

N33 - SOLUTIONS

Solubility Trends

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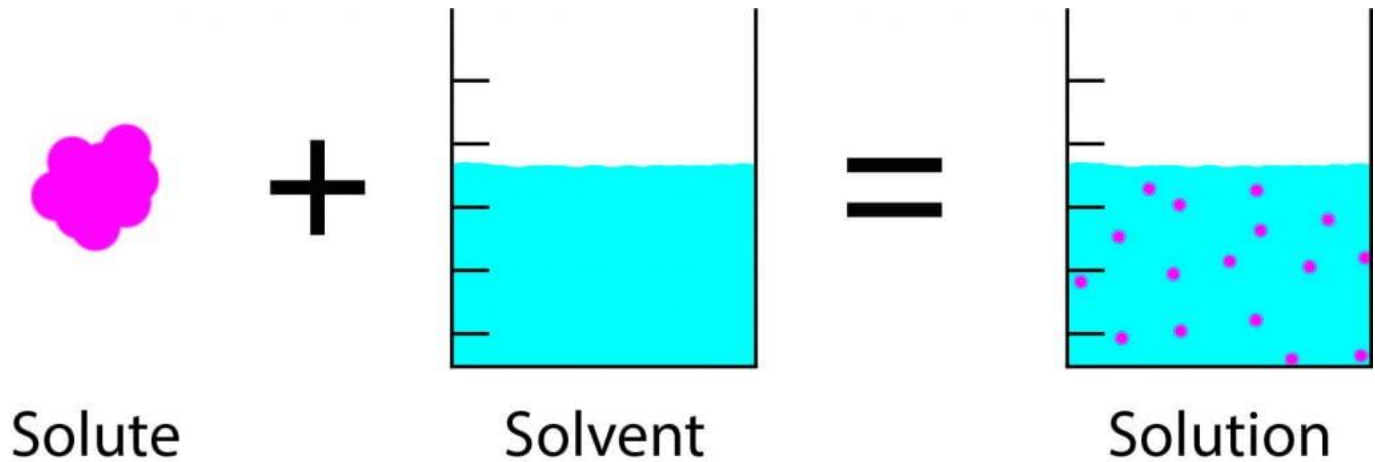
Solubility Trends

Target: I can determine if a substance is soluble, and can describe how the solubility changes based on the phase of the substance.

Solubility

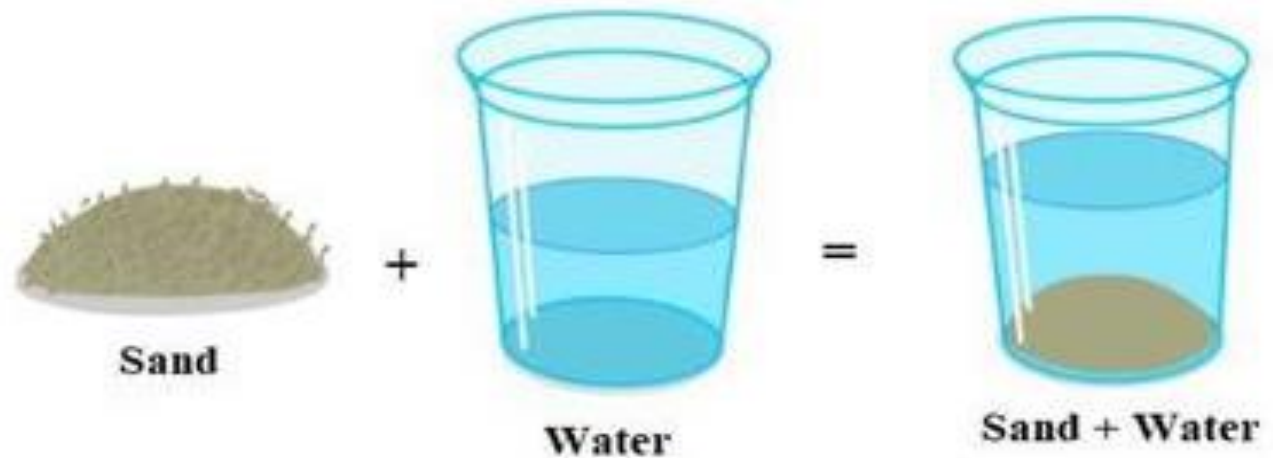
Soluble

Mixture AND solution



Insoluble

Mixture NOT solution



Miscibility

Sometimes when you mix a solute and a solvent together you end up with a saturated solution and you can't keep dissolving more solute.

Example: salt and water – at some point the extra salt will just sit on the bottom of the beaker.

When something is **miscible** it means that you can mix the two substances to form a homogeneous mixture no matter what the proportions are.

Example: it doesn't matter how much water and ethanol you mix together, they will always mix.

Dissolving vs. Dissociating



Dissolving

water molecules surround the particles and spread them apart from each other

Dissociating

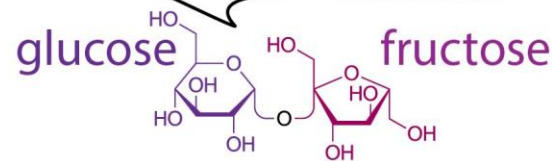
water breaks the ionic bond between particle and they split into individual ions

DISSOLUTION \neq DISSOCIATION

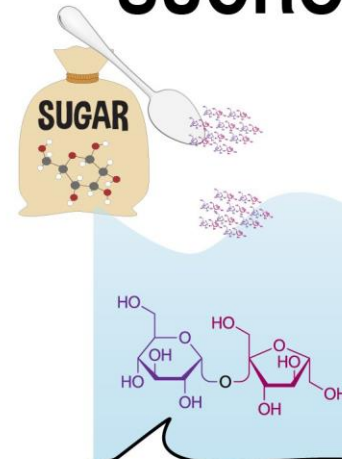
dissolution means getting solvated
(coated in water)

dissociation means breaking up
ionically-bound molecules into their
individual ions (charged particles)

I won't leave you sugar!
our covalent bond is strong!

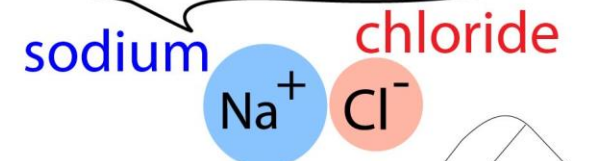


SUCROSE



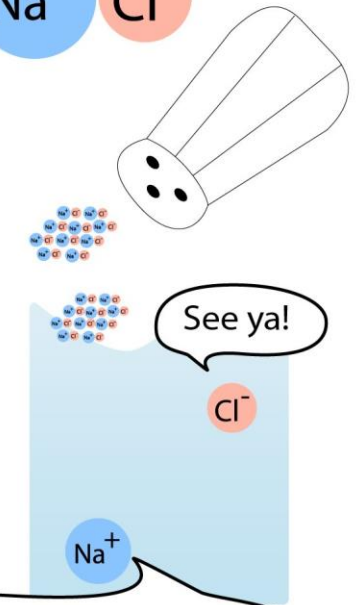
Water won't split us up!
I love you more!

I'm strongly attracted to you (your
charge is beautiful) but I'm still on the
lookout for something better



electrolytes dissolve
and dissociate

non-electrolytes
(might) dissolve but
they don't dissociate



Good thing we only ionically
bonded and didn't share
electrons!

Solubility Rules for Ionic Compounds

Solubility of Some Ionic Compounds in Water

Always Soluble

Alkali metals =	Li ⁺ , Na ⁺ , K ⁺ , Rb ⁺ , Cs ⁺
Ammonium =	NH ₄ ⁺
Acetate =	C ₂ H ₃ O ₂ ⁻
Chlorate =	ClO ₃ ⁻
Nitrate =	NO ₃ ⁻
Perchlorate =	ClO ₄ ⁻

Memorize the Always Soluble Ones!

These are the only ones you need to memorize. Others will be provided as needed.

AAA
CNP

Solubility of Some Ionic Compounds in Water

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Cl ⁻ , Br ⁻ , I ⁻	<i>Except when with:</i> Ag ⁺ , Pb ²⁺ , Hg ₂ ²⁺	AP-H
F ⁻	<i>Except when with:</i> Ca ²⁺ , Ba ²⁺ , Sr ²⁺ , Pb ²⁺ , Mg ²⁺	CBS-PM
Sulfate = SO ₄ ²⁻	<i>Except when with:</i> Ca ²⁺ , Ba ²⁺ , Sr ²⁺ , Pb ²⁺	CBS-P
Generally Insoluble		
O ²⁻ , OH ⁻	<i>Except when with:</i> Alkali metals and NH ₄ ⁺	AA
	<i>Somewhat soluble:</i> Ca ²⁺ , Ba ²⁺ , Sr ²⁺	CBS
CO ₃ ²⁻ , CO ₃ ²⁻ S ²⁻ , SO ₃ ²⁻ PO ₄ ³⁻ CrO ₄ ²⁻ , Cr ₂ O ₄ ²⁻	<i>Except when with:</i> Alkali metals and NH ₄ ⁺	AA

Insoluble = forms precipitate
Soluble = dissolves in water (aqueous)

Acronyms to help with memorizing the rules.

“Like Dissolves Like”

Don't just say that phrase as if it is an answer!

Things with similar IMFs will mix together.

- **Polar + Polar**
- **Nonpolar + Nonpolar**



Solubility Trends

Solids

- **Solubility of MOST solids increases with temperature.**
- **The rate at which solids dissolve increases with increasing surface area of the solid.**

Gases

- **Solubility decreases with temperature.**
- **Solubility increases with the pressure above the solution.**

Temperature Dependence of Solubility of Gases in Water

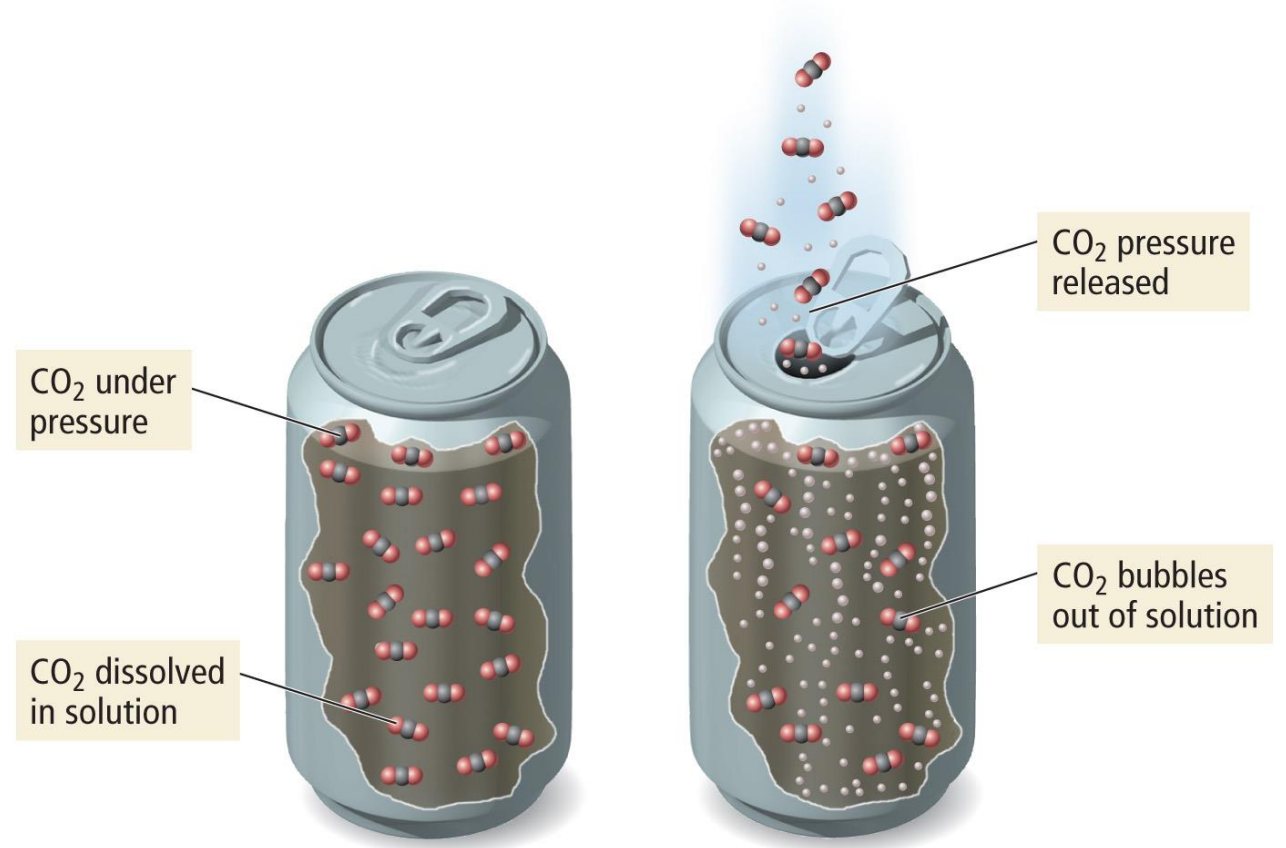


Cold soda pop

Warm soda pop

Pressure Dependence of Solubility of Gases in Water

The larger the partial pressure of a gas in contact with a liquid, the more soluble the gas is in the liquid.



Therefore...

Solids tend to dissolve best when:

- Heated
- Stirred
- Ground into small particles

Gases tend to dissolve best when:

- The solution is cold
- Pressure is high

Solubility Limit

Saturated - When the solute and solvent in dynamic equilibrium

- If you add more solute it will not dissolve.
- The saturation [] depends on the temperature and pressure of gases.

Unsaturated – When there is less solute than when saturated

- More solute will dissolve at this temperature.

Supersaturated – When there is more solute than when saturated

- Made by heating the solvent up, dissolving more solute than can be dissolved at the lower temperature, and then slowly cooling the solution down. Not a very stable situation, the extra solute will “crash out” if disturbed.

<http://www.youtube.com/watch?v=0wifFbGDv4I>

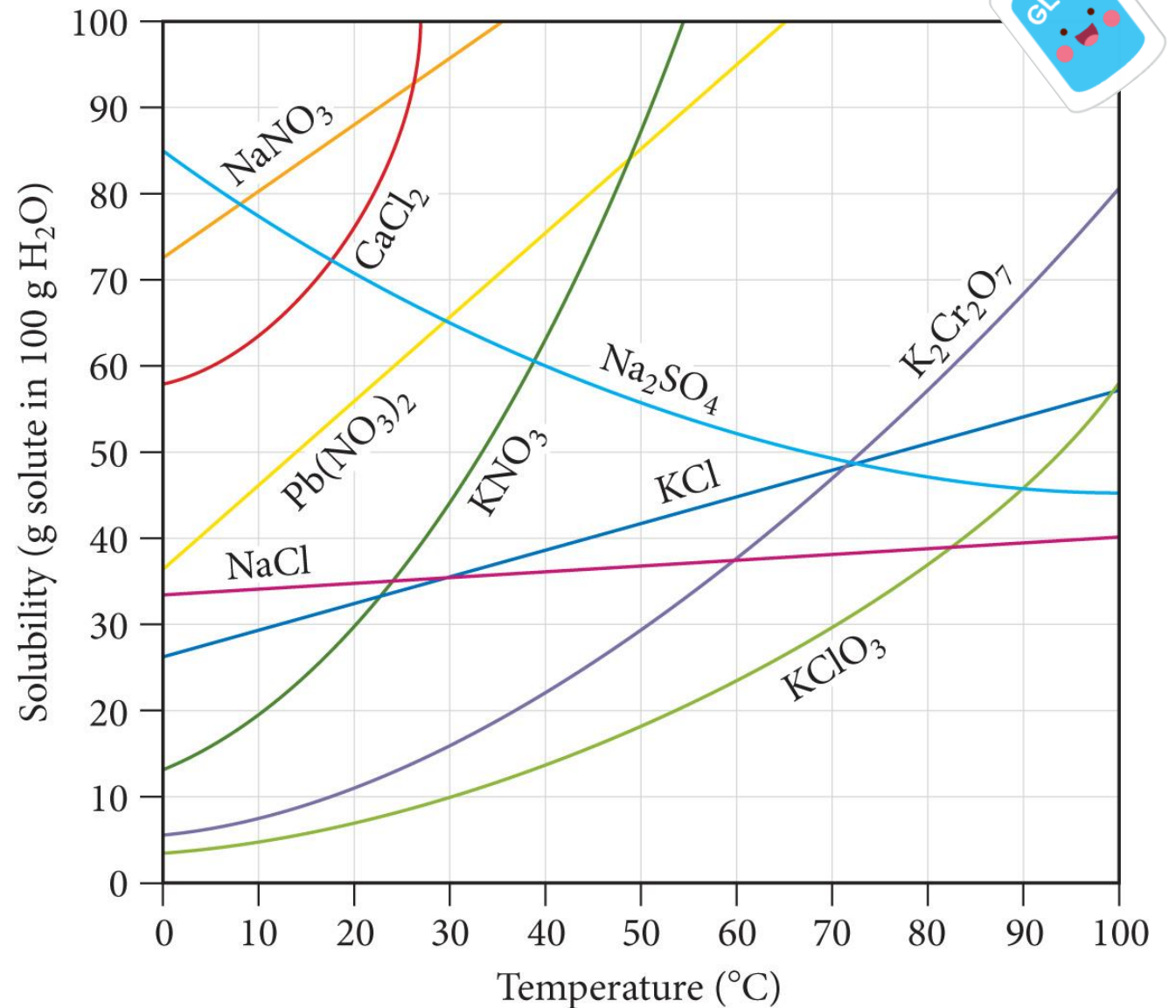
Solubility Curves

Can be used to predict solubility of a solute.

Saturated
On the line

Unsaturated
Below the line

Supersaturated
Above the line



Temperature Dependence of Solubility of Solids in Water

- **Units** - Solubility is often in grams of solute that will dissolve in 100 g of water. Be sure to check though!
- **For most solids, the solubility of the solid increases as the temperature increases.**
 - When $\Delta H_{\text{solution}}$ is **endothermic**
- **Sometimes, solubility decrease with increase in temp!**
 - When $\Delta H_{\text{solution}}$ is **exothermic**

Electrolytes vs. Non-electrolytes

Electrolyte

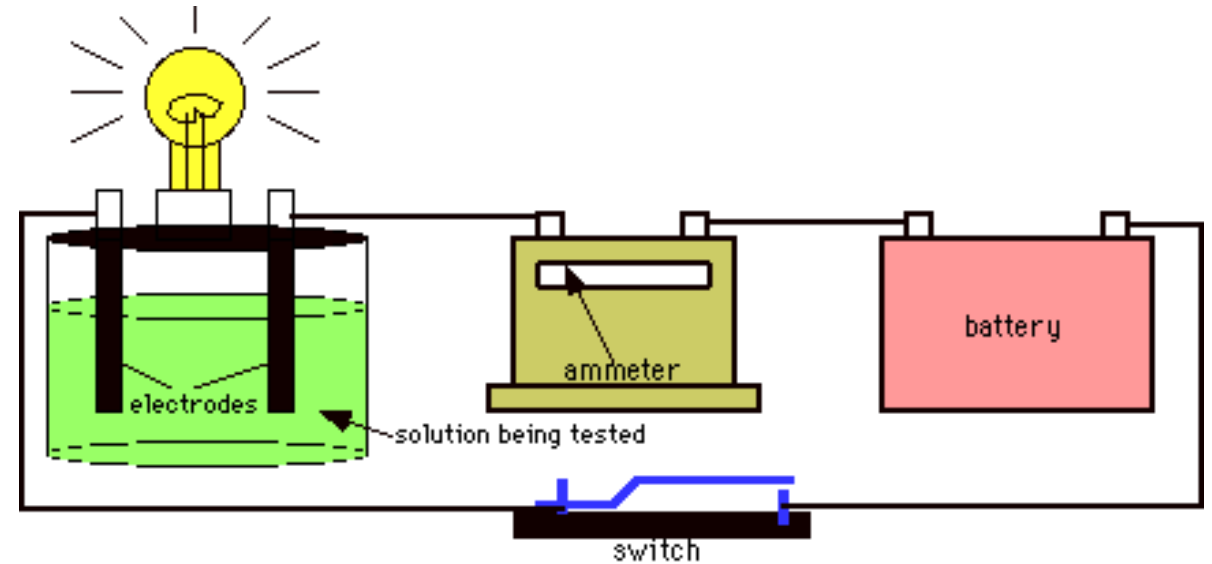
A substance whose aqueous solution conducts an electric current.

Nonelectrolyte

A substance whose aqueous solution does not conduct an electric current.

Electrolytes vs. Non-electrolytes

The **ammeter** measures the flow of electrons (current) through the circuit.



- If the ammeter measures a current, and the bulb glows, then the sol'n conducts.
- If the ammeter fails to measure a current, and the bulb does not glow, the solution is non-conducting.

Electrolytes or Non-electrolytes?

- 1) Pure water
- 2) Tap water
- 3) Sugar solution
- 4) Sodium chloride solution
- 5) Hydrochloric acid solution
- 6) Lactic acid solution
- 7) Ethyl alcohol solution
- 8) Pure sodium chloride

Answers

ELECTROLYTES:

- Tap water (weak)
- NaCl solution
- HCl solution
- Lactic acid solution (weak)

NONELECTROLYTES:

- Pure water
- Sugar solution
- Ethanol solution
- Pure NaCl (*unless molten!*)

YouTube Link to Presentation

OLD VERSION! Does not cover the intro part about solubility in general. I will update it when I can!

<https://youtu.be/S6VuAo-LIYw>