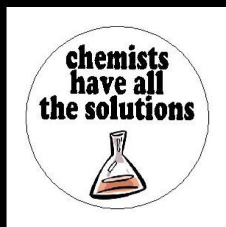
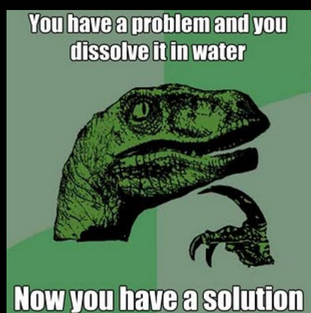
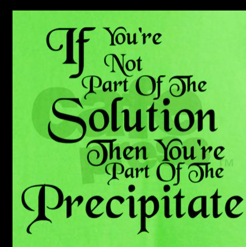


Solutions





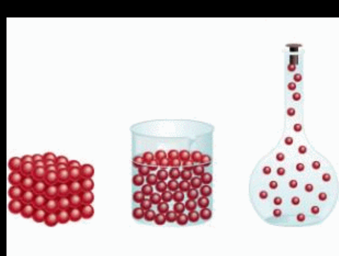
LPT

Solutions

Solution = homogeneous mixture
= uniform composition

Volume measurements convenient

Reactions typically faster in liquid state



Reactions occur when molecules collide
Liquids allow molecular movement

LPT

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

LPT

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"

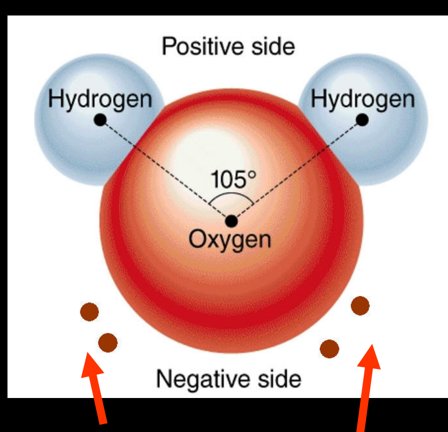
LPT

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

Water Molecule



Unshared Electrons

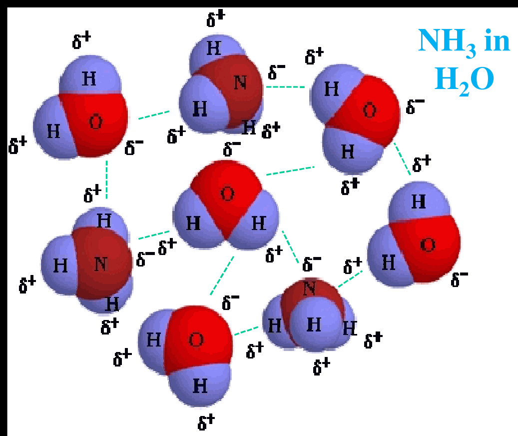
Static electricity bends water flow

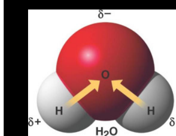
LPT

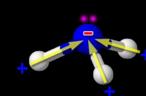
Water: Universal Solvent

Dipole = unequal distribution of charge (like a magnet)

Facilitates Dissolving Other Polar or Ionic Compounds







H_2O NH_3

Allows networks of attraction between dipoles

LPT

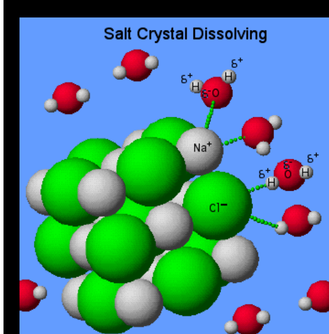
Dissolving Salts (Dissociation)

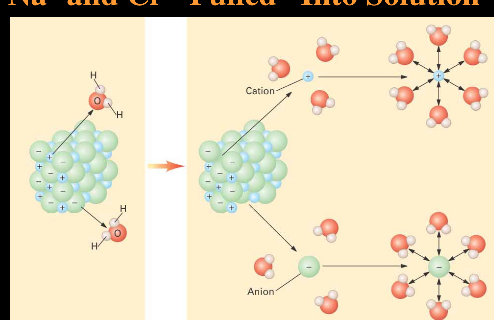
At the molecular level: Ions separated from solid surface

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

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

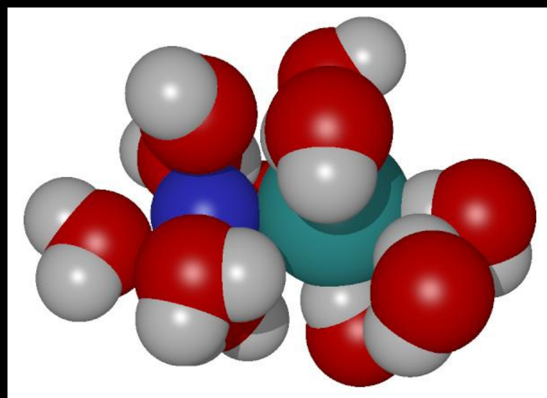
Na^+ and Cl^- "Pulled" Into Solution





LPT

Ions become "Hydrated"



Na = Blue
Cl = Cyan

H = White
O = Red

Ions do not change

Surroundings change

Physical Change

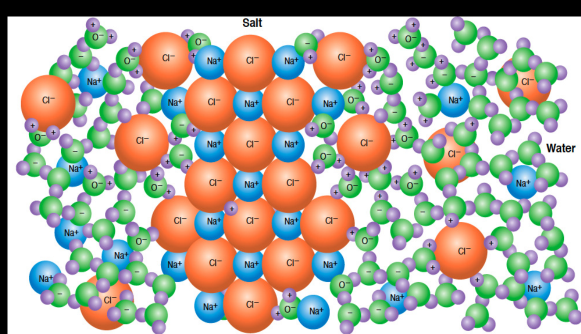
Individual ions surrounded by water molecules

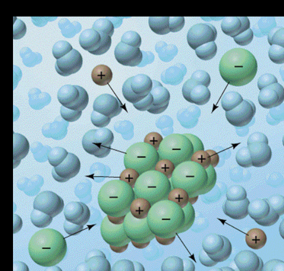
Equilibrium

In a saturated (maximum solute possible) solution:

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

forward rate = reverse rate
overall ion concentrations in solution remain constant





Solubility Terms

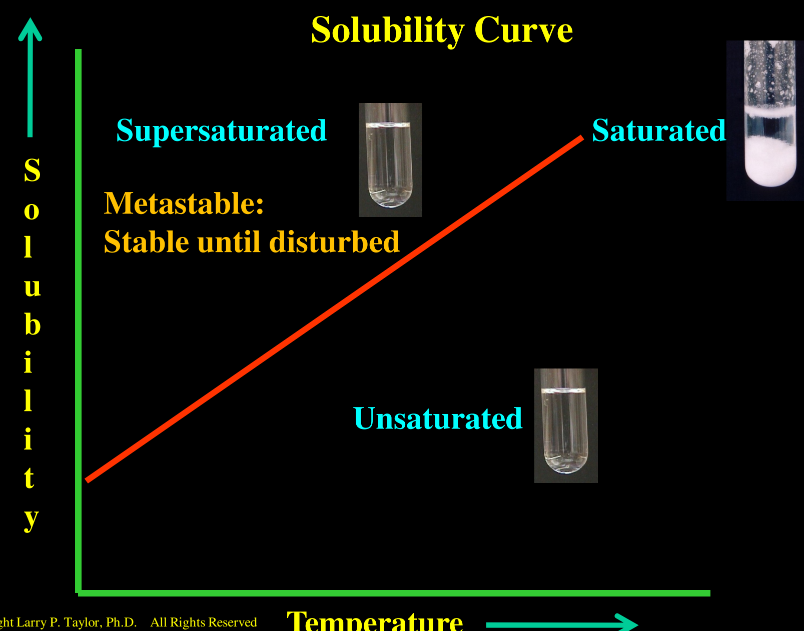
Saturated
solution contains the maximum amount of solute
A dynamic equilibrium exists

Unsaturated
solution contains less than the maximum amount of solute

Supersaturated
solution contains more than the maximum amount of solute
carefully prepared
unstable

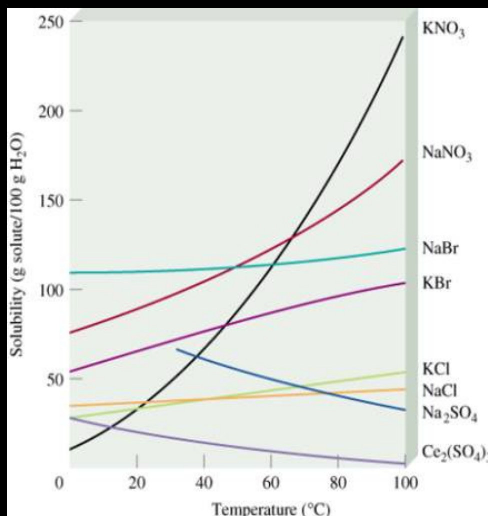
LPT

Solubility Curve



LPT

Solubility Curves



Plot of
Solubility vs. Temperature

For each compound (line):

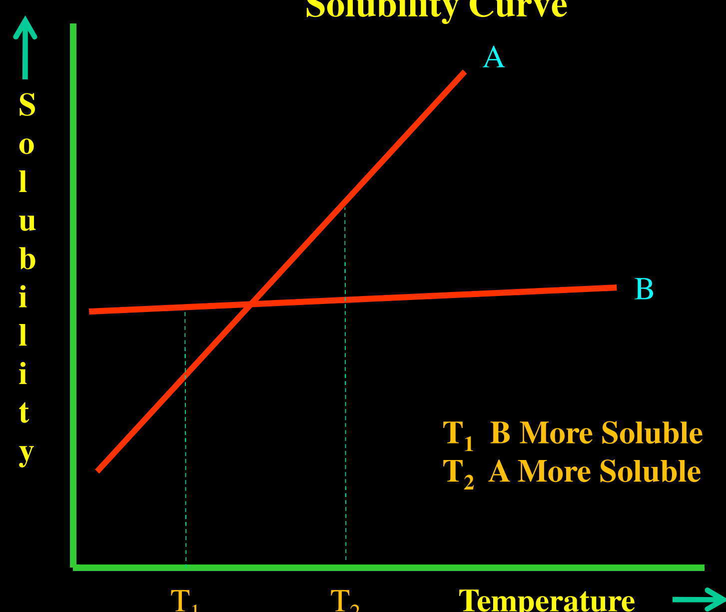
Saturated
On the solubility line

Unsaturated
Below the line

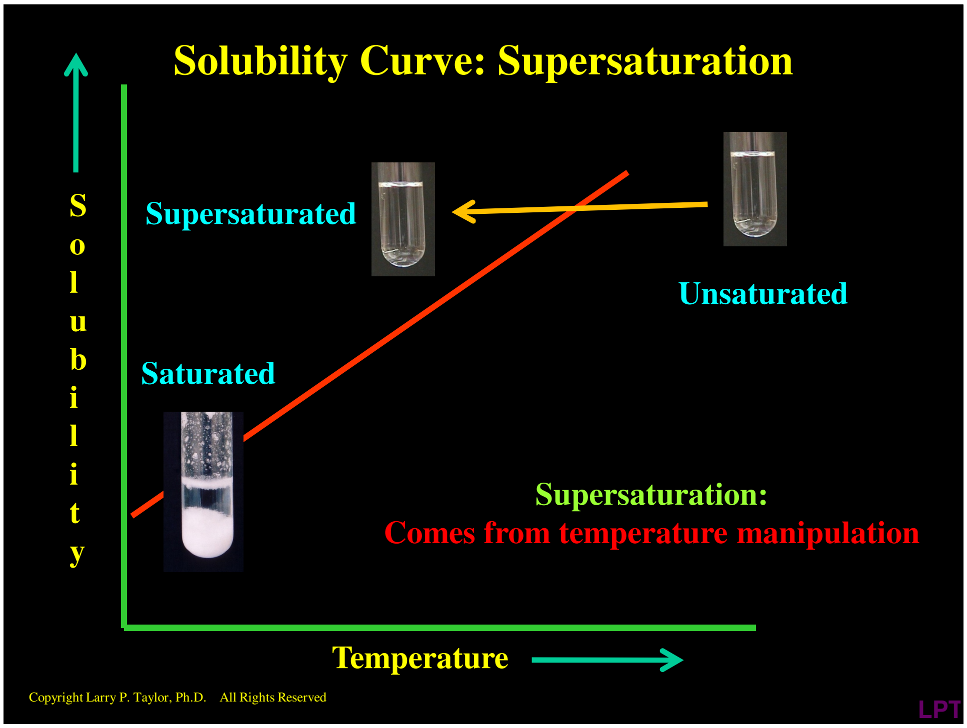
Supersaturated
Above the line

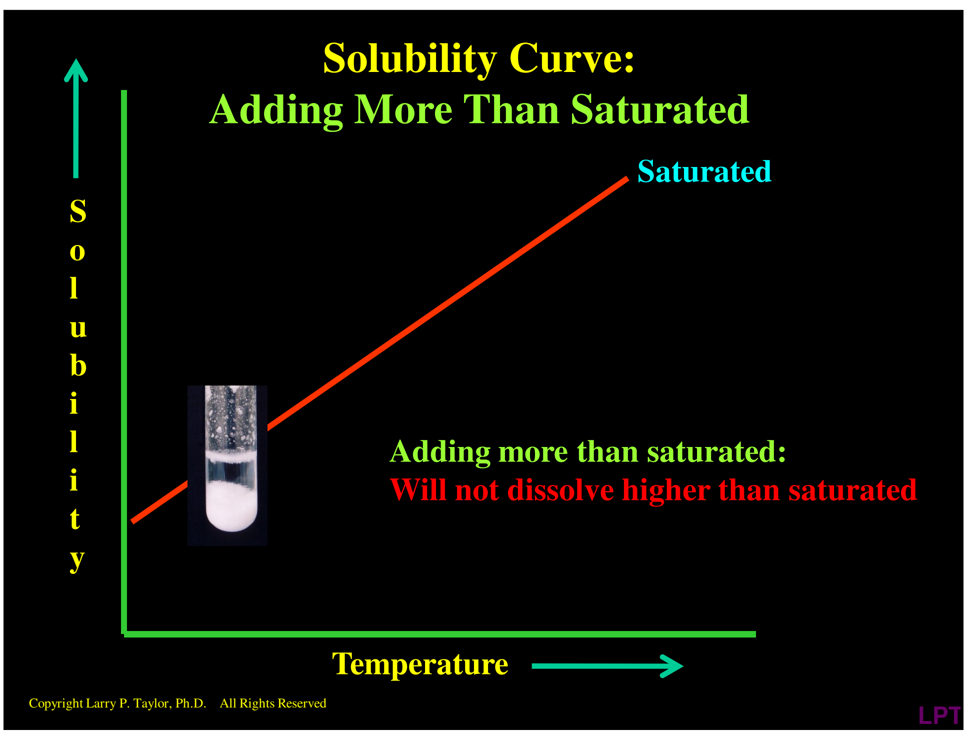
LPT

Solubility Curve



LPT


Solubility Curve: Supersaturation
Supersaturated
Unsaturated
Saturated
Solubility
Supersaturation:
Comes from temperature manipulation
Temperature
Copyright Larry P. Taylor, Ph.D. All Rights Reserved
LPT


Solubility Curve:
Adding More Than Saturated
Saturated
Solubility
Adding more than saturated:
Will not dissolve higher than saturated
Temperature
Copyright Larry P. Taylor, Ph.D. All Rights Reserved
LPT

Supersaturation

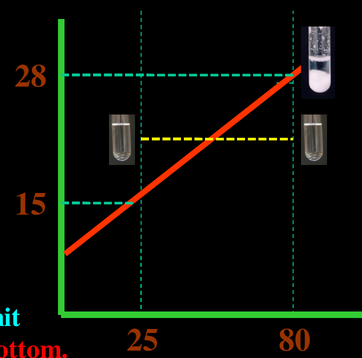
Solubility is a function of temperature

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

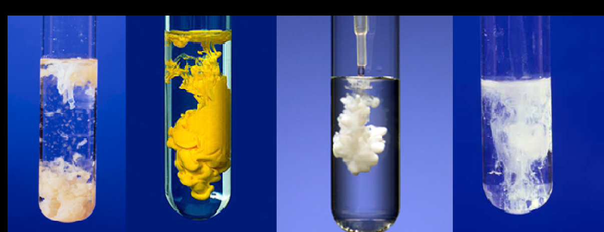
- Supersaturated since 18 g > 15 g solubility limit

If disturbed, 3 grams immediately falls to the bottom.

- Saturated since 15 g is solubility limit

LPT

State via Visualization



Solid visible: the liquid must be saturated

No solid visible: un or super saturated
Need "history" to determine

Super saturated only from special treatment

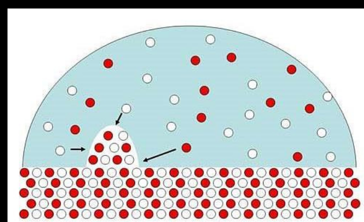
LPT

Saturated State: 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)



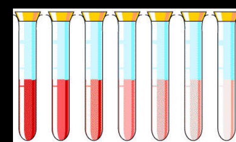
Dissolving: Going Into Solution
Crystallizing: Leaving Solution

Supersaturation Examples
"Metastable"
Must return to saturated state

- 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: 15.2 g $NaNO_3$ in 84.8 g water (15.2 %)
For Solution #2: 3.3 g $NaNO_3$ in 96.7 g water (3.3 %)

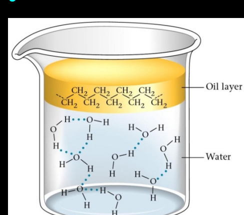
Solution #1 *more concentrated* than #2
Solution #1 *less dilute* than #2
Solution #2 *more dilute* than #1
Solution #2 *less concentrated* than #1

LPT

Solution Compatibility (Miscibility)

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

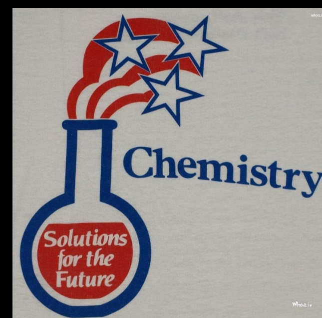
Immiscible
Liquids that do not dissolve in each other
Separate into separate layers
Hydrocarbons & water



LPT


CHEMIST
PARKING
ONLY
ALL OTHERS
WILL BE
DISSOLVED


OF COURSE I
DISSOLVED
THE COUNCIL
I AM THE
SOLUTION!
I THOUGHT THAT
WOULD PRECIPITATE
A BETTER RESPONSE.
SO MUCH PUN.COM


Chemistry
Solutions
for the
Future

LPT