



Physical and Chemical Properties of Water

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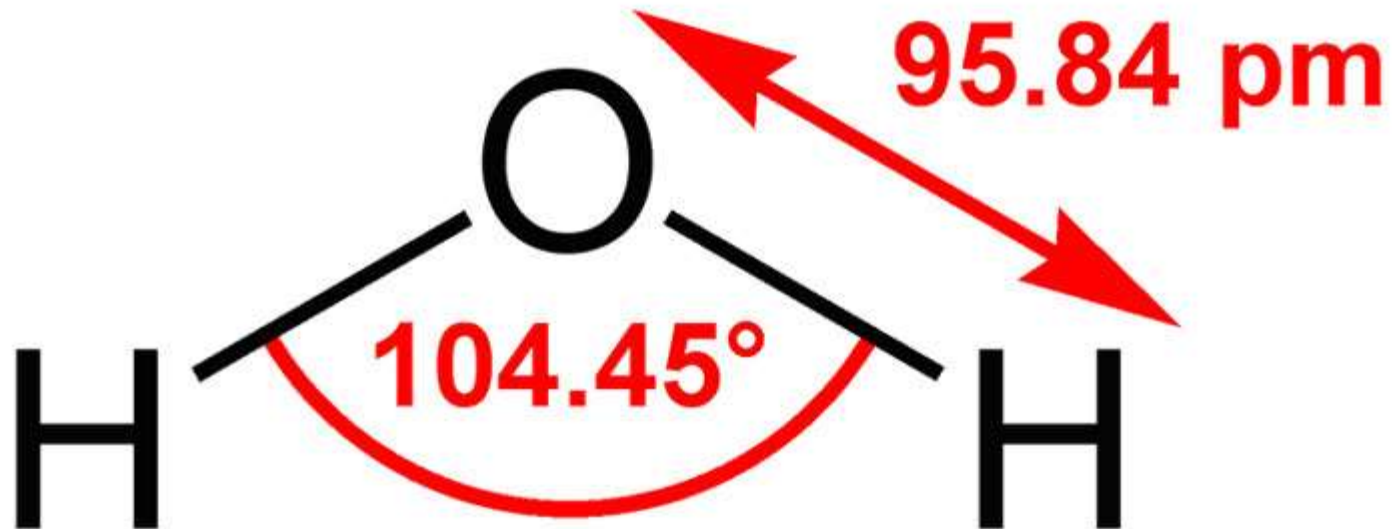
Bharathidasan University

Water

- More than 70% of the Earth's surface is covered with this simple molecule.
- Scientists estimate that the hydrosphere contains about 1.36 billion cubic kilometers of this substance mostly in the form of a liquid (water) that occupies topographic depressions on the Earth.
- The second most common form of the water molecule on our planet is ice.



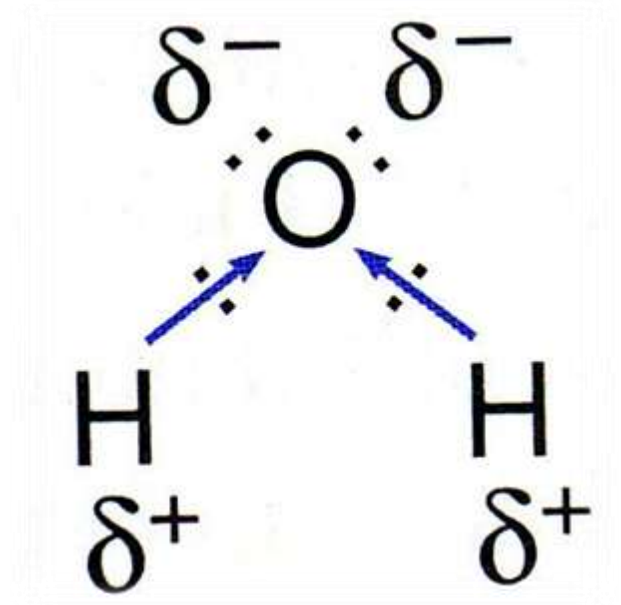
Structure of Water Molecule



Chemical formula: H₂O

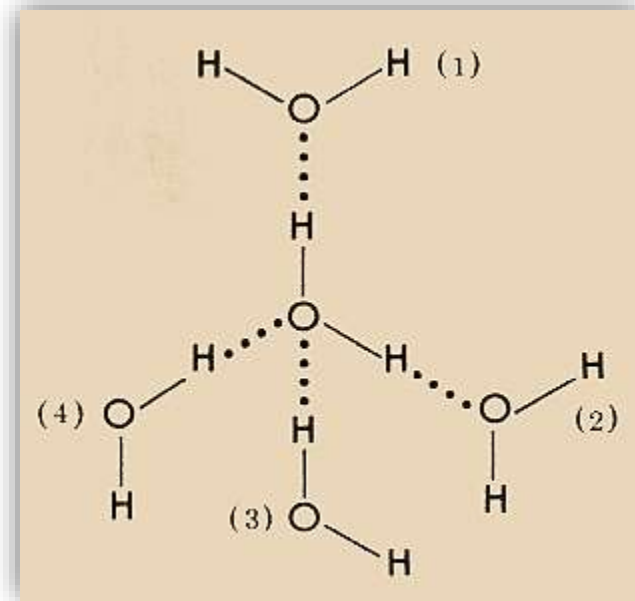
Dipolar nature

- Since the water molecule is not linear and the oxygen atom has a higher electronegativity than hydrogen atoms, it carries a slight negative charge, whereas the hydrogen atoms are slightly positive.
- As a result, water is a polar molecule with an electrical dipole moment.



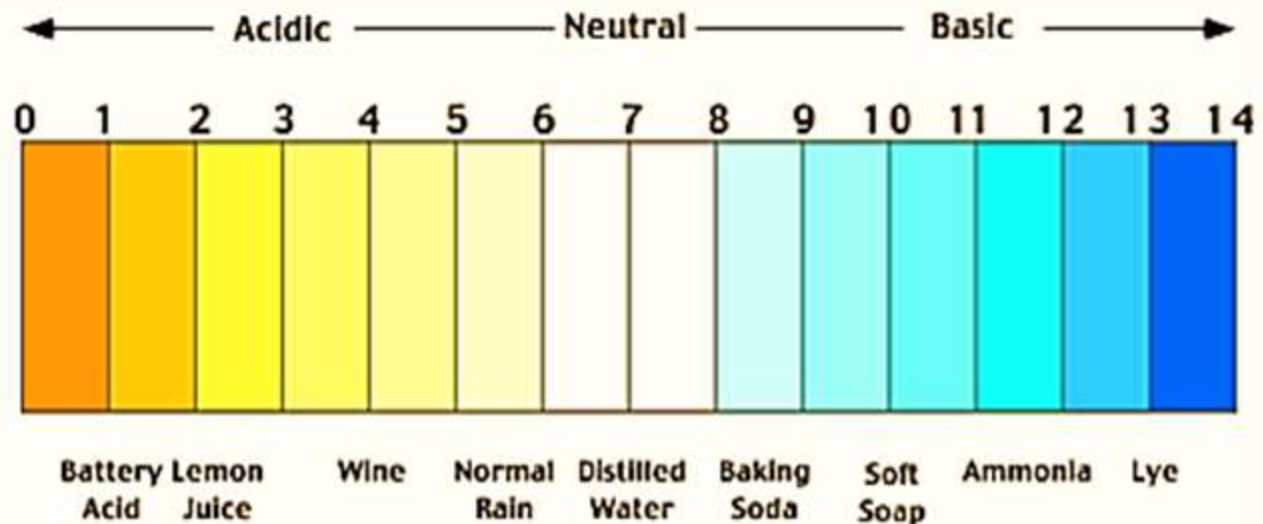
Hydrogen Bonding

- Water can form an unusually large number of intermolecular hydrogen bonds (four) for a molecule of its size due to its polar nature.



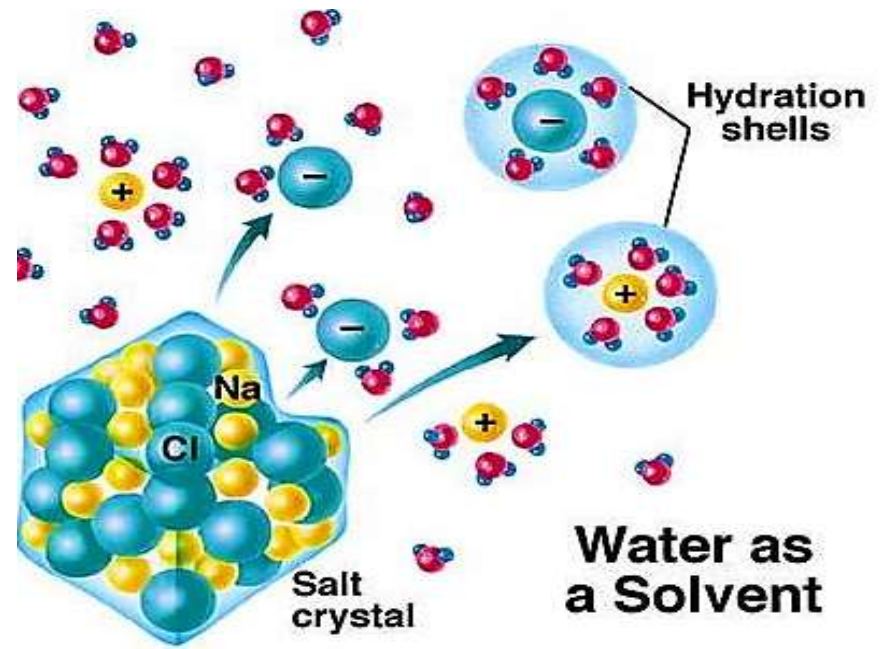
pH

- Water in a pure state has a neutral pH. As a result, pure water is neither acidic nor basic.
- Water changes its pH when substances are dissolved in it.
- Rain has a naturally acidic pH of about 5.6 because it contains natural derived carbon dioxide and sulfur dioxide.



Universal Solvent

- Water is often referred to as the universal solvent.
- Many substances, such as household sugar, dissolve in water. That is, their molecules separate from each other, each becoming surrounded by water molecules.
- Water is an excellent solvent for many substances because of its polar bonds.

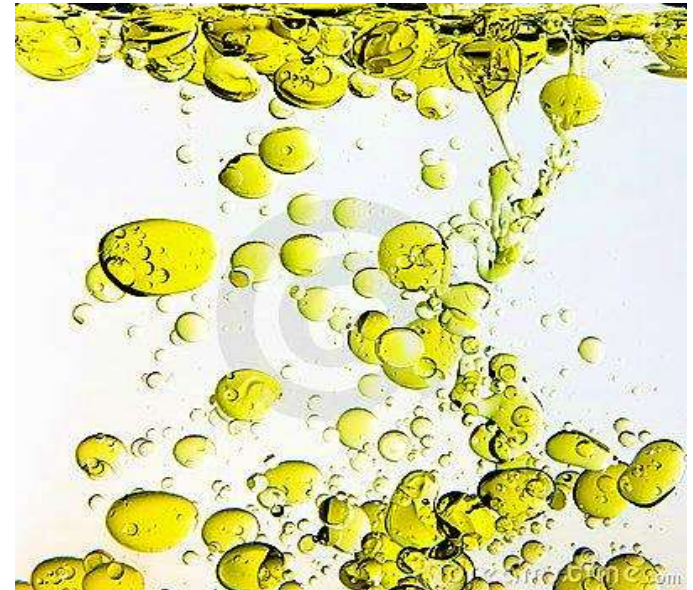


Hydrophilic Substances

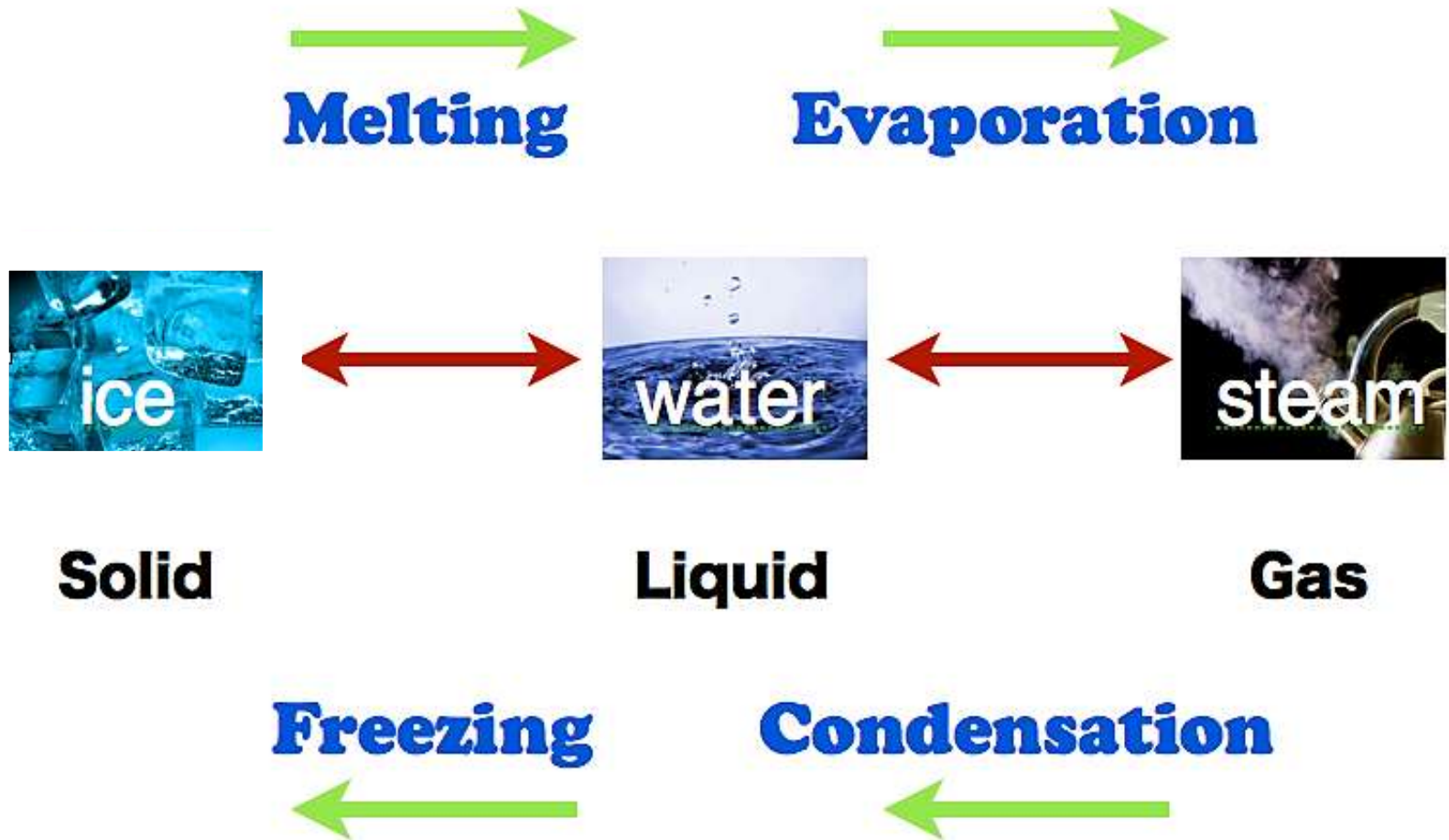
- Substances that dissolve in water, e.g., salts, sugars, acids, alkalis, and some gases are known as hydrophilic (water-loving) substances.
- They are composed of ions or polar molecules that attract water molecules through electrical charge effects.
- Water molecules surround each ion or polar molecule on the surface of a solid substance and carry it into solution.

Hydrophobic Substances

- While substances that do not mix well with water (e.g. fats and oils), are known as hydrophobic (water fearing) substances.



Physical States of Water



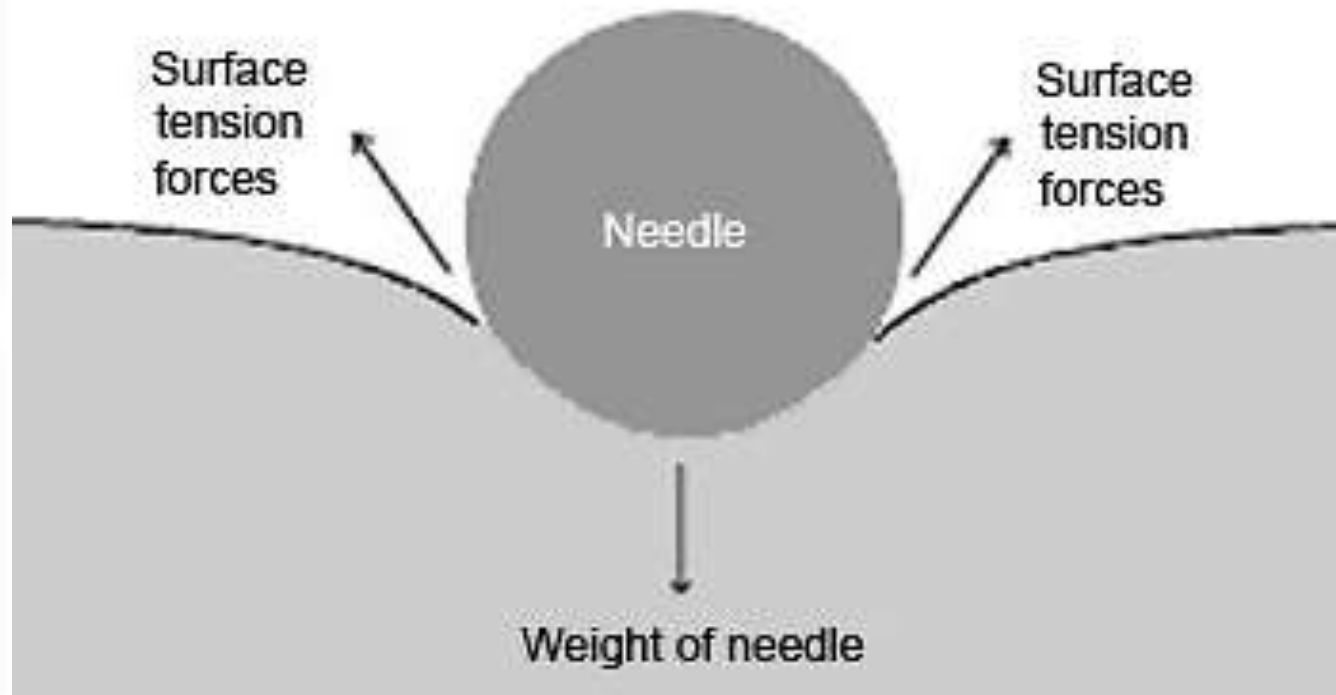
Taste, Odour & Colour

- Water is a tasteless, odourless liquid at standard temperature and pressure.
- The colour of water and ice is, intrinsically, a very slight blue hue, although water appears colourless in small quantities and thus aquatic plants can live within the water because sunlight can reach them.
- Ice also appears colourless, and water vapour is essentially invisible as a gas.

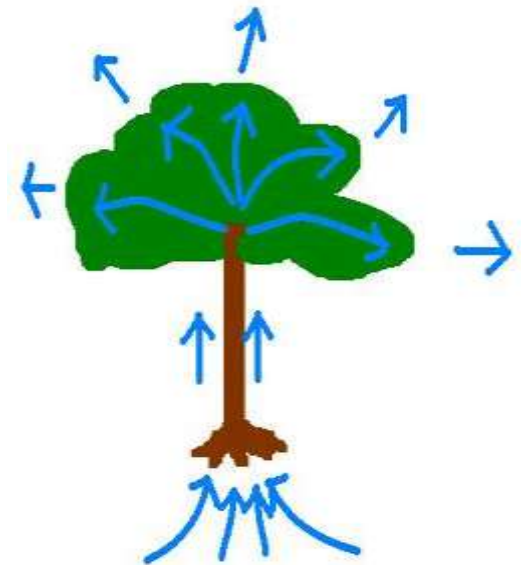
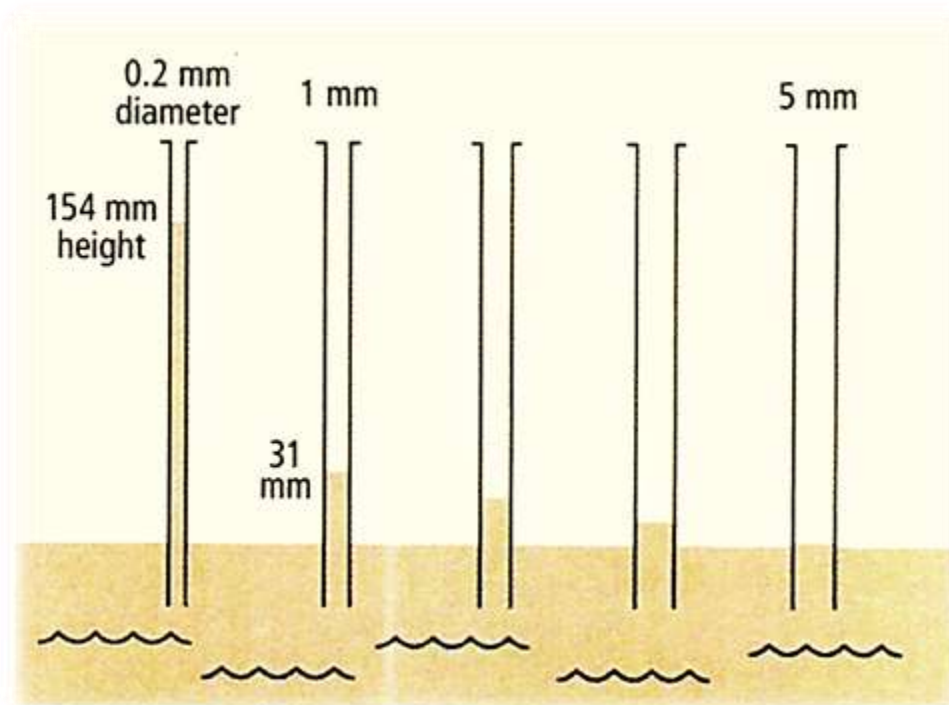


Surface Tension and Capillary Forces

- Hydrogen bonding lead to strong attractive forces between molecules of water, giving rise to water's high surface tension and capillary forces.

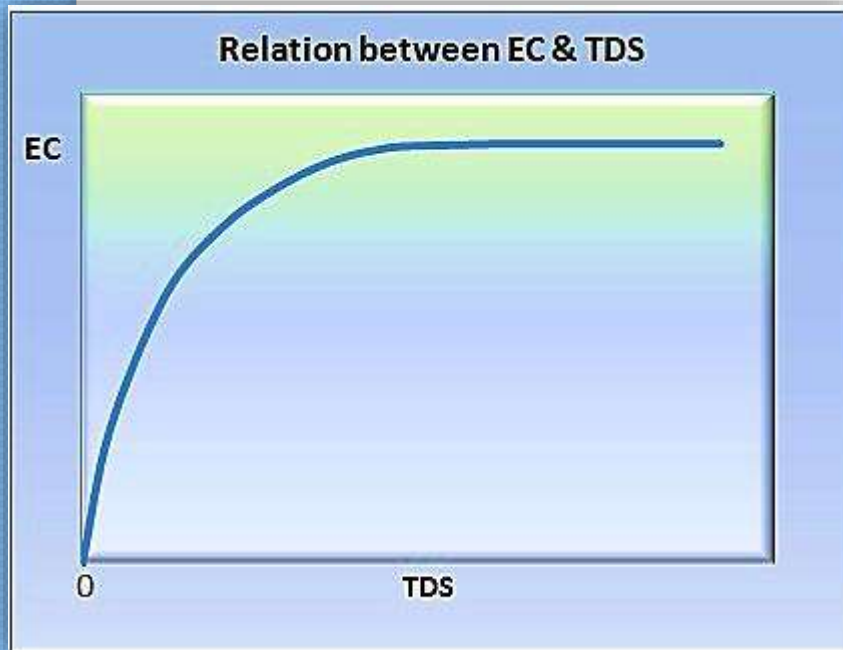


- The capillary action refers to the tendency of water to move up a narrow tube against the force of gravity.
- This property is relied upon by all vascular plants, such as trees.



Electrical Conductivity

- Pure water has a low electrical conductivity, but this increases significantly with the dissolution of a small amount of ionic material such as sodium chloride.



Type	Electrical Conductivity ($\mu\text{S}/\text{cm}$)
Pure Water	0.05
Distilled Water	1
Rain or Snow	2 - 100
Surface / Ground Water	50 - 50,000
Seawater	50,000

Melting Point & Boiling Point

- The boiling point of water (and all other liquids) is dependent on the barometric pressure.
- For example, on the top of Mt. Everest water boils at 68 degrees Celsius, compared to 100 degrees Celsius at sea level.
- Conversely, water deep in the ocean near geothermal vents can reach temperatures of hundreds of degrees and remain liquid.
- Melting point of water is 0 degrees Celsius.

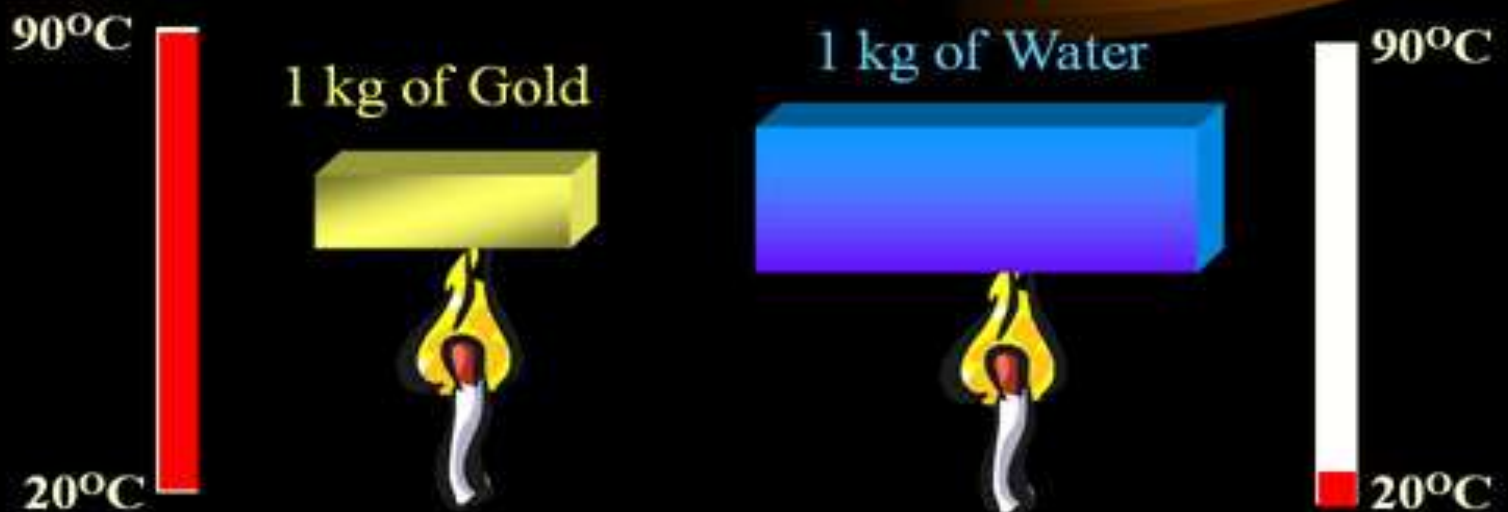


Specific Heat & Heat of Vaporisation

- Specific heat is the amount of energy required to change the temperature of a substance.
- Water has the second highest molar specific heat capacity of any known substance, after ammonia, as well as a high heat of vaporisation ($40.65 \text{ kJ} \cdot \text{mol}^{-1}$), both of which are a result of the extensive hydrogen bonding between its molecules.
- These two unusual properties allow water to moderate Earth's climate by buffering large fluctuations in temperature and helps organisms regulate their body temperature more effectively.

Specific Heat Comparison

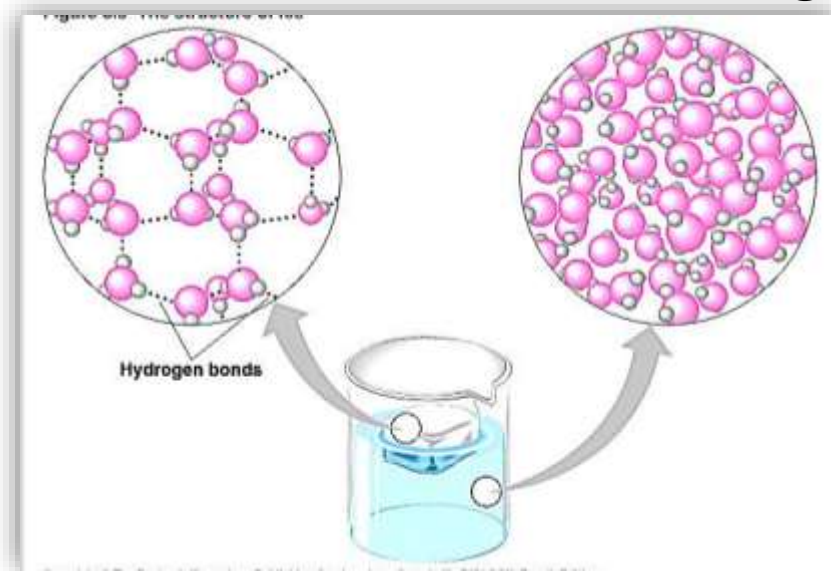
Different materials store different amounts of heat energy.



Water takes about 30 times longer to heat than gold, meaning it stores about 30 times more calories.

Density & Volume

- The maximum density of water occurs at 3.98 degrees Celsius.
- It has the anomalous property of becoming less dense, not more, when it is cooled down to its solid form, ice.
- It expands to occupy 9 percent greater volume in this solid state, which accounts for the fact of ice floating on liquid water.



Heat Conductivity

- Water conducts heat more easily than any liquid except mercury.
- This fact causes large bodies of liquid water like lakes and oceans to have essentially a uniform vertical temperature profile.



Thank You....