

## CLASSIFICATION OF SOLIDS: By structure

- Solids may also be classified by structure. A more in-depth look at solids is something you would find in a materials science class, but we'll discuss two broad categories of solid materials.

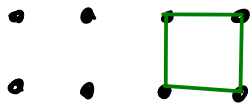
### ① AMORPHOUS SOLIDS

- have a disordered structure at the microscopic level.
- a very small amount of solids are completely amorphous, but quite a few plastics are at least partially amorphous.

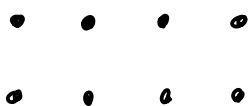
### ② CRYSTALLINE SOLIDS

- have a well-defined three dimensional structure at the microscopic level.
- structure is made up of a regular, repeating arrangement of points in space - a CRYSTAL LATTICE

## MORE ON CRYSTALS

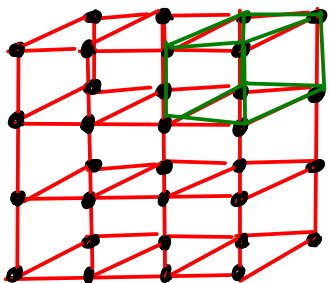


Here's a simple CRYSTAL LATTICE in 2D. The points represent atoms occupying LATTICE POINTS



The simplest repeating pattern that describes the entire crystal is called the UNIT CELL. It's outlined in GREEN here.

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Here's a crystal lattice in three dimensions. This one is called a SIMPLE CUBIC lattice. This simple structure can be found in some solid metals like polonium. A polonium atom occupies each lattice point.

The unit cell, again, is highlighted in GREEN.

See OpenStax page 570 for more types of crystal systems and more unit cells.

- Natural crystals almost always have some DEFECTS in their structure.
  - Holes in the crystal lattice, where an atom should be but isn't
  - Misaligned planes in the crystal
  - Substitutions of one atom for another in the crystal lattice
- Often defects are undesirable, but not always:

Alumina:  $Al_2O_3$

- clear / white in color
- usually used as the "grit" in cleaners like Comet and Soft Scrub!

ruby:  $Al_2O_3$  with some Al replaced with Cr

- red in color
- valuable gemstone!

## <sup>37</sup> 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.

## <sup>38</sup> 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.

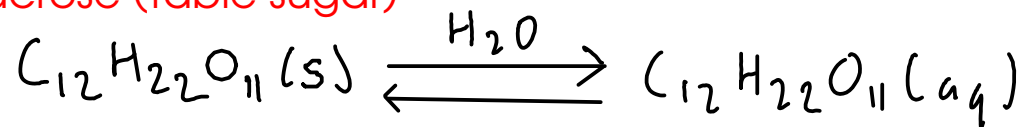
### ③ SOLID SOLVENTS

- 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.

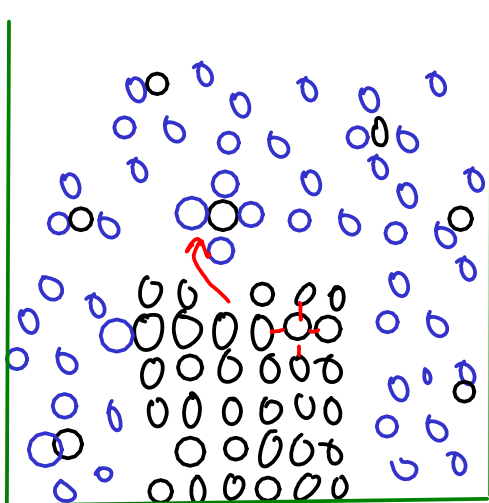
## HOW THINGS DISSOLVE

- 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)

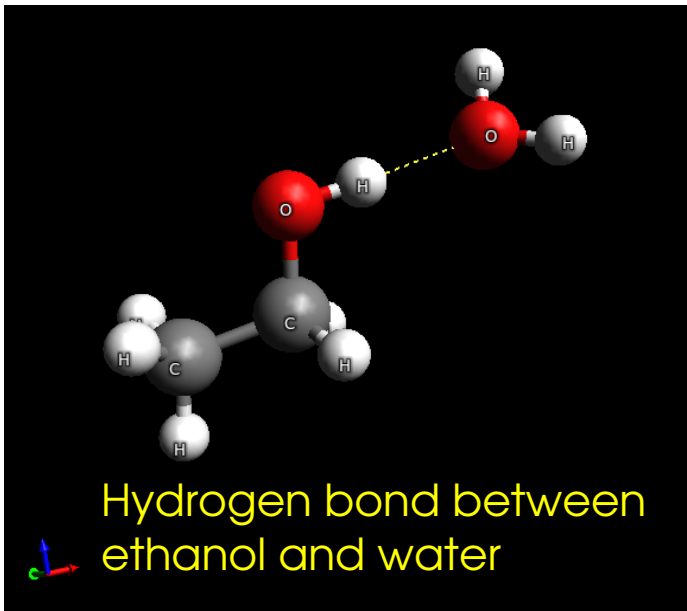
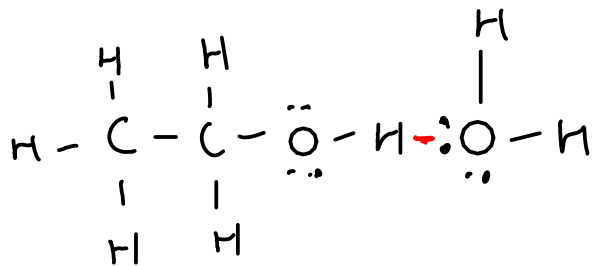
- "like dissolves like": Substances held together by similar (or at least compatible) kinds of attractive forces can dissolve in each other. Substances that are held together by very different kinds of attractive forces will not dissolve in one another!

## Consider WATER:

HYDROGEN BONDS



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



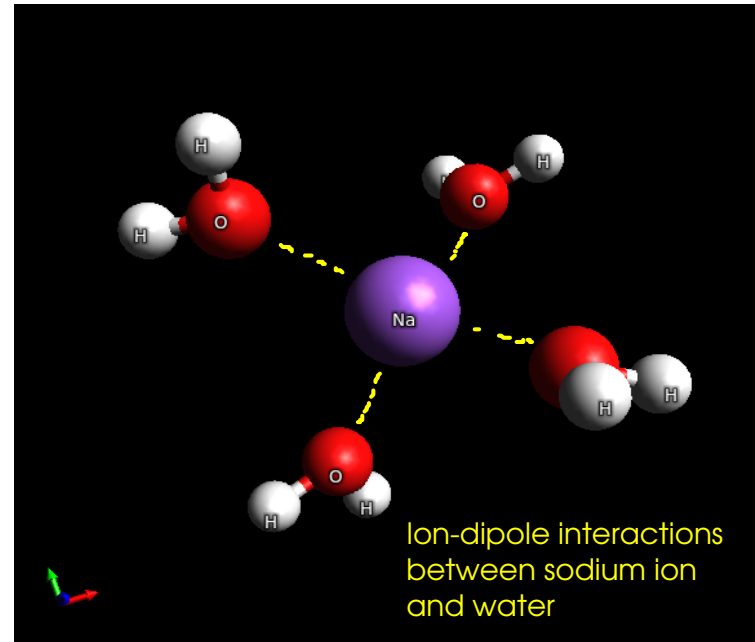
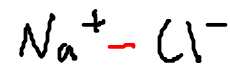
POLAR



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)