Soil water

Water in soil

Soil usually contains some moisture. Some soils, such as clay, retain water well. Others, such as those with a high sand content, drain quickly and do not retain water well.

Soil consists of inorganic particles and organic material. These are surrounded by water (often called soil water) and pockets of air. Soil water contains many dissolved substances, including nutrients essential for the healthy growth of plants.

Bonding, structure and solvent properties

The solvent properties of water are due to the structure and bonding of water molecules. Oxygen in more electronegative than hydrogen and so both oxygen-hydrogen bonds in a water molecule are polarised.

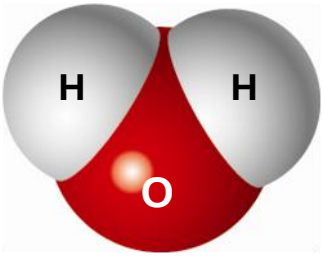

Figure 1 A water molecule in non-linear.

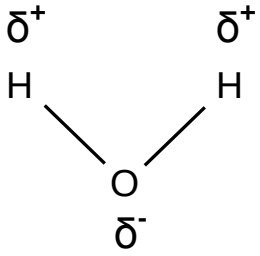

Figure 2 Polarised covalent bonds in water make a water molecule polar.

Due to their structure and bonding water molecules form hydrogen bonds with one another.

When a substance dissolves water molecules surround ions or molecules and carry them into solution. Water molecules bond to ions and molecules by electrostatic attraction.

Solubility of covalent compounds

Generally, compounds consisting of covalent molecules have low solubility in water. However, if the molecules are polar, and especially if they have structures that enable them to form hydrogen bonds with water, the compound may be soluble.

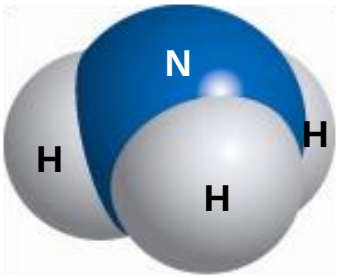

Figure 3 An ammonia molecule is pyramidal.

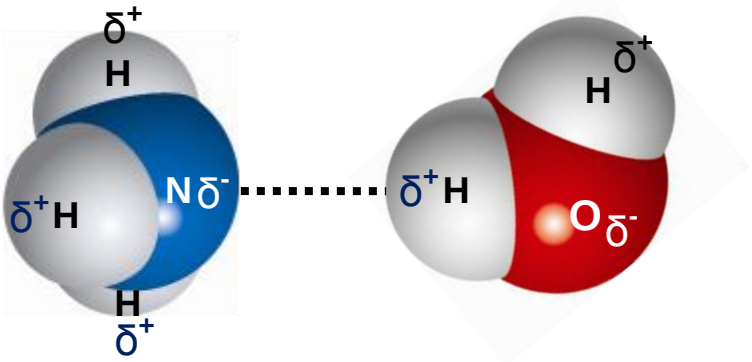

Figure 4 Hydrogen-bond formed between an ammonia molecule and a water molecule.

Ammonia and ethanol are very soluble in water. Water molecules form hydrogen bonds with ammonia molecules and with ethanol molecules, as well as with one another and.

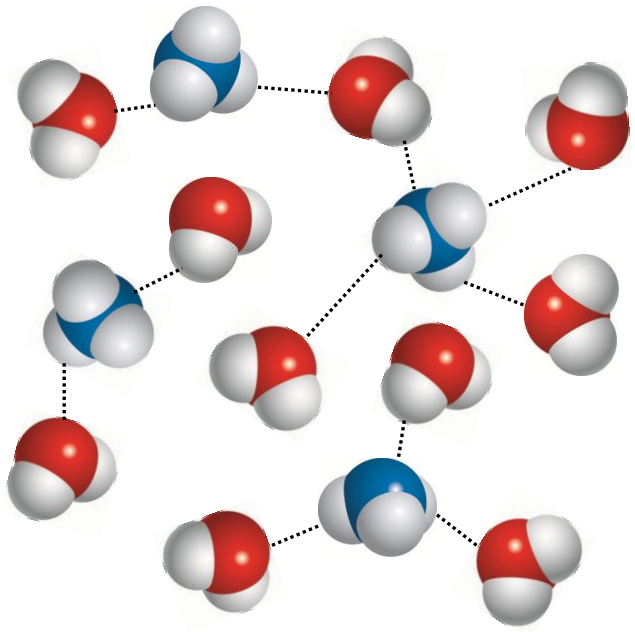

Figure 5 Dissolution of ammonia: $NH_3(g) + aq \rightarrow NH_3(aq)$. Hydrogen-bonding between ammonia and water molecules accounts for the solubility (hydrogen-bonding between water molecules not shown).

Solubility of ionic compounds

Ionic compounds dissolve because the ions become hydrated (surrounded by water molecules).

Ions on the edges and corners of sodium chloride crystals attract water molecules – oxygen in a water molecule is attracted to sodium ions, while hydrogen in a water molecule is attracted to chloride ions.

Sodium ions and chloride ions are carried off into solution as hydrated ions. The diagrams in figures 6 and 7 illustrate two-dimensional structures of the hydrated ions. However, the attached water molecules hydrogen-bond to further water molecules so that the ions are surrounded by a large cluster of water molecules. The structure of the cluster becomes less well-ordered further away from the ions.

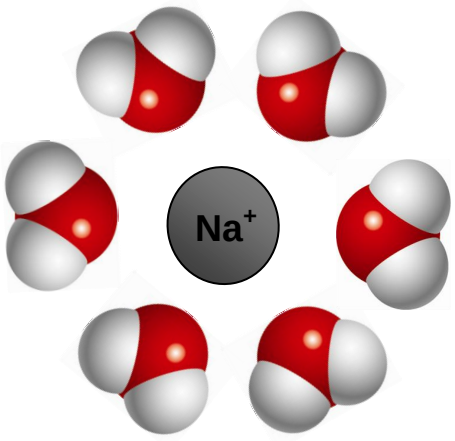

Figure 6 Hydrated sodium ion.

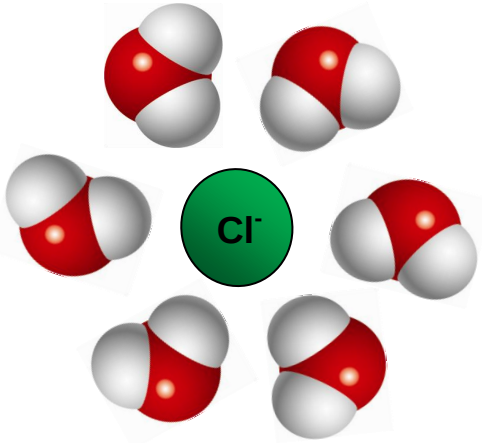

Figure 7 Hydrated chloride ion.

Finding out

What determines the solubility (g dm^{-3}) of a substance in water?

What is enthalpy of solution?

How might the enthalpy of solution be determined?

When some substances dissolve in water the dissolution is endothermic. What is the driving force for dissolution?