

## Acid-Base Titrations with Balances

Summary of experiment: This experiment allows students to gain experience in the process of titration without the use of costly burets. In the experiment, students measure mass, rather than the traditional volume, in order to obtain percent compositions of HCl in standard, as well as household, products. Students use travel-size plastic squeeze bottles to conduct acid-base titrations with HCl, NaOH, and household cleaning products in order to determine the amount of acid or base present in these products.

### Materials:

#### Chemicals

phenolphthalein solution (1% in ethanol)\*

5.00% NaOH solution (50.0 g NaOH dissolved in 950 mL distilled or deionized water)\*

7-9% HCl solution (170-220 mL concentrated HCl solution diluted to 1.00 liter with distilled or deionized water)\*

one or more of the following household products--clear ammonia, white vinegar, Lysol Toilet Bowl Cleaner, or antacid

#### Equipment

2 or 4-oz (65 mL or 120 mL) plastic squeeze bottles that will deliver single drops

centigram balance

250-mL Erlenmeyer flasks\*

Bunsen burner, tripod, and wire gauze or hot plate

pH meters

\*See Modifications/Substitutions



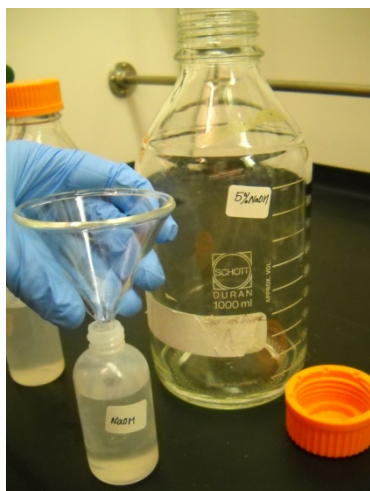
Modifications/Substitutions

1. Phenolphthalein indicator may be prepared by dissolving crushed Ex-Lax tablets from a drugstore in ethanol and filtering. Ethanol is available as rubbing alcohol, but isopropyl alcohol is also sold as rubbing alcohol.
2. NaOH is available in grocery stores as lye.
3. HCl solution is available from a hardware store as muriatic acid, 28% HCl; dilute this solution with 3 parts distilled or deionized water to 1 part of muriatic acid to prepare stock solution.
4. Beakers or glass bottles with a quarter-sized mouth may be used in place of Erlenmeyer flasks if necessary.

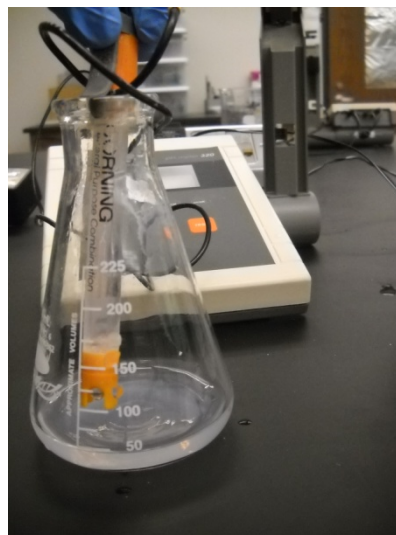
Procedure:

Determination of the concentration of an acid solution

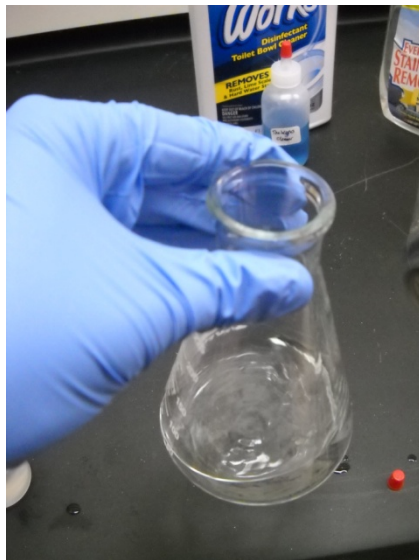
1. Fill one "buret" (plastic bottle) with the 5.00% NaOH solution. Determine the mass of the filled "buret" and contents and record. \*Make sure to use the same balance for all steps!
2. Fill the other "buret" with the HCl stock solution. Determine the mass and record.



3. Transfer 10-20 g of HCl solution (about 1/3 of the contents of a 2-oz "buret") to a flask. Add 3 drops phenolphthalein solution. Take pH of solution with pH meter.



4. Gradually add the NaOH solution, with swirling, until the pink phenolphthalein color begins to persist. When near the endpoint, add the NaOH solution dropwise until one drop causes a pink color that persists for 30 seconds. If the endpoint is over-run, more acid may be added and the titration continued.



5. Take pH of final solution with pH meter.

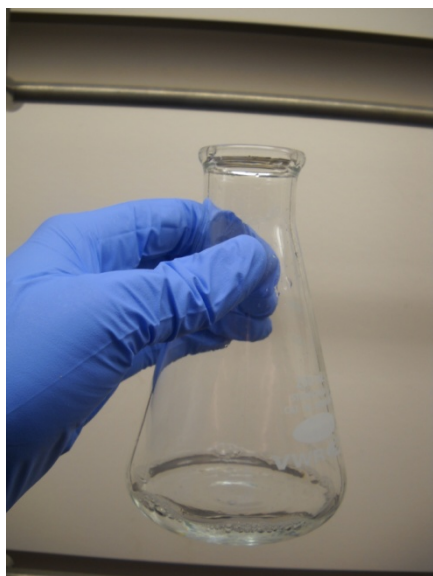


6. Remass both burets.
7. Repeat steps 1-4 two more times.
8. From the mass of NaOH solution used in each trial, calculate the mass of HCl in the sample.
9. Calculate the percent of HCl in the solution used in each trial.

10. Calculate the average percent of HCl in the solution

Determination of the % acid or base in a household solution

1. Carry out the above procedures using NaOH solution to titrate the neutral pH cleaner and The Works Toilet Bowl Cleaner. With the neutral pH cleaner, we are testing to make sure that it is truly neutral. The phenolphthalein changes sharply from colorless to pink after just a few drops of NaOH.



When phenolphthalein is used with The Works Toilet Bowl Cleaner, which is pale aqua-blue, the color changes sharply from blue to light purple. Use only 1/4 of the bottle for The Works Cleaner - it takes more NaOH to reach pH 7 than with the standard, and you may run out of solution if you use too much starting product.



2. Carry out the same procedures as above using HCl solution to titrate a solution of ammonia. With phenolphthalein as the indicator, the color change will be from pink to colorless.



#### Alternative Experiment: Determination of the amount of HCl neutralized by an antacid

1. Crush three antacid tablets and mix thoroughly. Mass three flasks and transfer 1-2 g of antacid to each flask and mass each again.
2. Add 10-20 mL of distilled water to each flask and swirl to dissolve the antacid. Add 15-20 mL of HCl solution and 4-5 drops of phenolphthalein solution. If the solution is pink, add more acid until the pink color disappears.
3. Heat each just to boiling and then cool.
4. Titrate the excess acid (acid not neutralized by the antacid) with NaOH solution to a phenolphthalein endpoint that persists for 30 seconds.
5. From the known concentration of the HCl solution, calculate the number of moles of HCl added to each sample.
6. From the concentration of the NaOH solution, calculate the number of moles of NaOH needed to neutralize the acid not neutralized by the antacid.
7. Calculate the number of moles of HCl neutralized by the antacid.
8. Calculate the number of moles of HCl neutralized per gram of antacid.

Procedure taken from: <http://www.woodrow.org/teachers/chemistry/institutes/1986/exp24.html>

Appendix: VWR Product Information

Bottles, 2 oz. Dispensing	13197-104
250 mL Erlenmeyer flasks	89000-362
Mortars and Pestles	89038-144 & 89038-160
5% Sodium Hydroxide	AA35604-AP
Phenolphthalein, 1% in alcohol	RC56204
2N HCl	BDH3203-4