

Why is water a polar solvent and why some substances are soluble/insoluble?

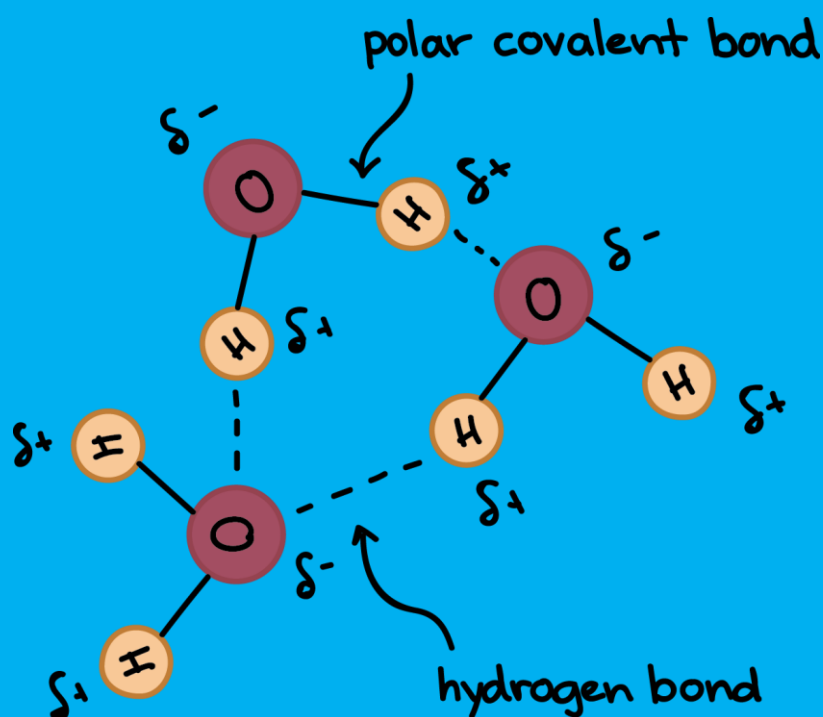
Water existed as polarised molecules that are attracted to each other and other polarised particles.

This is because a H₂O molecule has a bent planar shape due to the electronic arrangement around the central oxygen atom.

There are two hydrogen atoms bonded to an oxygen atom, with a further 4 unshared (valence) electrons.

The most stable arrangement is when all the groups repel and spread apart with bond angles of 107°. The two lone pairs (valence pairs) repel the bonding pairs apart more strongly resulting in an electron-dense region on one side of the molecule and the hydrogen bonds are forced to the opposite side. Oxygen is slightly more electro-negative and so has a stronger attraction to the bonding electrons than the hydrogen atoms. This gives the oxygen end of the water molecule a slight negative charge, while the hydrogen end has a partial positive charge, hence a permanent polarised dipole is formed.

Due to the polarity of water, the positive hydrogen end associates with the negative oxygen end of another water molecule, keeping water molecules attracted to each other.



An excellent explanation can be found on Khan academy!

Soluble compounds are ones that are able to form hydrogen bonds with water molecules, hence associate their negative polar ends with positive polar ends of water molecules and vice versa so dissolve. They either hydrogen bond or form ion-dipole interactions to do this.

A charged or polar substance that is able to interact and dissolve with water is soluble and is said to be hydrophilic (can form hydrogen bonds with water).

In contrast, non-polar molecules like fats and oils (and proteins/plastics) are called hydrophobic. They separate from rather than dissolve in water to form a discontinuous phase. They either form insoluble precipitates or an emulsion (if an emulsifier is added).