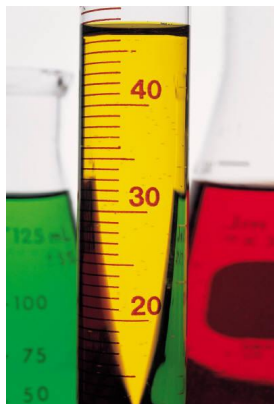


## Experiment 4 Acid-Base Titration

CH 204 Fall 2007  
Dr. Brian Anderson



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### What 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

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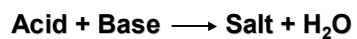
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### This Week: Acid-Base Titrations

What exactly *is* a titration, anyway?



At the equivalence point  
Moles  $\text{H}^+$  = Moles  $\text{OH}^-$

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## Titration Setup

Burette containing **NaOH**.

Read all volumes to **0.01 mL!**

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

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## Phenolphthalein

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

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

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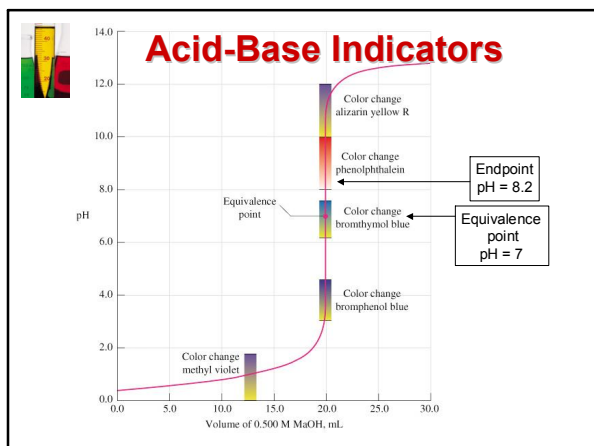
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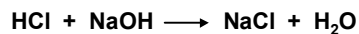
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## Today: Titration Marathon!

Determine the concentration  
of an unknown acidic solution:



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

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

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

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## 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

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

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## Moles aqueous = Moles solid

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

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

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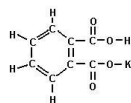
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## Was ist KHP?



Das ist KHP.  
Ist Potassium Hydrogen Phthalate.  
 $C_8H_5O_4K$

Nicht haben der Phosphorus!

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## 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.

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## 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.

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## 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,

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

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## 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:

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

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## Moles $_{H^+}$ = Moles $_{OH^-}$

For HCl and  $HNO_3$ ,

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

For  $H_2SO_4$

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

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

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### 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.

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### A word about citric acid

That word is triprotic!

**1** Mole of citric acid = **3** moles of H<sup>+</sup>

So the number of moles of H<sup>+</sup> is **3 times**  
the number of moles of citric acid:

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

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### 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.

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### **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!**

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