CHEM 1515.001 - 006
Exam I
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Week of March 25, 2002

Name _____

TA's Name _____

Section _____

Experiment #6 Acid and Base Classifications

Problem Statement: What are the characteristics of acid and base solutions?

I. Data Collection: Acid/Base Properties

A. Obtain a 96 well plate, aligning it as shown in Figure I, use a Beral pipet from the labeled dispensing container to half fill each well in Column 1 (rows (A-F) with 1 M NaOH (see Figure II.).

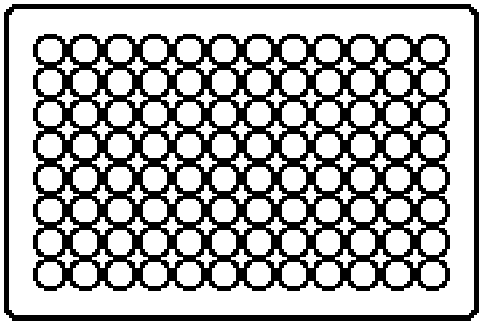


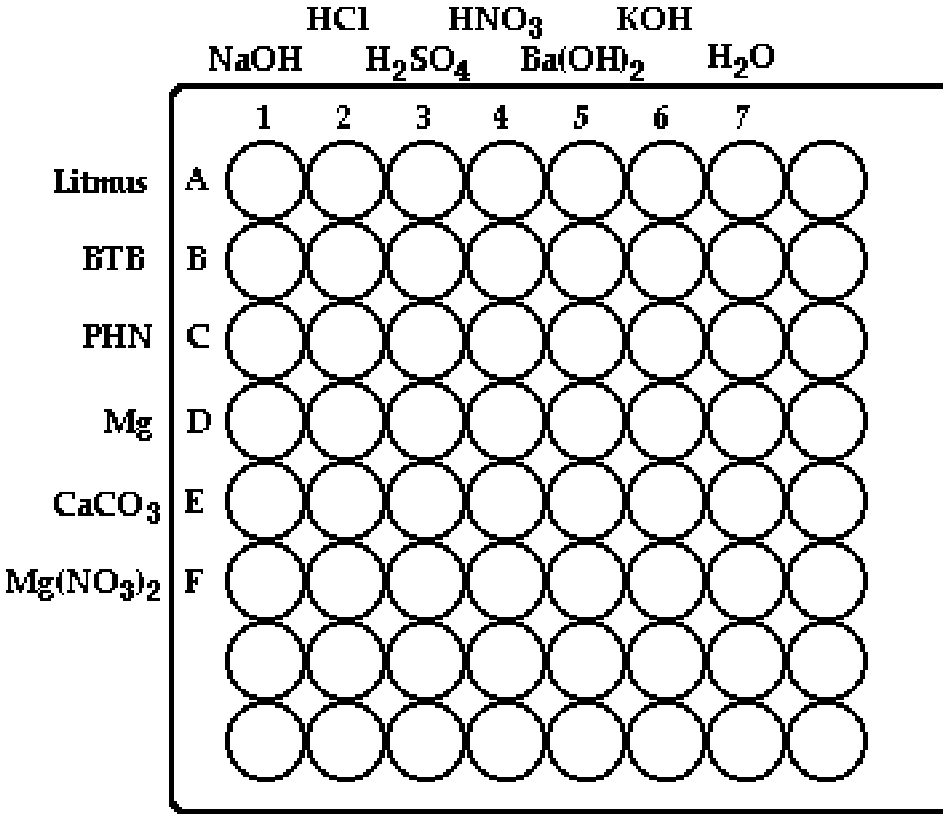
Figure I.

B. Do the same with Columns 2 - 7 with 1 M HCl, 1 M H_2SO_4, 1 M HNO_3, saturated $Ba(OH)_2$, 1 M KOH and distilled water, respectively.

C. Dip small pieces of red and blue litmus paper in each of the solutions in row A (see Figure II.) and record your observations in the table on the next page.

D. Add one microdrop of bromothymol blue (BTB) to each of the solutions in row B and one microdrop of phenolphthalein (PHN) to each of the solutions in row C. Record your observations in the table.

E. Place a small piece of magnesium ribbon in each of the solutions in row D. Record your observations in the table.



F. Place a small amount (an amount just covering the tip of a spatula) of solid $CaCO_3$ in each of the solutions in row E. Record your observations in the table.

G. Add one microdrop of $Mg(NO_3)_2$ solution to each of the solutions in row F. Record your observations in the table.

	NaOH	HCl	H_2SO_4	HNO_3	$Ba(OH)_2$	KOH	Distilled H_2O
Litmus							
Bromothymol blue							
Phenolphthalein							
Mg							
$CaCO_3$							
$Mg(NO_3)_2$							
Conductivity							

II. Data Analysis

A. Group the seven solutions (NaOH, HCl, H_2SO_4, HNO_3, $Ba(OH)_2$, KOH, and H_2O) according to similar chemical properties. What are the least number of groups needed? What substances are in each group?

B. Write an equation for any one of the reactions you observed when you added the $Mg(NO_3)_2$ solution.

C. Obtain 20 mL of 1.0 M HCl and divide it into two 50 mL beakers. Place several pieces of $CaCO_3$ into one solution and cover the beaker with a watch glass. After waiting several minutes remove the watch glass and insert a lighted match into the beaker without touching the solution. Record your observations and write a chemical equation.

III. Interpretation

A. Your teaching assistant will convene a discussion of at this point in the experiments. The goal of this discussion is to invent some concepts that can be used to classify the substances in the groups you identified in IIA. Record your notes of the discussion here.

B. Summarize what you have learned about this investigations so far.

C. Using their chemical formulae, identify similarities and differences among each of the groups you have identified in part II.A.

III. Data Collection: Concentrations of Acids and Bases

A. Obtain 5 mL of each of these solutions and put them in separate clean 18 x 150 mm test tubes: 6 M HCl, 1 M HCl and 0.1 M HCl. Add a single chip of $CaCO_3$ to each solution. Describe and explain the results of this experiment.

B. Put 10 mL of a 0.1 M HCl solution in a clean 18 x 150 mm test tube and label it "10^{-1} M H^+". Using a 10 mL graduated cylinder, transfer 1 mL of the 10^{-1} M H^+ solution and 9 mL of distilled water to a second test tube. Mix and label it "10^{-2} M H^+". Rinse and "shake dry" your measuring equipment. Transfer 1 ml of the "10^{-1} M H^+ solution to a third test tube, add 9 mL of distilled water, mix, and label this "10^{-3} M H^+". Continue this "serial dilution" until you have 5 solutions from "10^{-1} M H^+". to "10^{-5} M H^+".

C. Obtain 10 mL of a 0.1 M NaOH solution and carry out a "serial dilution" similar to that in part IV.B. At the end you should have 5 solutions from "10^{-1} M OH^-". to "10^{-5} M OH^-".

D. The pH of each of the solution prepared in the "serial dilution" must be measured and recorded. Depending on whether you use a pH meter or pH paper follow the specific instructions.

pH Meter: Obtain a pH meter. Rinse the electrode with distilled water. Wipe excess water off using a KIM wipe (see the small green and white box next to the beaker.) On the top of the pH meter is an ON/OFF switch. Flip the switch to ON. Insert the pH electrode into a sample of distilled water and be sure to avoid touching the bottom or sides of the container. Be sure to give the pH meter reading a moment to settle down so the value is not fluctuating too much. Record the pH of the solution in the table below. Remember to rinse the electrode with distilled water after each measurement. After you have measured the pH of all of the samples be sure to turn the pH meter ON/OFF switch to the OFF position.

pH Paper: Obtain a strip of wide range pH paper. Dip a clean dry glass rod into a sample of distilled water and then touch the rod to small section of the pH paper. Compare the color of the paper with the color code provided with the paper and record the value in the table below. Using the same

procedure, test the ten solutions you made in parts IVB and C. Record these data in the table on the following pape.

Distilled water pH =

Acid		Base	
Dilution	pH	Dilution	pH
10^{-1} M	_____	10^{-1} M	_____
10^{-2} M	_____	10^{-2} M	_____
10^{-3} M	_____	10^{-3} M	_____
10^{-4} M	_____	10^{-4} M	_____
10^{-5} M	_____	10^{-5} M	_____

IV. Data Analysis and Interpretation

A. What conclusions can be drawn from these data in IV.D.

B. Mental Model-Draw a series of pictures that contrasts four of your dilutions (two acids and two bases) with each other and represent the atomic and molecular species involved. Explain how your picture illustrates your observations.

Data Collection and Analysis

A. Obtain 5 mL of each of 6 M acetic acid ($HC_2H_3O_2$) and 1 M acetic acid. Add a single chip of $CaCO_3$ to each solution. Compare the rate of these reactions to those in part IV.A. Repeat the IV.A reactions if a more direct comparison is necessary.

B. Obtain a few mL of each of the following solutions: 0.1 M HCl, 0.1 M HNO_3, 0.1 M H_2SO_4, 0.1 M $HC_2H_3O_2$. Test each solution with the handheld pH meter or the pH paper. Record your observations.

V. Interpretation

A. What are the similarities and differences between HCl and $HC_2H_3O_2$ in VI.A?

What are the similarities and differences among the 5 acids in part VI.B?

B. Mental Model-Draw three pictures representing the molecular levels of 0.1 M HCl, , 0.1 M H_2SO_4, and 0.1 M $HC_2H_3O_2$.

VI. Data Collection and Analysis: Acid/Base Interactions

A. Using the graduations printed on a 50 mL beaker add 0.1 M NaOH solution to the 10 mL mark. Add two drops of bromothymol blue to this solution. Note the color of the solution. Titrate this solution with 0.1 M HCl solution (by adding HCl from a graduated Beral pipet and swirling the solution during addition) until one drop of HCl changes the color of the solution. Note the color and the approximate amount of HCl added. Write a chemical equation for the reaction that occurs between the acid and base.

B. Repeat the experiment using 0.1 M HNO_3 instead of 0.1 M HCl. Compare your finding with part VIII.A.

C. Repeat the experiment using 0.1 M $HC_2H_3O_2$ instead of 0.1 M HCl or HNO_3. Compare your finding with part VIII.A and B.

VII. Interpretation

A. What conclusions can be drawn from these data? Compare these data with the information gathered concerning pH of these acids in part VI.B. If you had used 0.05 M HCl in part VIII.A., how would the results have been different? (Feel free to try this by dilution the HCl solution.)

B. Repeat the experiment of part VIII. A, B and C using 0.1 M H_2SO_4 instead of HCl, HNO_3 or $HC_2H_3O_2$. Compare your data with that of those sections and account for any differences.

C. Mental Model-Draw pictures of the atoms and molecules involved in the interaction between acids and bases. Explain how your pictures account for the observations in part VIII.A.

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