Activity 9

pH and Total Alkalinity

Part 1

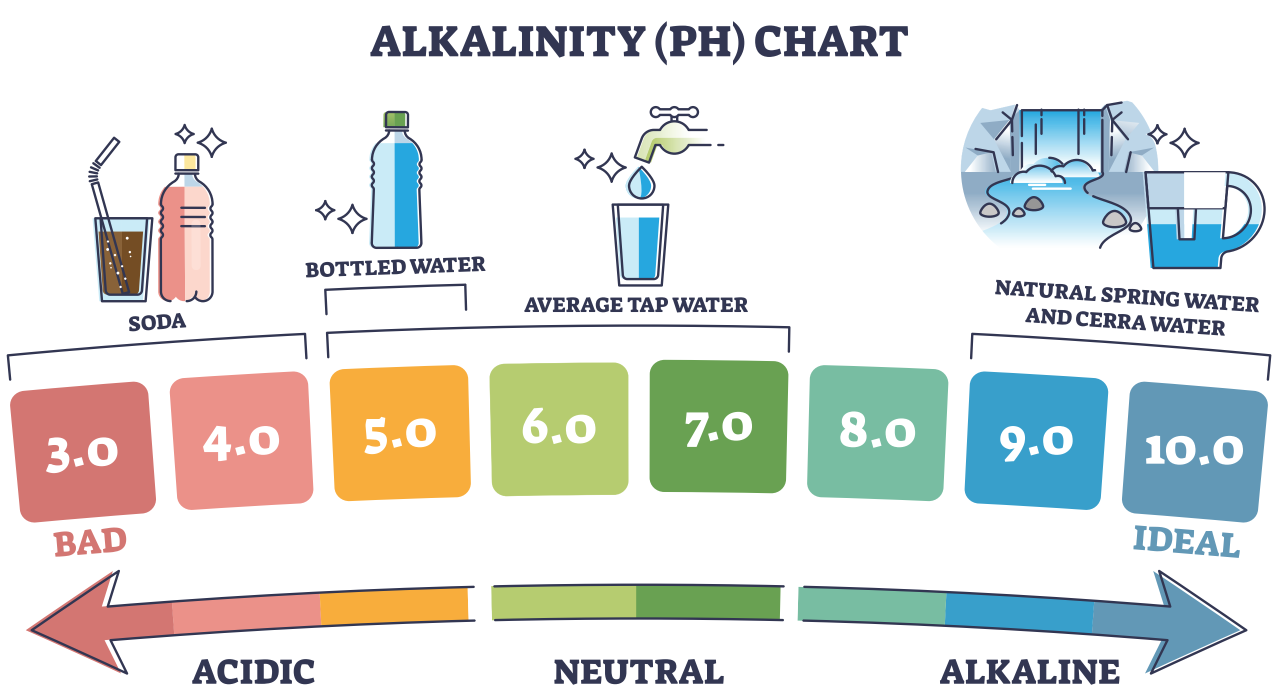
Many living things can survive only in a very narrow pH range, normally pH 6 to 9. Even small shifts in pH can kill aquatic organisms. pH determines the solubility of most metals. Most water treatment processes only work at carefully controlled pH levels.

Acidic substances regularly enter our water from naturally occurring environmental processes. Tannic acids from the decay of plant materials turn the water brown. Carbonic acid (also found in soft drinks) is formed from the reaction between water and carbon dioxide in the air. Mineral acids are inorganic acids, they may be formed from the metal salts left over from mining operations. Acid rain results when pollutants from automobiles, industry and/or volcanoes combine with water vapor in the air to form sulfuric and nitric acids.

Acidic water (low pH) tends to corrode metal pipes, etch glass, erode marble statues and buildings, and dissolve concrete. Metals such as copper and iron, dissolved by acidic water, may stain plumbing fixtures and cause deformities in fish. Acid rain, usually falling down-wind from areas with high automobile and/or industrial pollution, harms crops, forests and wildlife habitats. It may drop the pH of lakes so low that organisms cannot live, or melting snows in the spring may result in "acid shock," causing sudden fish kills.

High alkalinity levels lead to a build up of mineral deposits (scale) in pipes and fixtures. However, moderate amounts of dissolved carbonates and bicarbonates (alkalis) are desirable because they neutralize acids that enter the water from the environment. Thus In this way alkalinity reflects the ability of the system to resist changes in pH from the addition of acidic or basic substances, i.e. alkaline compounds act as a buffer.

Why do we test both pH and alkalinity together? pH and alkalinity tend to "flow" together. Water with low pH (water that is acidic) has low alkalinity. Water with high alkalinity (high amounts of dissolved carbonates and bicarbonates) typically has a high pH and is basic. Using both measures together allows the water quality scientists use both measurements to determine not only the acidic or basic properties of the water system (the pH), but also the stability of the pH reading (due to the buffering effect of the alkaline minerals).



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Activity 9

pH and Total Alkalinity

Part 2

OBJECTIVES:

1. Use water quality test strips to measure pH and total alkalinity in common solutions, including lemon juice, vinegar, baking soda, dishwashing detergent, tap water and distilled water.
2. Demonstrate the effect of excess nitrate on a body of water.

VOCABULARY:

H_2O – Water contains both H+ (hydrogen ions) and OH- ions (hydroxyl ions). Pure water contains equal numbers of hydrogen and hydroxyl ions. It is considered neutral, with a pH of 7.

Acid – A solution that has more H+ (hydrogen ions) than OH- (hydroxyl ions), with a pH less than 7.

Base – A solution that has more OH- ions than H+ ions, with a pH greater than 7. A base is the opposite of an acid.

pH – A measure of the acidic or basic nature of a solution, or the relative balance of H+ and OH- ions. The pH scale runs from 0 to 14, with 7 as the neutral point.

Alkalinity – This refers to the total dissolved minerals (usually carbonates and bicarbonates originating from limestone and gypsum soils) that react with acids to neutralize them. Alkalinity helps buffer a solution.

Buffer – A solution that resists changes in pH in response to the addition of small amounts of acid or base.

MATERIALS:

School Test Kit Materials:
pH and Total Alkalinity test strips
Plastic droppers
School Kit Color Chart and Instruction card
Data collections sheet, copied for number of students

Equipment:
Clean Glass Jars or Cups
Sample jars with lids

Shopping list:
Reconstituted Lemon Juice
Distilled White Vinegar
Baking Soda
Dishwashing Detergent (Liquid or Powder)
Distilled Water
Tap Water

SAMPLE PREPARATION:

Lemon juice solution – (1 drop reconstituted lemon juice: 100 ml distilled water)

Vinegar solution – (1 drop distilled white vinegar in 100 ml distilled water)

Baking soda solution – (4 g in 100 ml water X volume needed)

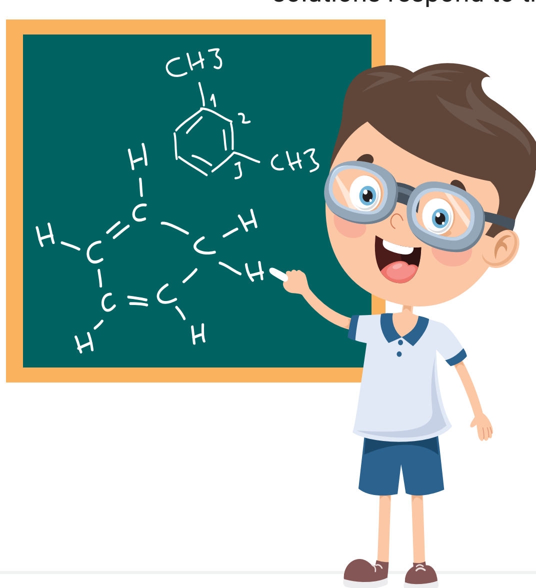
Detergent solution – (4 g detergent dissolved in 100 ml water X volume needed)

Tap water – (Let water run for 1 minute before collecting sample)

Distilled water

PROCEDURE:

1. Take 50 ml sample of each of the 6 solutions above, clearly labeled, and 8 pH/Total Alkalinity test strips, and the data sheet.
2. Dip one test strip into the distilled water sample for 10 seconds without any motion. Immediately (within the first 15 seconds,) remove the strip from the water sample and match the pH (end pad) color to the pH color chart. Record results on the data sheet. Quickly, before 30 seconds have passed, match the total alkalinity pad color to the total alkalinity color chart. Record results on the data sheet.
3. Repeat the process for lemon juice, vinegar, baking soda, detergent, and tap water.
4. Compare how the distilled water and the baking soda solutions respond to the addition of an acid. Use the same distilled water and baking soda samples from steps 2 and 3. Fill a dropper with the vinegar solution. Drop 5 drops of the vinegar solution into the distilled water sample. Using a clean test strip, test for pH and total alkalinity; record the results on the data sheet. Repeat with the baking soda solution.



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Activity 9

pH and Total Alkalinity

Part 3

ANALYSIS AND APPLICATION

1. Analyze the results of steps 1-3 by answering the following questions. Record answers in the notes column on the data sheet.
2. Which solution is most acidic?
3. Which solution is most basic?
4. Which solution tested highest for total alkalinity?
5. Which solution tested lowest for total alkalinity?
6. Using the results from step 4, compare the change in pH when vinegar is added. Explore further: How many drops total of vinegar solution would it take to lower the pH of the baking soda solution so that it is equal to the distilledwater solution with 5 drops of vinegar added? Why does it take so many more drops of vinegar solution to lower the pH of the baking soda solution than it does to reduce the pH of the distilled water? [Note: in this experiment, the baking soda solution acts as a buffer.]

EXTENSION

1. Predict how your results in steps 1-3 might have been affected if the solutions had been made with tap water instead of distilled water? Record your hypothesis. Test your hypothesis. Describe what you did to test your hypothesis and the results that you obtained.
2. Design an experiment to demonstrate how dissolved carbon dioxide affects the pH of rainwater. Record your hypothesis, procedure, data, results and conclusion.