Concentration Units

Molarity: defined as moles of solute per liter of solution

$$M = \frac{\text{moles solute}}{\text{liters of solution}} = \frac{\text{mol}}{\text{L}}$$

The volume used in the denominator is the total volume of the solution, not just the volume of the solvent

However, the volume of the solute is often negligible compared to the solvent volume

Concentration Units

Molality: defined as moles of solute per mass of solvent

$$m = \frac{\text{moles solute}}{\text{kilograms of solvent}} = \frac{\text{mol}}{\text{kg}}$$

In this case, the mass is only the mass of the solvent, not the total mass of the solution

Concentration Units

Mole fraction: mole fraction is defined as the number of moles solute divided by the total number of moles of all species in the solution

$$X_A = \frac{\text{moles solute}}{\text{total moles in solution}} = \frac{n_A}{n_{tot}}$$

Mole fraction is a unitless number

Concentration Units

Parts-per-million (ppm) and parts-per billion (ppb)

For dilute aqueous solutions, we can make the assumption that the density of the solution is 1.00 g/mL

ppm and ppb express the *mass* of a specific solute relative to the *mass* of the solvent

Concentration Units

Parts-per-million (ppm) and parts-per billion (ppb)

ppm = μg solute/mL soln
= mg solute/L soln
(1.0 mL H_2O ≈ 1.0 g)

ppb = ng solute/mL soln
= μg solute/L soln

Concentration Units

Parts-per-million (ppm) and parts-per billion (ppb)

When referring to gaseous mixtures, we usually compare the number of solute particles in a specific volume (not the mass of solute particles)

ppmv = μmol solute/total mol in volume

ppbv = nmol solute/total mol in volume

Aqueous Solutions

- A solution is composed of two parts: the solute and the solvent.
  - The solute is the minor component of the solution.
  - The solvent is the major component of the solution and is the liquid into which the solute is added.
- Aqueous solutions are those in which water acts as the solvent.

Molarity

Determine concentration of a solution in which 6.081 g $NaNO_3$ is dissolved to a total volume of 843 mL.

1. Calculate moles of solute

   moles of $NaNO_3$

   6.081 g / 84.994 g mol^{-1} = 7.155×10^{-2} mol

Molarity

2. Calculate molarity of solution
   a. convert volume to L

      843 mL = 0.843 L

   b. calc M

   7.155×10^{-2} mol / 0.843 L = 8.49×10^{-2} M

Dilutions

- When diluting a solution by adding more solvent, the moles of solute in the container does not change (you do not add or take away the solute), only the amount of solvent changes.

  $C_1V_1 = C_2V_2$ (C = concentration, V = volume)

Dilutions

50.0 mL of .650 M NaCl solution is diluted to a total volume of 1000.0 mL of water. Determine concentration of final solution.

1. C_1V_1 = (0.650 M)(0.0500 L) = 0.0325 mol NaCl
2. final volume = V_2 = 1000.0 mL
3. $C_2V_2 = C_1V_1$ = 0.0325 mol NaCl

   $C_2 = C_1V_1 / V_2$ = 0.0325 mol / 1.0000 L

   = 3.25×10^{-2} M

Dilutions

You prepare a Cu stock solution with a concentration of 209.5 ppm. You need to now prepare a standard solution with a concentration of 7.5 ppm in a 25 mL volumetric flask. How do you prepare the standard?

C_1 = 209.5 ppm V_1 = ?

C_2 = 7.5 ppm V_2 = 25 mL

$$V_1 = \frac{C_2V_2}{C_1} = \frac{(7.5\,\text{ppm})(25\,\text{mL})}{(209.5\text{ppm})} = 0.895\,\text{mL}$$