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GENERAL CHEMISTRY

LAB COMPONENT CHE101L

GUIDED INQUIRY EXPERIMENTS

CONTENT: LAB 1

ACID AND BASE CLASSIFICATIONS

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DATE 10-09-2024 TIME 12.15pm

NAME OF THE INSTRUCTOR Dr. Mohammed Kabir Uddin (MKUN)

SIGNATURE & DATE .....

REPORT SUBMISSION DATE (ASSIGNED BY INSTRUCTOR) 24-09-2024

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

Record your observations: **Mark: 2**

	NaOH	HCl	H_2SO_4	HNO_3	$Ca(OH)_2$	KOH	Distilled Water
Litmus (Red)	Blue	Red	Red	Red	Blue	Blue	Red
Litmus (Blue)	Blue	Red	Red	Red	Blue	Blue	Blue
Bromothymol blue	Blue	orange	orange	orange	Blue	Blue	orange
Phenolphthalein	Pink	No change	No change	No change	Pink	Pink	No change
Mg	No change	Bubble	Bubble	Bubble	No change	No change	No change
$CaCO_3$	PPT	Bubble	Bubble	Bubble	Cloudy	PPT	Cloudy

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? **Mark: 2**

According to similar properties in each group the included substances are given below:

The least number of groups needed is three. The groups are: Acid, Base and Neutral.

The substances in each group according to their similarities:

Acid : HCl, H_2SO_4, HNO_3 . These molecules have H^+ ions.

Base : NaOH, $Ca(OH)_2$, KOH . These molecules have OH^- ions.

Neutral : Distilled water. This is pure water.

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.

Here, $Mg(s) + 2HCl(l) \longrightarrow MgCl_2(aq) + H_2(g)$

In beaker, Mg reacts with acid HCl and create H_2 gas. H_2 gas is highly flameable. So, holding a lighted match to the pouring spout, we observed that an explosion occurred with a 'pop' sound and the flame of the match stick went off.

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.

Here, $CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

In beaker, $CaCO_3$ reacts with HCL acid and produce $CaCl_2$, water (H_2O) and CO_2 gas. When we took a burning match stick close to the beaker, we observed that, the flame of the match stick was extinguished sliently. As we know that CO_2 is fire extinguisher, it helps to be went off the flame of the match stick.

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? **Mark: 4**

HCl is an acid and NaOH is a base. They both are strong acid and base. They undergo a neutralization reaction to form sodium chloride (NaCl) salt and water (H_2O). The reaction:

$$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$

But the reaction of HCl and NaOH are not same. Explained below:

HCl (acids): (1) They react with metal like Mg to give H_2 gas.
(2) They react with $CaCO_3$ to give water and CO_2 gas.
(3) They will change the color of bromothymol blue to orange.
(4) They will remain colorless when react with phenolphthalein
(5) They will change the color of blue litmus paper to red litmus.

NaCl (bases): (1) They donot react with Mg.
(2) They form precipitates of $Ca(OH)_2$ when they react.
(3) They will remain same color when react with bromothymol blue
(4) They will change the color of phenolphthalein to pink.
(5) They will change the color of red litmus paper to blue litm

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. **Mark: 2**

The groups I identified are acids, bases and neutrals.

Similarities: Acids lower the pH, bases raise the pH and neutral substances have a pH around 7. All three can be tested with pH indicators like litm paper, phenolphthalein or bromothymol blue to determine their nature.

Differences:

Properties	Acid	Base	Neutral
pH Range	Less than 7	Greater than 7	Around 7
litmus Paper	Turns blue litmus paper red	Turns red litmus paper blue	No significant color change
Formulation	They have either metal or non metallic element next to the 'H' in their formula.	They have different metals combined with 'OH'	The only neutral substance is water (H_2O).

Part III

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 and b above. **Mark: 4**

Distilled water pH = 7

Acid		Base	
Dilution	pH	Dilution	pH
10^{-1}	1	10^{-1}	13
10^{-2}	2	10^{-2}	11
10^{-3}	4	10^{-3}	9
10^{-4}	6	10^{-4}	8
10^{-5}	7	10^{-5}	7

Part IV

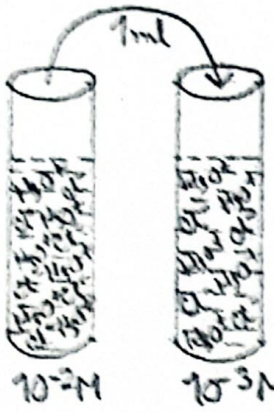
Data Analysis and Interpretation

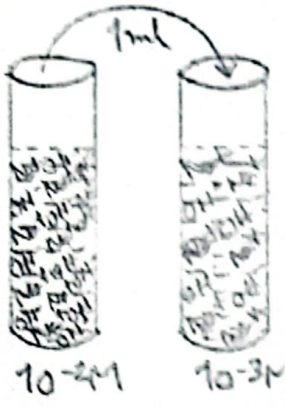
a. What conclusions can be drawn from these data? **Mark: 2**

0.1M H^+ shows pH = 1, meaning it is very strong acid. As it is diluted by 10 times and each time, the pH decreases. When the grouping of both acid and base was decreasing, their respective characters were also decreasing. When we diluted acid, pH level increased and its character transformed from strong to weak acid. In term of base, when we diluted, pH level decreased and its character transformed from strong to weak base.

a. **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. **Mark: 4**

My observations are illustrated in the picture below:





$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$

$NaOH + H_2O \longrightarrow Na^+ + OH^- + H_2O$

Here, from acid concentration, as the grouping of HCl was high, H^+ ions were more available and pH was gradually decreasing. At the point when fixation was decreasing, the number of H^+ particles decreased and pH was gradually increasing. In term of bases

concentration, the grouping of NaOH was high, so the availability of OH^- was high and pH was increasing as well. When the fraction was decreasing, the pH went low because of the decreased OH^- ions.