Water and its Properties

Water

Water is designated as a compound known as the "universal solvent" and the "solvent of life". As it was the most abundant substance on world and the solely common substance which is existed as a solid, liquid, and gas on Earth. Water is also the third most abundant molecule in the universe. Water has considered to be an inorganic, transparent, tasteless, odorless, and almost colorless chemical substance, which has made the main constituent of landscape hydrosphere and the fluids of many living organisms. It has important roles in all known ways of life, as it has provided no calories or have no nutrientional value. Water has chemical formula which is H_2O, means that each of it molecules constitutes one oxygen and two hydrogen atoms, held together via covalent bonds. Water ,as the name is of the liquid state of H_2O at standardized specific temperature and pressure. It made precipitation in the form of rain and aerosols in the state of fog. Clouds were made from suspended drops of water and of ice,which is its solid state. When firmly divided, crystalline ice precipitate in the state of snow. In gaseous state of water was steam or water vapor. Water moved continuously by the water cycle of evaporation, transpiration (evapotranspiration), condensation, precipitation, and runoff, mostly reaching the sea.

Water was covered 71% of the Earth's crust ,which is present inside in seas and oceans.Little proportions of water occurred as groundwater which is only 1.7%, and in the glaciers and the ice caps of Antarctica and Greenland its percentage is also 1.7 and in the air as in form of vapor, clouds which were made up of ice and liquid water suspended in air and precipitation (0.001%).

Water has been playing a vital role in the world's economy. Appropriately 70% of the freshwater consumed by humans went to agriculture. Fishing in salt and fresh water places was a main hotspots of food for various regions of the world. Many of the long-distanced trade of goods like oil, natural gas, and manufacturing products was delivered by boats through seas, rivers, lakes, and canals. Big quantities of water, ice, and steam were consumed for cooling and heating in the industries and in homes. Water has considered a brilliant solvent for a wider varieties of substances for both mineral and organic; as it is largely consumed in industrial systems, and in cooking and washing purposes. Water, ice and snow were also centralized to most of the sports and other forums of entertainment, like in swimming, pleasure boating, boat racing, surfing, sport fishery , diving, ice skating and skiing.

Water has been amphoteric in nature means that it have possesses both properties of an acid or a base, depending upon the pH of desired solution in that it is, it spontaneously made both H^+ and OH^- ions. Relative to its amphoteric character, it undergone self -ionization. The product of the entries or approximately the concentrations of H^+ and OH^- was remain same , so their corresponding concentrations were conversely proportional to each other.

Water molecules made hydrogen bonds with one another and were strongly polar. That polarity allowed it to disassociate ions in salts and bonds to other polar substances like the alcohols and acids, thus dissolved them. Water' s hydrogen bonding caused its most different properties, such as had a solid form less dense than its liquid form, and a comparatively high boiling point of 100 °C for its molar mass, and a higher heat capacity.

Physical properties

Water has been the chemical substance with the chemical formula H2O ,as one molecule of water is made from two hydrogen atoms covalently bonded to an oxygen atom.Water has considered as tasteless, odorless liquid at room temperature and pressure. Liquid water had weaker absorption ranges at wavelengths of about 750 nm which caused it to appear to had a blue colour. That have readily be observed in a water-filled bath or wash-basin those lining was white. Big ice crystals, as in glaciers,were also appear blue.

Unlikely other analogous hydrides of the oxygen group , water had primarily a liquid under standardized conditions because of the hydrogen bonding. The molecules of water were consistently moving relatively to each other, and the hydrogen bonds were continuously breaking and making at an equal timetable which was faster than 200 femtoseconds (2×10−13 seconds). Moreoverr, those bonds were strong enough to made most of the important properties of water, some of which made it an integral part to life.

Heat capacity and heats of vaporization and fusion

Water had a very high specific heat capacity which is equal to 4.1814 J at room temperature – the second highest among all the heteroatomic species after the ammonia, they also have a high heat of vaporization that is 40.65 kJ/mol or 2257 kJ/kg at the avearge boiling point, both of which were as a result of the extensively present hydrogen bonding between its molecules. That two unusual properties allowed the water to regulate our planet climate by buffering big fluctuations in temperature. Many of the additional energy collected in the climate system since 1970 has been accumulating in the oceans.

The specific enthalpy of fusion most usually known as latent heat of water has a value of 333.55 kJ/at 0 °C temperature, the same amount of energy has required to melt ice as to warm ice from −160 °C up to it's melting point or to heat the same amount of water by about 80 °C.

Density of water and ice

Water has density at about 1 gram per centimetre cube (62 lb/cu ft): that relationship had basically used to define the gram. The density varied with temperature, but not follow a linear trend ,as the temperature increased the density raises to a peak at 3.98 °C (39.16 °F) and at decreased level that was unusual. Normally the hexagonal ice cube was also less denser than the liquid water and upon freezing, the density of water decreased by around 9%

Miscibility and condensation

Water was miscible with many of the liquids, included ethanol in all of the proportions. Water and many of the oils were immiscible generally making layers accordingly to increase density from the top. That have to be predicted by relating the polarity. Water having a relatively polar compound would tend to be miscible with the liquids of higher polarity like ethanol and acetone, whereby compounds with lower polarity would tend to be immiscible and poorly soluble like with the hydrocarbons.

Compressibility

The compressibility of water was a function of pressure and temperature, At 0 °C, at the zero pressure, the compressibility of water had equal to the 5.1×10−10 Pa^{-1}. At the zero-pressure limit, the compressibility reached a minimum of 4.4×10^{-10} Pa^{-1} about 45 °C before it increased again with the increasing temperature. Then the pressure was increased, the compressibility decreased, that was 3.9×10^{-10} Pa^{-1} at 0 °C and 100 megapascals .

The bulk modulus of water was about 2.2 GPa.The low compressibility of non-gases, and of water in particularly, leading to their often being assumed as incompressible. The low compressibility of water meant that even in the deep oceans at 4 km depth, where pressures were at 40 MPa, there was only a 1.8% decrease in volume occurred.

Triple point

The value of the temperature and pressure at that common solid, liquid, and gaseous water coexist in equilibrium has called as a triple point of water. Since 1954, that point had used to describe the base unit of temperature, which was the kelvin but, starting in 2019, the kelvin has now defined usually as the Boltzmann constant, rather than the triple point of water.

Due to the existence of many forms of ice, water had other triple points, which had either three polymorphs of ice or two polymorphs of ice and the liquid in equilibrium. Gustav Heinrich Johann Apollon Tammann in Göttingen predict data on many l other triple points in the early 20th century. Kamb and others has documented further triple points in the 1960s.

Melting point

The melting point of ice has a value equal to the 0 °C (32 °F; 273 K) at standardized pressure; moreover, pure liquid water would be supercooled well below this temperature without freezing if the liquid has not mechanically disturbed. It would remains in a fluid state down to it homogeneous nucleation point of around 231 K (−42 °C; −44 °F).The melting point of common ice fell slightly under the moderately high pressures, by 0.0073 °C or around 0.5 °C (0.90 °F)/70 atm] as the stabilization energy of hydrogen bonding was exceeded by intermolecular repulsion forces , but as ice transforms into itpolymorphs (crystalline states of ice) above 209.9 MPa (2,072 atm), the melting point increased marked with pressure, i.e., reaching 355 K (82 °C) at 2.216 GPa (21,870 atm) (triple point of Ice)

Cohesion and Adhesion

Water molecules stayed near to each other that is the cohesion, due to the collaborative action of hydrogen bonds between water molecules.

That hydrogen bonds wereconstantly breaking, with new bonds which were formed with different water molecules,but at any of the given time in a sample of liquid water, a larger portioned part of the molecules were held together by that bonds.

Water also has higher value of adhesion properties due to its polar nature. On purely smoother and cleaner glass the water may be form a thin film due to the molecular forces which were present between glass and water molecules that were adhesive forces of stronger force than the cohesive forces. In the biological cells and organelles, water was in connection with membranes and protein surfaces that were water loving ; that is, surfaces that had strong attraction to water. Irving Langmuir had observed a strong repulsive force between hydrophilic surfaces. To dehydrate hydrophilic surfaces and to remove the strongly held layers of water of hydration—required doing substantially workout against these forces, known as the hydration forces. These forces were very largest but decreased sooner over a nanometer or less than this, They were vital in biology, particularly when cells were dehydrated by exposure to dry atmospheres or to extracellular freezing.

Rain water flux formed a canopy. Among the forces that governs formation: Surface tension, Cohesion (chemistry), Van der Waals force , Plateau–Rayleigh instability.

Surface tension

Water has been an unusuall high surface tension of 71.99 mN/m at room temperature which is caused by the strengthening of the hydrogen bonding which has present between water molecules.That allowed the insects to walked on water.

Capillary action

As water had strong cohesive and adhesive forces, it exhibited capillary action. Strong cohesion occurred from hydrogen bonding and adhesion allowed trees to transport water more than 100 m upward.

Water as a solvent

Presence of colloidal calcium carbonate from higher concentrations of dissolved lime turned the water of Havasu Fell turquoise.Water has an excellent solvent because of its high dielectric constant.Substances that mix well and dissolve in water were known as hydrophilic substances, while those that did not mix well with water were known as hydrophobic substances. The ability of a substance to dissolve in water was determined by whether or not the substance would match or better the strong attractive forces that water molecules generated between other water molecules. If a substance had properties that do not allow it to overcome those strong intermolecular forces, the molecules were precipitated out from the water. Contrary to the common misconception, water and hydrophobic substances did not "repel", and the hydration of a hydrophobic surface was energetically, but not entropically, favorable.

When an ionic or polar compound entered in water, it was surrounded by water molecules (hydration). The relative smaler l size of water molecules (~ 3 angstroms) allowed many water molecules to surround one molecule of solute. The partially negative dipole ends of the water were attracted to positively charged components of the solute, and vice versa for the positive dipole ends.

In general, ionic and polar substances such as acids, alcohols, and salts were relatively soluble in water, and non-polar substances such as fats and oils are not. Non-polar molecules stayed together in water because it was energetically more favorable for the water molecules to hydrogen bond to each other than to engage in van der Waals interactions with non-polar molecules.An example of an ionic solute was table salt; the sodium chloride, NaCl, separated into Na^+ cations and Cl^- anions, each via surrounded by water molecules. The ions were then easily transported away from their crystalline lattice into solution. An example of a non ionic solute was table sugar. The water dipoles made hydrogen bonds with the polar regions of the sugar molecule (OH groups) and allowed it to be carried away into solution.

Quantum tunneling

The quantum tunneling dynamics in water had reported as early as in 1992. At that time it had known that there were motions which destroy and regenerated the weak hydrogen bond by internal rotations of the substituent water monomers. On 18 March 2016, it had reported that the hydrogen bond can be broken by quantum tunneling in the water hexamer. Unlikely previousreported tunneling motions in water, this involved the concerned breaking of two hydrogen bonds. Later in the same year, the discovery of the quantum tunneling of water molecules had reported.

Electromagnetic absorption

Water was relatively transparent to visible light, near ultraviolet light, and far-red light, but it absorbed most ultraviolet light, infrared light, and microwaves. Most photoreceptors and photosynthetic pigments utilized the portion of the light spectrum that was transmitted well through water. Microwave ovens took advantage of water's opacity to microwave radiation to heat the water inside of foods. Water's light blue colour has caused by weak absorption in the red part of the spectrum.