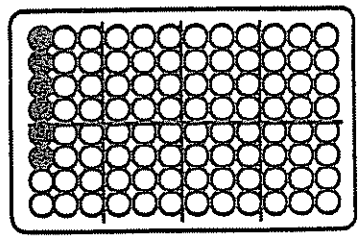
ACID AND BASE CLASSIFICATIONS—Exp. G-1

Name_____ Lab Section _____

Lab Partner_____

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

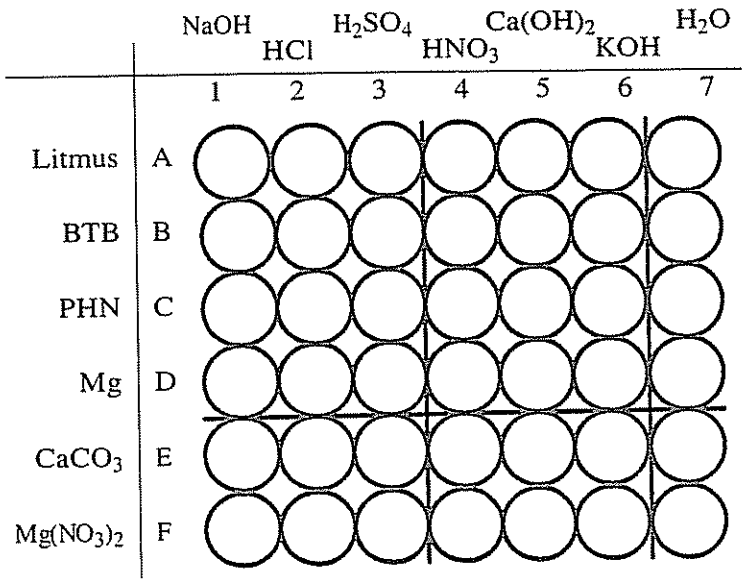
I. Data Collection: Acid/Base Properties



A. Obtain a 96 well microplate. With a medicine dropper or dropper bottle carefully 1/2 fill each well in column 1 (rows A–F) with 1 M NaOH solution (see diagram).

B. Do the same with columns 2–7 with 1 M HCl, 1 M H_2SO_4, 1 M HNO_3, saturated $Ca(OH)_2$, 1 M KOH, and distilled water, respectively. Rinse the dropper when changing solutions.

C. Dip small pieces of red and blue litmus paper in each of the solutions in row A (see diagram) 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 metal 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.

H. Test each of the seven solutions with a lightbulb-conductivity apparatus. To do this, fill a 100 mL beaker half full of distilled water. Add 10 mL of the test solution. Test each with the conductivity apparatus. Record your observations in the table.

	NaOH	**HCl**	**H_2SO_4**	**HNO_3**	**$Ca(OH)_2$**	**KOH**	**Distilled Water**
Litmus							
Bromothymol blue							
Phenolphthalein							
Mg							
$CaCO_3$							
$Mg(NO_3)_2$							
Conductivity							

II. Data Analysis

A. Group the seven solutions according to similar 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.

Obtain 20 mL of 1.0 M HCl and divide it into two 50 mL beakers. Put several pieces of Mg into one solution and cover the beaker with a watch glass. After waiting several minutes and without removing the watch glass, hold a lighted match to the pouring spout of the beaker. Record your observations. Write a chemical equation which represents the reaction.

Using the same procedure outlined above, put several chips of $CaCO_3$ into the second sample of 1.0 M HCl and test with a lighted match. Record your observations and write a chemical equation.

III. Interpretation

A. Assume the HCl is one of a class of compounds called acids and that NaOH is one of a class of compounds called bases. Summarize what you learned about acids and bases in this investigation so far.

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

IV. Data Collection: Concentrations of Acids and Bases

A. Obtain 5 mL of each of these solutions and put them in separate clean 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 an 0.1 M HCl solution in a clean test tube and label it "10^{-1} M H^+." Using a 10 mL graduated cylinder or a 10 mL graduated pipet, transfer 1 mL of the 10^{-1} M 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^{-2} M 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 to 10^{-5} M.

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

D. 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 a 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 10 solutions you made in parts IV.B and C. Record these data in the following table.

Distilled water pH = _____

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

V. Data Analysis and Interpretation

A. What conclusions can be drawn from these data?

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

VI. Data Collection and Analysis: Comparison of Different Acids and Bases

A. Obtain 5 mL of each of 6 M acetic acid and 1 M acetic acid ($HC_2H_3O_2$). Add a single chip of $CaCO_3$ to each solution. Compare the rate of these reactions to those of 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 $HC_2H_3O_2$, and 0.1 M H_3BO_3. Test each solution with pH paper using the procedure outlined earlier. Record your observations.

VII. Interpretation

A. How can you account for the data obtained in VI.A and B? 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 $HC_2H_3O_2$. Explain how these drawings illustrate the differences seen between the species in part VI.B.

VIII. 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 dropper bottle dropwise, swirling the solution during addition) until one drop of the HCl changes the color of the solution. Note the color and the approximate amount of HCl added. Write an equation for the reaction.

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

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

IX. 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 diluting 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 your observations in part VIII.A.