

³⁷ SOLUTIONS

- a SOLUTION is a HOMOGENEOUS MIXTURE.

└─ Uniform properties throughout!

- parts of a solution:

① SOLUTE(S)

- component(s) of a solution present in small amounts.

② SOLVENT

- the component of a solution present in the GREATEST amount

- in solutions involving a solid or gas mixed with a LIQUID, the liquid is typically considered the solvent.

- solutions are usually the same phase as the pure solvent. For example, at room temperature salt water is a liquid similar to pure water.

- SOLUBILITY is the amount of one substance that will dissolve in a particular solvent. It depends on temperature and a few other factors.

³⁸ SOLVENTS

- We traditionally think of solutions as involving gases or solids dissolved in liquid solvents. But ANY of the three phases may act as a solvent!

① GAS SOLVENTS

- Gases are MISCIBLE, meaning that they will mix together in any proportion.
- This makes sense, since under moderate conditions the molecules of a gas don't interact with each other.
- Gas solvents will only dissolve other gases.

② LIQUID SOLVENTS

- Can dissolve solutes that are in any phase: gas, liquid, or solid.
- Whether a potential solute will dissolve in a liquid depends on how compatible the forces are between the liquid solvent and the solute.

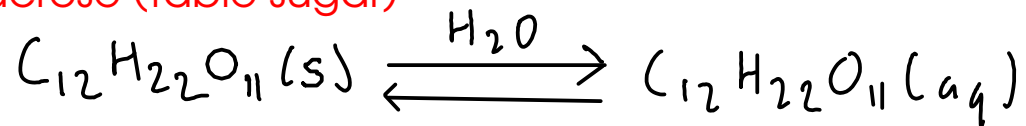
③ SOLID SOLVENTS

- Solids can dissolve other solids, and occasionally - liquids.
- Solid-solid solutions are called ALLOYS. Brass (15% zinc dissolved in copper) is a good example.
- AMALGAM is a solution resulting from dissolving mercury into another metal.

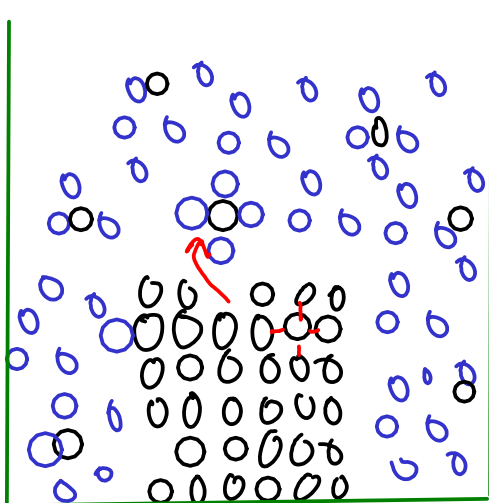
HOW THINGS DISSOLVE

- Let's look at how things dissolve into water, since aqueous solutions are quite common.

sucrose (table sugar)



... what happens?



- Water molecules pull the sugar molecules out of the sugar crystal and into solution.
- Attractions between sugar molecules and water allow this to happen.
- The solubility of the sugar depends on how well water and sugar interact (SOLVATION) versus how well the sugar molecules are held in the crystal (LATTICE ENERGY)

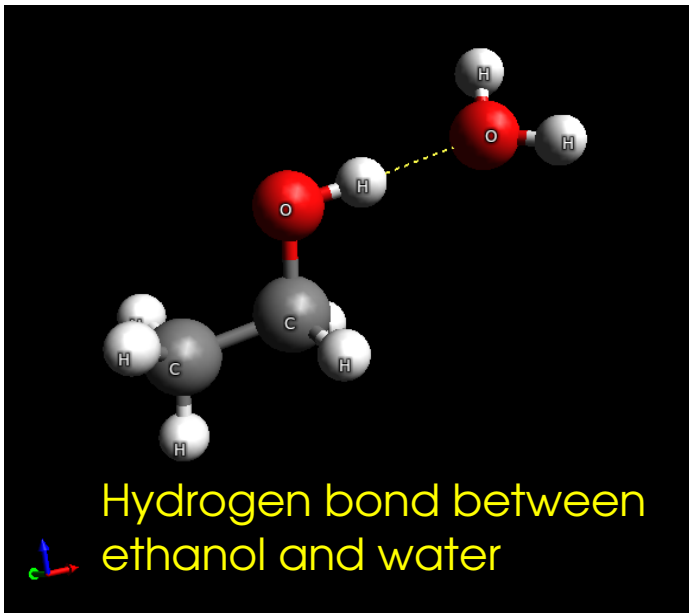
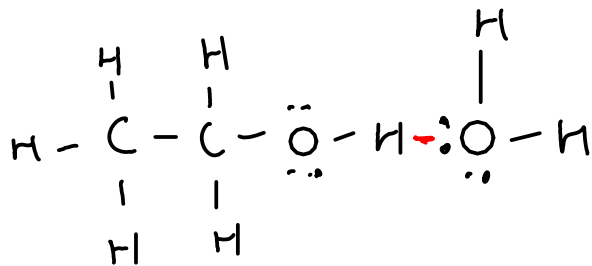
- "like dissolves like": Substances held together by similar (or at least compatible) kinds of attractive forces can dissolve in each other. Substances that are held together by very different kinds of attractive forces will not dissolve in one another!

Consider WATER:

HYDROGEN BONDS



Water mixes well with other substances that can hydrogen bond, like ETHANOL!



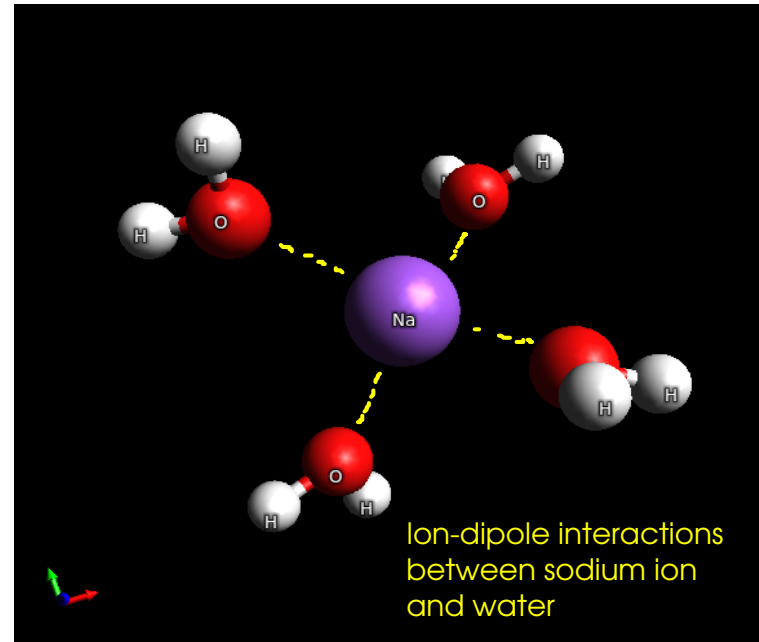
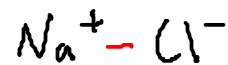
POLAR



Water can dissolve polar substances!
(SUCROSE is polar!)



Since IONIC BONDS are also interactions between opposite charges (You can think of an ionic bond here as an extreme case of dipole-dipole interaction), many IONIC SUBSTANCES will also dissolve in water!



SMALL (little London force)



large and/or nonpolar solutes do not dissolve well in water!

(example: OILS and WAXES)

ELECTROLYTES

... are substances that form free ions when dissolved into an aqueous solution!

STRONG ELECTROLYTES

- Substances where all the dissolved substance forms ions

WEAK ELECTROLYTES

- Substances where only a small fraction of the dissolved substance forms ions

NONELECTROLYTES

- Substances that do not form ions when dissolved

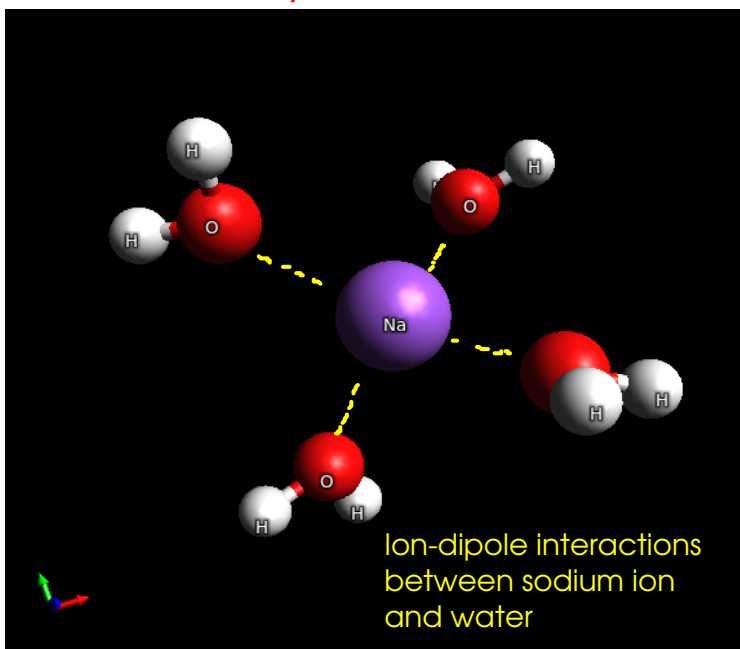
Whether a substance is an electrolyte can be easily tested with a simple conductivity meter. The stronger the electrolyte, the more electric current an aqueous solution of that electrolyte will conduct! (What about water itself? Water does self-ionize, but to such a small extent - about 0.0000002% - that it conducts very little electric current!)

What kinds of substances can be electrolytes?

IONIC COMPOUNDS

- WATER-SOLUBLE ionic compounds tend to be STRONG ELECTROLYTES, since water pulls apart ionic compounds as they dissolve (DISSOCIATION)

Whether an ionic compound dissolves depends on how strongly the ions in the compound attract each other relative to the strength of the ion-dipole interactions and entropy



MOLECULAR COMPOUNDS

- Most molecular compounds are NONELECTROLYTES
- Some molecules REACT WITH WATER to produce ions in solution, These molecules are electrolytes. Most of these are WEAK ELECTROLYTES, but some are STRONG. The most common examples of molecules that are electrolytes are ACIDS and BASES.

EXTERNAL FACTORS AFFECTING SOLUBILITY

- There are a few external factors that affect the solubility. (By external, we mean other than the chemical identity of the solute and solvent).

① TEMPERATURE

-For gases dissolved in liquids, the solubility DECREASES as the temperature INCREASES

- This is why THERMAL POLLUTION is bad! Hot water holds less oxygen than cooler water.

- For solids dissolved in liquids, solubility USUALLY increases with temperature. This is not true for ALL solid/liquid solutions.

② PRESSURE

- For gases dissolved in liquids, solubility INCREASES when the partial pressure of the solute gas over the solution INCREASES.

- Consider soft drinks. They go flat after opening because the pressure of carbon dioxide over the liquid goes down.

- No significant pressure effects for solid/liquid solutions.