pH

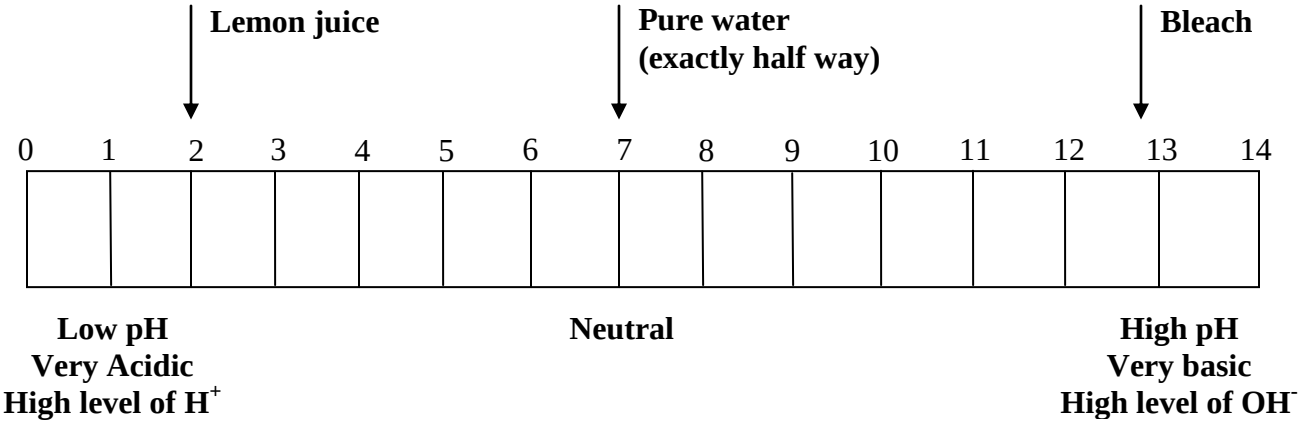
What is pH?

pH is a measurement of the degree to which water is "acidic" (like lemon juice) or "basic" (like bleach or soap). pH is measured on a scale that ranges from 0 (strongly acidic) to 14 (strongly basic). In the middle is 7, where the pH is "neutral" (like in pure water).

In the term pH, the H refers to the element Hydrogen, specifically Hydrogen H^+. The plus means that this Hydrogen is carrying a positive charge. Charged chemicals are also commonly called "ions", so H^+ is a Hydrogen ion. The "p" in pH stands for "power" of the activity of the H^+ ion activity in the water.

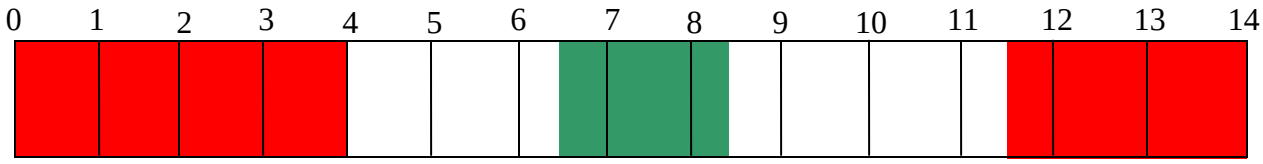
The pH scale is based on the balance between H^+ ions and negatively charged Hydroxide ions (OH^-) in the water. When pH is low (e.g., pH = 2) there are a lot of H^+ ions in the water. When pH is high (e.g., pH = 13) there are a lot of OH^- ions in the water. At the middle (pH=7), the two ions balance each other out completely. Each whole pH value below 7 is ten times more acidic than the next higher value. The same is true for whole pH values above 7, each is ten times more basic than the value below it.

Most lakes are basic (also referred to as "alkaline") when they first form. They become more acidic as they age due to buildup of organic material from plant leaves and animals. As organic substances decompose in the lake, carbon dioxide gas (CO_2) is formed. This CO_2 combines with water to form a weak acid, called "carbonic" acid. This carbonic acid lowers the water's pH over time.



Why does pH matter?

Most fish prefer to live in water that ranges in pH from around 6.4 to 8.4. Fish eggs grow and survive best at a narrower range of pH; from 6.0 to 7.2. Most North American rivers, lakes and streams fall within the range of 6.5 to 8.2. Trout can only survive when the pH of the water is between 4.1 and 9.5. If the pH of the water goes above or below those limits, the trout will die. Perch can survive as long as the pH does not fall below 4.6 or exceed 9.5.



In freshwater lakes and ponds, pH of the water can be affected by chemicals discharged by communities and industries. For example, acid rain has affected many Southern Canadian lakes and rivers. Acid rain occurs when certain pollutants (sulfur dioxide and nitrogen oxides) are released to the air from industries like power plants. These chemicals react with water in the air to form acids. These acids are then deposited to the land, lakes, and rivers in rain and snow.

When acid waters come into contact with certain chemicals and metals, they often make them more toxic than normal. As an example, fish that can usually live in pH values as low as 4.8 will die at the higher pH of 5.5 if the water contains a certain level of iron. When acid water is mixed with small amounts of aluminum, lead or mercury, the same problem occurs. The metals are much more toxic than they would normally be when the water is acidic.

Seawater is not as vulnerable to pH shifts as freshwater because different salts in seawater tend to prevent large shifts in pH. This being said, climate change is slowly increasing the acidity of the ocean because more carbon dioxide is entering seawater and forming carbonic acid. Normal pH values in seawater are about 8.1 at the surface and about 7.7 in deep water. Some shellfish and algae are very sensitive to changes in pH because they need to form calcium shells; we are already seeing effects of increased ocean acidity on these animals and plants.

How do we measure pH?

pH can be estimated using strips of paper embedded with different chemicals (litmus paper). These strips change colour depending on the acidity or alkalinity of the water they are placed, and the colour changes are evaluated against a guide to determine the approximate pH range of the water. pH can also be measured directly in a lake or river using a water quality meter. The meter has a sensor that is specific for measuring pH. Before use, this sensor is first calibrated in the lab using standards of known pH (typically pH 4, 7 and 10).

Photo credit: Jenny Graydon

References/For More information

Hach Company' H_2O University. 2007. *Important Water Quality Factors*. http://www.h2ou.com/h2wtrqual.htm#pH

Horne, A. J., and Goldman, C. R. 1994. Limnology, 2nd edition. McGraw-Hill, Inc. 576 pp.

U.S. E.P.A. What is pH? http://www.epa.gov/acidrain/measure/ph.html

Wetzel, R. G. 1983. Limnology, 2nd edition. Saunders College Publishing. 760 pp.