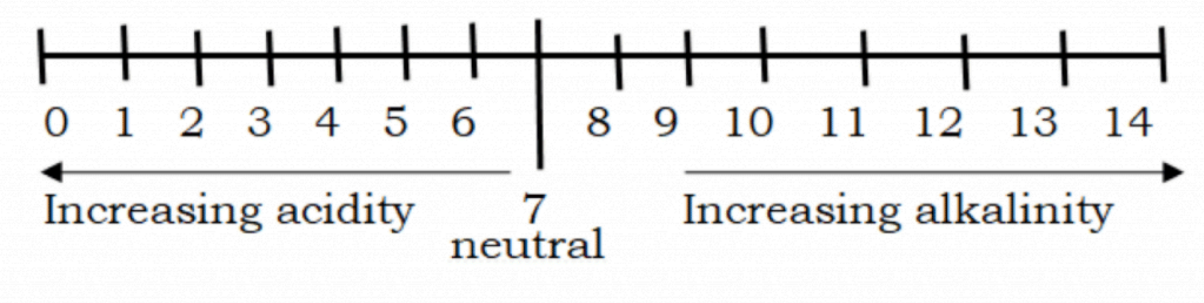
# Water pH

The pH of water is a very important measurement concerning water quality. pH is a measure of how acidic/basic water is. The range goes from 0 to 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base.

The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.).




## Sorensen's pH Scale:

If a molecule of water is splitted up or dissociated it derives one positively charged hydrogen ion (H+) and one negatively charged hydroxyl ion (OH-). The presence of greater amount of hydrogen ion in the soil is the cause of acidity and the presence of hydroxyl ion in greater amount is the cause of alkalinity.

Under natural conditions when water gets ionized some amount of dissociated hydrogen ion (H+) and some amount of dissociated hydroxyl ion (OH-) remain in dissolved state. It has been observed that in a litre of water the amount of those two ions i.e., H+ and OH ions is $10^{-14}$. It is a constant (Kw) i.e., the concentration of hydro gen ion and hydroxyl ion in one litre of pure water will be $10^{-14}$. If by chance the amount is greater than $10^{-14}$, then the extra amount of ions will readily form molecules of water. Under reverse condition the equivalent amounts of molecules of water will be dissociated to maintain the constant.

As because water is a neutral substance the concentration of hydrogen ion and the concentration of hydroxyl ion will be the same. This means that the concentration of hydrogen ion will be $10^{-7}$ gms/litre and the concentration of hydroxyl ion will be $10^{-7}$ gms/ litre.

According to the theory of electrolytic dissociation, when liquids have number of H ions just equal the number of OH ions the solution is neutral and when H ions exceed OH ions the solution is said to be acidic. Conversely, if OH ions are in excess, the solution is said to be alkaline.

To measure water reaction the power of 10 is always being used and its value is always negative. To overcome this difficulty Sorensen in 1909 has devised a scale known as pH to express or measure acidity or alkalinity.

- **$pH = -\log [H^+]$**
- where, log is a base −10 logarithm and [H+] is the concentration of hydrogen ions in moles per litre of solution.
- $pOH = -\log [OH^-]$

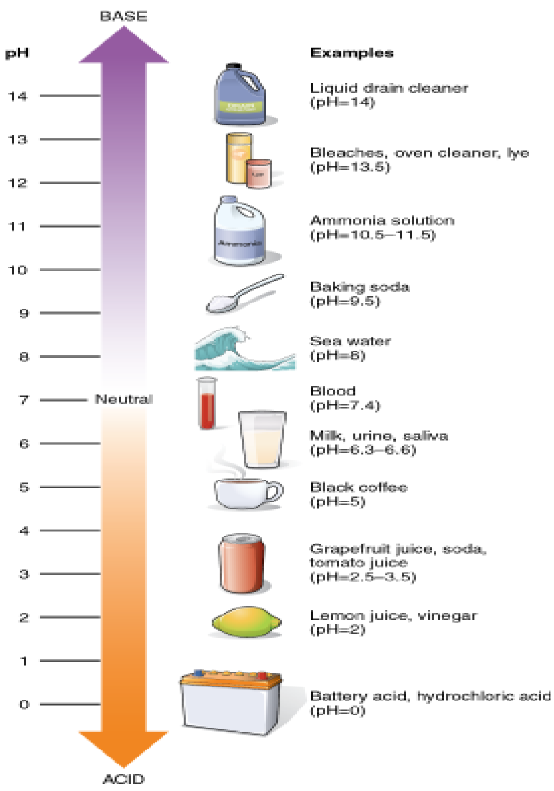
**Therefore,**

- pH is negative logarithm of H+ ion concentration
- A pH scale is a tool for measuring acids and bases. The scale ranges from 0-14
- Acidic water has a pH lower than 7. Strongly acidic substances can have a pH of 0. Battery acid falls into this category.
- Alkaline water has a pH of 8 or above. Strongly alkaline substances, such as lye, can have a pH of 14.
- Pure water has a pH of 7 and is considered “neutral” because it has neither acidic nor basic qualities.
- Presence of hydrogen ion (H+) is the cause of acidity. So, the solution in which the intensity of hydrogen ion (H+) is greater, that solution is acidic. But it is observed from the scale that when the pH value is less, then it is acidic and in the reverse case it is alkaline. The reason is that all pH values are actually negative values. It means that the values ranging from 0 to -7 are greater than the values ranging from -7 to - 14.

| pH | $[H^+]$ | $[OH^+]$ |
|---|---|---|
| 0 | $(10^{0})$ 1 | 0.00000000000001 $(10^{-14})$ |
| 1 | $(10^{-1})$ 0.1 | 0.0000000000001 $(10^{-13})$ |
| 2 | $(10^{-2})$ 0.01 | 0.000000000001 $(10^{-12})$ |
| 3 | $(10^{-3})$ 0.001 | 0.00000000001 $(10^{-11})$ |
| 4 | $(10^{-4})$ 0.0001 | 0.0000000001 $(10^{-10})$ |
| 5 | $(10^{-5})$ 0.00001 | 0.000000001 $(10^{-9})$ |
| 6 | $(10^{-6})$ 0.000001 | 0.00000001 $(10^{-8})$ |
| 7 | $(10^{-7})$ 0.0000001 | 0.0000001 $(10^{-7})$ |
| 8 | $(10^{-8})$ 0.00000001 | 0.000001 $(10^{-6})$ |
| 9 | $(10^{-9})$ 0.000000001 | 0.00001 $(10^{-5})$ |
| 10 | $(10^{-10})$ 0.0000000001 | 0.0001 $(10^{-4})$ |
| 11 | $(10^{-11})$ 0.00000000001 | 0.001 $(10^{-3})$ |
| 12 | $(10^{-12})$ 0.000000000001 | 0.01 $(10^{-2})$ |
| 13 | $(10^{-13})$ 0.0000000000001 | 0.1 $(10^{-1})$ |
| 14 | $(10^{-14})$ 0.00000000000001 | 1 $(10^{0})$ |

- Increase or decrease in pH value by 1.00 means that acidity or alkalinity has increased by 10 times because all the pH values are actually log values.

**Descriptive terms** commonly associated with certain ranges in pH are:




- **Extremely acid:** < than 4.5; lemon=2.5; vinegar=3.0; stomach acid=2.0; soda=2–4
- **Very strongly acid:** 4.5–5.0; beer=4.5–5.0; tomatoes=4.5
- **Strongly acid:** 5.1–5.5; carrots=5.0; asparagus=5.5; boric acid=5.2; cabbage=5.3
- **Moderately acid:** 5.6–6.0; potatoes=5.6
- **Slightly acid:** 6.1–6.5; salmon=6.2; cow's milk=6.5
- **Neutral:** 6.6–7.3; saliva=6.6–7.3; blood=7.3; shrimp=7.0
- **Slightly alkaline:** 7.4–7.8; eggs=7.6–7.8
- **Moderately alkaline:** 7.9–8.4; sea water=8.2; sodium bicarbonate=8.4
- **Strongly alkaline:** 8.5–9.0; borax=9.0
- **Very strongly alkaline:** > than 9.1; milk of magnesia=10.5, ammonia=11.1; lime=12

**Aquaculture and pH**

- Water that has a pH that is too low or too high can be harmful to fish and other aquatic life. At low pH, toxic metals such as aluminum can enter the water in greater concentrations, some nitrogen-bearing chemicals become more toxic, and the metabolic processes of fish can become less efficient. Water with pH below 5 can inhibit reproduction or lead to death, and young fish and other aquatic organisms are especially susceptible. Water with a pH below 6.5 can inhibit growth.

- At high pH values (such as >9), most ammonium ions are converted to ammonia, which is toxic to fish. This problem gets worse with higher temperatures. Water with pH between 9 and 10 will tend to inhibit growth, and water with pH of 11 or higher will kill fish.

- The pH range of 6.5-9 is acceptable for most fish.

**Water treatment and pH**

- Whether in treating drinking water or waste water, pH is important. The pH of drinking water should be between 6.5 and 8.5. Low-pH drinking water can degrade pipes, causing toxic metals such as copper and lead to leach into the water supply.

Water with a pH that is too high has an unpleasant taste, and the effectiveness of disinfectants such as chlorine is decreased.

- In wastewater treatment (e.g., sewage or industrial waste), pH is controlled so that desired chemical or microbial reactions will proceed as efficiently as possible. Operators carefully monitor and adjust pH to respond to changing chemical or microbiological conditions

**Swimming pool maintenance and pH**

Swimming pools typically have pH values in the range of 7.2 to 7.8. If the pH is too high, the effectiveness of the chlorine disinfectant becomes too low, making the pool becomes susceptible to algal growth and preventing it from effectively killing viruses and bacteria. If the pH is too low, the water becomes irritating to the eyes and nose, and it may corrode plaster or metal surfaces.

## What does pH have to do with drinking water?

pH levels in drinking water are monitored extremely closely and are required to be kept in a range of 6.5–8.5 by different Environmental Protection Agencies. Though, if not regulated carefully, the effects of drinking acidic or alkaline water could be harmful. When water is below a pH level of 7, it has a corrosive quality to it. This means it could contain iron, copper, lead, or zinc from plumping and various other metal fixtures. It will have a bitter and metallic taste to it. High alkaline water doesn't pose health risks but does cause aesthetic problems. Formation of scale or precipitate on piping, fixtures, dishes, and utensils will occur. The taste will have a baking soda-like taste and will have a slippery feel.

| Type of water | pH level |
|---|---|
| Tap water | Varies; typically about 7.5 |
| Distilled reverse osmosis water | 5 to 7 |
| Common bottled waters | 6.5 to 7.5 |
| Bottled waters labeled as alkaline | 8 to 9 |
| Ocean water | About 8 |
| Acid rain | 5 to 5.5 |

**Why does a Water Source Change pH?**

- Surface water usually has a pH value of 6.5 to 8.5 and groundwater appears to have a pH of 6.0 to 8.5. The pH of a source of water can naturally vary. Some types of rock and soil, such as limestone, can more effectively neutralize acid than other rock and soil types, such as granite.
- Or, when large numbers of plants grow in a lake or river, when they die and decompose, they release carbon dioxide. A weak carbonic acid is produced when the

carbon dioxide interacts with the water; this can then cause the water body to decrease its pH.

**What does a changing or unsafe pH mean?**

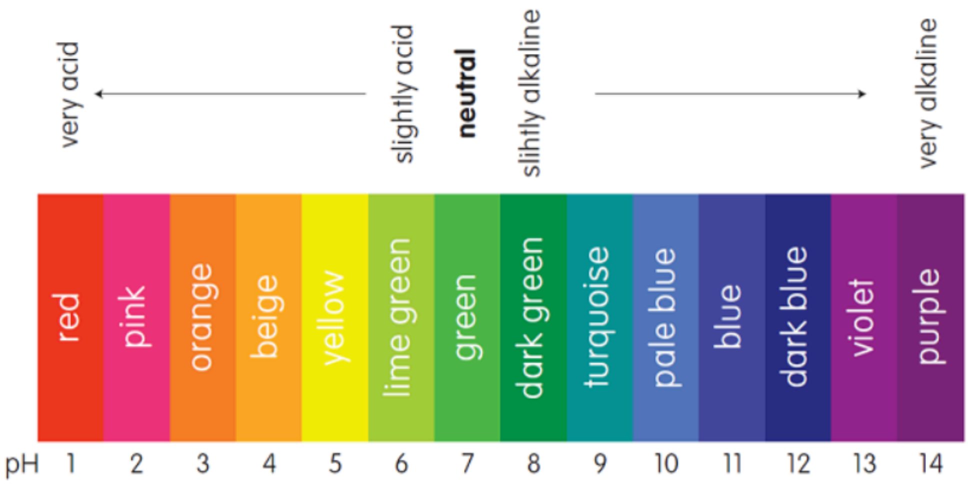
- Freshwater pH varies across the world depending on weather patterns, human activity, and natural processes.
- Water with a very low or high pH can be a sign of chemical or heavy metal pollution.
- Water that doesn't fall in the "safe" pH range of 6.5 to 8.5, particularly if it's alkaline, isn't necessarily unsafe. However, very alkaline water can have an unpleasant smell or taste, and it can also damage pipes and water-carrying appliances.
- Acidic water with a pH of less than 6.5 is more likely to be contaminated with pollutants, making it unsafe to drink. It can also corrode (dissolve) metal pipes.
- Many municipal water suppliers voluntarily test the pH of their water to monitor for pollutants, which may be indicated by a changing pH. When pollutants are present, water companies treat their water to make it safe to drink again.

**So what happens if your body isn't balanced?**

Being either too alkaline or too acidic can be detrimental to your health. The importance of water pH is to keep our body in balance and to regulate metabolic processes. A diet high in acidity will lead to weight gain, slower immune response, and susceptibility to disease, while a diet too alkaline will lead to inability to metabolize key nutrients. Our bodies are constantly working to achieve a balanced pH level. The foods we eat, the liquids we drink, even the emotions we feel, are all contributing to our pH level.

**pH Determination by Colorimetric Method**

Colorimetric analysis is a method of determining the concentration of a chemical element or chemical compound in a solution with the aid of a color reagent. One of the simplest ways to measure the pH of a solution is by color. Litmus paper is a common laboratory application of this principle, where a color-changing chemical substance infused on a paper strip changes color when dipped in the solution. Comparing the final color of the litmus paper to a reference chart yields an approximate pH value for the solution.


very acid
slightly acid
neutral
slihtly alkaline
very alkaline
red
pink
orange
beige
yellow
lime green
green
dark green
turquoise
pale blue
blue
dark blue
violet
purple
pH
1
2
3
4
5
6
7
8
9
10
11
12
13
14


## Acid - Base Detection
## Through Litmus Paper (Blue and Red) and Universal pH Paper