNaOH" in the third fraction.
- A green arrow points from "Molarity" to the "1L" in the fourth fraction.
- A blue arrow points from "Need mL" to the "1000mL" in the fifth fraction.

- Need **30. mL of NaOH solution**

# Example #3

During a titration, it took 11.5 mL of 6.8M NaOH to neutralize 75mL of a solution of HCl. What is the molarity of the HCl solution?

# Example #4

How many milliliters of a 0.54 M HCl solution are required to titrate a 47.9 mL sample of 0.83 M Ba(OH)<sub>2</sub> solution?