**Acid-Base Titrations**

Acids and bases are familiar substances that are involved in many important chemical reactions. The most common is the neutralization reaction – where and acid and base are combined to make salt and water.

Some acids are stronger than others and since they can be mixed into water at many different concentrations (strengths) it is often important to determine the exact concentration of an acidic or basic solution. This process is called titration – where a measured amount of solution (with a known concentration) is added to a solution with an unknown concentration until it is neutralized, in order to determine its strength.

**Safety**: *All of the acids and bases used in this lab are very corrosive to eyes, skin, and other body tissues. They are toxic by ingestion. Avoid all body tissue contact. Wear safety glasses and aprons at all times.*

Materials:

Chemical samples, toothpicks, Microplate, pH paper, Indicator

Prepare a map of your microplate below. Write what is added to each plate in the boxes below in order to avoid errors.

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**Part 1. Neutralization — Microtitration of Monoprotic and Diprotic Acids**

1. Add about 5 drops of each of the following to four individual wells of your microplate

• 0.1 M HCl • 0.1 M HC2H3O2

• 0.1 M H2SO4 • 0.1 M NaOH

1. Using a different piece of dry pH paper for each solution, dip the end of the paper into each solution. Remove the paper immediately and record the color of the pH paper in Table 1. Use the pH indicator color chart on the pH paper container to assign a numerical pH value to each solution. Record this value in Table 1.
2. To each solution, add 1 drops of phenolphthalein indicator solution. Record the color of each solution in Table 1. Note the color of the phenolphthalein in each solution.
3. Use your results from step 2 to label each solution as one of the following: strong acid, weak acid, strong base, weak base. Record your classification in Table 1.

**Titration #1 — HCl with NaOH**

1. Now place exactly 5 drops of 0.1 M HCl in an individual well of your microplate. (*Reminder:* Hold the pipet vertically for evenly-sized drops.) Add 1 drops of phenolphthalein indicator solution. Place your microplate on a sheet of white paper for better viewing of the color change.
2. Slowly, and with careful counting of the drops, add 0.1 M NaOH dropwise until the solution just turns and remains a faint pink color. Use a toothpick to mix the solutions. The neutralization point or endpoint is the point at which the faintest pink color remains without fading back to colorless. Record the exact number of drops of NaOH used to neutralize the HCl in Table 2.
3. Repeat steps 1-2. Again use 5 drops of 0.1 M HCl and titrate with 0.1 M NaOH. Record your results in Table 5.
4. Compute the average number of drops of NaOH needed for neutralization. Record this value in Table 2.

**Titration #2 —** H2SO4 **with NaOH**

1. Repeat steps 5-6, this time using 5 drops of 0.1 M H2SO4 and again titrating with 0.1 M NaOH. Conduct two trials and record your results in Table 2. Compute the average number of drops of NaOH needed to arrive at the neutralization point. Record this value in Table 2.

**Titration #3 —** HC2H3O2**with NaOH**

1. Repeat steps 5-6, this time using 5 drops of 0.1 M HC2H3O2and again titrating with 0.1 M NaOH. Conduct two trials and record your results in Table 2. Compute the average number of drops of NaOH needed to arrive at the neutralization point. Record this value in Table 2.
2. Clean the well plate by pouring the solutions down the drain and rinsing the well plate with plenty of water. *Caution:* Take care when rinsing the plates so that the solution does not splash out.

**Part 2. Determine the Concentration of an Acid via Titration with NaOH**

**Titration #4 — Unknown A (? M HCl) with NaOH**

1. Place exactly 5 drops of Unknown A (? M HCl) in an individual well of your microplate. Add 1 drops of phenolphthalein indicator solution. Place your microplate on a sheet of white paper for better viewing of the color change.
2. Slowly, and with careful counting of the drops, add 0.1 M NaOH dropwise until the solution just turns and remains a faint pink color. The titration should be performed as outlined in step 6 above. Record the exact number of drops of NaOH used to neutralize the unknown concentration of acid in Table 2.
3. Repeat steps 11-12, again using Unknown A. Record your results in Table 2. Compute the average drops of NaOH. Record this value in Table 2.

**Titration #5 — Unknown B (? M** H2SO4**) with NaOH**

1. Repeat steps 11-12, this time using Unknown B (? M H2SO4). Gather data for two or three trials and record your results in Table 2. Compute the average drops of NaOH. Record this value in Table 2.

**Table 1**



**Table 2**

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Analysis Questions

1. From table 2:
* What is the ratio of drops of 0.1 M NaOH to 0.1 M HCl?
* What is the ratio of drops of 0.1 M NaOH to 0.1 M H2SO4?
* What is the ratio of drops of 0.1 M NaOH to 0.1 M HC2H3O2?
1. Both HCl and HC2H3O2 are monoprotic acids, meaning they each have only one proton to lose to a base. H2SO4 is a diprotic acid which means it has 2 protons to lose to a base. Relate this to your experimental results.
2. While the 0.1 M HCl and the 0.1 M HC2H3O2 have the same molar concentration of 0.1 M, the strengths of these two acids differ. From your results in Table 4, which is a stronger acid? How do you know?
3. Which acid, HCl or HC2H3O2, required more NaOH to reach neutralization? Does acid strength have an effect on the amount of base needed for neutralization?
4. Estimate the concentration of the Unknown A HCl solution. Use the average data from your trials and show all of your work.
5. Estimate the concentration of the Unknown B H2SO4 solution. Use the average data from your trials and show all of your work.