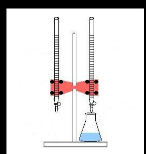
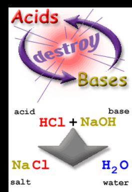
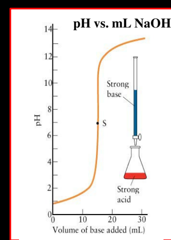




Titrations



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Titration Terms

Titration
Controlled addition of a liquid into a vessel to measure the volume that reacts with a substance already in the vessel

Indicators
substances that change color to signal when to stop a titration
Organic dyes whose color is sensitive to pH

Endpoint
point in a titration when the indicator changes color

Standard Solution
solution of known concentration used in a titration

Neutralization
double replacement reaction: an acid and a base react to form water and a salt

Acid + Base → Salt + Water

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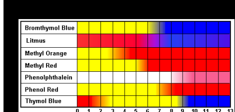
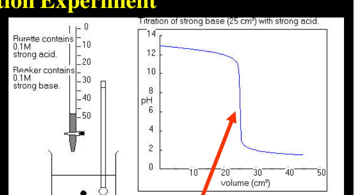
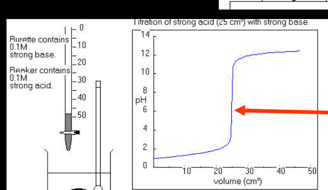
Titration Experiment







End Point

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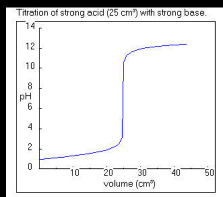
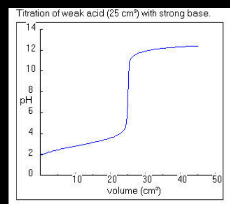
Titration of Strong vs. Weak Acids

Strong Acid (HCl)



Weak Acid (HOAc)



Same End-point

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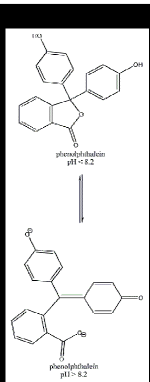
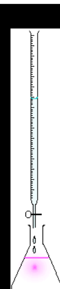


Phenolphthalein



- One of the most common indicators used
- Laxative
- C.S.I. = preliminary test for blood
  - Kastle-Meyer Spot Test
  - Phenolphthalein plus sample
  - Add H_2O_2
  - Hemoglobin present oxidizes to pink form

OH^- attacks acid form → changes structure
- Acid form: colorless
- Basic form: magenta

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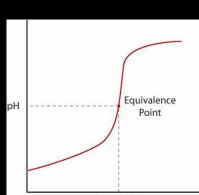
Titration Experiment

Key to "Titrations"

At end point:

Moles standard added = moles unknown present



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Neutralization Reactions: Solution Stoichiometry

At Endpoint: moles added = moles unknown

All titration problems solved the same way:

Balance the chemical Reaction
Determine moles present in standard solution (moles /L x L)
Use reaction coefficients ("per expression") to get moles unknown
Convert moles of unknown
- to solution concentration (molarity)
- to grams present
- to gas volume

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Titration of Acetic Acid with Sodium Hydroxide

Vinegar = dilute solution of acetic acid (CH_3COOH or $HC_2H_3O_2$ or HOAc) in water

The acetic acid will react with a base such as sodium hydroxide (NaOH)

$$NaOH_{(aq)} + HC_2H_3O_{2\,(aq)} \rightarrow NaC_2H_3O_{2\,(aq)} + HOH_{(l)}$$

Acid + Base ➔ Salt + Water

Problems

Typically prepared NaOH solution is not well characterized:

Solid NaOH readily absorbs moisture from the air.

Initial weighing error

Atmospheric CO_2 reacts with water to make carbonic acid.

$$CO_{2\,(g)} + H_2O_{(l)} \rightarrow H_2CO_{3\,(aq)}$$

Acid reacts with some NaOH ➔ lowers concentration of the NaOH

$$H_2CO_{3\,(aq)} + 2\,NaOH \rightarrow Na_2CO_3 + 2\,H_2O$$

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Solution

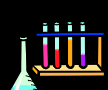
Concentration of the NaOH is determined by titration with known strong acid

Titrating NaOH with standard acid solution ➔ "standardization"

$$HCl_{(aq)} + NaOH \rightarrow HOH_{(l)} + NaCl_{(aq)}$$

Standardization gives accurate value of NaOH solution.
Standardized NaOH titrated against unknown acid
At Endpoint: Moles standard NaOH = moles unknown

Standard NaOH then used to titrate acid concentrations



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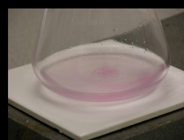
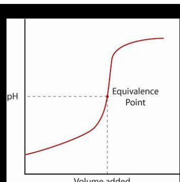
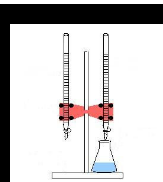
Keep Your End-Point Indicator Barely Visible







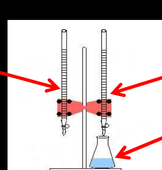
Titration Lab

Online Lab

Purpose:
To determine the molarity of acetic acid

Since NaOH concentration can vary with time, the lab is done in 2 parts:

1. **Determine the molarity of NaOH solution using standard HCl**
2. **Using the standardized NaOH solution, determine the molarity of HOAc**



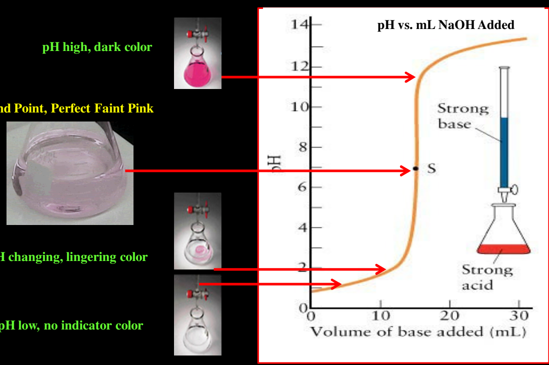
The Titration Curve

pH high, dark color

End Point, Perfect Faint Pink

pH changing, lingering color

pH low, no indicator color



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Data

Titration Volumes

Calculations

First Titration: Molarity NaOH

Molarity of HCL (from instructor): 0.7664

$$\text{HCl (mL)} \times \frac{\text{HCl Moles}}{1000\text{ mL}} \times \frac{1\text{ mole NaOH}}{1\text{ mole HCl}} \times \frac{1}{\text{NaOH added from buret (L)}} = \text{Molarity NaOH}$$

$$25.00\text{ HCl mL} \times \frac{0.7664}{1000\text{ mL}} \times \frac{1\text{ mole NaOH}}{1\text{ mole HCl}} \times \frac{1}{0.02398\text{ L}} = \text{Molarity NAOH}$$

Second Titration: Molarity HOAc

Molarity NaOH (from Titration 1)

$$\text{NaOH added (mL)} \times \frac{\text{NaOH Moles}}{1000\text{ mL}} \times \frac{1\text{ mole HOAc}}{1\text{ mole NaOH}} \times \frac{1}{\text{HOAc in Erlenmeyer (L)}} = \text{Molarity HOAc}$$

$$28.48\text{ mL} \times \frac{0.7990\text{ moles}}{1000\text{ mL}} \times \frac{1\text{ mole HOAc}}{1\text{ mole NaOH}} \times \frac{1}{0.02500\text{ L}} = \text{Molarity HOAc}$$

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Results

Fill In table

Conclusion

Fill-In molarity value

Nothing needed but that value

Let’s Boldly Go Explore Today’s Lab

LPT