Solutions: Homogenous mixture consisting of a solute dissolved in a solvent

Solvents: the substance that does the dissolving
: in the case of a liquid dissolving another liquid, the one that is present in a greater quantity is usually considered the solvent

Like dissolves like:
Polar solvents dissolve polar and ionic solutes
Nonpolar solvents dissolve nonpolar solutes

Solutes: the substance that is being dissolved

Concentration: the amount of solute that is present w/respect to a certain amount of solvent or solution present

Note that these DO NOT all have the same denominator:

$$\text{Molarity} = M = \frac{\text{mol solute}}{L \text{ solution}}$$

$$\text{molality} = m = \frac{\text{mol solute}}{\text{Kg solvent}}$$

$$\text{parts per million} = \text{ppm} = \frac{\text{grams solute}}{\text{grams solution}} \times 10^6$$

Just a few suggestions:

- grams $\xrightarrow{\text{gfm}}$ mol $\xrightarrow{\text{volume}}$ M
- M $\xrightarrow{\text{volume}}$ mol $\xrightarrow{\text{gfm}}$ grams solute
- g solute $\xrightarrow{\text{gfm}}$ mol solute $\xrightarrow{\text{Kg solvent}}$ molality
- mol solute $\xrightarrow{\text{gfm}}$ g solute $\xrightarrow{\text{Kg solvent}}$ ppm

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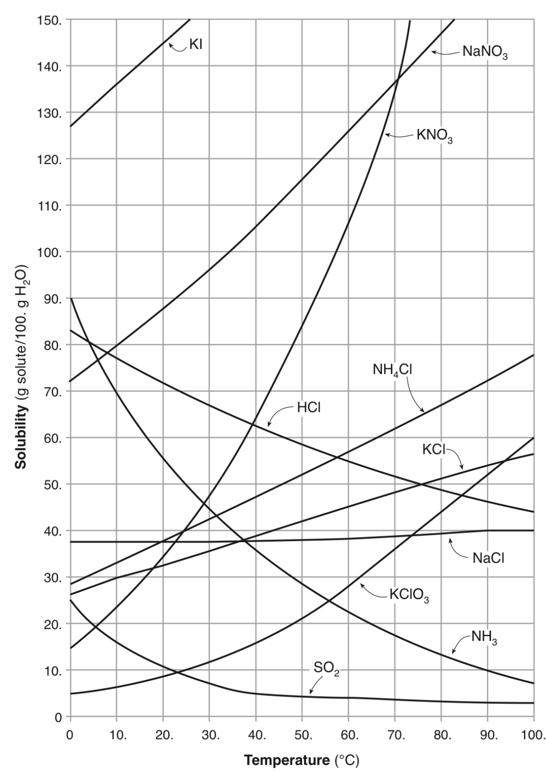
Saturated / Unsaturated / Supersaturated

* Given a certain amount of solvent @ a certain temperature & pressure can dissolve a specific amount of solute.
* See Table G

Table G
Solubility Curves at Standard Pressure



Determine if something is unsat/sat/supersat

* For 100g H_2O, determine where your sample is on the graph
* Compare that spot to the line for your substance @ the same temperature
* Below the line: more could be dissolved
  unsaturated
  On the line: the max is dissolved
  Saturated
  Above the line: more dissolved than is stable
  Supersaturated

How can you tell by looking/testing if it is unsat/sat/supersat?

1. Unsaturated
   everything is dissolved
   adding more increases concentration
   additional is dissolved
2. Saturated
   everything is NOT dissolved
   adding more does not change the concentration
   additional solute joins other solute that is not dissolved
3. Supersaturated
   an unstable solution
   adding more DECREASES the concentration of the solution

Review of Net Ionic Equations:

Only substances that change are included

Molecular Equation

$AgNO_{3}(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_{3}(aq)$

Complete ionic

$Ag^{+}(aq) + NO_3^{-}(aq) + Na^{+}(aq) + Cl^{-}(aq) \rightarrow AgCl(s) + Na^{+}(aq) + NO_3(aq)$

Net ionic

$Ag^{+}(aq) + Cl^{-}(aq) \rightarrow AgCl(s)$

Molecular Equation

$Na_2S(aq) + Fe(NO_3)_2(aq) \rightarrow 2NaNO_3(aq) + FeS(s)$

Complete ionic

$2Na^{+}(aq) + S^{-2}(aq) + Fe^{+2}(aq) + 2NO_3^{-}(aq) \rightarrow 2Na^{+}(aq) + 2NO_3^{-}(aq) + FeS(s)$

Net Ionic

$Fe^{+2}(aq) + S^{-2}(aq) \rightarrow FeS(s)$

Solubility: Know the rules

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ClO_4^{-}	perchlorate	$S_2O_3^{2-}$	thiosulfate

Table F
Solubility Guidelines for Aqueous Solutions

Ions That Form *Soluble* Compounds	Exceptions
Group 1 ions (Li^{+}, Na^{+}, etc.)	
ammonium (NH_4^{+})	
nitrate (NO_3^{-})	
acetate ($C_2H_3O_2^{-}$ or CH_3COO^{-})	
hydrogen carbonate (HCO_3^{-})	
chlorate (ClO_3^{-})	
halides (Cl^{-}, Br^{-}, I^{-})	when combined with Ag^{+}, Pb^{2+}, or Hg_2^{2+}
sulfates (SO_4^{2-})	when combined with Ag^{+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, or Pb^{2+}

Ions That Form *Insoluble* Compounds*	Exceptions
carbonate (CO_3^{2-})	when combined with Group 1 ions or ammonium (NH_4^{+})
chromate (CrO_4^{2-})	when combined with Group 1 ions, Ca^{2+}, Mg^{2+}, or ammonium (NH_4^{+})
phosphate (PO_4^{3-})	when combined with Group 1 ions or ammonium (NH_4^{+})
sulfide (S^{2-})	when combined with Group 1 ions or ammonium (NH_4^{+})
hydroxide (OH^{-})	when combined with Group 1 ions, Ca^{2+}, Ba^{2+}, Sr^{2+}, or ammonium (NH_4^{+})

*compounds having very low solubility in H_2O

Reference Tables for Physical Setting/Chemistry – 2011 Edition 2

Ksp = the Solubility Product

Given a salt A_aB_b the Ksp is written:

$$K_{sp} = [A]^a[B]^b$$

$$A_aB_b(s) \xrightarrow{H_2O} aA(aq) + bB(aq)$$

This means that the Ksp is equal to the product of the molar concentrations of the ions from the salt, each raised to the power of their respective quantity in the formula of the salt. The Ksp represents the maximum value for a saturated solution @ that temp.

Equations for dissolving salts in water

$NaCl(s) \xrightarrow{H_2O} Na^{+}(aq) + Cl^{-}(aq)$

$Mg(OH)_2(s) \xrightarrow{H_2O} Mg^{+2}(aq) + 2OH^{-}(aq)$

Solution Stoichiometry

Given mol or M/volume of reactants:

1) Determine LR
2) Determine quantity/concentration of product formed
3) In precipitation Rxns especially, but not exclusively, find % yield
4) Determine heat released/absorbed

Dilutions: we call it the dilution formula but it goes both ways - it works anytime the amount of water (or other solvent) changes.

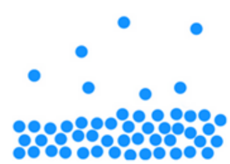
$$M_1V_1 = M_2V_2$$

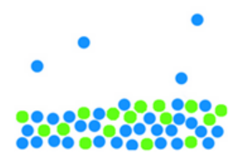
- M_1: Molarity @ start
- V_1: initial volume
- M_2: molarity after change
- V_2: volume after Δ

Why this works: $M \cdot V = mol$

If you just add/Remove solvent then the moles of solute is constant.

Raoult's Law:



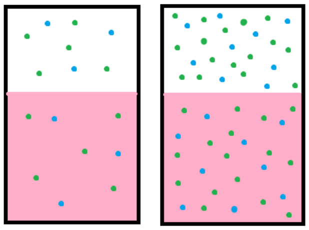


$$P_A = \chi_A \cdot P_A^{o}$$

- P_A: the Pressure you observe
- χ_A: the mole fraction of this liquid
- P_A^{o}: the standard Vap of A @ this temperature

$$\chi_A = \frac{mol\ A}{total\ mol}$$

Henry's Law



Henry's Law Practice Problems

This equation also describes Henry's Law:

$$\frac{S_1}{P_1} = \frac{S_2}{P_2}$$

'S' = solubility
'P' = pressure

Solubility (S) = $\frac{g}{L}$ or $\frac{mol}{L}$ or $\frac{mol}{kg}$ or etc.