GENERAL CHEMISTRY I
GUIDED INQUIRY EXPERIMENTS
LAB COMPONENT CHE101L CONTENT: LAB 1
SPRING 2023
ACID AND BASE CLASSIFICATIONS

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Experiment 1 (session1)
Acid and Base Classifications

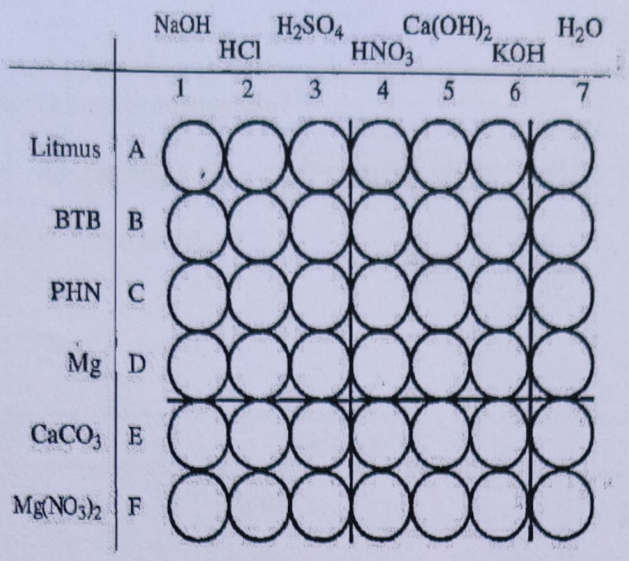
Acids and bases are classes of chemical compounds. There are weak and strong acids and bases based on their ability to dissociate in aqueous solution. They can interact with each other. Be careful when you handle acid or base in any situation. Please read the lab safety section carefully and consult with your instructor if necessary.

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

Part I

Data Collection: ***Properties of acids and bases***

A. Set up a 96 well micro-plate on the lab bench. Label rows and columns which can be seen in figure below. With a medicinal dropper or dropper bottle carefully ½ fill each well of column 1(***rows A-F***) with 1.00 M NaOH solution.



B. Do the same with columns 2-7 with 1.00 M HCl, 1.00 M H_2SO_4, 1.00 M HNO_3, saturated Ca $(OH)_2$, 1M 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 below.

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

E. Place a small piece of magnesium (Mg) metal in each of the solutions in row **D**. Record your observation in the table.

F. Place a small amount of $CaCO_3$ in each of the solutions in row **E**. Record your observation in the table.

G. Add one micro drop of Mg $(NO_3)_2$ solution to each of the solutions in row **F**. Record your observation in the table.

Record your Observation.

	NaOH	HCl	H_2SO_4	HNO_3	Ca $(OH)_2$	KOH	Distilled Water
Litmus Blue	Blue	Red	Red	Red	Blue	Blue	Blue
Litmus Red	Blue	Red	Red	Red	Blue	Blue	Red
Bromothymol blue	Blue	Orange	Orange	Orange	Blue	Blue	Green
Phenolphthalein	Purple	No Change	No Change	No Change	Pink	Purple	No Change
Mg	No Change	Bubble	Bubble	Bubble	No Change	No Change	No Change
$CaCO_3$	PPT	Bubble	Bubble	Bubble	Cloudy	PPT	PPT
~~$Mg(NO_3)_2$~~							

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?

We need at least 3 groups to categorise the seven solutions based on their similar properties. These are,

i. Acids
ii. Bases
iii. Neutral

Acids	Bases	Neutral
- HCl - H_2SO_4 - HNO_3	- NaOH - KOH - $Ca(OH)_2$	- Distilled Water

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

When I added $CaCO_3$ in the solution of NaOH, I observed,

$$CaCO_{3\,(s)} + 2\,NaOH_{(aq)} \longrightarrow Ca(OH)_{2\,(s)} + Na_2CO_{3\,(aq)}$$

Here, $Ca(OH)_2$ was the white precipitate.

Part II

Data Collection: *Reactions of acids and bases*

Obtain 20.00 mL of 1.00 M HCl and divide it equally into two 50.00 mL beakers. Mark them as beaker 1 and beaker 2.

Beaker 1

Put several pieces of Mg metal into beaker 1 and cover it with a watch glass. Wait few minutes, don't remove the watch glass. Hold a lighted match to the pouring spout of the beaker. Write down your observations. Write a chemical equation which represents the reaction.

i. Bubble formation

ii. Explotion with POP sound

iii. Flame of burning match stick was extinguished

Equation:

$$\underset{(aq)}{HCl} + \underset{(s)}{Mg} \longrightarrow \underset{(aq)}{MgCl_2} + H_2\uparrow$$

Beaker 2

Put several chips of $CaCO_3$ into the second beaker of 1.00 M HCl solution and test with a lighted match. Record your observation and write a chemical equation which represents the reaction.

i. Bubble formation

ii. Flame of burning match stick was extinguished.

Equation:

$$2HCl + CaCO_3 \longrightarrow CaCl_2 + CO_2 + H_2O$$

Data Interpretation for part I and part II

a. Suppose HCl is one of a class of compounds call "acid" and NaOH is one of class of compounds called "base". What did you learn about them in this experiment so far?

So far, in this experiment I have learnt about acid and base are,

i. Acid - Base reaction:
When an acid, such as HCl, reacts with a base, such as NaOH, they will neutralize each other, forming water (H_2O) and salt (NaCl).

ii. pH scale:
Acids and bases are also associated with the pH scale. Acids have a pH below 7, while bases have a pH above 7.

iii. Chemical Properties:
Acids and bases have distinct chemical properties. Acids can donate protons (H^+) to other substances, while bases can accept protons.

b. From there chemical formula given, identify the similarities and differences among each of the groups you identified in the data analysis section of **Part I**.

i. Blue Litmus gives Red color for acids, blue color for bases and neutral solutions.
ii. Red litmus gives red color for acids and neutral and blue color for bases.
iii. Bromothymol blue gives orange solutions for acids, blue solutions for bases and green solutions for neutral.
iv. Phenolphthalein gives no change for acids and neutral but, makes pink/purple solutions on bases.
v. Mg gives bubble for acids and no change for bases and neutral.
vi. $CaCO_3$ give bubble for acids and PPT/cloudy for bases and neutral solutions.

Part III (Session2)

Data Collection: *Preparation of various* concentrations of acids and bases

Following serial dilution method prepare 0.1, 0.01, 0.001, 0.0001 & 0.00001 M HCl and NaOH from 1M 10 ml stock solution. All in 10ml container.

To prepare 0.1M HCl, you need to dilute the 1M stock solution by a factor of 10. To do this, you need to mix 1 part of the 1M stock solution with 9 parts of distilled water.

1. Take 1ml of 1M HCl stock solution in a 10ml container.
2. Add 9ml of distilled water to the container.
3. Mix well and the final concentration of the solution will be .1M HCl.

To prepare .01M HCl, you need to dilute the .1M solution by a factor of 10. To do this, you need to mix 1 part of the .1M solution with 9 parts of distilled water.

1. Take 1ml of .1M HCl solution in a 10ml container.
2. Add 9ml of distilled water to the container.
3. Mix well and the final concentration of the solution will be .01M HCl.

To prepare 0.001M HCl, you need to dilute the .01M solution by a factor of 10. To do this, you need to mix 1 part of the .01M solution with 9 parts of distilled water.

1. Take 1ml of .01M HCl solution in a 10ml container.
2. Add 9ml of distilled water to the container.
3. Mix well and the final concentration of the solution will be 0.001M HCl.

To prepare 0.0001M HCl, you need to dilute the 0.001M solution by a factor of 10. To do this, you need to mix 1 part of the 0.001M solution with 9 parts of distilled water.

1. Take 1ml of 0.001M HCl solution in a 10ml container.
2. Add 9ml of distilled water to the container.
3. Mix well and the final concentration of the solution will be 0.0001M HCl.

To prepare 0.00001M HCl, you need to dilute the 0.0001M solution by a factor of 10. To do this, you need to mix 1 part of the 0.0001M solution with 9 parts of distilled water.

1. Take 1ml of 0.0001M HCl solution in a 10ml container.
2. Add 9ml of distilled water to the container.
3. Mix well and the final concentration of the solution will be 0.00001M HCl.

The same steps can be followed to prepare 0.1, 0.01, 0.001, 0.0001, and 0.00001M NaOH solutions from the 1M stock solution.

Part IV

Data Collection: Concentrations of acids and bases

a. Obtain 10.00 mL of a 0.10 M HCl solution in a clean test tube and label it "10^{-1} M H^+". Transfer 1.00 mL of 10^{-1} M HCl solution to a test tube and add 9.00 mL of distilled water in it. Mix it thoroughly and label the test tube as "10^{-2} M H^+". Rinse and shake dry the transferring glass wires. Repeat the procedure to prepare solutions 10^{-3} M H^+", 10^{-4} M H^+" and "10^{-5} M H^+".

b. Again obtain 10.00 mL of 0.10 M NaOH in a test tube and label it as "10^{-1} M OH^-". Repeat above serial dilution procedure to prepare up to "10^{-5} M OH^-" solution.

c. Obtain a centimeter long strip of a broad range pH paper. Dip a glass rod into distilled water and touch that to a small section of a 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 sections a and b above.

Distilled water pH = 7

Acid		Base	
Dilution	pH	Dilution	pH
10^{-1}	1	10^{-1}	13
10^{-2}	2·5	10^{-2}	11
10^{-3}	5·5	10^{-3}	9
10^{-4}	6·5	10^{-4}	7·5
10^{-5}	7	10^{-5}	7

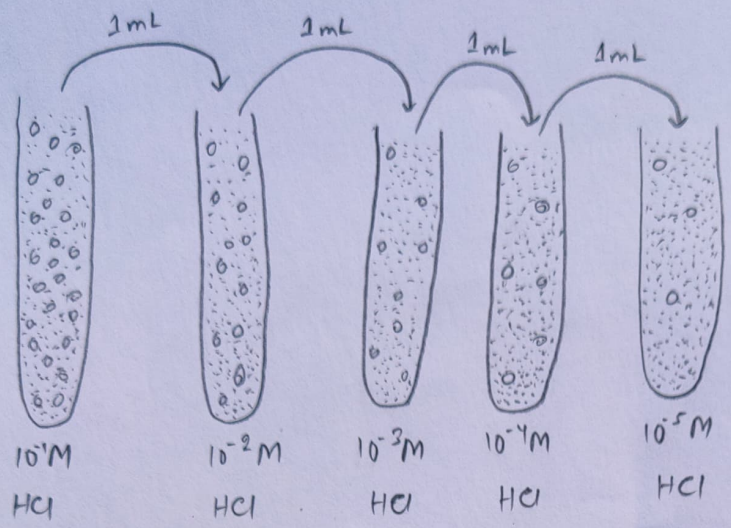
Data Analysis and Interpretation

a. What conclusions can be drawn from these data?

The conclusion from dilution is that the concentration of the solution decreases. This means that there are fewer acid or base particales (H^+ in acids & OH^- in bases) per unit volume in the diluted solution compared to the original solution. Dilution of an acid solution will result in an increase in pH, moving it closer to neutrality (pH7). Conversely, dilution of a base solution will lead to a decrease in pH, also moving it closer to neutrality.

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.

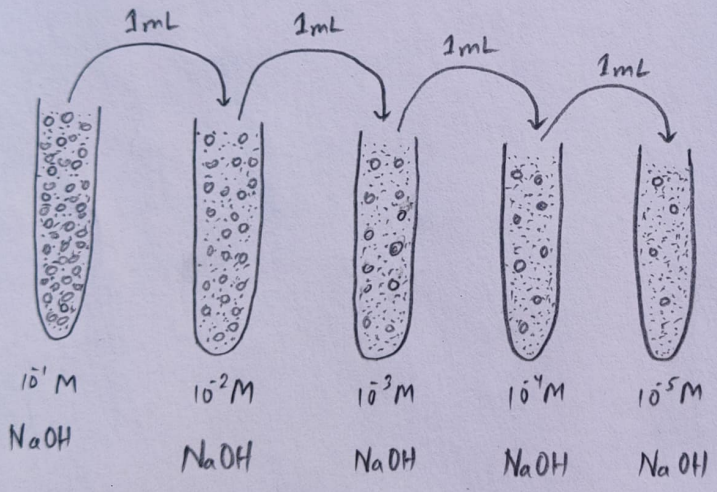
Acid:



o — HCl particales

. — H_2O particles

Base:



o — NaOH Particles

. — H_2O particles