

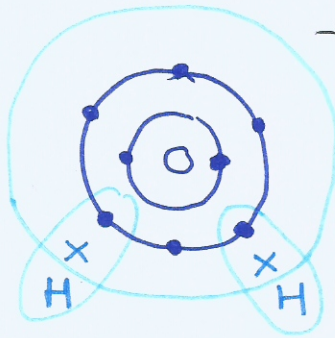
2.2. WATER

Hydrogen Bonding

- Water molecules are polar and form hydrogen bonds between them.

WATER

The bond has unequal sharing of electrons. It has **Polar covalent bond**.

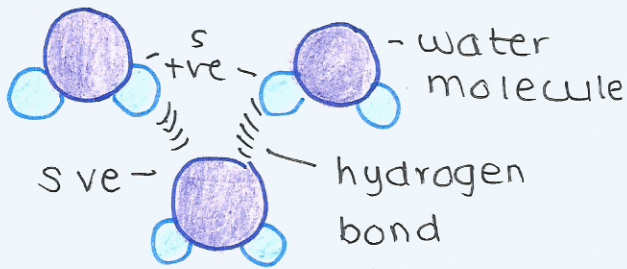


→ Formed by covalent bonds between an oxygen atom and 2 hydrogen atoms.

Because of the unequal sharing, hydrogen atoms have a **slight positive charge**

→ The nucleus of O_2 atom is more attractive towards electrons than the nuclei of H_2 atoms.

and oxygen has a slight **negative charge**.



Positive and negative (slight) charges attract each other and form a bond.

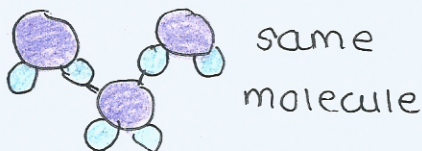
The attraction between 2 H_2O molecules is a hydrogen bond.

↓
The force that forms when a hydrogen atom is attracted to a slightly negative atom of another polar covalent molecule.

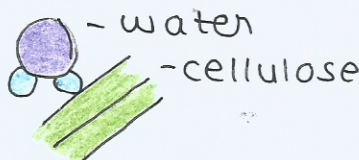


PROPERTIES OF WATER

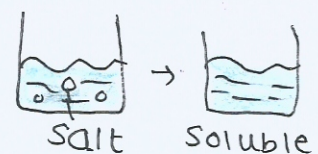
Cohesive Property



Adhesive property



Solvent property



Thermal property



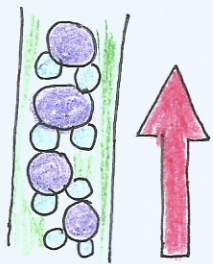
COHESIVE PROPERTY:

cohesion :- the binding together of 2 molecules of the same type.

Water molecules stick to each other because of the hydrogen bonding.

EXAMPLE: water transport in plants

- Water is sucked through xylem vessels at low pressure.



This can only work if the water molecules do not separate due to suction force.

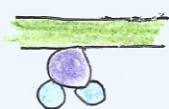
Because of the hydrogen bonding, this doesn't happen and water is transported.

ADHESIVE PROPERTY:

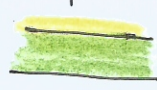
Hydrogen bonds are formed between water and other polar molecules causing water to stick to them. This is called adhesion.

EXAMPLE: Cell wall

- The water adheres to the cellulose molecules in cell wall.



cell wall



↓ CO₂ absorbed

xylem vessel

- If water evaporates from cell walls and via the leaf, adhesive forces causes water to be drawn out of the xylem vessel.

- This keeps the cell wall moist so that they can absorb carbon dioxide needed for photosynthesis.

THERMAL PROPERTY

• High Specific heat capacity:

- Hydrogen bonds restrict the motion of water molecules and increases in the temperature of water require hydrogen bonds to be broken.
- The energy needed to raise the temperature of H_2O is large.
- To cool H_2O must lose large amounts of energy.
- The H_2O temperature is stable in land or air which allows a stable habitat for aquatic animals.

• High Latent heat of vapourization:

- A molecule evaporates, it separates from other molecules in a liquid and becomes a vapour molecule.
- The heat required to break the hydrogen bond is known as latent heat of vapourization.

- Evaporation has a cooling effect.

↓

considerable amount of heat is required to evaporate water as the hydrogen bonds need to be broken.

• High Boiling point:

- Boiling point of a substance is the highest temperature it can reach in a liquid state.
- water's boiling point is very high.
- Therefore there are a broad range of temperatures - from $0^\circ C$ to $100^\circ C$.

SOLVENT PROPERTY:

- Polar nature of H_2O molecule allows it to form shells around charged and polar molecules.
- This prevents them from clumping together and keeps them in the solution.

Example: Cytoplasm

- It is a complex mixture of dissolved substances in which the chemical reactions of metabolism occurs.
- Water weakens the inter-molecule forces and results in the dissociation of ~~to~~ the atoms.

HYDROPHILIC AND HYDROPHOBIC



Substances that freely associate and dissolve in water are hydrophilic.

- includes ions & all polar molecules



Substances that do not freely associate or dissolve in water are called hydrophobic.

- includes large and non-polar molecules (lipids & fats).

TRANSPORTATION IN THE BLOODSTREAM:

The transport of essential molecules in the bloodstream will depend on their solubility in water.

- Water soluble substances are able to travel freely in the blood plasma, whereas insoluble substances cannot.

Water Soluble Substances:

- Sodium chloride ($NaCl$) - ionic compound and its components (Na^+ and Cl^-) are freely transported within the blood.
- Oxygen is soluble in H_2O but in low amounts - it is transported through haemoglobin in the RBCs.

- Glucose ($-OH$) has hydroxyl groups which may associate with water.
- Amino acids - transported in the blood in an ionized state.

Water Insoluble substances

- Lipids (fats and cholesterol) are non-polar and do not dissolve in water.
- They form complexes with proteins (lipo proteins) in order to move through the blood stream.
- Hydrophilic parts of proteins, cholesterol, and phospholipids face outwards and protect the hydrophobic components.

COMPARISON OF WATER AND METHANE

- Water is polar and can form intermolecular hydrogen bonds.
- Methane is non-polar and forms weak forces between its molecules.

Water absorbs more heat before changing its state
Water has a higher

MELTING POINT	BOILING POINT	SPECIFIC HEAT CAPACITY
HEAT OF VAPOURIZATION	HEAT OF FUSION	

WATER AS A COOLANT

- change of water from liquid to vapour needs energy
- energy comes from the skin when body is hot
- water has a high specific heat capacity $\therefore$ it absorbs a lot of heat before it evaporates as sweat.
- acts as a coolant.