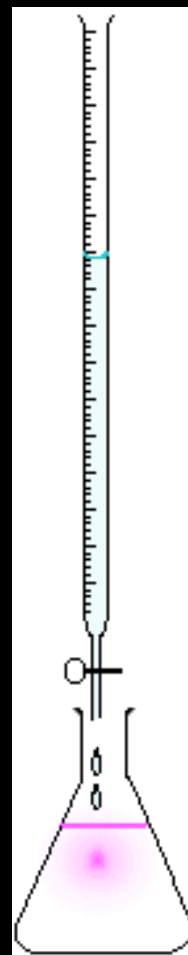
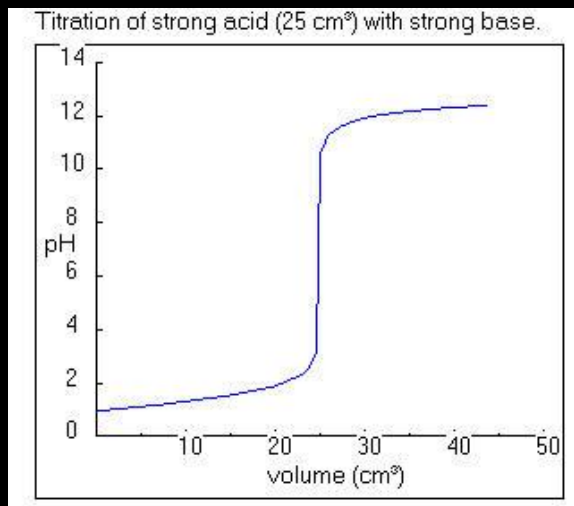
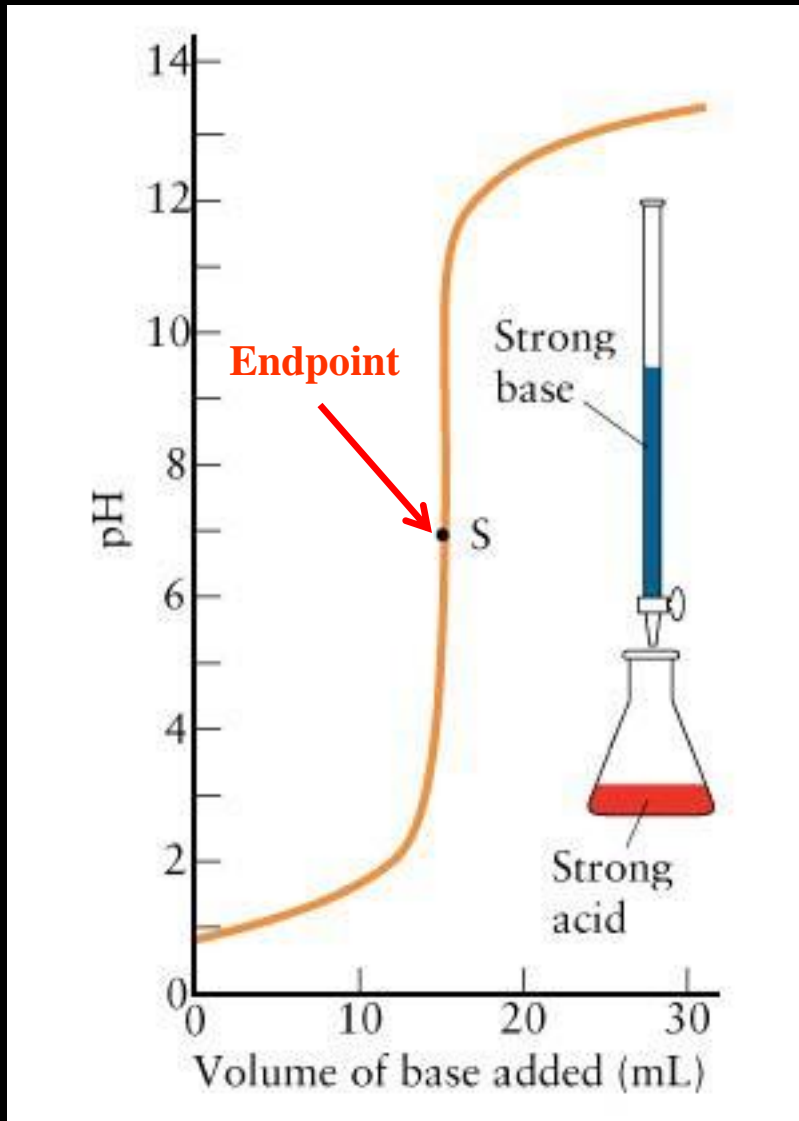


Titration Calculations



The Titration Experiment



At Endpoint:

1. Moles Standard (Given) Added:

$$\left(\frac{\text{Moles}}{1000 \text{ ml}} \times \text{ml added} \right)$$

2. Moles in Unknown:

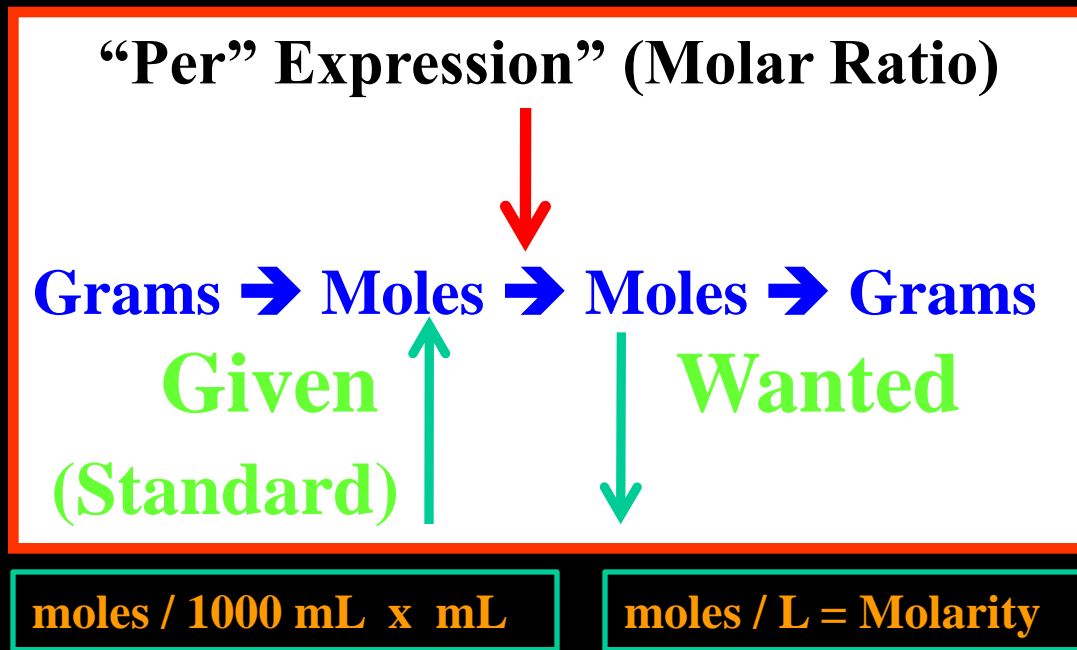
$$1 \times \left(\frac{\text{Reaction Coefficient Wanted}}{\text{Reaction Coefficient Given}} \right)$$

3. Unknown Molarity (mole/Liter):

$$\frac{\text{Moles Unknown}}{\text{Volume Unknown}}$$

Standard in Burette; Unknown in flask

Generalized Titration Pathway



Entry & Exit Points Depend On:
Given
Wanted

A student finds that 15.80 mL of 0.2840 M H₂SO₄ are required to neutralize a 20.00 mL sample of a certain NaOH solution. What is the molarity of the NaOH solution? $\text{H}_2\text{SO}_4 + 2 \text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2 \text{H}_2\text{O}$

Given: 15.80 mL of 0.2840 M sulfuric acid

Wanted: molarity (M/L) of 20.00 mL solution of sodium hydroxide

1. Start with given and get moles H₂SO₄

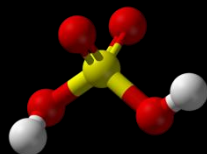
$$\frac{0.2840 \text{ moles H}_2\text{SO}_4}{1000 \text{ mL}} \times 15.80 \text{ mL}$$

2. Use “per expression” to convert to moles sodium hydroxide

$$\frac{0.2840 \text{ moles H}_2\text{SO}_4}{1000 \text{ mL}} \times 15.80 \text{ mL} \times \frac{2 \text{ mole NaOH}}{1 \text{ moles H}_2\text{SO}_4}$$

3. Convert moles NaOH to molarity (moles per Liter) of the solution:

$$\frac{0.2840 \text{ moles H}_2\text{SO}_4}{1000 \text{ mL}} \times 15.80 \text{ mL} \times \frac{2 \text{ mole NaOH}}{1 \text{ moles H}_2\text{SO}_4} \times \frac{1}{0.02000 \text{ L}} = 0.4487 \text{ M}$$



A student finds that 34.80 mL of 0.4830 M KOH are required to neutralize a 10.00 mL sample of a certain H₃PO₄ solution. What is the molarity of the H₃PO₄ solution?



Given: 34.80 mL of 0.4830 M potassium hydroxide

Wanted: Molarity (M/L) of 10.00 mL phosphoric Acid



1. Start with standard molarity 2. 3.

$$\frac{0.4830 \text{ moles KOH}}{1000 \text{ mL}} \times 34.80 \text{ mL} \times \frac{1 \text{ mole H}_3\text{PO}_4}{3 \text{ moles KOH}} \times \frac{1}{0.01000 \text{ L}} = 0.5603 \text{ M}$$

1. Start with standard added 2. 3.

$$34.80 \text{ mL} \times \frac{0.4830 \text{ moles KOH}}{1000 \text{ mL}} \times \frac{1 \text{ mole H}_3\text{PO}_4}{3 \text{ moles KOH}} \times \frac{1}{0.01000 \text{ L}} = 0.5603 \text{ M}$$



Let the Units Drive the Solution

A student finds that 20.00 mL of 0.3950 M HNO₃ are required to neutralize a 29.70 mL sample of a certain KOH solution. What is the molarity of the KOH solution?



Given: 20.00 mL of 0.3950 M nitric acid

Wanted: Molarity (M/L) of 29.70 mL potassium hydroxide



1. Start with standard molarity

2.

3.

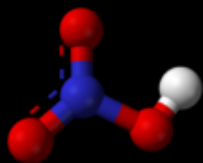
$$\frac{0.3950 \text{ moles HNO}_3}{1000 \text{ mL}} \times 20.00 \text{ mL} \times \frac{1 \text{ mole KOH}}{1 \text{ mole HNO}_3} \times \frac{1}{0.02970 \text{ L}} = 0.2660 \text{ M}$$

1. Start with standard added

2.

3.

$$20.00 \text{ mL} \times \frac{0.3950 \text{ moles HNO}_3}{1000 \text{ mL}} \times \frac{1 \text{ mole KOH}}{1 \text{ mole HNO}_3} \times \frac{1}{0.02970 \text{ L}} = 0.2660 \text{ M}$$



Let the Units Drive the Solution

A student finds that 15.00 mL of 0.1860 M H₂SO₄ are required to neutralize a 26.30 mL sample of a certain NaOH solution. What is the molarity of the NaOH solution?

$$\text{H}_2\text{SO}_4 + 2 \text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2 \text{H}_2\text{O}$$

Given: 15.00 mL of 0.1860 M sulfuric acid

Wanted: Molarity (M/L) of 26.30 mL sodium hydroxide



1. Start with standard molarity

2.

3.

$$\frac{0.1860 \text{ moles H}_2\text{SO}_4}{1000 \text{ mL}} \times 15.00 \text{ mL} \times \frac{2 \text{ mole NaOH}}{1 \text{ mole H}_2\text{SO}_4} \times \frac{1}{0.02630 \text{ L}} = 0.2122 \text{ M}$$

1. Start with standard added

2.

3.

$$15.00 \text{ mL} \times \frac{0.1860 \text{ moles}}{1000 \text{ mL}} \times \frac{2 \text{ mole NaOH}}{1 \text{ mole H}_2\text{SO}_4} \times \frac{1}{0.02630 \text{ L}} = 0.2122 \text{ M}$$



Let the Units Drive the Solution



**Took an Acid/Base
Chemistry test today**

It was pretty basic