Solutions

Solution = homogeneous mixture
= uniform composition

Reactions faster (better molecular interactions)

Volume measurements convenient

Solutions Characteristics:

Uniform distribution of components (homogeneous)
Components cannot be seen

Variable compositions

May exist in any of three states:
solid, liquid, or gas

Particles do not settle upon standing

Terms

Solvent
single substance that does the dissolving
substance present in the largest amount

Solute
1 or more substance that is dissolved
substance present in the lower amount

Solubility
quantity of a solute that will dissolve at a fixed temperature
typically expressed a grams solute/per 100 mL

Conventions
when solid or gas dissolved in liquid,
solvent = liquid
solute = solid or gas

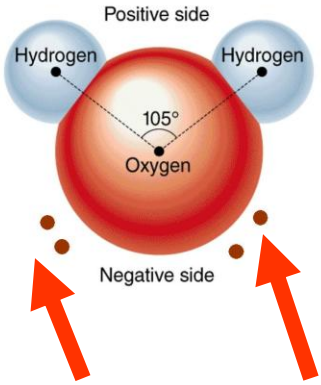
Water as solvent = aqueous solution (aq)
"universal solvent"

Solvent Examples

Solvent	Solute	Example
gas	gas	O_2 in N_2
liquid	gas	CO_2 in H_2O
solid	gas	H_2 in Pd
gas	liquid	Clouds
liquid	liquid	Alcohol in water
solid	liquid	H_2O (from air) & NaOH
solid	gas	S in Air
liquid	solid	Ag in Hg
solid	solid	Cu in Zn (brass)

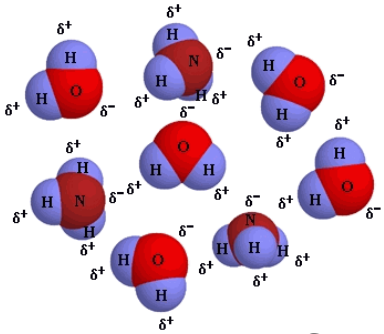
LPT

The Water Molecule



Unshared Electrons

Dipole = unequal distribution of charge (like a magnet)
created by electron repulsion between oxygen's 2 unshared pairs



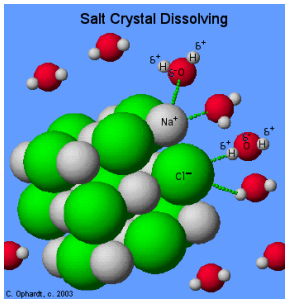
Solution:
NH_3 in H_2O

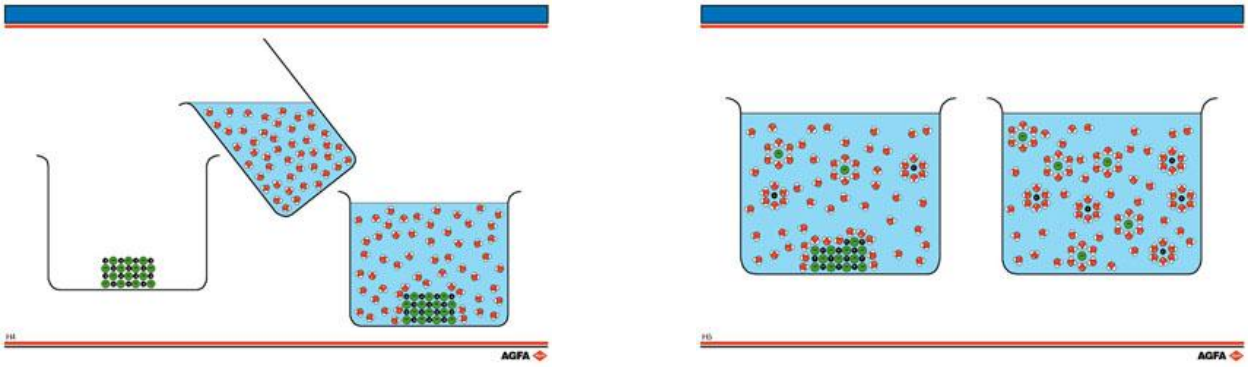
Allows networks of attraction between polar molecules

Dissolving Salts

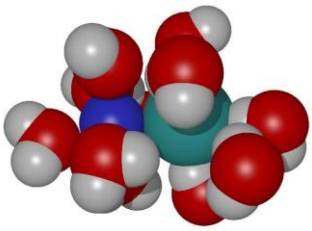
At the molecular level: Ions separated from solid surface

(-) charged ions at surface attracted by (+) (H) regions of water
(+) charged ions at surface attracted by (-) (O) regions of water





Ions become "Hydrated"



Na = Blue
Cl = Cyan

H = White
O = Red

Individual ions surrounded by water molecules

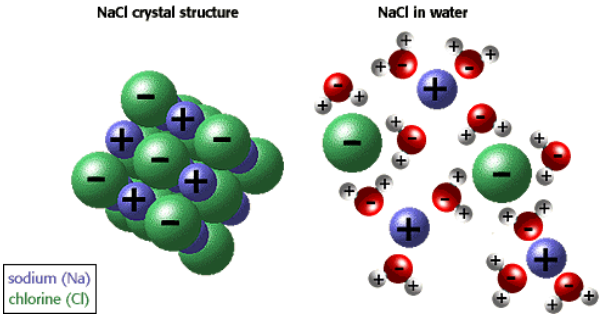
Dissociation (Dissolving)

Process of using water to separate ions of a substance
sodium chloride dissociates when dissolved in water

$$NaCl_{(s)} \rightarrow Na^{+}_{(aq)} + Cl^{-}_{(aq)}$$

A physical change

Results in a uniform mixture of water & Na^+ & Cl^-

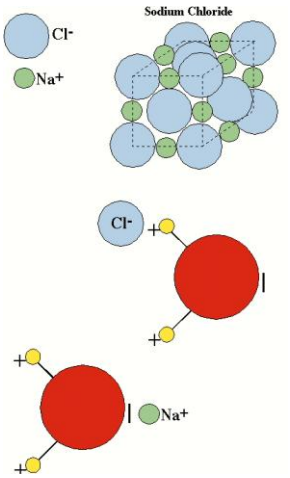


Solution Process is Reversible

Dissolved particles move randomly as they leave salt crystal

Solution becomes homogeneous (stirring helps)

Dissolved particles may return to solid state (crystallize)



Equilibrium

In a saturated (maximum solute possible) solution:

$$NaCl_{(s)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$$

forward rate = reverse rate

overall concentrations remain constant

Solubility Terms

Saturated

solution contains the maximum amount of solute

A dynamic equilibrium exists

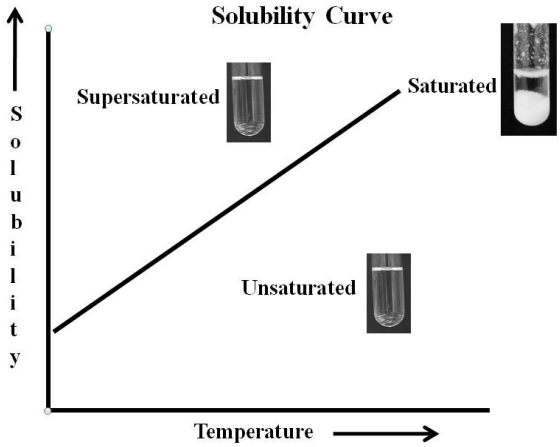
Unsaturated

solution contains less than the maximum amount of solute

Supersaturated

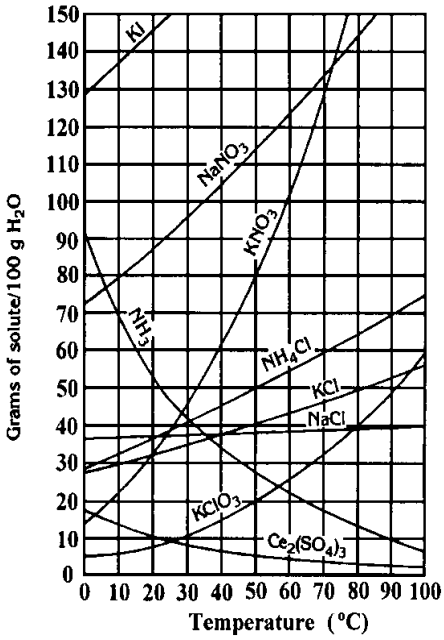
solution contains more than the maximum amount of solute carefully prepared

unstable



Solubility Curves

Plot of amount of solute vs. temperature



Saturated
On the solubility line

Unsaturated
Below the line

Supersaturated
Above the line

Supersaturation

Solubility is a function of temperature

In general, increase in temperature increases solubility

Assume:

solubility of X = 15 g/100 g H_2O at 25°C

solubility of X = 28 g/100 g H_2O at 80°C

So:

Place 18 g X in a beaker of water

heat to 80°C … all 18 g of X dissolves

Unsaturated since 18 g < 28 g solubility limit

Slowly cool back to 25°C

If left undisturbed, 18 g remain in solution

Supersaturated since 18 g > 15 g solubility limit

If disturbed, 3 grams immediately falls to the bottom.

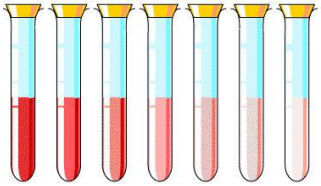
Saturated since 15 g is solubility limit

Supersaturation Examples

Carbonated beverages
gas (CO_2) in liquid (water)
Rock Candy
solid (sugar) in liquid (water)
Decompression Sickness (Bends)
gas (N_2) in liquid (tissues)
Reef Growth
solid ($CaCO_3$) in water
Cumulus Clouds
liquid (water) in gas

Relative (Qualitative) Solution Concentration Terms

Concentrated
Contains a relatively large amount of solute
Dilute
Contains a relatively small amount of solute



For Solution #1: 15.20 g $NaNO_3$ in 84.8 g water
For Solution #2: 3.29 g $NaNO_3$ in 96.7 g water

Solution #1 *more concentrated* than #2
Solution #1 *less dilute* than #2
Solution #2 *more dilute* than #1
Solution #2 *less concentrated* than #1

Solution Compatibility (Miscibility)

Miscible
Liquids that dissolve in each other in all proportions
Alcohol & water
Vinegar & water

Immiscible
Liquids that do not dissolve in each other
Separate into separate layers
Hydrocarbons & water

Assignment

Start Taking Unit 9 Practice Test

The Practice Quiz is very similar to the Unit Exam
Success on Unit exam is directly related to practice exam experience