Density in Gases & Liquids vs. Concentration in Solutions

Density = How much stuff in a particular amount of space

PURE SUBSTANCES

<u>(Call it Density)</u>

Gases: 2 ways to express

- Particle density
 - How many particles (moles) in 1L
- Mass density
 - Mass (grams) of particles in 1L

Liquids & solids: usually only <u>1 way to express</u>

- Mass density
 - Mass (g) of particles in 1L

MIXTURES (Call it Concentration)

Solutions: 4 ways to express

- 3 kinds of "particle density"
 - Molarity: how many moles of solute in 1L of solution (total volume of the mixture)
 - Molality: how many moles of solute in 1 kg of solvent
 - Mole fraction: fraction of moles of each substance in the total moles
- 1 kind of "mass density"
 - Weight percent: fraction of grams of one substance in the total number of grams of all substances

Concentration in solutions (liquids)

- Remember that "solution" is the term used to mean "mixture" that's in a liquid phase
- A solution contains:
 - Solvent: the principal component, often water ("aqueous")
 - Solute(s): the component (gas, liquid or solid) that is mixed into the solvent, whose concentration level is the cause for interesting properties
- Molarity
- Molality
- Mole fraction
- Weight percent

Concentration in solutions (liquids)

- 1. Molarity
 - How many moles of (each) solute in 1 L of solution (total mixture)
 - Easy way to express a concentration when you deliberately make a solution in the lab
 - Useful for stoichiometry calculations (e.g., titration)
- 2. Molality
 - How many moles of a solute in 1 kg of the solvent
 - Another easy way to express a concentration when you make a solution in the lab
 - Useful for colligative properties calculations (e.g., boiling point elevation)

Concentration in solutions (S, L & G)

- 3. Mole fraction
 - Fraction of moles of a substance in all the total moles
 - Expressed as a decimal between 0 and 1, total of all the mole fractions in a mixture sums to 1
 - Easiest to calculate from knowing masses of each component
 - Useful for partial pressure calculations (e.g., phase diagrams of mixtures of liquids and gases)
- 4. Weight percent
 - Fraction of mass of each substance in the whole mixture
 - Expressed as a percentage between 0 and 100%
 - Easiest to calculate from knowing masses of each component
 - Typically weight fractions are the goal of chemical analysis of unknowns