pH

Why does a lemon taste tart? Acidity, measured as pH accounts for part of the explanation. Lemons, which have a low pH, are acidic. The scale of pH measurements goes from 0 (the most acidic) to 14 (the most basic). Pure water is right smack in the middle with a pH of 7, which is neutral. The pH scale is logarithmic, meaning that each one-unit change in pH actually represents a 10-fold change in acidity. For example, lemon juice at pH 2.0 is ten times more acidic than vinegar at pH 3.0. pH is a measurement of the amount of H+ ions in a solution. Pure water is considered neutral at a pH of 7 because the number of H+ ions is exactly the same as the number of OH- (hydroxide) ions produced when these dissociate in water. In nature, water is never pure; it has dissolved substances and gases in it. For example, the carbon dioxide in the air causes water to have an acidic pH (near 5.6).

pH, which literally stands for the 'power of hydrogen', is an important part of water quality. Many fish and invertebrates are sensitive to high (above 9) and low (below 5) pH levels. At low pH levels the bones of fish can become soft and they may be unable to lay eggs successfully. In acidic conditions fish gills become clogged with mucus, making it difficult for the animals to get oxygen into their bloodstream. Sometimes, air pollution can cause precipitation to have a lower than normal pH. The pH of unpolluted rain is about 5, while rain that has become acidic because of pollutants has a range from 3.5 to 4.5. This is called "acid rain". Other substances, like concrete or drain cleaner can cause the pH of water to be very high. During intense algal blooms (caused by high nutrient loads), the drawdown of carbon dioxide from photosynthesis also leads to high pH, over 10 in some cases.

Natural variation in soil and bedrock can greatly alter the pH of streams and ponds as well as buffer their susceptibility to acidification. Areas of limestone, therefore, have naturally high pH and greater resistance to acid rain. Much of the lower Hudson (below the Troy dam) is well-buffered and therefore fairly insensitive to acid deposition, while parts of the Adirondacks are poorly buffered and therefore very sensitive to acid deposition. Aquatic invertebrates can be more sensitive to pH changes than fish. Some insects that are especially sensitive to drops in pH are mayflies, sowbugs, damselflies, and dragonflies, crayfish, and snails. Carbonate, which is a component of the shells of clams and snails, begins to dissolve if pH goes below about 6.0. The pH of the Hudson River varies with location, season and freshwater discharge. It is typically moderately alkaline with a pH range of about 7.5 to 8.

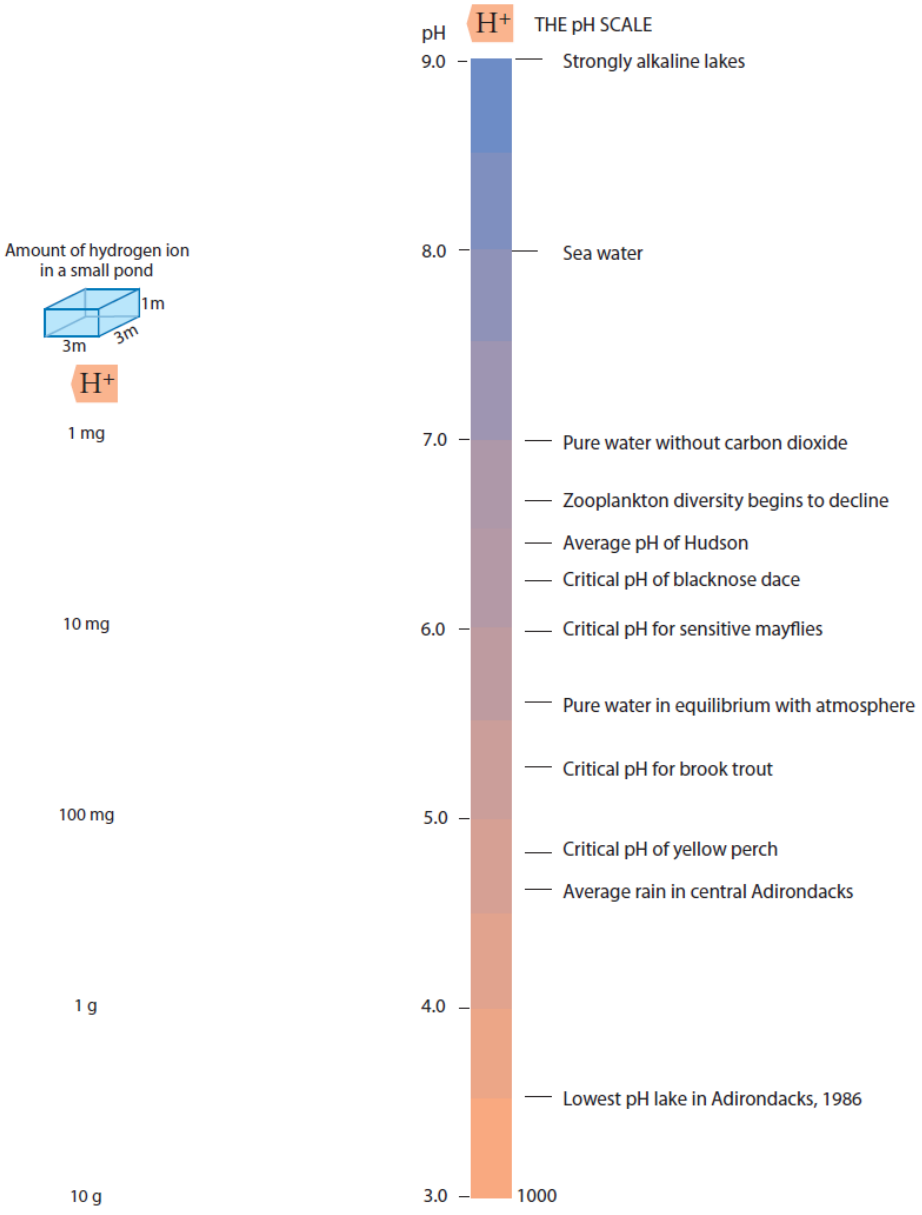
What does this mean?

Water with a pH range from 6.5 to 8.6 is best for fish and most invertebrates, and most natural waters fall within this range. Exceptions are bog-dominated lakes which often have a very low pH and some naturally eutrophic systems and inland saline lakes which can have very high pH values. Water with a pH less than 5.0 or greater than 9.0 is harmful for aquatic life, and is usually due to some kind of human input.

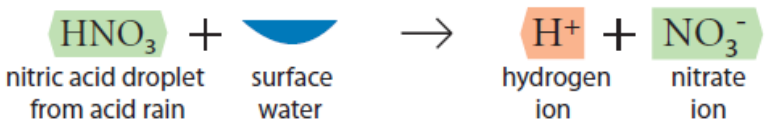
pH of some Common Substances

	pH
4% HCl	0
Stomach acid	1
Lemon juice	2
Orange juice, vinegar	3
Soda, tomato juice	4
Rainwater (unpolluted)	5
Milk	6
Pure water	7

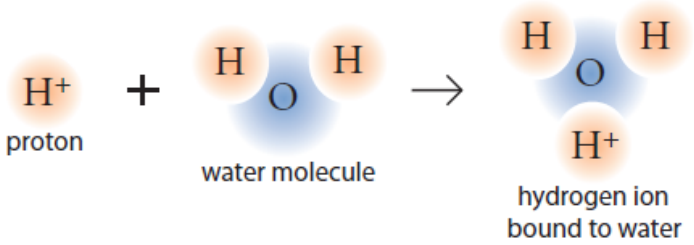
Sea water, egg whites, Hudson River	8
Baking soda dissolved in water	9
Ammonia	10
Bleach, milk of magnesium	11
Drano	12
4% NaOH	13



Acids release hydrogen ions in water



A hydrogen ion is a single proton. In water, it is always bound to a water molecule.

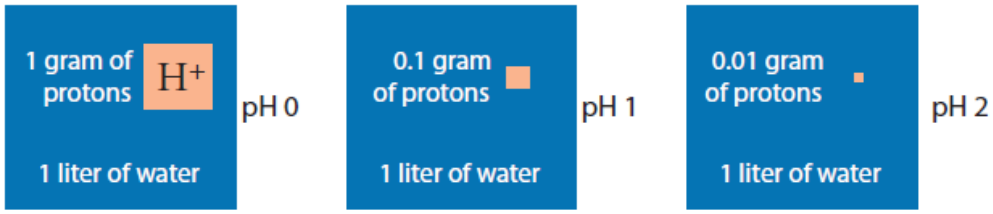


Molecules and ions are counted in moles. One mole is (about) 600,000,000,000,000,000,000,000 (6×10^{23}) molecules.vv

1 gram of protons H^+ = 1 mole of hydrogen ion = 6×10^{23} protons

A hydrogen ion concentration of 1 mole per liter is a 1 molar solution.

pH is a measure of the concentration of hydrogen. A 1 molar solution has a pH of 0.



The pH goes up 1 unit every time the concentration of hydrogen ions goes down 1 unit.

Pure water, which is slightly ionized, has a hydrogen ion concentration of 1/10,000,000 molar and a pH of 7.