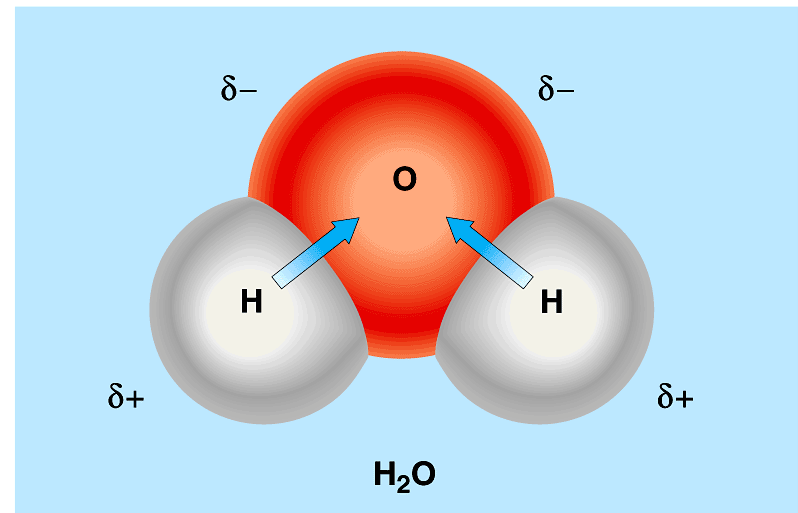


BI 107 CHAP 3

WATER

Water's Polarity - Effects

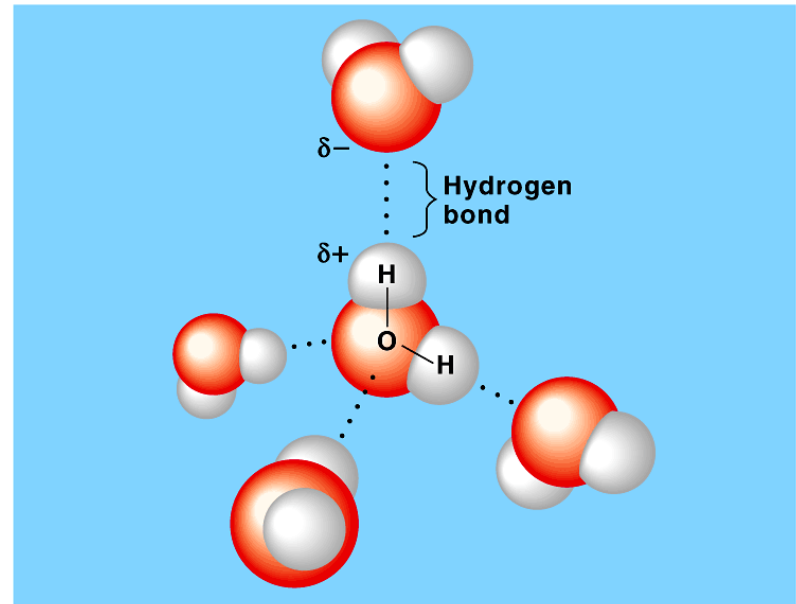
- Polarity of water results in hydrogen bonding
- Polarity due to fact oxygen atom is more electronegative than hydrogen atoms so electrons of hydrogen spend most of time around oxygen



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Water's Polarity - Effects

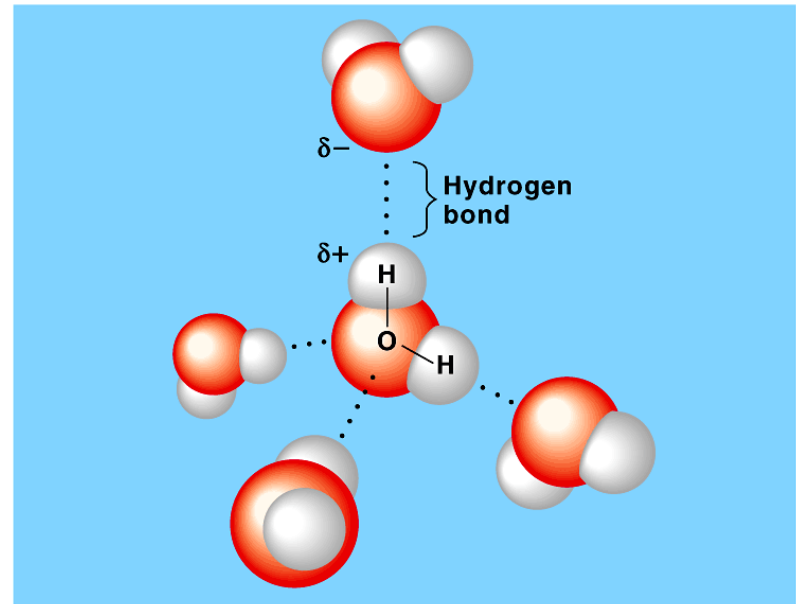
- Leads to oxygen having a partial negative charge and 2 hydrogens having partial positive charge – molecule is polar
- Polar molecules interact by electrical attraction with slightly positive hydrogen of 1 molecule attracted to slightly negative oxygen of 2nd water molecule



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Water's Polarity – Effects cont.

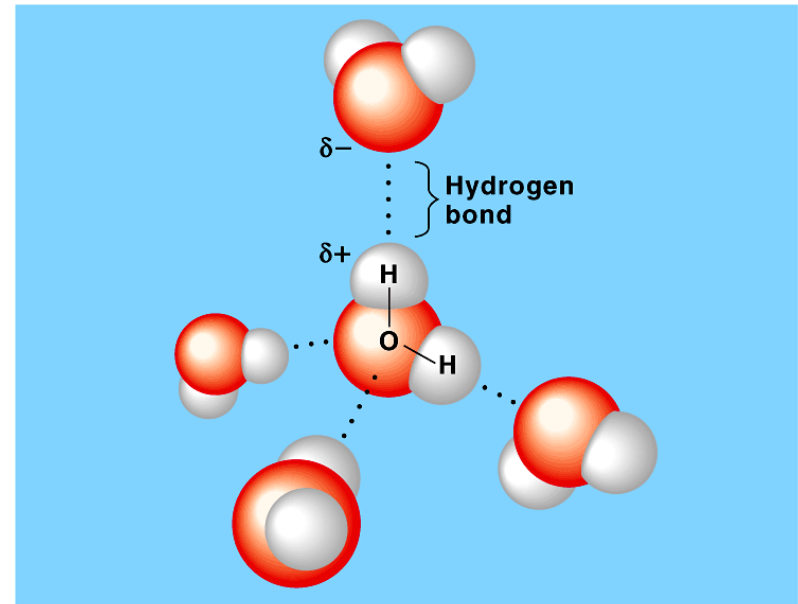
- Water forms network of interconnected electrical attractions due to hydrogen bonding – gives water its important properties



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Water – 1st property

- Cohesion – hydrogen bonds form, break, and reform constantly & rapidly
- Large % of water molecules hydrogen bonded at any instant – holding water together – called cohesion



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Water 1st property cont.

- Organisms depend on cohesion
- Trees ‘pull’ water from roots to leaves
- Surface tension – difficulty in breaking surface of a liquid – small animals can walk on water



Water – 2nd property cont.

- Water moderates temperature – water can absorb or release large amounts of heat with only slight change in its own temperature
- Water absorbs heat from warmer air and releases heat to colder air
- Heat & temperature – atoms and molecules have kinetic energy – energy of motion – faster movement means more kinetic energy

Water – 2nd property cont.

- Heat – measure of total amount of kinetic energy in a body of matter
- Temperature – measure of intensity of heat due to average kinetic energy of molecules
- If average speed of molecules increases then detect this as increased temperature
- Heat always passes from warmer body to colder body until equal – indicated by Celsius scale

Water – 2nd property cont.

- Calorie – unit of heat
– amount of heat needed to raise 1 gram of water 1 degree Celsius
- Joule (J) = 0.239 cal.
- Cal = 4.184 J
- High specific heat of water – amount of heat absorbed or lost to change temp. of substance by 1 degree Celsius
- 1 cal/gr/degree Celsius for water – higher than most substances

Water – 2nd property cont.

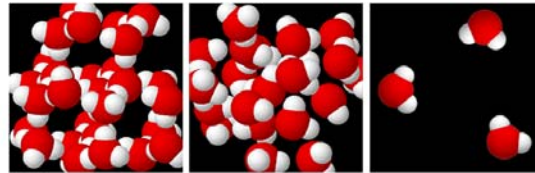
- High specific heat due to hydrogen bonding – heat absorbed to break hydrogen bonds and released when hydrogen bonds form
- Oceans help keep earth's temp. in range compatible with life
- Evaporative cooling – molecules in liquid water attracted to each other so stay together
- Fastest molecules escape to gas phase – called vaporization or evaporation

Water 2nd property cont.

- Heat of vaporization – amount of heat needed for 1 gr of water to go from liquid to gas
- Water has high heat of vaporization
- As liquid evaporates surface of liquid left behind cools – called evaporative cooling – contributes to temp. stability
- Sweat cools the body

Water – 3rd property

- Ice floats – water is less dense as solid than as liquid
- Hydrogen bonds more rigid in ice than in liquid and keep water molecules farther apart in ice so it is less dense – water not freeze solid so life survives underneath



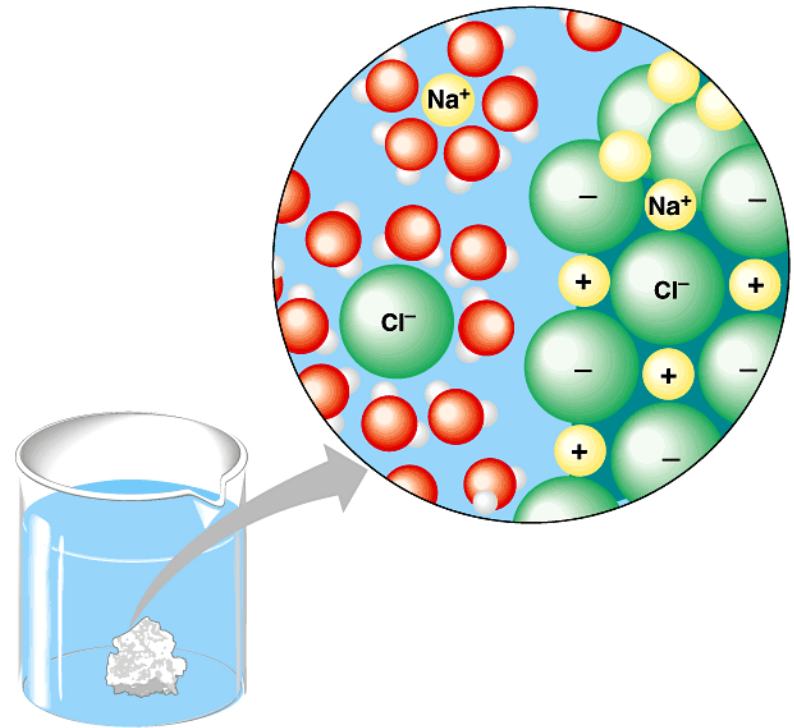
Water – 4th property

- Water is solvent of life
- Solution – homogeneous mix of 2 or more substances dissolved in a liquid
- Liquid called solvent
- Dissolved substances called solutes
- Aqueous solution – water is solvent



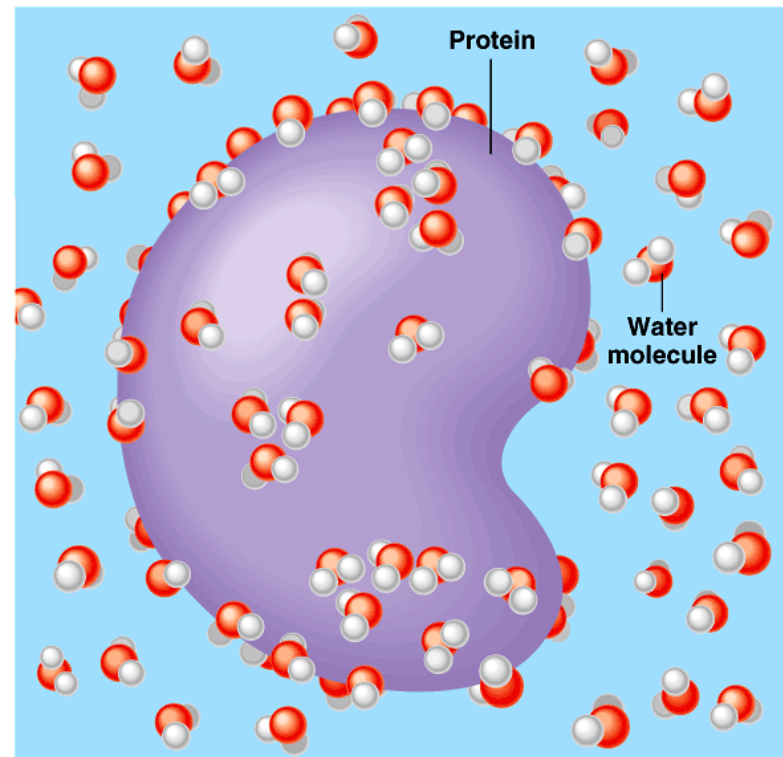
Water – 4th property cont.

- Water molecules surround ions forming a hydration shell
- Water molecules surround polar molecules such as sugars & proteins which have polar & ionic regions



Water – 4th property cont.

- Any substance – ionic or polar – with an affinity for water is hydrophilic
- Any substance without an affinity for water is hydrophobic – has many nonpolar bonds



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Water – 4th property cont.

- Solute concentrations in aqueous solution
- 1 mole is equal to the molecular weight of a substance in grams
- 1 mole of any substance has same number of molecules of the substance
- Called Avogadro's number 6.02×10^{23} molecules
- A 1M solution of any substance has the same number of molecules of the substance
- Molarity – number of moles of solute per liter of solution – unit of concentration most used in biology

Dissociation of Water

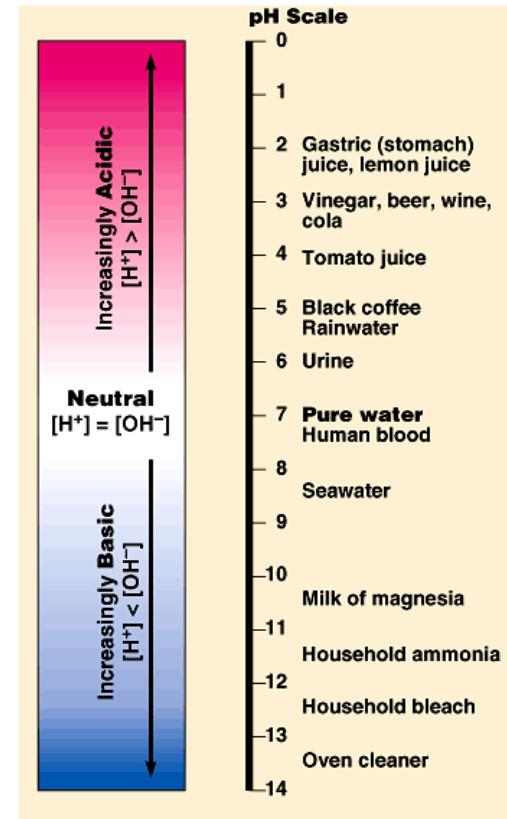
- 2 H₂O molecules dissociate into H₃O⁺ and OH⁻ but write equation as H₂O → H⁺ + OH⁻ in pure water dissociation is slight – 10⁻⁷M
- Hydrogen ion conc. = hydroxide ion conc. In pure water
- Dissociation is reversible as both ions very reactive
- Adding certain solutes called acids or bases changes the balance
- pH scale used to describe how acidic or basic a solution is

Acids and bases

- Acids – substances that increase hydrogen ion conc. of solution
- Bases – substances that decrease hydrogen ion conc. of a solution
- Decrease H^+ ion conc. Directly or indirectly
- Directly when accepts H^+ and indirectly when dissociates into something and a hydroxide ion which accepts a H^+ ion
- Dissociate completely called strong acid or base – incompletely called weak acid or base

pH scale

- In aqueous soln. product of H^+ ion conc. and OH^- conc. Always = 10^{-14} M
- Acids add H^+ ions and remove OH^- ions
- Bases add OH^- and remove H^+ from soln.



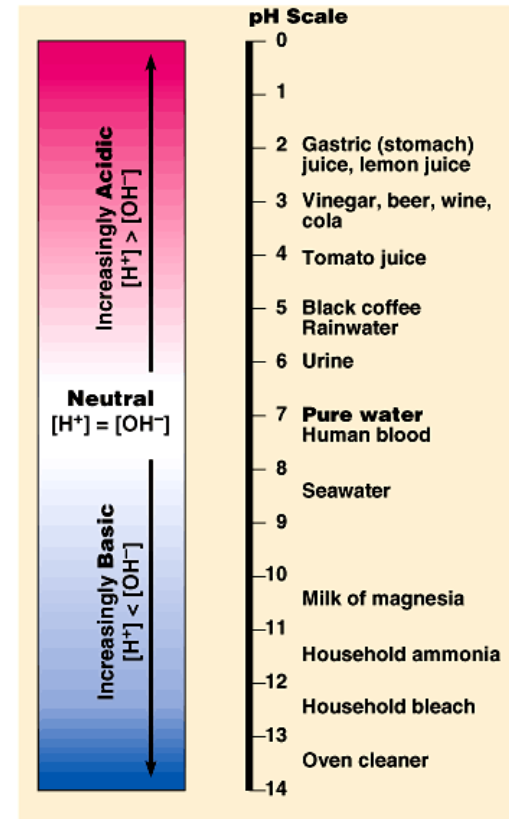
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pH scale cont.

- pH ranges from 0 – 14 which compresses range of H^+ ion and OH^- ion conc. by using logarithms
- pH = negative log (base 10) of H^+ ion conc.
- $pH = -\log [H^+]$ for neutral soln. $[H^+] = 10^{-7} M$
- $pH = -\log 10^{-7} = -(-7) = 7$
- pH decreases as H^+ ion conc. increases
- pH implies OH^- conc. as total equals $10^{-14} M$

pH scale cont.

- Scale below 7 is acidic
- Scale above 7 is basic
- Biological soln. mostly in range pH 6-8 with exceptions
- 10 fold increase in H^+ ion conc. for each pH unit



buffers

- Substances which minimize changes in H^+ ion or OH^- ion conc. in biological systems
- Act by accepting or donating H^+ ions – usually weak acid or base

