South Pasadena • AP Chemistry

Name ___________________________________

Period ___ Date ___/___/___

18 • Acid-Base Reactions

TITRATION LAB

Titration is the name given to the process of determining the volume of a solution needed to react with a given mass or volume of a sample. You will use this process to study quantitatively the reaction between an acid and a base. Phenolphthalein will be used as the indicator in this experiment since its color change occurs when the same number of moles of acid and base have been added. This point in the reaction is called the *equivalence point* or the *end point*.

Overview

Using a measured mass of a solid acid (such as $KHC_4H_4O_6$), you will standardize a sodium hydroxide solution—that is, determine its concentration in moles per Liter. Using the standard base, you will then titrate samples of the strong acid, HCl and a vinegar solution to determine their concentrations.

Equipment

At each station you should find:

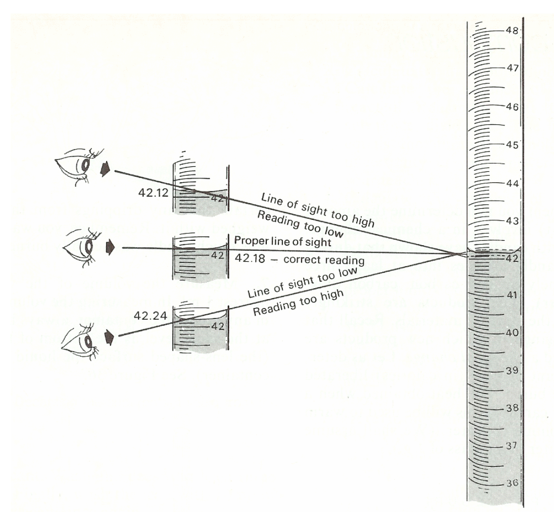
- ring stand with buret clamp
- two burets (labeled "acid" and "base")
- two funnels
- 250 mL Erlenmeyer flask
- index card with dark line

Shared equipment on a tray:

- bottle of phenolphthalein ("phth")
- bottle of distilled water (blue top)
- 50-mL beakers labeled "acid"
- 100-mL beakers labeled "base"
- vials of solid acid

I. Standardization of the NaOH solution of a base with a solid acid.

1. Obtain the solid acid from your teacher. Find the ***mass of the vial*** to the nearest ±0.01 g. Remove about 0.7 g into a clean flask. Find the mass of the vial and contents again. Dissolve the sample in 50 mL of distilled water, add 3 drops of phenolphthalein. If all the acid does not dissolve at this point, it will dissolve later during the titration when the acid will be converted to the more soluble sodium salt.
2. Fill the buret at your station with base (NaOH) solution using the 100-mL beaker at your station. (Read the labels carefully.)
3. Record the liquid level in the buret by reading the bottom of the meniscus to the nearest 0.1 mL.
4. Hold the neck of the Erlenmeyer flask with one hand and manipulate the buret with the other. As you add the sodium hydroxide, gently swirl the flask so the solutions will mix. Continue adding sodium hydroxide until the first faint pink color develops. If the color disappears upon mixing the solution, add more sodium hydroxide, drop by drop, until a persistent pink color is obtained. (Take care not to go beyond the last calibration marks on the buret.) Record the liquid level at the bottom of the meniscus of the base buret. Rinse the Erlenmeyer flask thoroughly before repeating the titration.
   Be careful not to overrun the endpoint. If you pass the endpoint, add a little more of the solid acid and reweigh the vial. Be sure to include the mass of any solid acid added to the mass of your sample. Re-titrate to the endpoint and record the final buret reading.



5. Repeat the titration with a similar sample. Use the knowledge you gained in the first titration. That is, assuming you used 40 mL of base to titrate a certain mass of acid, and that you have almost the same mass of acid for the second trial, you can run 35 mL of base into the flask rapidly and complete the last part of the titration cautiously.
6. Repeat your titrations until the *ratio of mass of solid acid to volume of base used* agrees to within 1%

II. Titration of the Strong Acid, HCl

1. Refill base buret. Check to be certain that the acid buret is also filled.
2. Record the liquid level in the acid buret to the nearest 0.1 mL. Let about 10 mL of hydrochloric acid flow into a clean 250-mL Erlenmeyer flask. Record the final volume in the buret. Add about 15 mL of distilled water and 3 drops of phenolphthalein.
3. Record the liquid level in the base buret and add base to the acid sample while swirling. Continue adding sodium hydroxide until the first faint pink color develops. If the color disappears upon mixing the solution, add more sodium hydroxide, drop by drop, until a persistent pink color is obtained. Record the liquid level at the bottom of the meniscus of the base buret. Rinse the Erlenmeyer flask thoroughly with distilled water before repeating the titration.
4. Refill the base buret and perform at least one more titration. Repeat until you obtain ratios of volume of acid to volume of base that agree to within 1 percent.

III. Titration of Vinegar

1. Refill the base buret and record the liquid level in the base buret.
2. Using the volumetric pipette, measure 10.0 mL of the diluted vinegar solution (10%) into a clean 250-mL Erlenmeyer flask. Add about 15 mL of distilled water and 3 drops of phenolphthalein.
3. Follow the directions above to titrate the vinegar sample.

Data—Standardization of Base with Solid Acid

	Solid Acid	Base (NaOH)	Ratio: volume base / mass acid
Final mass or volume			
Initial mass or volume			
mass or volume			
	Solid Acid	Base (NaOH)	Ratio: volume base / mass acid
Final mass or volume			
Initial mass or volume			
mass or volume			
	Solid Acid	Base (NaOH)	Ratio: volume base / mass acid
Final mass or volume			
Initial mass or volume			
mass or volume			
	Solid Acid	Base (NaOH)	Ratio: volume base / mass acid
Final mass or volume			
Initial mass or volume			
mass or volume			

Data—Titration of HCl

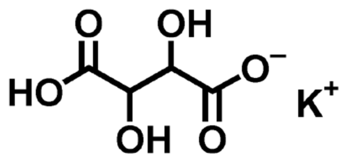
	Acid (HCl)	Base (NaOH)	Ratio: volume base / volume acid
Final volume (± .1 mL)			
Initial volume (± .1 mL)			
Volume			
	Acid (HCl)	Base (NaOH)	Ratio: volume base / volume acid
Final volume (± .1 mL)			
Initial volume (± .1 mL)			
Volume			
	Acid (HCl)	Base (NaOH)	Ratio: volume base / volume acid
Final volume (± .1 mL)			
Initial volume (± .1 mL)			
Volume			
	Acid (HCl)	Base (NaOH)	Ratio: volume base / volume acid
Final volume (± .1 mL)			
Initial volume (± .1 mL)			
Volume			

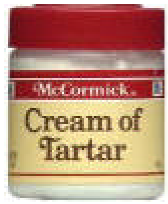
Data—Titration of Vinegar

	Vinegar	Base (NaOH)	Ratio: volume base / volume acid
Final volume (± .1 mL)			
Initial volume (± .1 mL)			
Volume			
	Vinegar	Base (NaOH)	Ratio: volume base / volume acid
Final volume (± .1 mL)			
Initial volume (± .1 mL)			
Volume			
	Vinegar	Base (NaOH)	Ratio: volume base / volume acid
Final volume (± .1 mL)			
Initial volume (± .1 mL)			
Volume			
	Vinegar	Base (NaOH)	Ratio: volume base / volume acid
Final volume (± .1 mL)			
Initial volume (± .1 mL)			
Volume			

Calculations: ***(Show work when possible and pay attention to significant figures)***

1. Task 1: Determine the concentration of NaOH used to titrate the solid acid.





   a) The solid acid we use is potassium hydrogen tartrate or potassium bitartrate. This is also called cream of tartar and is used in place of lemon juice or vinegar in some recipes. It is a component of baking powder. Redraw the structural formula to the right of the jar showing all of the atoms. The abbreviated structural formula above does not show the carbon atoms (they are the intersections of lines) and does not show all of the hydrogen atoms (you are supposed to know where they are.) The formula of potassium hydrogen tartrate is: $KHC_4H_4O_6$

   What is the molar mass of the solid acid? _______________

   b) Use the mass of your solid acid to determine the number of moles of H^+ in your acid?

   c) How many mole of OH^- are in the volume of NaOH used to titrate the acid? _________________

   d) What is the concentration of the NaOH solution? ______________

2. Task 2: Knowing the concentration of NaOH, determine the concentration of the HCl solution.

3. Task 3: Determine the concentration of the ***diluted*** vinegar solution. Remember that the solution is 10% vinegar (by volume), calculate the concentration of the original vinegar. The vinegar is labeled as 5% acetic acid by mass ($HC_2H_3O_2$) which should be 0.833 M $HC_2H_3O_2$.