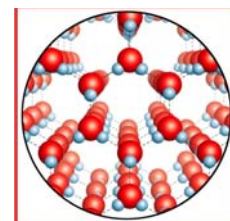
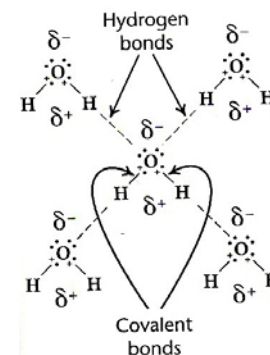


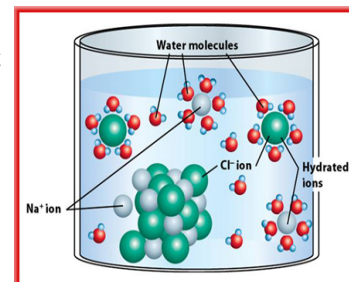


**Water and Solutions (from Chapter 13)**

- ◆ Polarity and hydrogen bonds are responsible for many of the unusual physical properties of water.
- ◆ Water has very strong intermolecular forces called hydrogen bonds an interaction between the hydrogen atoms ( $\delta^+$ ) and free electron pairs of the oxygen atoms ( $\delta^-$ ).
- ◆ Water has a high boiling point for its small molecular size.
- ◆ On earth, water exists primarily a liquid, but also as solid and gas.
- ◆ Density: Most substances are more dense as solids than as liquids, but water is an important exception (anomaly of water). Water has its highest density (“heaviest”) at  $4^\circ\text{C}$ . Ice is less dense than water, thus floats on lakes and ponds, helping fish to survive the winter. On the other hand pipes and bottles break when water inside expands when turning into ice. Rocks also erode faster (crumble) when trapped water freezes.
- ◆ Drops of water are formed because of surface tension, which is a force needed to overcome intermolecular attractions and break through the surface of a liquid or spread the liquid out.
- ◆ Capillarity (or capillary action) is the rising of a liquid in a narrow tube. It results from the competition between the Interparticle attractive forces between the molecules of the liquid and the attractive forces between the liquid and the tube. Water forms a concave meniscus in glass tubes because it is attracted to the  $\text{SiO}_2$  molecules in glass. Mercury on the other hand forms a convex (high-centered) meniscus because it does not.
- ◆ Water has a very high specific heat. (Specific heat is the amount of heat needed to raise the temperature of 1g of a substance by  $1^\circ\text{C}$ .) A lot of energy is needed to heat up water (endothermic), and cooling down water releases a lot of energy (exothermic). This affect’s the earth’s climate, e.g. ocean climate: summers are less hot and winters are less cold in areas close to the ocean or big lakes.
- ◆ During vaporization (change from liquid to gas) the attractive intermolecular forces have to be overcome, which cost a lot of energy (energy of vaporization). When sweat evaporates on your skin the evaporating water removes heat from your body, thus cooling you down (endothermic). Condensation releases energy (exothermic).
- ◆ Water is a great solvent for polar molecular and ionic compounds, thus rarely pure.
- ◆ Ionic compounds (like NaCl) dissociate in water, meaning the cations and anions are separated and hydrated (surrounded by water molecules through dipole interaction).



Ice



**Solution:** Homogeneous mixture (*example salt water*)

**Solute:** Dissolved particles in a solution (*example salt*)

**Solvent:** The dissolving medium in a solution (*example water*)

**Concentration** of a solution is a measure of the amount of solute that is dissolved in a given quantity of solvent.

**Dilute solutions** contain only a low concentration, while **concentrated solutions** contains a high concentration of solute. **Saturated solutions** contain the maximum amount of solute in a given solvent at a given temperature and pressure.

**Like dissolves like.** Polar solvents, such as water, tend to dissolve polar and ionic compounds (solutes), but not nonpolar ones. Interparticle forces between solvent and solute strongly influence solution formation. Hydrogen bonding plays an important role in the dissolving of many covalent compounds, such as sugar, in water.

**Temperature affects solubility.** Generally, solubility of solids increases with increasing temperature.

**Molarity** is a measure of concentration in chemistry: How much solute is dissolved in 1L of solution. Another way to express concentration is in **percent** (percent by volume or percent by mass).