

Water

Why is water so important?

- Water is a major component of all cells and has many important roles within organisms, such as **cytoplasm** in both animal and plant cells.
- Has a role in synthesising and breaking down biological molecules in **condensation and hydrolysis** reactions. In other words, water is a **metabolite** in many important metabolic reactions. (such as photosynthesis)
- It is an important **solvent** (substances dissolve in it) in which metabolic reactions occur. (such as in the cytoplasm)
- Provides a **cooling effect** with little loss of water through evaporation
- It has a **high latent heat of vaporisation** and a **high specific heat capacity**.
- It has strong **cohesion** (stick well) between water molecules which helps water transport in plants as well as transport in other organisms.

What is the chemical structure of water?

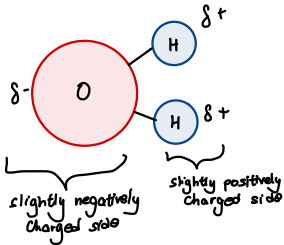
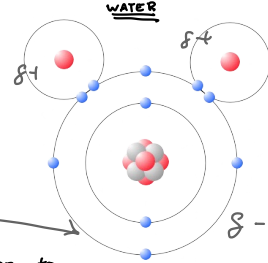


- The hydrogen atoms are bonded to oxygen atoms through **covalent bonds**. (electrons are shared)

The polar nature of water

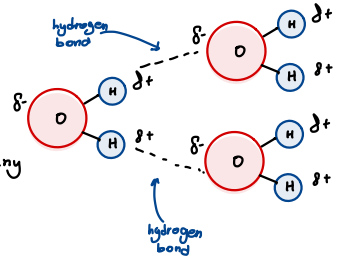
meaning it is charged due to unequal sharing of electrons

- The **electrons** in the covalent bonds of water are **not equally shared** - they lie closer to the **oxygen nucleus** than the hydrogen nuclei.
↓ hence
- The unshared negative electrons on the oxygen atom give it a **slight negative charge** (δ^-), and therefore the other side of each **hydrogen atom** is left with a **slight positive charge** (δ^+).
- This makes water a **polar** molecule.



Why are there hydrogen bonds within water?

- **What is a hydrogen bond:** Hydrogen bonds are weak bonds between a slightly positively charged hydrogen atom and a slightly negatively charged atom in another molecule.
- **Why are they formed:** The slightly negatively charged oxygen atoms of water attract the slightly positively charged hydrogen atoms of other water molecules.

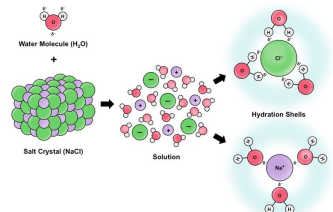


Properties of water

- It is an important **metabolite** (a substance involved in a metabolic reaction) in many metabolic reactions. (e.g. condensation and hydrolysis reactions)
- It is an important solvent in which metabolic reactions occur.

Why is water such a good solvent?

- Water is **polar** (has a slight negative charge on one side and positive on the other)
↓ hence
- The **positive end of water** is attracted to the **negative ion**.
- The **negative end of water** is attracted to the **positive ion**.
- Hence the ions get totally surrounded by water molecules → they dissolve.



Why does water have a high latent heat of vaporisation? And why is this useful?

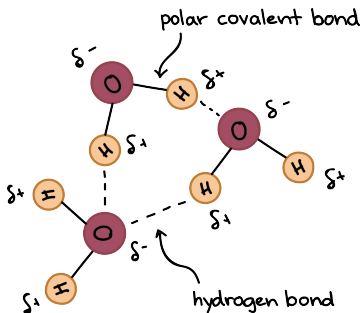
- **How does water evaporate:** When the **hydrogen bonds** (known as intermolecular bonds in GCSE) holding water molecules together are broken.
- It takes a LOT of energy (heat energy) to break the hydrogen bonds between water molecules.
↓ hence
- Water has a **high latent heat of vaporisation** → lots of heat is used to change water to gas.
- This is useful for organisms as they can use **water loss through evaporation to cool down** within losing too much water. (e.g. humans sweat to cool down)

How does water having a high heat capacity help buffer changes in temperature? → Makes water a stable environment

- **What is specific heat capacity:** The energy needed to raise the temperature of 1 gram of a substance by 1°C.
- **Why does water have a high specific heat capacity:** A LOT OF heat energy is used to break the hydrogen bonds between the water molecules. → less heat energy is diverted to increase the actual temperature of water instead of breaking intermolecular (hydrogen) bonds.
↓ hence
- It takes a LOT of energy to heat water up.
- This is useful as water doesn't experience rapid temperature changes.
↓
- This makes water a **good habitat** as temperature under water is more stable than land. (for aquatic animals)
- Its stable temperature helps maintain organisms' constant internal body temperature. (acts as a medium)

Why is the cohesive nature of water useful?

- **What does cohesive mean:** There is high attraction between molecules of the same type.
- **Why is water cohesive:** Because water is polar (hence making hydrogen bonds to make it stick)
- **Why is cohesion useful in water:** It helps water flow, making it great for transporting substances.
↓
- This supports columns of water in xylem cells of plants and produces surface tension where water meets air.



Hydrophilic vs Hydrophobic

- Hydrophilic means liking water.
- Hydrophobic means not liking water.

Solvent vs Solute vs Solution

For a coffee;

- **Solvent** is the water.
- **Solute** is the sugar + powder.
- **Solution** is the coffee.