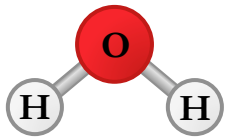


TOPIC 2.2: WATER

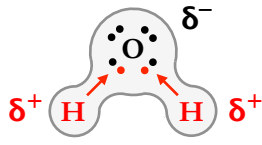
Water Structure

Water is made up of two hydrogen atoms covalently bonded to an oxygen atom (molecular formula: H_2O)

Oxygen has a higher electronegativity and attracts the shared electrons more strongly, resulting in polarity



Water Structure

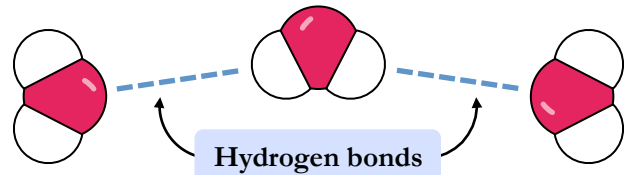


Water Polarity

Hydrogen Bonding

The dipolarity of the water molecule enables it to form polar associations with other charged molecules (polar or ionic)

Water molecules can also form hydrogen bonds with other water molecules (between an δ^+ hydrogen and an δ^- oxygen)



Hydrogen bonds

Cohesive Properties

Water can form intermolecular associations with other molecules that share common properties (e.g. polarity)

- Water can form hydrogen bonds with other water molecules (cohesion: like molecules stick together)
- Water can form polar associations with charged molecules (adhesion: unlike molecules stick together)

The cohesive properties of water results in a relatively high surface tension (can resist low level external forces)

The adhesive properties of water allow for potential capillary action (e.g. transpiration stream in plants)

Solvent Properties

Water is commonly referred to as the universal solvent due to its capacity to dissolve a large number of substances (ionic / polar)

- Large quantities of water molecules can sufficiently weaken forces (e.g. ionic bonds) and form dispersive hydration shells

Substances that can dissolve in water are called hydrophilic

- Includes glucose, amino acids, sodium chloride, oxygen (low)

Substances that cannot dissolve in water are called hydrophobic

- Includes lipids (fats and cholesterol)

These solvent properties make water an important medium for metabolic reactions, as well as a necessary transport medium

Thermal Properties

Water has the capacity to absorb large amounts of heat energy before undergoing a resultant change in state

- Extensive hydrogen bonding must first be broken

Water therefore has a very high specific heat capacity

- Energy required to raise temperature of 1g by 1°C

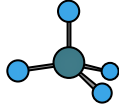
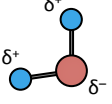
These properties make water a very effective coolant

- Evaporation of sweat requires absorption of heat

Water versus Methane

Water and methane differ in thermal properties despite having similar structures (comparable weight, size, valence structure)

The differences are due to the polarity of water and its capacity to form intermolecular hydrogen bonds

	METHANE	WATER
		
Formula	CH_4	H_2O
Polarity	Non-polar	Polar
Heat Capacity ($J \cdot g^{-1} \cdot ^\circ C^{-1}$)	2.20	4.186
Boiling Point ($^\circ C$)	-161	100

Other Properties

Water is transparent, allowing light to pass through it

- Important for photosynthesis and also for vision

Water expands when frozen, becoming less dense

- Important for life on Earth as it means ice floats and the oceans underneath don't automatically freeze