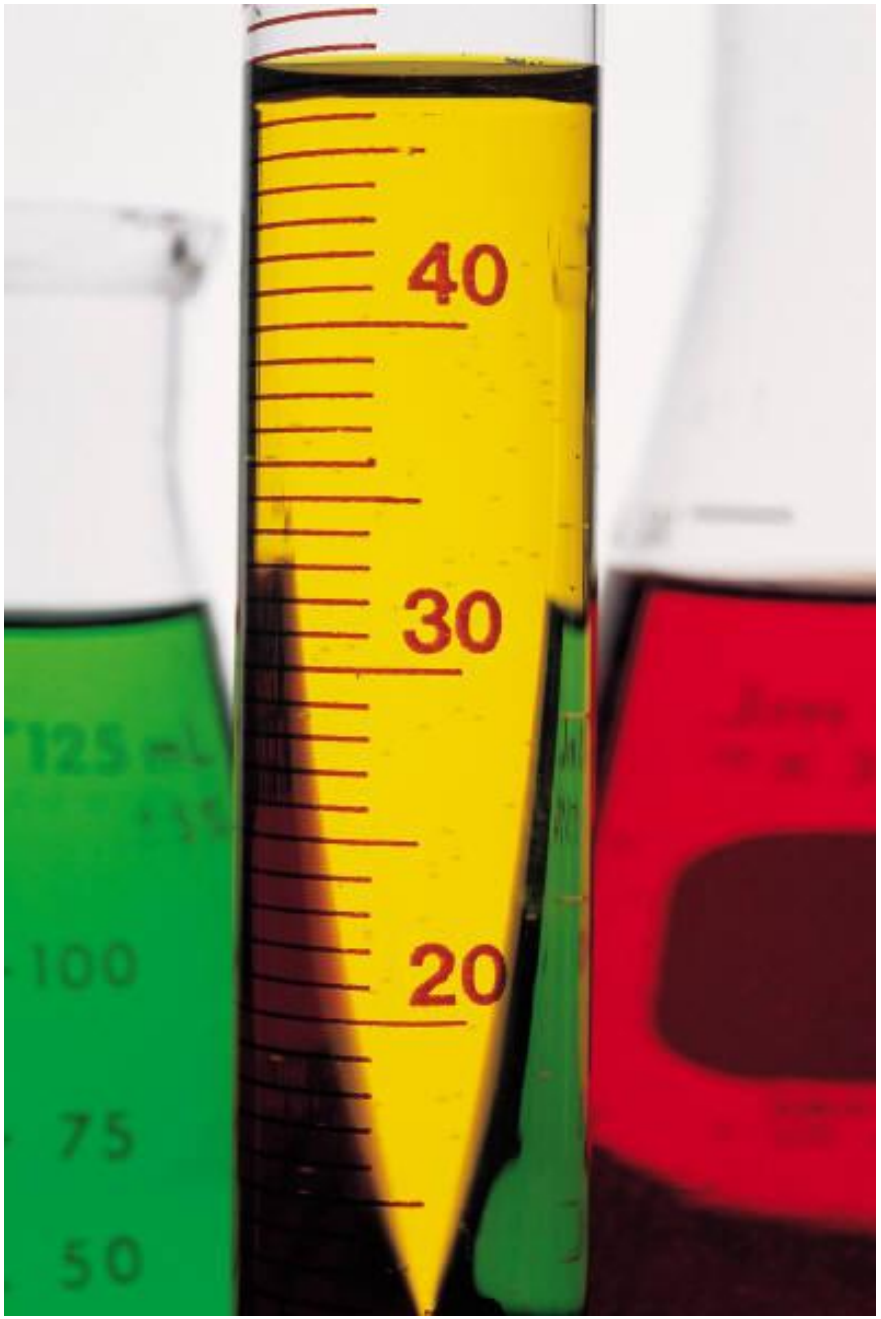
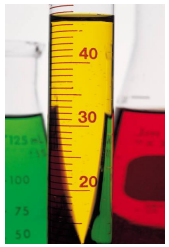
Experiment 4
Acid-Base Titration

CH 204 Fall 2007

Dr. Brian Anderson





Whut We Lernd in Skool Last Week

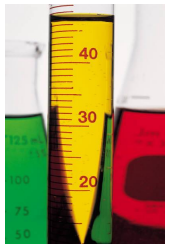
Molecular Equations

Simple Solubility Rules

Spectator Ions and Net Ionic Equations

Microscale Techniques

Your section number and your TA's name

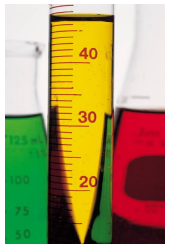


This Week:
Acid-Base Titrations

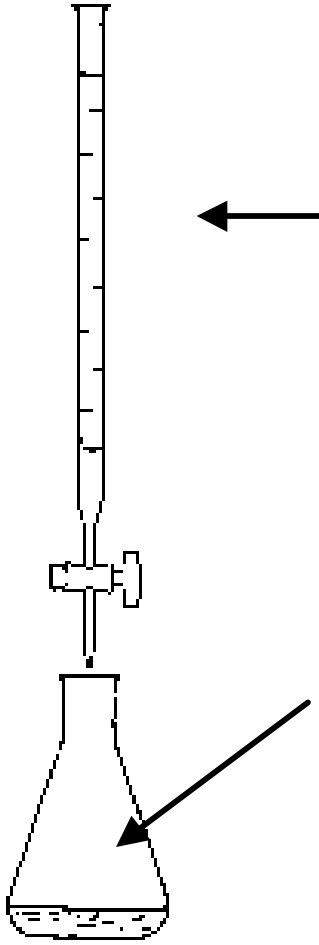
What exactly *is* a titration, anyway?

Acid + Base $\longrightarrow$ Salt + H_2O

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



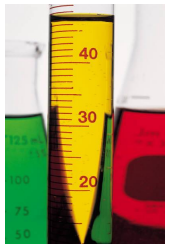
Titration Setup



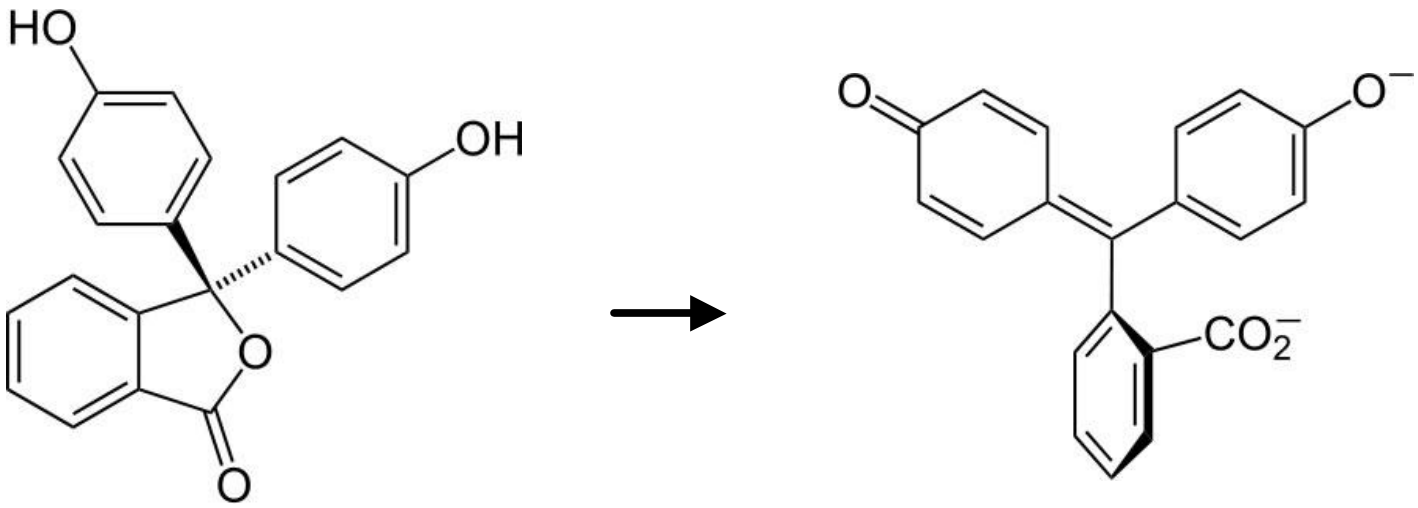
Burette containing NaOH.

Read all volumes to 0.01 mL!

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

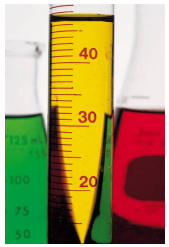


Phenolphthalein

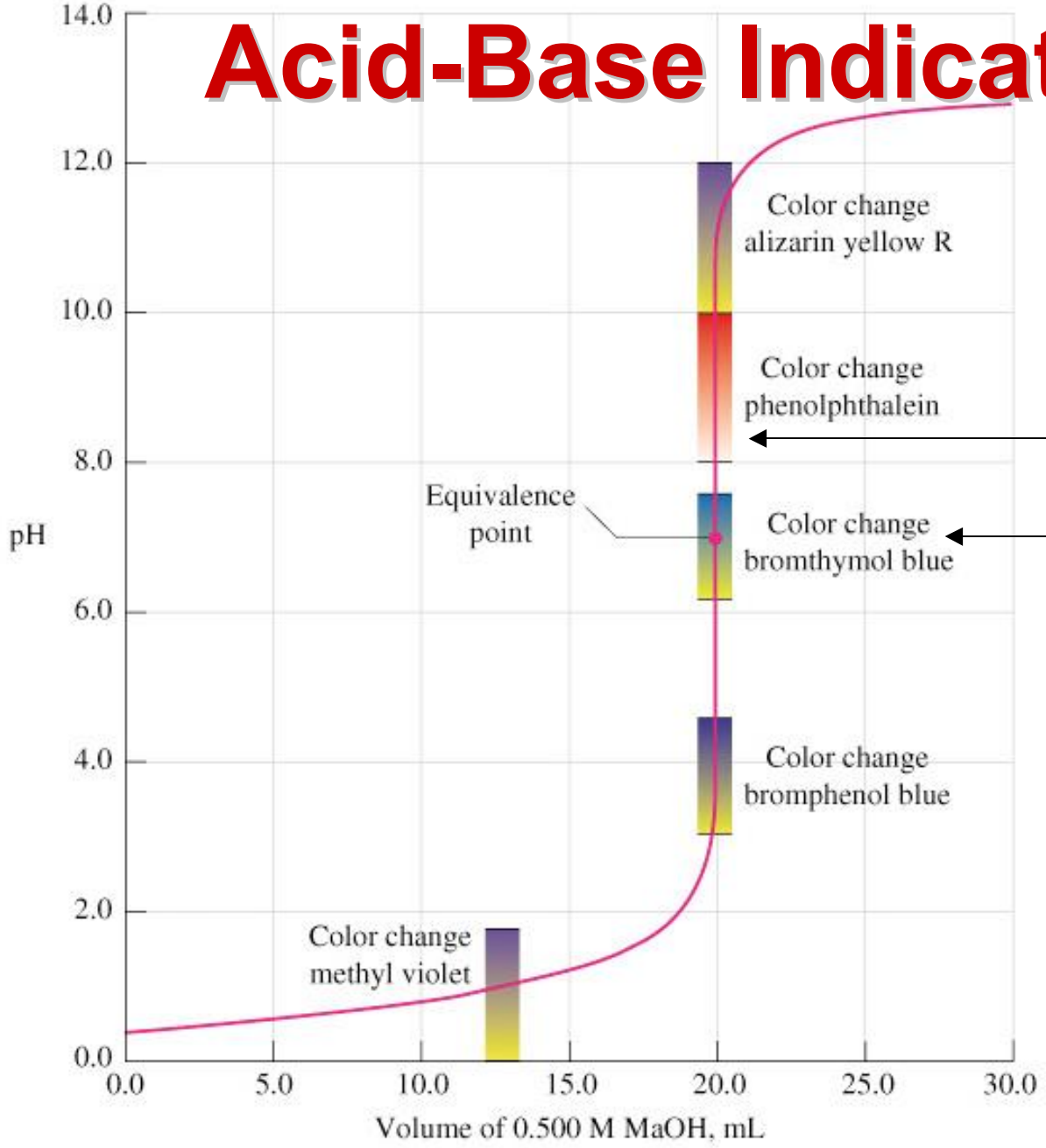


Colorless below pH 8.2 **Pink above pH 8.2**

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

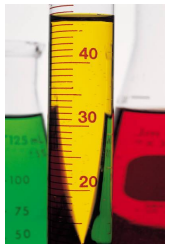


Acid-Base Indicators



Endpoint
pH = 8.2

Equivalence point
pH = 7



Today: Titration Marathon!

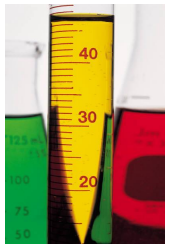
Determine the concentration of an unknown acidic solution:

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

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

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

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



Experiment 4 Overview

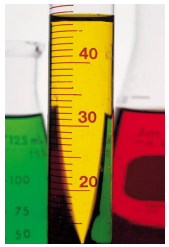
PART 1: STANDARDIZATION OF NaOH

Mix up 1 liter of NaOH solution.

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

Calculate the concentration of NaOH using

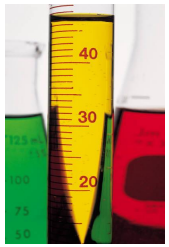
$$\text{Moles of } H^+ = \text{Moles of } OH^-$$



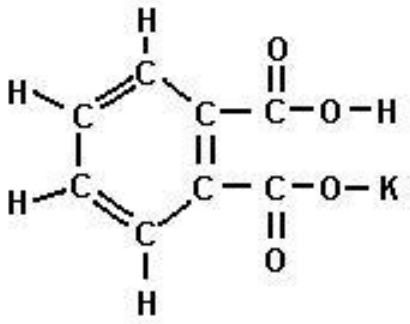
Moles aqueous = Moles solid

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

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



Was ist KHP?

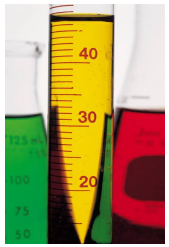


Das ist KHP.

Ist Potassium Hydrogen Phthalate.

$C_8H_5O_4K$

Nicht haben der Phosphorus!

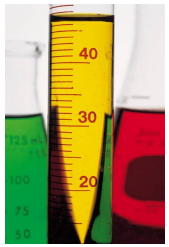


Part Two: A Return to the Potions Lab

Fill out an unknown request slip and get an unknown acid from the stockroom.

Ignore any writing on the bottle.

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



Part 3: Titrate Your Unknown

5.00 ml unknown acid, 75 ml water, and

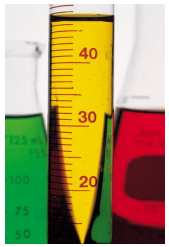
2 drops of phenolphthalein

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.



General Form for Acid-Base Titrations

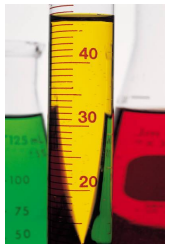
Moles H^+ = Moles OH^-

For NaOH, moles OH^- = moles NaOH

For HCl or HNO_3, moles H^+ = moles acid

In these cases,

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



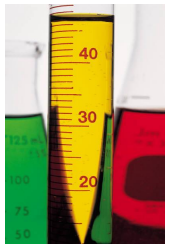
But...

For H_2SO_4, moles $H^+ \neq$ moles H_2SO_4

Moles H^+ = 2 x Moles of H_2SO_4

General formula for titrations/neutralizations:

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



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

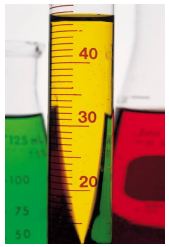
For HCl and HNO_3,

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

For H_2SO_4

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

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



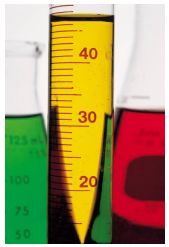
Part 4: Citric Acid in Juice

Orange or Pineapple

15 ml juice, 60 ml water, and

2 drops of phenolphthalein.

Titrate just once. Solution goes from yellowish to orangey.



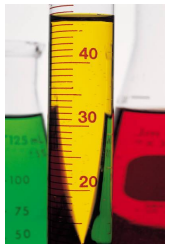
A word about citric acid

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:

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



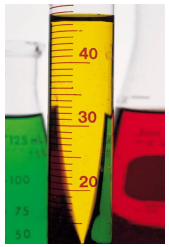
All your base are belong to us

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.



Final Exam Part 3

No calculator this week.

You will need a calculator on every quiz after this one.

Learn your section number

and your TA's name!