Titrations

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

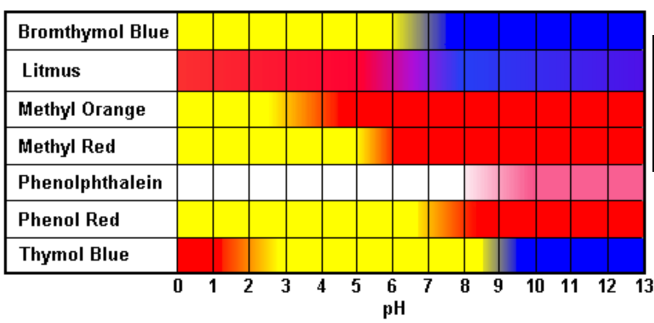
Endpoint
point in a titration when the indicator changes color

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

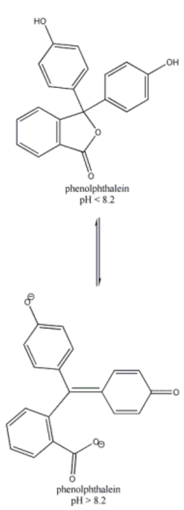
Acid + Base ➔ Salt + Water

Indicators



Complex Organic Compounds
Change color with pH
Choice depends on desired end-point

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

pH = measurement of molar H^+ concentration

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

The p in pH means "the negative logarithm of

"

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

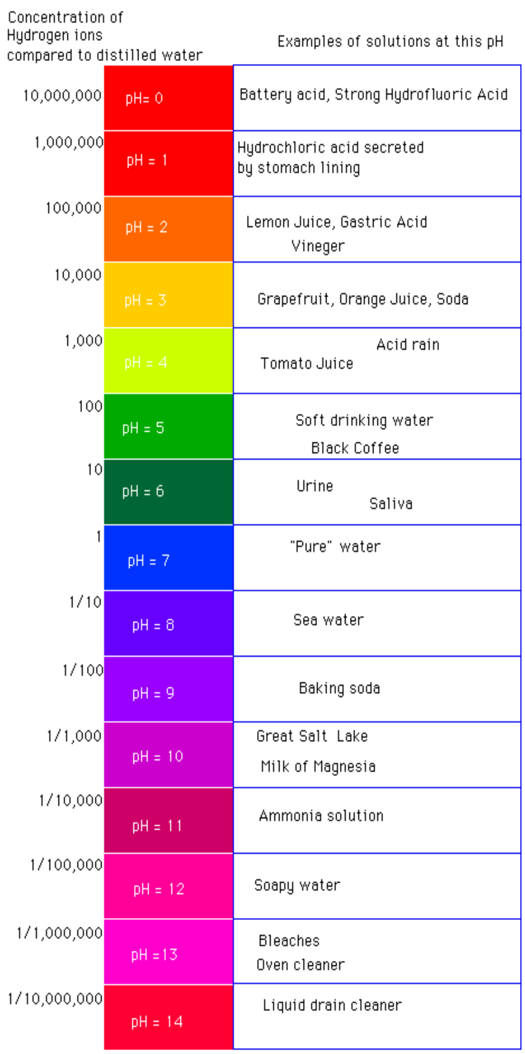
pH 7 means the concentration of $H^+ = 10^{-7}$ M

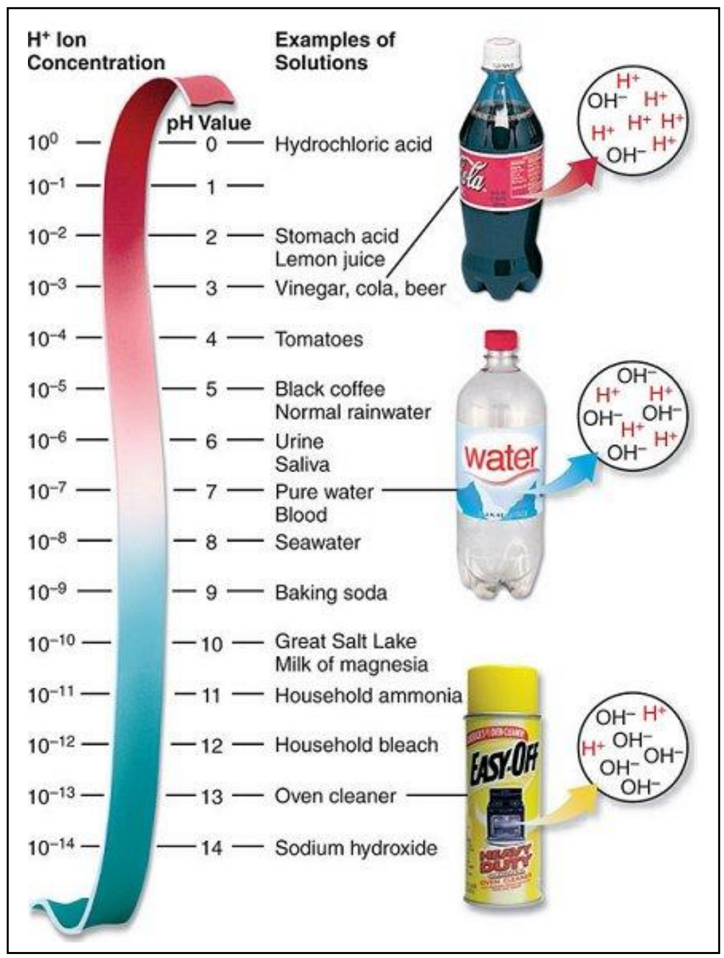
pH < 7 ➔ acidic

pH = 7 ➔ neutral

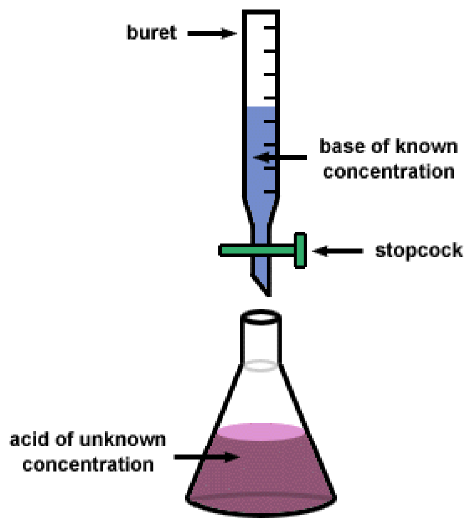
pH > 7 ➔ basic (alkaline)

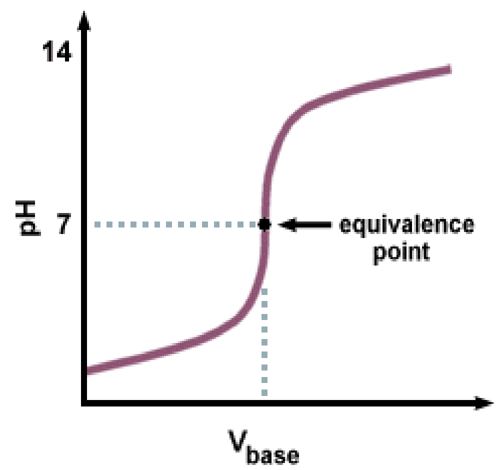
Common Substances

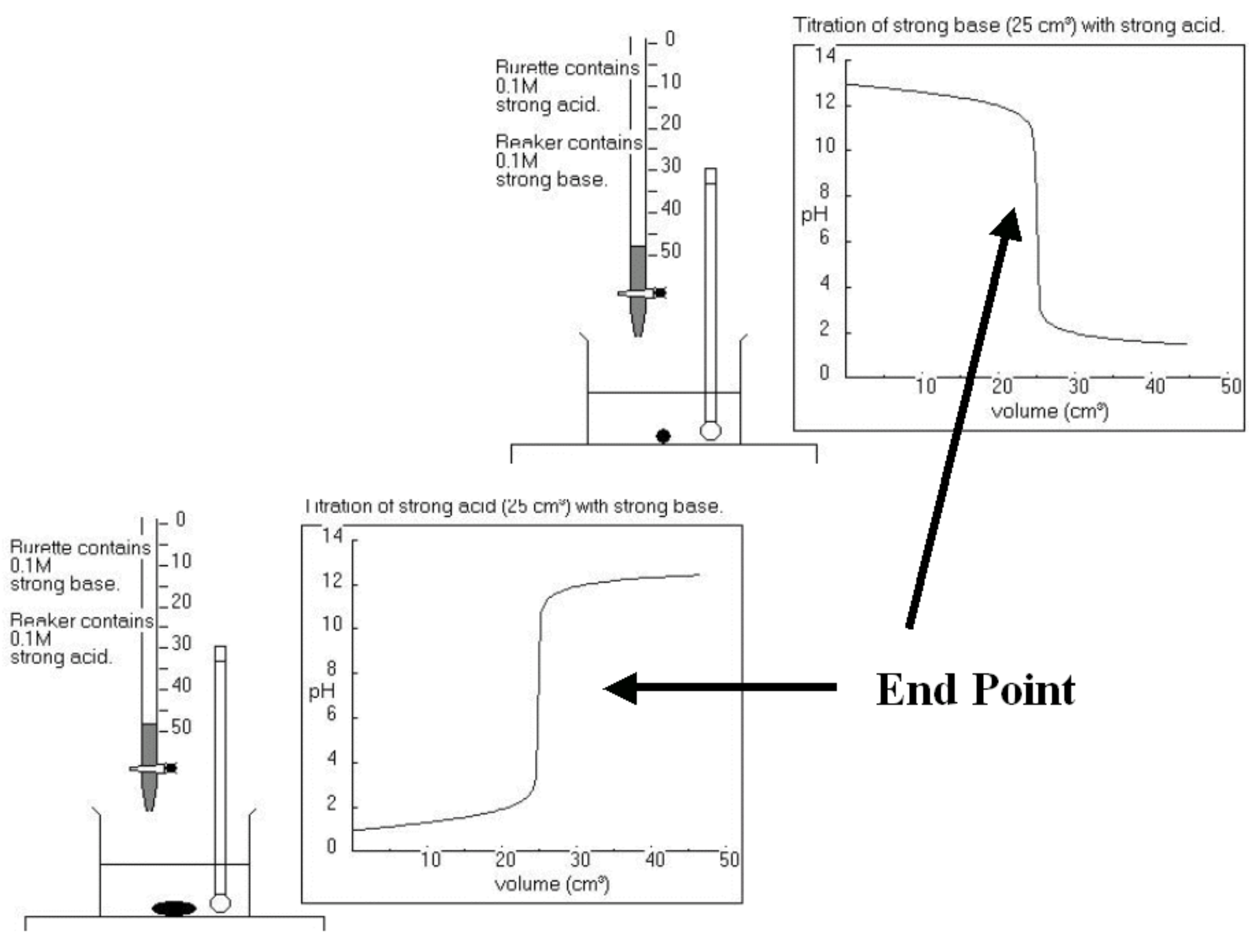




Titration Experiment







Indicators

Neutralization Reactions

Acid + Base ➔ Salt + Water

For HNO_3 + $Mg(OH)_2$ ➔

 # mL's of 0.835M HNO_3 needed to neutralize 38.5 mL of 0.522M $Mg(OH)_2$?

Complete and balance 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 0.0835 M nitric acid

Start with # moles of given (known) substance

$Mg(OH)_2$: $\frac{0.522 \text{ moles}}{L} \times \frac{1 \text{ L}}{1000 \text{ ml}} \times 38.5 \text{ ml} = 0.0201 \text{ moles}$

Problem is now just another Stoichiometry thing (moles ➔ moles)

Given: 0.00201 Moles magnesium hydroxide
Wanted: ml's 0.835 M nitric acid

Use per expression from reaction coefficients:

$0.0201 \text{ moles } Mg(OH)_2 \times \frac{2 \text{ moles } HNO_3}{1 \text{ mole } Mg(OH)_2} = 0.0402 \text{ moles}$

Finally, convert moles to solution available:

$0.0402 \text{ moles} \times \frac{1 \text{ L}}{0.835 \text{ moles}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 48.1 \text{ mL}$

How many mL of 0.0957 M NaOH neutralize 20.0 mL of 0.180 M HCl?

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

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

How many mL of 0.266 M KOH are needed to neutralize 25.0 mL of 0.172 M H_2SO_4? Write the balanced reaction

H_2SO_4 + 2 KOH ➔ K_2SO4 + 2 H_2O

As Linear String: Starting with standard molarity

$$\frac{0.172 \text{ moles } H_2SO_4}{1000 \text{ mL}} \times 20.5 \text{ mL} \times \frac{2 \text{ moles KOH}}{1 \text{ mole } H_2SO_4} \times \frac{1 \text{ L}}{0.266 \text{ moles}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 26.6 \text{ mL}$$

As Linear String: Starting with standard ml's added

$$20.5 \text{ mL} \times \frac{0.172 \text{ moles } H_2SO_4}{1000 \text{ mL}} \times \frac{2 \text{ moles KOH}}{1 \text{ mole } H_2SO_4} \times \frac{1 \text{ L}}{0.266 \text{ moles}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 26.6 \text{ mL}$$

How many milliliters of 0.832 M HCl are needed to neutralize 1.46 grams of sodium carbonate? 2 HCl + Na_2CO_3 ➔ H_2O + CO_2 + 2 NaCl

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

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:

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

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

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

Assignment

Continue Taking Unit 9 Practice Test
The Practice Quiz is very similar to the Unit Exam
Success on Unit exam is directly related to practice exam experience