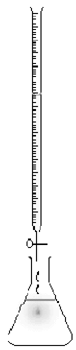
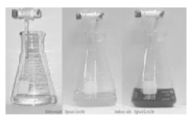
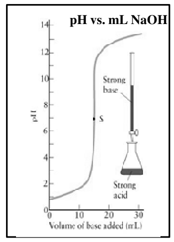


Titrations





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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. Titration measures concentration.

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

$H^+ + OH^- \rightarrow H_2O$

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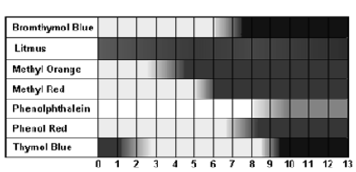
Indicators

Complex Organic Compounds
Change color (chemical change) with pH changes
Choice depends on desired end-point

Most Used →



Indicators INDICATE Endpoint
An Indicator is the substance that indicates end of titration

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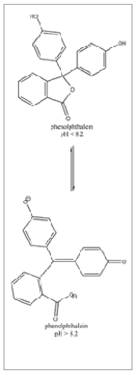
Phenolphthalein



One of the most common indicators used

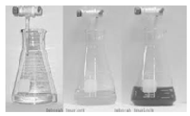
Laxative

C.S.I. = used to determine if stain is blood

- **Kastle-Meyer Spot Test**
  - **Phenolphthalein plus sample**
  - **Add H_2O_2**
  - **Hemoglobin present oxidizes to pink form**

OH^- attacks acid form and changes structure

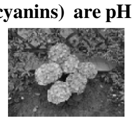
- **Acid form: colorless**
- **Basic form: magenta**



Many Plant Colors (Anthrocyanins) are pH Indicators

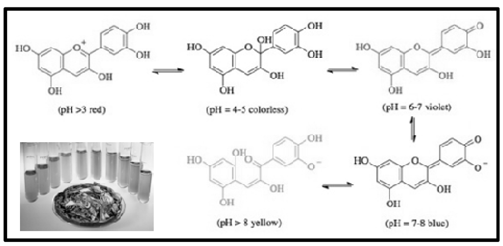
Indicators ➔ color depends on pH
Color change ➔ Chemical change

The "colors" in vegetables have significant cancer risk reductions



Hydrangea Basic Soil

Hydrangea Acidic Soil



pH

pH = measurement of molar H^+ concentration

The H means $[H^+]$ (molar concentration of hydrogen ions)

The p in pH means "the negative logarithm of"

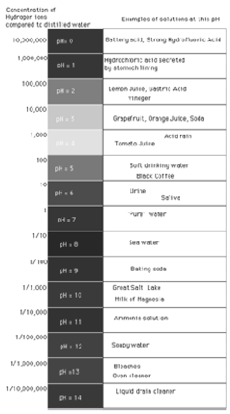
$$[H^+] = 1 \times 10^{-pH}$$

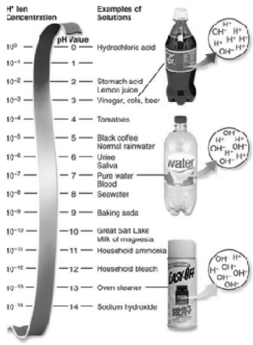
pH 7 means the concentration of $H^+ = 10^{-7}$ M

pH < 7 ➔ acidic
pH = 7 ➔ neutral
pH > 7 ➔ basic (alkaline)

pH is measured with electronics or indicators

Common pH Values





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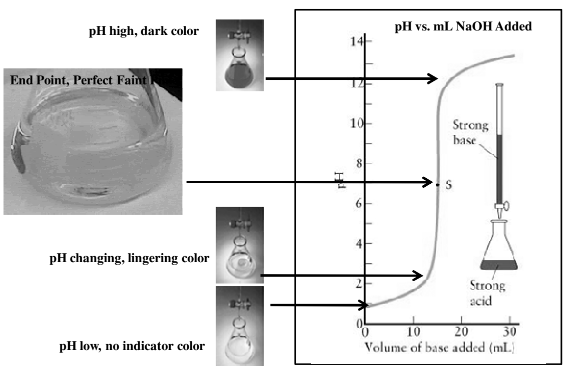
The Titration Experiment



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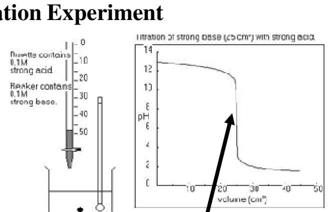
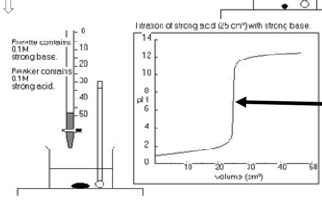
Titration Experiment

Using Phenolphthalein

Color change
Colorless → Magenta
Easier to visualize

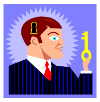
Most Common





End Point

LPT



Titration Experiment

Key to "Titrations"

At end point:

Moles standard added = Moles unknown present

↑

via "Per Expression" from reaction coefficients

Let the units drive the solution

LPT

Neutralization Reactions: Acid + Base → Salt + Water

How many mL's of 0.835 M HNO_3 will neutralize 38.5 mL of 0.522 M $Mg(OH)_2$?

Write the balanced reaction

$$2\ HNO_3 + Mg(OH)_2 \rightarrow Mg(NO_3)_2 + 2\ H_2O$$

Given: 38.5 mL 0.522 M magnesium hydroxide
Wanted: ml's 0.835 M nitric acid

1. Find # moles (using molarity) of given:

$$\frac{0.522 \text{ moles } Mg(OH)_2}{1000 \text{ mL}} \times 38.50 \text{ ml}$$

2. Use per expression from reaction coefficients to find moles unknown:

$$\times \frac{2 \text{ moles } HNO_3}{1 \text{ mole } Mg(OH)_2}$$

3. Use unknown molarity to convert to volume unknown needed:

$$\times \frac{1000 \text{ mL}}{0.835 \text{ moles}} = 48.1 \text{ mL}$$

LPT

How many mL of 0.0957 M Sodium Hydroxide are needed to neutralize 20.00 mL of 0.180 M Hydrochloric acid?

Write the balanced reaction

$$HCl + NaOH \rightarrow NaCl + H_2O$$

Given: 20.00 mL 0.180 M hydrochloric acid
Wanted: ml's 0.0957 M sodium hydroxide

As Linear String: Starting with standard molarity

$$\frac{0.180 \text{ moles HCl}}{1000 \text{ mL}} \times 20.00 \text{ mL} \times \frac{1 \text{ mole NaOH}}{1 \text{ mole HCl}} \times \frac{1000 \text{ mL}}{0.0957 \text{ moles NaOH}} = 37.6 \text{ mL}$$

As Linear String: Starting with mL's standard added

$$20.00 \text{ mL} \times \frac{0.180 \text{ moles HCl}}{1000 \text{ mL}} \times \frac{1 \text{ mole NaOH}}{1 \text{ mole HCl}} \times \frac{1000 \text{ mL}}{0.0957 \text{ moles NaOH}} = 37.6 \text{ mL}$$

Let the units drive the solution

LPT

How many mL of 0.266 M Potassium Hydroxide are needed to neutralize 20.5 mL of 0.172 M Sulfuric acid?

Write the balanced reaction:

$H_2SO_4 + 2\,KOH \rightarrow K_2SO_4 + 2\,H_2O$

Given: 20.5 mL 0.172 M sulfuric acid
Wanted: ml's 0.266 M potassium hydroxide

As Linear String: Starting with standard molarity

$$\frac{0.172 \text{ moles } H_2SO_4}{1000 \text{ mL}} \times 20.5 \text{ mL} \times \frac{2 \text{ moles KOH}}{1 \text{ mole } H_2SO_4} \times \frac{1 \text{ L}}{0.266 \text{ moles}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 26.5 \text{ mL}$$

As Linear String: Starting with standard ml's added

$$20.5 \text{ mL} \times \frac{0.172 \text{ moles } H_2SO_4}{1000 \text{ mL}} \times \frac{2 \text{ moles KOH}}{1 \text{ mole } H_2SO_4} \times \frac{1 \text{ L}}{0.266 \text{ moles}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 26.5 \text{ mL}$$

Let the units drive the solution

LPT

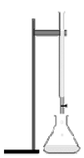
How many mLs of 0.832 M HCl are required for 1.46 g of Na_2CO_3?

$2\,HCl + Na_2CO_3 \rightarrow H_2O + CO_2 + 2\,NaCl$

Given: 1.46 grams sodium carbonate (molar mass 105.98 g/mole)
Wanted: mL of 0.832 M HCl

As Linear String:

$$1.46 \text{ g } Na_2CO_3 \times \frac{1 \text{ mole}}{105.98\text{g}} \times \frac{2 \text{ mole HCl}}{1 \text{ mole } Na_2CO_3} \times \frac{1 \text{ L}}{0.832 \text{ moles HCl}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 33.1 \text{ mL}$$



Let the units drive the solution

LPT

Neutralization Reactions: Solution Stoichiometry

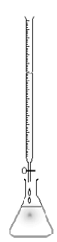
Determine moles present in given solution
Use reaction coefficients ("per expression") to get moles wanted
Convert moles wanted to solution concentration

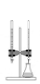
At endpoint:

Moles added ($\frac{\text{Moles}}{1000 \text{ mL}}$ x mL standard) = moles present in standard

Moles present standard x "per expression" = moles present in unknown

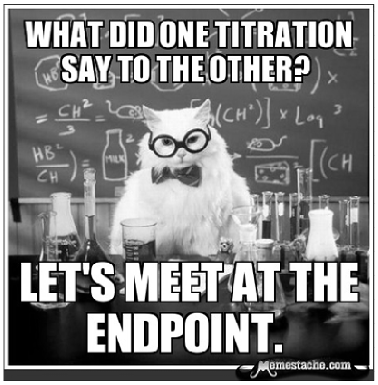
$$\frac{\text{moles present in unknown}}{\text{ml unknown}} \times \frac{1000 \text{ ml}}{\text{L}} = \text{Molarity (M /L) unknown}$$





Let the units drive the solution

LPT


WHAT DID ONE TITRATION SAY TO THE OTHER?
LET'S MEET AT THE ENDPOINT.
Memestache.com

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