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NAAC ACCREDITED "A" GRADE



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Physical Properties of Water

By Sumana Mukherjee

What is physical property of water ?

Physical properties of water are related to the appearance of water, namely, the color, temperature, turbidity, taste, and odor. To be suitable for use, water must be free from all impurities that are offensive to the sense of sight, taste, or smell and one very important physical characteristic that should be encountered when discussing water quality is turbidity.

Phases of water:

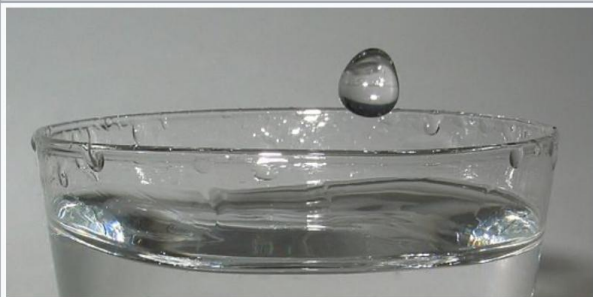
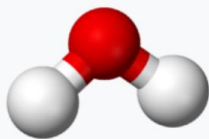
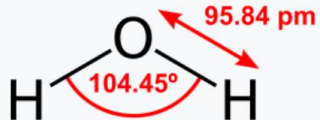
Within the Earth's atmosphere and surface, the liquid phase is the most common and is the form that is generally denoted by the word "water".

The solid phase of water is known as ice and commonly takes the structure of hard, amalgamated crystals, such as ice cubes, or loosely accumulated granular crystals, like snow.

Aside from common hexagonal crystalline ice, other crystalline and amorphous phases of ice are known.

The gaseous phase of water is known as water vapor (or steam). Visible steam and clouds are formed from minute droplets of water suspended in the air.

Water H₂O



Names

IUPAC name

water, oxidane

Other names

Hydrogen hydroxide (HH or HOH),
hydrogen oxide, [dihydrogen monoxide](#)

- Water is the chemical substance with chemical formula H₂O; one molecule of water has two hydrogen atoms covalently bonded to a single oxygen atom.
- Water is a tasteless, odorless liquid at ambient temperature and pressure. Liquid water has weak absorption bands at wavelengths of around 750 nm which cause it to appear to have a blue colour.
- This can easily be observed in a water-filled bath or wash-basin whose lining is white. Large ice crystals, as in glaciers, also appear blue.

Temperature, Colour and Odour of water :

Water temperature is a physical property expressing how hot or cold water is. As hot and cold are both arbitrary terms, temperature can further be defined as a measurement of the average thermal energy of a substance.

Thermal energy is the kinetic energy of atoms and molecules, so temperature in turn measures the average kinetic energy of the atoms and molecules.

This energy can be transferred between substances as the flow of heat. Heat transfer, whether from the air, sunlight, another water source or thermal pollution can change the temperature of water.

Temperature is an important factor to consider when assessing water quality. In addition to its own effects, temperature influences several other parameters and can alter the physical and chemical properties of water. In this regard, water temperature should be accounted for when determining

- Metabolic rates and photosynthesis production
- Compound toxicity
- Dissolved oxygen and other dissolved gas concentrations
- Conductivity and salinity
- Oxidation reduction potential (ORP)
- pH
- Water Density

Unit of temperature :

As temperature measures thermal energy, scales have been developed to give temperature values meaning relative to other values.

Today, water temperature is commonly measured on one of three scales: Celsius, Fahrenheit or Kelvin.

When using the Celsius or Fahrenheit scales, temperature is measured in degrees.

On the Kelvin scale, the unit is a kelvin, but it is the same magnitude as a Celsius degree. Due to its universal use, water temperature is generally reported on the Celsius scale.

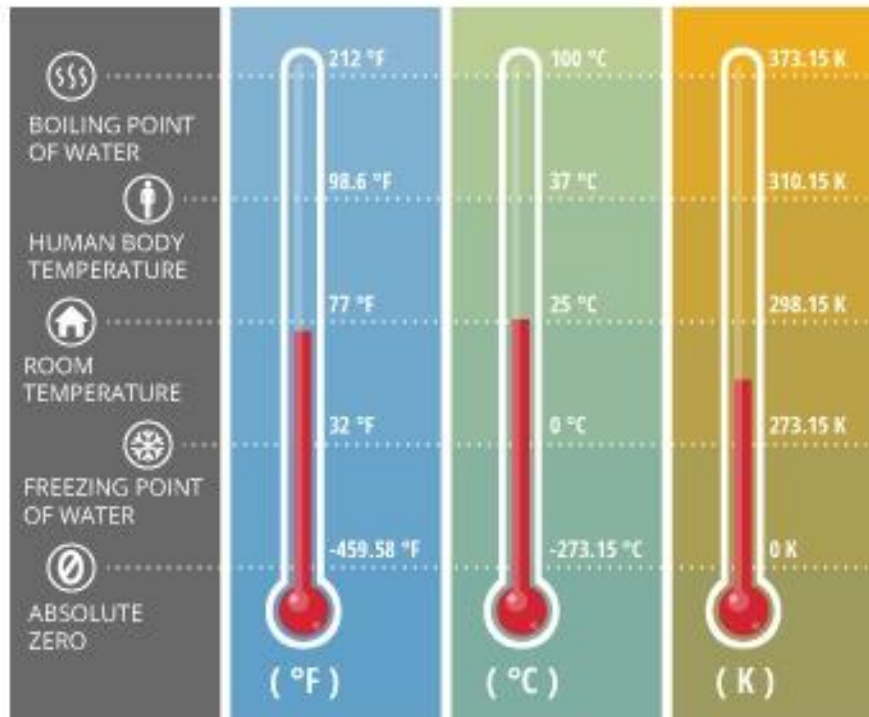
The Fahrenheit and Celsius scales are defined by the degrees at which water freezes and boils. The Celsius scale is also referred to as centigrade because there is a 100 degree interval between the two defined points (freezing and boiling of water)

The Kelvin scale is based on the theoretical point of absolute zero .

A temperature in degrees Celsius can be converted to Fahrenheit or Kelvins by the following equations :

$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$$

$$\text{K} = ^{\circ}\text{C} + 273.15$$



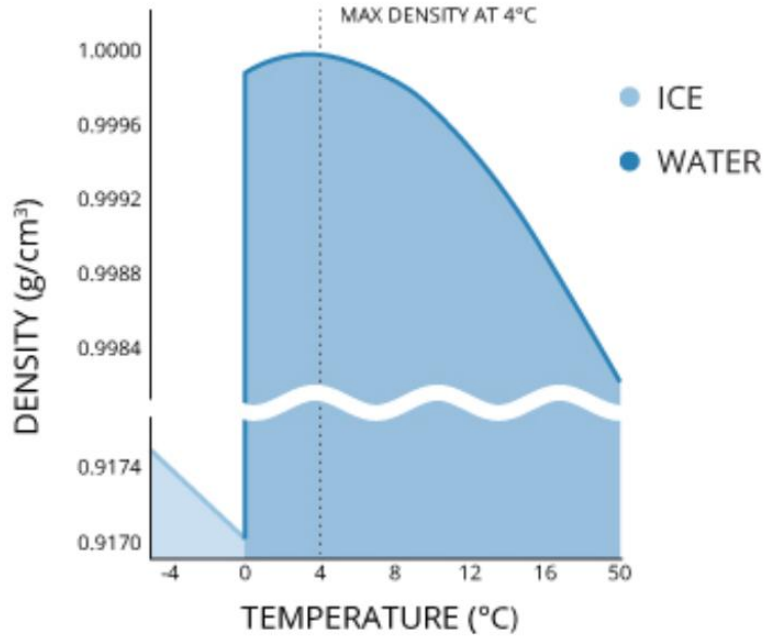
The most common temperature scales: Fahrenheit, Celsius and Kelvin.

Density and Water Temperature

Water temperature and water density are directly related. As the temperature of water increases or decreases, it will alter the density of water.

This is a unique relationship in that unlike most materials, the density of pure water decreases approximately 9% when it freezes. This is why ice expands and floats on water.

Pure water is also unique in that it achieves its maximum density, 1.00 g/ml, at 4°C. Water at temperatures above and below this, including superheated and supercooled water, will float on 4°C water.



The maximum density point is particularly important in freshwater. If water was most dense at its freezing point (0 °C) then it would sink to the bottom, freezing a body of water from the bottom up, killing all of the organisms living within it. Instead, this property ensures that the bottom of a body of water will remain at least 4°C, and thus unfrozen. The temperature/density relationship thus creates a water convection pattern as it cools. As surface water temperature approaches the maximum density temperature, it sinks and is replaced by warmer, lighter water.

This process continues until the water is uniformly cool. Any water that is colder than this point will float on top of the denser water. This convection pattern allows water both warmer and colder than 4°C (and at potentially different dissolved oxygen concentrations) to intermix.

Water is most dense at 4 degrees Celsius, and least dense in its solid form as ice.

We know that freshwater begins to freeze at 0° C.

Salt water, however, has a lower freezing point. That is why salt is used in winter to de-ice roads and sidewalks. Average seawater has a salinity level of 35 PPT (parts per thousand), which shifts the freezing point to -1.9°C.

The density of pure water ice at 0°C is 0.9168 g/ml, nearly 9% lighter than liquid water at 0°C, which has a density of 0.99987 g/ml.

This is the reason why ice floating on top of water and allows aquatic organisms to survive the winter. This drop in density occurs because the hydrogen bonds in water create an open hexagonal lattice, leaving space between the molecules



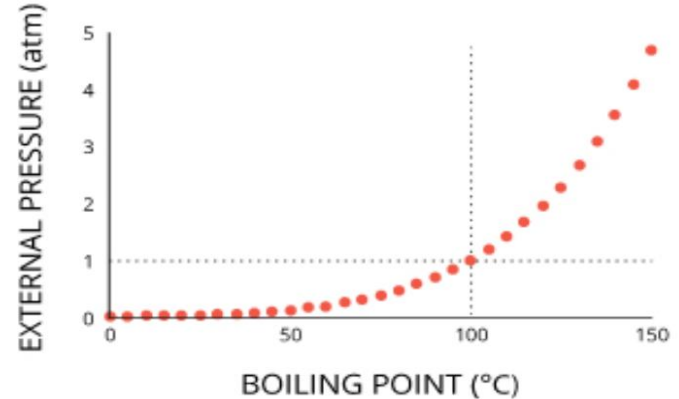
Ice floats on top of the denser water.

Pressure and Water Temperature Points

Pressure does not directly alter water temperature. Instead, it shifts the freezing, boiling and maximum density points. The temperature at which boiling and freezing occur will only hold true at sea level.

For example cooking times are longer at higher elevations, due to a shift in water's boiling point. This is due to the effect of atmospheric pressure. At a lower pressure (higher altitude), water will boil at a lower temperature. On the other side of the scale, at higher pressures (such as in a pressure cooker), water will boil at a higher temperature.

Atmospheric pressure does not affect the temperature of the water itself, but only its ability to become vapor, thus shifting the boiling to the left or right.

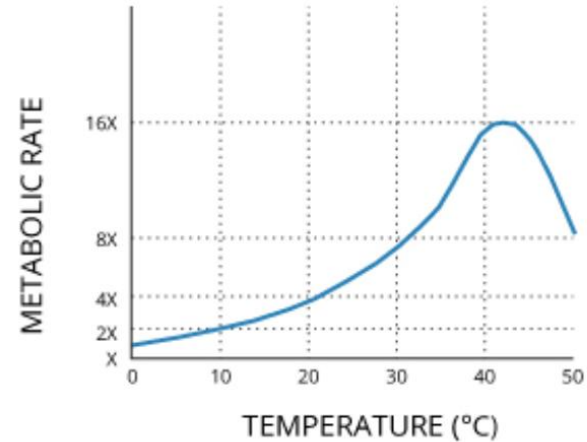


Pressure can change the boiling point of water.

Water Temperature and Aquatic Life :

Considered alone, water temperature can affect the metabolic rates and biological activity of aquatic organisms. As such, it influences the chosen habitats of a variety of aquatic life. Some organisms, particularly aquatic plants flourish in warmer temperatures, while some fishes such as trout or salmon prefer colder streams.

Studies have shown a direct relationship between metabolic rates and water temperature. This occurs as many cellular enzymes are more active at higher temperatures. For most fish, a 10°C increase in water temperature will approximately double the rate of physiological function. This increase in metabolic rate can be handled by some species better than others.



The metabolic rates of aquatic organisms increase as the water temperature increases.

Plants are also affected by water temperature. While some aquatic plants tolerate cooler waters, most prefer warmer temperatures. Tropical plants in particular will show restricted growth and dormancy in water temperatures below 21°C

Temperature can also inhibit plant respiration and photosynthesis.

In general, algal photosynthesis will increase with temperature, though different species will have different peak temperatures for optimum photosynthetic activity.

Color and Odour :

Pure water doesn't have any Color and any odour.

When water gets polluted by any means it might get a Color depending upon the type of pollution it has.

Happy reading