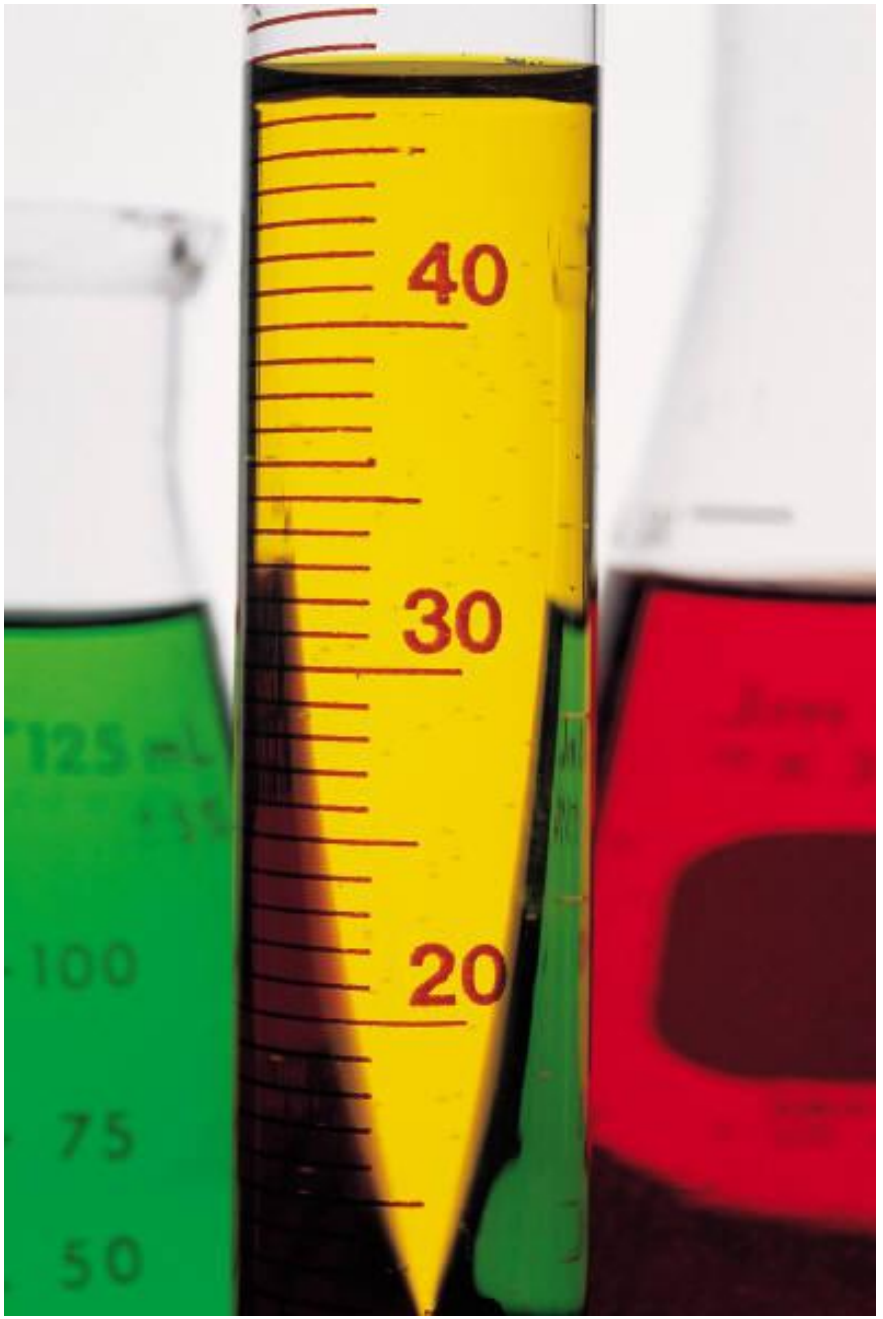
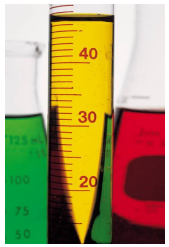
Experiment 4
Acid-Base Titration

CH 204 Fall 2006

Dr. Brian Anderson





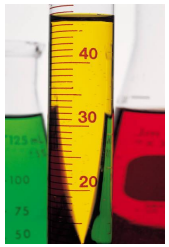
Whut We Lernd in Skool Last Week

Molecular Equations

Simple Solubility Rules

Spectator Ions and Net Ionic Equations

Microscale Techniques

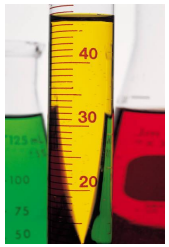


This Week:
Acid-Base Titrations

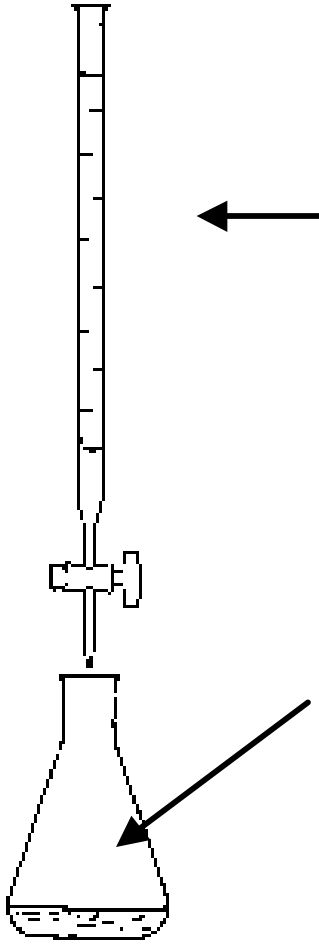
What exactly *is* a titration, anyway?

Acid + Base $\longrightarrow$ Salt + H_2O

At the equivalence point
Moles H^+ = Moles OH^-



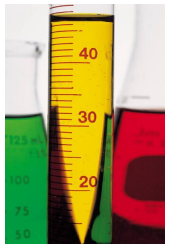
Titration Setup



Burette containing NaOH.

Read all volumes to 0.01 mL!

Erlenmeyer flask containing acid sample, water, and two drops of phenolphthalein.



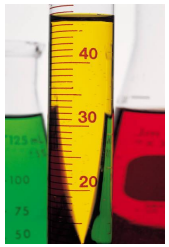
Phenolphthalein

A weak acid.

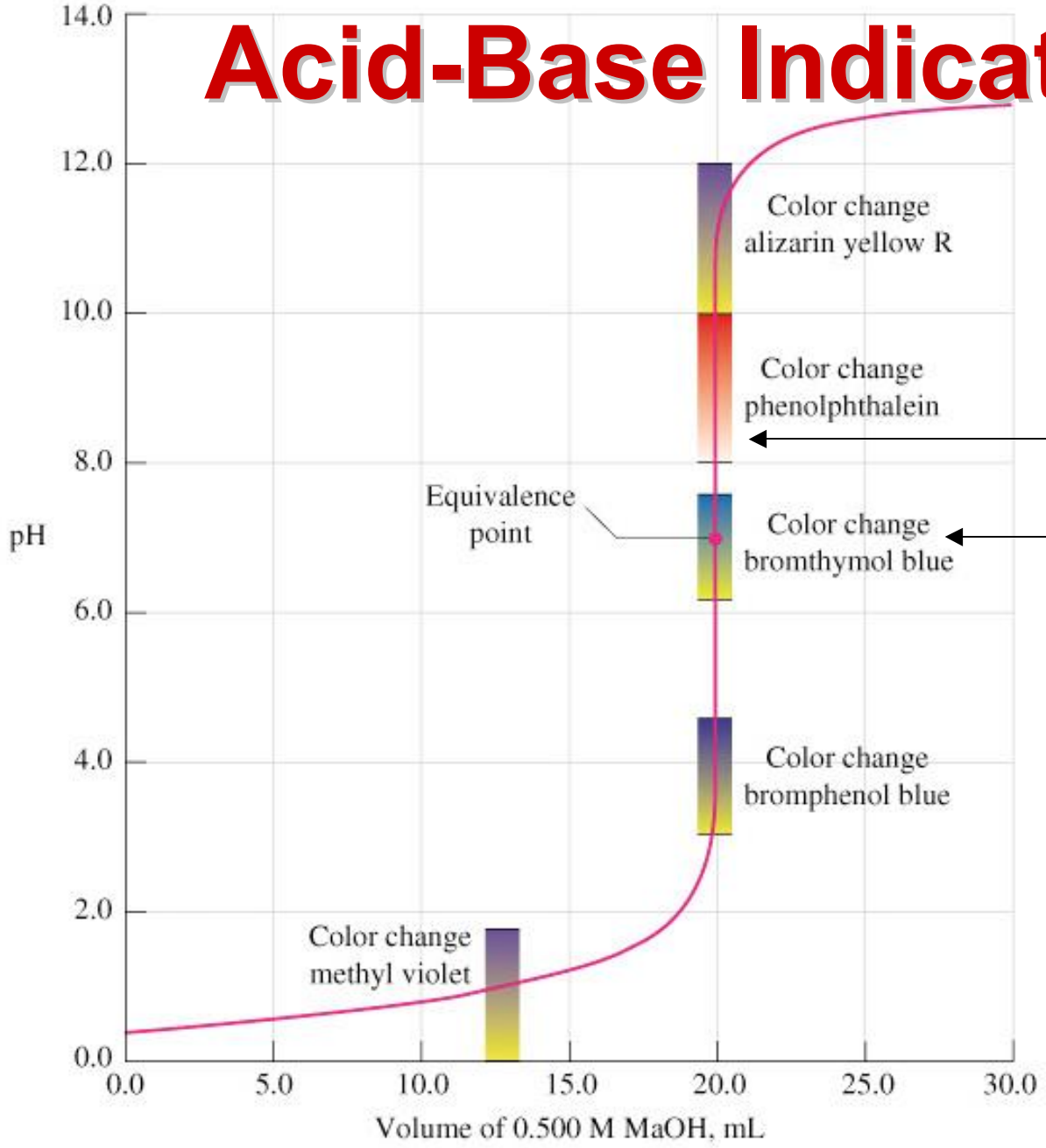
Colorless below pH 8, pink above pH 8.

Your acid solution will go from colorless to faint pink at the endpoint. If it turns bright pink, you have gone too far.

http://www.chemistry.wustl.edu/~courses/genchem/Labs/AcidBase/phph.htm

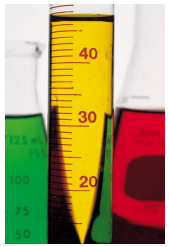


Acid-Base Indicators



Endpoint
pH = 8.1

Equivalence point
pH = 7

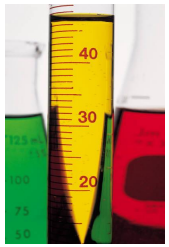


1

Review of pH

Neutral	pH = 7
Acidic	pH < 7
Basic (alkaline)	pH > 7

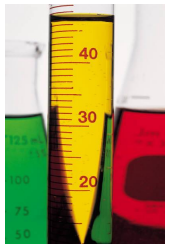
pH is like a Richter scale for acid concentrations, but the higher the pH, the lower the $[H^+]$.



2

$pH = \log_{10}[H^+]$

$[H^+]$	$\log[H^+]$	pH
10^{-1}	- 1	1
10^{-2}	- 2	2
10^{-3}	- 3	3
10^{-4}	- 4	4
1.78×10^{-5}	- 4.75	4.75
4.68×10^{-7}	- 6.33	6.33
8.13×10^{-12}	- 11.90	11.90



Calculating pH

3

Given the $[H^+]$, $pH = -\log[H^+]$

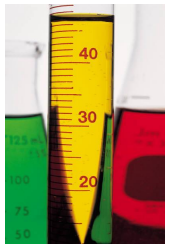
What is the pH of a 0.025 M HCl solution?

$pH = -\log[.025] = -(-1.6) = 1.6$

Given the pH, $[H^+] = 10^{-pH}$

What is the $[H^+]$ concentration in human arterial blood, which has a pH of 7.40?

$[H^+] = 10^{-pH} = 10^{-7.40} = 3.98 \times 10^{-8}\ M$



4

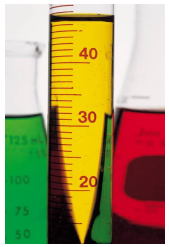
Review

If you are given the $[H^+]$

$pH = -\log[H^+]$

If you are given the pH

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



Today: Titration Marathon!

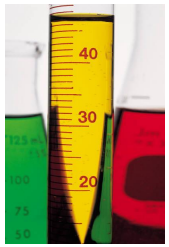
Determine the concentration of an unknown acidic solution:

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

$$\text{Moles } H^+ = \text{Moles } OH^-$$

$$M_{H^+} \times V_{H^+} = M_{OH^-} \times V_{OH^-}$$

$$M_{acid} \times V_{acid} = M_{base} \times V_{base}$$



Experiment 4 Overview

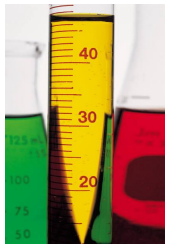
PART 1: STANDARDIZATION OF NaOH

Mix up 1 liter of NaOH solution.

Weigh out 2 grams of KHP powder, dissolve in 75 ml water, ADD PHENOLPHTHALEIN, and titrate (3×).

Calculate concentration of NaOH using

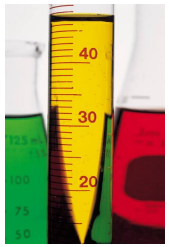
Moles of Acid = Moles of Base



Moles solid = Moles aqueous

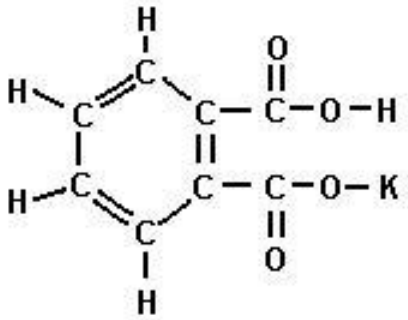
$$\frac{\text{Mass of KHP}}{\text{MW of KHP}} = M_{NaOH} \times V_{NaOH}$$

$$\frac{\text{Mass of KHP}}{\text{MW of KHP} \times V_{NaOH}} = M_{NaOH}\ (0.xxxx\ M)$$

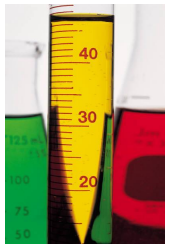


KHPhthalate

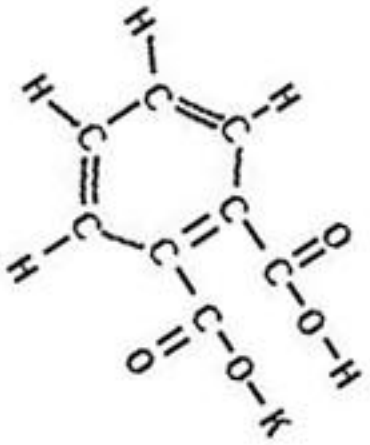
Molecular weight is NOT K + H + P = 71.



$C_8H_5O_4K$

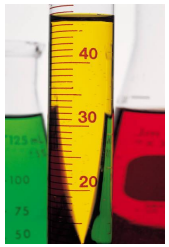


KHPhthalate vs Cthulhu



KHPHTHALATE

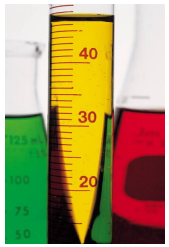
CTHULHU



Part Two: A Return to the Potions Lab

Identify your unknown acid sample using the qualitative reactions from last week.

HNO_3 HCl H_2SO_4



Part 3: Titrate Your Unknown

5 ml unknown acid, 75 ml water, and

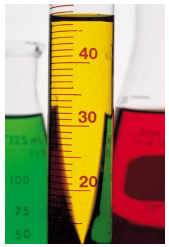
2 drops of phenolphthalein

in a 250 ml flask.

Titrate using NaOH (3×)

In an ideal world, you will get the exact same V_{NaOH} all three times.

Calculate the molarity of your acid.



$Moles_{H^+} = Moles_{OH^-}$

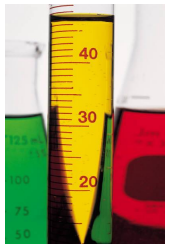
For HCl and HNO_3,

$$M_{acid} \times V_{acid} = M_{base} \times V_{base}$$

For H_2SO_4

$$2 \times M_{acid} \times V_{acid} = M_{base} \times V_{base}$$

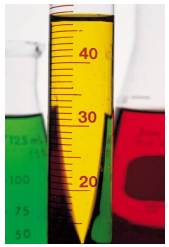
$$V_{acid} = 5.00\ ml$$



General Form for Acid-Base Titrations

$$\text{Moles } H^+ = \text{Moles } OH^-$$

$$M_{acid} \times V_{acid} \times \#\text{ of } H^+ = M_{base} \times V_{base} \times \#\text{ of } OH^-$$



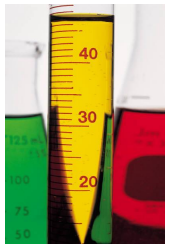
Part 4: Citric Acid in Juice

Orange, Grapefruit, or Pineapple

15 ml juice, 60 ml water, and

2 drops of phenolphthalein.

Titrate just once. Endpoint is hard to see in orange juice.



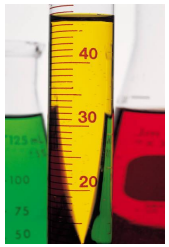
A word about citric acid

That word is *tri*protic!

1 **Mole of citric acid =** ***3*** **moles of H^+**

So the number of moles of H^+ is *3 times* the number of moles of citric acid:

$$3 \times M_{\text{Citric acid}} \times V_{\text{Citric acid}} = M_{\text{base}} \times V_{\text{base}}$$



All your base are belong to us

Leftover NaOH goes into the waste container in the hood.

Keep your unknown acid for now.

DO YOUR CALCULATIONS BEFORE YOU DUMP YOUR LEFTOVER BASE!!

If you have time, fill in all the data tables before you leave the lab.