To: Professor Richmond-Hall, Chemistry Professor

From: [redacted] 91 / 100

Lab Partner: [redacted]

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Subject: Acid Strength & Titration

Hypothesis:

Because pH is a measurement of proton concentration, HCl will have a lower pH than acetic acid. When using color indicators to find a neutral pH, the amount of acid and base to be used will depend on the molarity of the substances.

Summary of Experimental Findings:

The acids of a higher molarity proved to have a lower pH compared to the acids with a lower molarity. In making a neutral solution, the molarity of the bases and acids did play a role in how much of each would be needed to achieve the neutral pH. What was the molarity of the NaOH solution?

Procedure:

Part A of the lab starts by obtaining four test tubes. One will be labeled HCl and it gets filled with a small amount of 0.1 M hydrochloric acid. The second is labeled AA and is filled with a small amount of 0.1 M acetic acid. Find the pH of the two acids by dipping pH paper into the acid and compare the colors to what is on the container. Next, the MiVi=MfVf formula is used to determine the volume of water that should be added to the acids to dilute them to 0.01 M. Fill a small graduated cylinder with 4.5mL of water. In the third test tube add the water and .5mL of the 0.1 M HCl to make 0.01 M HCl. In the fourth test tube, 4.5 mL of water should be added again, but this time with .5mL of 0.1 M acetic acid to make 0.01 M acetic acid. Use pH paper again to find the pH of the two new acids and the pH of the water used. There should be a total of five pH papers used.

Part B and C of the lab starts by diluting another solution. After setting up a clean buret in the buret stand, fill a small beaker with 40 mL of NaOH stock solution. Add water to the beaker until it reaches 200 mL. Use this solution to fill the buret. Next, use a graduated cylinder to measure out 25 mL of 0.1 M HCl. Pour this into a flask and add 5-7 drops of phenol red indicator. Swirl the flask until the color resembles 'bad lager beer'. Bleed the buret so there are no air bubbles and record the initial volume. Start adding the NaOH from the buret to the flask one drop at a time. Hold the flask underneath the buret so it can be swirled while the NaOH is dripping in. Patience is important because one extra drop may be too much. Keep swirling and watching for color changes. There will be a reddish burst where the base hits the acid when it is nearly complete. Slow the rate of NaOH so one drop can be added at a time. Swirl completely after each drop until the solution is a light peach color. Record the final volume and repeat this second portion of the experiment for a total of 3 trials.

Results:

Part A

	Hydrochloric Acid		Acetic Acid		Water
	0.1 M	0.01 M	0.1 M	0.01 M	
pH data	1	2	3	5	6
Hydrogen Concentration	.1000	.0100	.0010	$1.0x10^{-5}$	$1.0x10^{-6}$

Part B & C

	Trial 1	Trial 2	Trial 3
HCl in the flask (mol) 3 sf	$2.500x10^{-3}$	$2.500x10^{-3}$	$2.500x10^{-3}$
NaOH added to the flask (mL)	17.14	17.52	17.14
NaOH used (mol)	$2.500x10^{-3}$	$2.500x10^{-3}$	$2.500x10^{-3}$
NaOH molarity (M)	.1459	.1427	.1459
NaOH molarity mean (M)	.1448		
NaOH molarity standard deviation (M)	.0018		

The color of the solution in flasks from trials 1 and 3 are a peach-pink color. They are identical. The flask from trial 2 is a more bright pink color.

Discussion:

It is conclusive that the pH of an acid is lower if it is more concentrated. PH is a measure of the amount of hydrogen in something. When water is added, it is a higher number because the concentration of hydrogen is less. After using the pH strips, it is clear that the acetic acid is less acidic than the hydrochloric acid because it has a higher pH when the molarity is the same. The hydrogen concentration of all the acids tested is an inverse of the pH. As the pH higher, the concentration number gets smaller.

The second half of this lab has more likelihood for skewed results. Patience and precision is needed when adding NaOH. The goal is to create a neutral solution (in which pH is 7) by using color indicator. The solution is neutralized when the color of the solution is a light peach. Trials 1 and 3 have identical peach colors. The volume of NaOH added to the flask is the same for each, so the matching colors makes sense. Trial number 2 did now match these results so well. The color in the flask for trial 2 is a much brighter pink. The amount of NaOH needed was over estimated resulting in a more basic solution. At this point, to bring it back to its peach color there would need to be more HCl added. So, the true molarity of NaOH is actually more likely trial 1 or 3 and not the average of the three trials. In the future more patience when adding the base would have made trial 2 more consistent with the other results.

Raw Data: What about data for part A?

NaOH added to the flask			
	Trial 1	Trial 2	Trial 3
Initial Volume (mL)	5.00~~0~~	1.31~~0~~	10.71
Final Volume (mL)	22.52	18.45	27.85

HCl starting in the flask			
	Trial 1	Trial 2	Trial 3
Initial Volume (mL)	0.00~~0~~	0.00~~0~~	0.00~~0~~
Final Volume (mL)	25.00	25.00	25.00

Drops of phenol red?

Calculations:

Acid and water (mL) to make 0.01 M dilution:

MiVi=MfVf

(.1 M)(.5 mL) = (.01 M)(?mL)

$\frac{.05mL}{.01\ M} = \frac{(.01\ M)(?mL)}{.01M}$

5 mL/M = ?mL

5 - .5 = *4.5 mL water*

H+ in concentration:

pH = -log $[H^{+1}]$

3 = .001

Moles of HCl:

(molarity)(liters)=moles

(.1 M)(.025L)=$2.500x10^{-3}$

Volume of NaOH added:

Vfinal – vinitial = volume used

18.45 mL – 1.310 mL = 17.14 mL

Moles of NaOH used:

HCl : NaOH ~ 1:1

2.500×10^{-3} (HCl) = 2.500×10^{-3} (NaOH)

Molarity of NaOH dilution:

Moles/ volume (L) = molarity

$\frac{2.500 \times 10^{-3}}{.01714\ L} = .1459\ M$

Mean:

.1459+.1427+.1459=4345

4345/3=.1448

Standard Deviation:

Sum of molarity 1, 2 and 3 squared. Divide by n-1 : 2. Square root: .0018