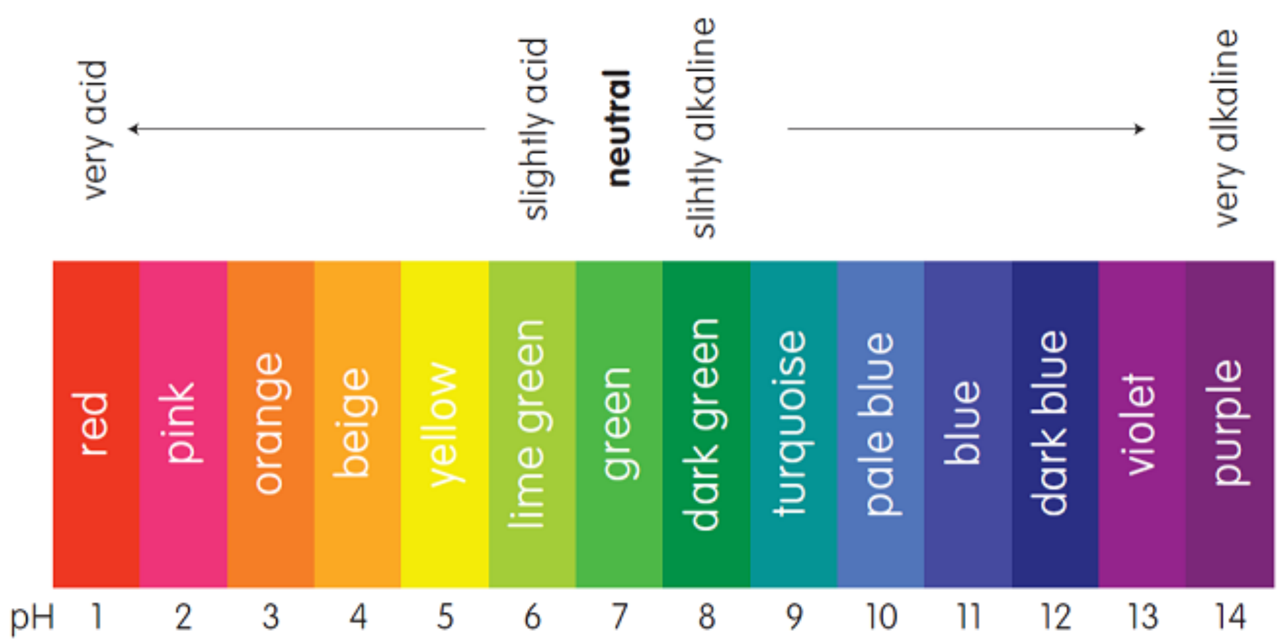
Kingsborough Community College City University of New York
The Science of Nutrition Laboratory
Science 7000

pH Scale

Humans come in contact with acids and bases all the time-when cooking, cleaning, and eating. Baking soda is base used in household cleaners. Vinegar is a weak form of acetic acid used in salad dressing. Citrus fruits contain citric acid. Sodas are loaded with carbonic acid which is made when carbon dioxide combines with the water in your body. If you combine vinegar with baking soda a chemical reaction occurs with lots of fizzing and foaming that result from the interaction between the acid (vinegar) and the base (baking soda). There are also acids in the human body. Hydrochloric acid is in your stomach and is used to digest food. The stomach acid has to be kept away from the rest of the body because it is very harsh and can cause serious damage. The lining of the stomach is especially built to survive an acidic environment.

The pH scale is used to classify substances as acids and bases. The scale goes from 0 to 14. Things that are acids have a pH number that is less than 7. The lower the number, the stronger the acid. Bases have pH values higher than 7. The higher the number, the stronger the base. An example of a strong base is drain cleaner or oven cleaner. Both strong acids and strong bases can be very harmful to your skin and tissues. Distilled water has a pH of 7, which is neutral.



Water is made of 2 hydrogen atoms and 1 oxygen atom. When water breaks apart, it can form hydrogen ions (H+) or hydroxide ions (OH-). Solutions are classified as acids or bases depending upon what kinds of ions they release. Acid solutions have lots of hydrogen ions present and basic solutions have lots of hydroxide ions present. For example, stomach acid has a pH of 2 or 3, which means that it is very acidic and has lots of hydrogen ions. The pH outside of your stomach is much closer to neutral. Most of the cells in living things cannot live in the presence of a strong acid. That is why it is important that the stomach acid stays in the stomach. The cells in the stomach lining replace themselves continually because it is a rough environment in which to live. One of the easiest ways to measure the pH of a substance is to use a pH indicator. Litmus is a paper coated with an indicator that turn red in an acid and blue in a base. Other pH indicators have a whole range of colors-one for every number on the pH scale. There are also pH indicators that can be found in nature. The juice produced by boiling red cabbage is useful for determining pH. A very acidic solution will turn red cabbage juice red. Neutral solutions appear purple and basic solutions turn a greenish-yellow when cabbage juice is added.

Environmental and chemical engineers who focus on water quality, water treatment and water remediation need to measure, monitor and sometimes even adjust the pH of water. For example, in the water treatment process, important chemical reactions are affected by the pH of the water. Through today's activity, we will learn more about the pH of different liquids.

Part A

Goal

This activity is designed for students to identify the pH level of compounds. By testing substances, they will understand how the pH determines why a compound reacts with other substances and for what purpose. Students will understand the property of acid and base; and how to test the pH of a liquid. Students may engage in a water quality field study and testing the pH of water in a local area.

Procedure

1. Label a cup with each of the liquids to be tested.
2. Fill cup approximately ½ full with corresponding liquid.
3. Record the test result of each substance. Write name of the liquid next to the number which corresponds to the tested result.
4. Dispose of acids and bases in separate containers or at separate sinks.

Table 1.

Substance	Indicator color	pH	Classification
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			

Questions:

What pH of water is recommended for human consumption? How does it affect your health?

What other acids and bases do we encounter every day?

PartB

There is still another way of classifying solutions, and it has to do with their electrical properties. If you take a material which does dissolve in water, the resulting solution will conduct electricity to varying degrees, anywhere from hardly at all to very well, depending upon what the material is.

Materials which **do not** increase the electrical conductivity of water when they are dissolved in the water are referred to as **nonelectrolytes**. Materials which **do** increase the electrical conductivity of water when they dissolve are called **electrolytes**.

Even among electrolytes, there are some variations. We can talk about **weak electrolytes**, and we can talk about **strong electrolytes**. Strong electrolytes increase the electrical conductivity of the water much more than do the weak electrolytes for comparable concentrations. All of this is summarized below.

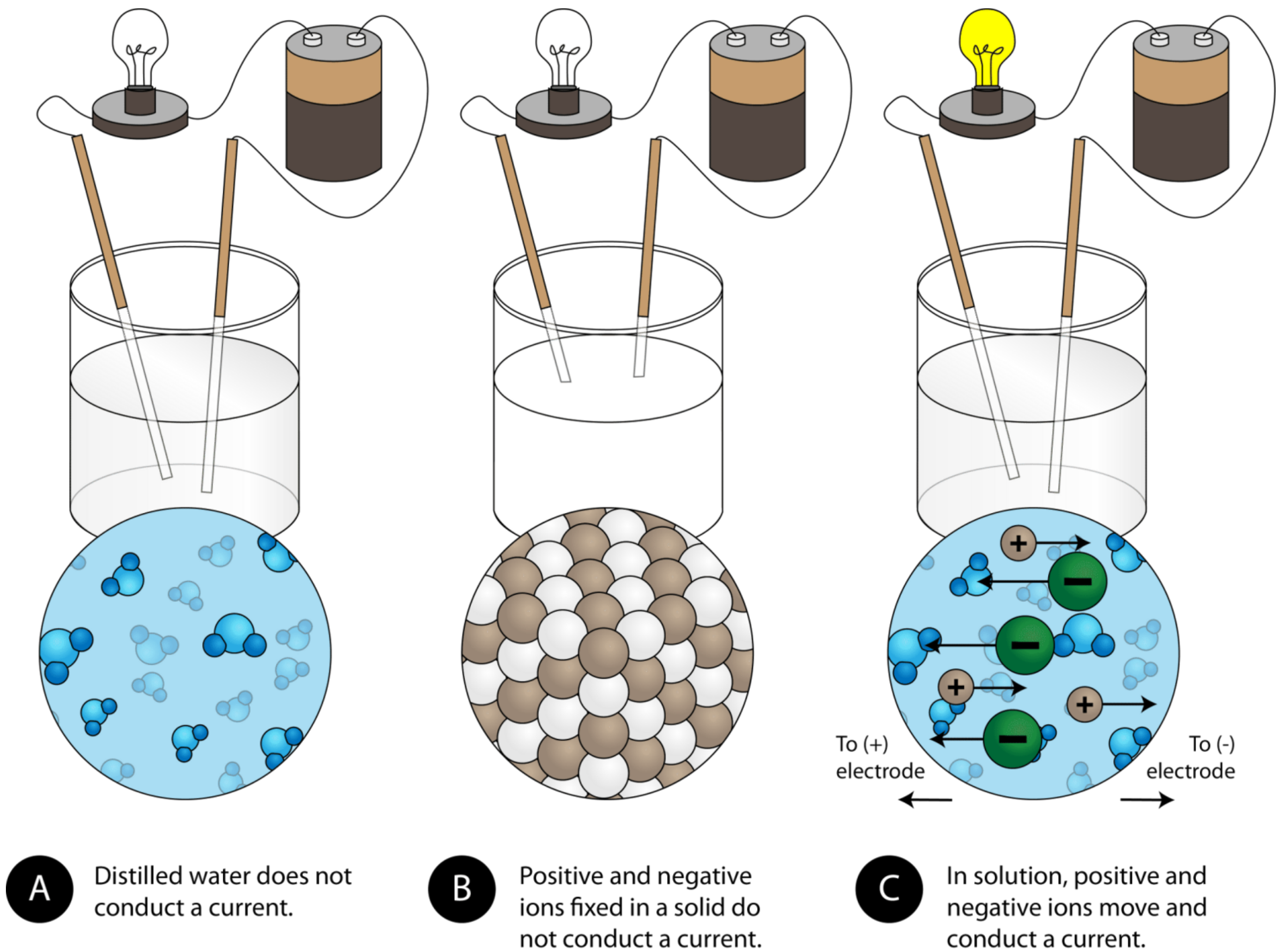
Materials soluble in water:

- **Nonelectrolytes** do not increase the electrical conductivity of water
- **Electrolytes** do increase the electrical conductivity of water
    - **Weak electrolytes** cause a mild increase in conductivity
    - **Strong electrolytes** cause a greater increase

Electrolytes are minerals that are found in body tissues and blood in the form of dissolved salts. As electrically charged particles, electrolytes help move nutrients into and wastes out of the body's cells, maintain a healthy water balance, and help stabilize the body's acid/base or pH level.

Any disease or condition that affects the amount of fluid in the body, such as dehydration, or affects the lungs, kidneys, metabolism, or breathing has the potential to cause a fluid, electrolyte, or pH imbalance (acidosis or alkalosis). Normal pH must be maintained within a narrow range of 7.35-7.45 and electrolytes must be in balance to ensure the proper functioning of metabolic processes and the delivery of the right amount of oxygen to tissues.

The conductivity of solutions can be tested by using a light bulb such as the one shown here. When there is little or no electrical conductivity between the probes the bulb will not light up. The more electrolytes available in solution the more light intensity will be observed.



The tests of conductivity shown above are somewhat crude because a number of factors come into play when determining the resistance of a solution to conducting electricity. These factors include concentration of the solute, distance between the probes, and also how far into the solution the probes are placed.

Table 3.

Substance	Observation