**Lab #47: The pH Scale (Investigation 13A)**

The “p” stands for potential and the “H” stands for Hydrogen.  What is potential Hydrogen? pH level refers to the amount of acid and alkaline contained inside the solution. The pH scale is associated with acids and bases. It is a logarithmic scale, meaning a change of 1pH unit means the concentration of H+ ions is solution changes by a factor of ten. The level of pH is measured on a scale of 0 to 14 with 0 representing the highest concentration of acid and 14 representing of the most alkaline.   Seven is the magic figure for pH because it means that there is a balance of acid and alkaline in the solution and is often referred to as pH neutral.

***Pre-Lab questions***

1. *According to the reading, what does pH stand for? What does pH actually measure?*
2. *The term “alkaline” is a synonym for what type of solution?*

**



**Part 1: Setting up for Acids**

1. Label 6 small test tubes with numbers 1 through 6 and place them in the test tube rack.
2. Make mixture #1 by adding 45mL of water and 5mL of 1M HCl. ***MIX*** well.
3. Put about 10mL of mixture #1 in test tube #1. Save it for later!
4. Make mixture #2 by adding 45mL of water and 5mL of mixture #1. Mix well.
5. Put 10mL of mixture #2 in test tube #2 and save it for later.
6. Clean out the first graduated cylinder. Make mixture #3 by adding 45mL of water and 5mL of mixture #2. Mix well.
7. Put10mL of mixture #3 in test tube #3 and save it for later.
8. Repeat the process three more times, each time mixing 5mL of each mixture with 45mL of water to get the next mixture. You should finish with 6 test tubes like the diagram on the next page.
9. Add 2 drops of methyl orange indicator to each test tube.

**Reading Check:** pH is dependent on the concentration of H+ ions in a solution measured in moles/liter. The mathematical expression is pH = -log[H+]. pH is actually in factors of ten. For example, a solution with a pH of 1 is 10 times more acidic than a solution with a pH of 2 and 100 times more acidic than a solution with a pH of 3, etc.

1. How many times stronger is a solution with a pH of 1 than a solution with a pH of 4?

**Part 2: Doing the math for Acids**

Each of the test tubes has a different concentration of acid. In the next step, you are going to calculate the concentration of each test tube of acid.

1. Calculate the concentration of the mixture itself. Use Table 2 to record the results of your concentration. (M1V1=M2V2)
2. Calculate the pH of each tube and put it in the table below.

|  |  |  |
| --- | --- | --- |
| **Table 2: Concentration Data** | | |
| Test Tube # | Vol of 1M HCl  (mL) | Total Vol.  (mL) | | [H+]  Molarity | pH |
| 1 | 5 | 50 | | 0.1 | 1.0 |
| 2 | 0.5 | 50 | |  |  |
| 3 | 0.05 | 50 | |  |  |
| 4 | 0.005 | 50 | |  |  |
| 5 | 0.0005 | 50 | |  |  |
| 6 | 0.00005 | 50 | |  |  |

**Part 4: Observations**

1. What can you say about the appearance of the test tubes? How do they compare to each other? Which is lightest? Which is darkest? Do any appear the same? Answer all of these questions using 2-3 sentences.

**Part 3: Setting up for Bases**

Clean your acid test tubes. You will need them to prepare a pH series of bases next.

1. Label six small test tubes with numbers 8 through 13.
2. Make mixture #13 by adding 45mL of water and 5mL of NaOH. Put about 10mL in test tube #13 and save it for measuring later.
3. Make mixture #12 by adding 45mL of water and 5mL of mixture #13. Put 10mL or so in test tube #12 and save it for measuring later.
4. Clean out the first graduated cylinder. Make mixture #11 by adding 45mL of water and 5mL of mixture #12. Save 10mL in test tube #11.
5. Repeat the process three more times, each time mixing 5mL of each mixture with 45mL of water to get the next mixture. You should finish with 6 test tubes.
6. Add 2 drops of universal indicator to each test tube.

**Part 4: Doing the math for Bases**

Each of the test tubes has a different concentration of acid. In this next step, you are going to calculate the concentration for each one.

1. Calculate the concentration of the mixture itself. Use Table 4 to record the results of your concentration. Show your work. (M1V1=M2V2)

b. Use the equation to the right to calculate the pH of each tube.

|  |  |  |
| --- | --- | --- |
| **Table 4: Concentration Data** | | |
| Test Tube # | Vol of 1M  NaOH (mL) | Total Vol.  (mL) | | [OH-] Molarity | pH |
| 13 | 5 | 50 | | 0.1 | 13.0 |
| 12 | 0.5 | 50 | |  |  |
| 11 | 0.05 | 50 | |  |  |
| 10 | 0.005 | 50 | |  |  |
| 9 | 0.0005 | 50 | |  |  |
| 8 | 0.0005 | 50 | |  |  |

**Part 5: Observations**

1. What can you say about the appearance of the test tubes? How do they compare to each other? Which is lightest? Which is darkest? Do any appear the same? Answer all of these questions using 2-3 sentences.
2. Do your observations agree with what you expect?

**Part 6: Comparing Acids and Bases**

1. According to what you observed in the first half of your labs, what colors are acids in the presence of an indicator? What color are bases?
2. As you dilute the concentration of H+ ions in solution, will the pH increase or decrease. Provide a range of pH that indicates a solution is an **acid.**
3. Provide a range of pH that indicates a solution is a **base.**
4. Using your answers from b and c, what pH is considered “neutral”?
5. pH is dependent on the concentration of H+ ions in a solution measured in moles/liter. The mathematical expression is pH = -log[H+]. Why do we need to plot the differences in pH on a log scale? What does this mean?