**Activity 5.3.3 Basic or Acidic?**

The measure of acidity or alkalinity of water soluble substances is called the pH of the liquid. This is based on the number of hydrogen ions (H+) in the liquid. In pure water there is an equal number of hydrogen ions and hydroxide ions. So water is neutral, neither acidic nor basic. A pH value (pH stands for power of Hydrogen) is a number between 0 and 14, with 7, the pH of water, being neutral. When an acid is dissolved in water there are more hydrogen ions than hydroxide ions so it is acidic. When a base is dissolved in water there are more hydroxide ions than hydrogen ions so it is basic or alkaline. Each whole pH value below 7 is 10 times more acidic than the higher value and each whole pH value above 7 is 10 times less acidic than the one below it. For example a pH of 2 is 10 times more acidic than a pH of 3 and 1000 times more acidic than a pH of 5. A pH of 11 is 10 times more alkaline than a pH of 10. So values above 7 indicate alkalinity which increases as the number increases, 14 being the most alkaline. But values below 7 indicating acidity increase as the number decreases, 1 being the most acidic.

**The formula for pH is:**

**pH = -log[H+]**

where **[**H+**]** is the concentration of hydrogen ions in moles per liter, M/L. One mole = 6.022 X 1023 molecules or atoms. The brackets mean “the concentration of.” Typical concentrations range from 10-15 M to 1010 M. The pH scale was invented by the Danish biochemist S. P. Sorensen in 1909.

If you were to graph pH on the y axis and **[**H+**]** on the x axis you would get a base 10 logarithmic curve that has been reflected across the x axis.

Liquids with a low pH (as low as 0) are more acidic than those with a high pH. Water is neutral and has a pH of 7.0 . A substance with a pH > 7 is called basic or alkaline. If the pH < 7, the substance is acidic. Note the lower the pH the higher the acidity and the higher the concentration of hydrogen ions. It is customary to round pH values to the nearest tenth.

1. Complete the following table

|  |  |  |  |
| --- | --- | --- | --- |
| pH value | H+ Concentration | H+ Concentration Relative to Pure Water | Substance |
|  | 100 = 1 | 10,000,000 | Battery acid |
| 2 |  |  | Lemon juice |
|  | 10-3 = .001 | 1000 | Acid rain |
|  |  | 100 | Black coffee |
| 7 | 10-7=.000 000 1 | 1 | Pure water |
|  |  | 0.1 | Sea water |
| 11 | 10-11 = .000 000 000 01 |  | Ammonia |
|  |  | .000001 | Bleach |
| 14 |  |  | Liquid drain cleaner |

Example: Find the pH of a solution with [H+] = 2.5X 10-5 and state whether it is acidic or basic.

pH = -log[H+]

 = -log ( 2.5X 10-5) = -(log 2.5 + log 10-5) why?

 $≈$ -(.3979 + -5) why?

 $≈$ -.3979 + 5 why?

 $≈$ 4.6 so the pH = 4.6 so the solution is acidic

1. Now find the concentration of hydrogen atoms for the example.
2. Vinegar has a pH of 2. Compare its acidity to that of water.
3. Lime juice has a pH of 1.7. What is the concentration of hydrogen ions to the nearest thousandth?
4. Suppose that you test orange juice and find that the hydrogen ion concentration is [H+] = $7.94 ×10^{-5}$. Find the pH value and determine whether the juice is basic or acidic.
5. How much more acidic is cranberry juice, with a pH of 2.35, compared to apple juice, with a pH of 3.5?