Solution Calculations

# Solution Concentration

The concentration of a solution may be expressed as molarity (M), percent by volume, percent by mass, or parts per million (ppm).

Expressing concentration

Qualitative descriptions can be useful but solutions are more often described quantitatively (with numbers). The description used depends on the type of solution analyzed and the reason for describing it.

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| **TABLE T**  **Concentration description** | **Concentration Ratio** |
| Percent by mass | Mass of solute × 100  Mass of solution |
| Percent by volume | Volume of solute\_\_ × 100  Volume of solution |
| Molarity | Moles of solute\_\_  Liters of solution |
| Parts per million | Grams of solute\_\_ × 1,000,000  Grams of solution |

# Using percent to describe concentration

Percent by mass describes a solution in which a solid is dissolved in liquid. Mass of the solution is the sum of the masses of the solute and solvent.

Percent by volume describes a solution in which both solute and solvent are liquids. Volume of the solution is the sum of the volumes of the solute and solvent.

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| Practice – calculate the concentration using percent by mass or percent by volume | |
| 1) 25 g NaCl in a 100 g solution  2) 25 g NaCl in 100 g water | 3) 76 mL O2 in 140 mL solution  4) 225 mL O2 in 1 L solution |

# Molarity

Molarity (M) is the number of moles of solute dissolved per liter of solution. Molarity is also called molar concentration. A liter of solution with 1 mole of solute is a 1M solution, a liter of solution with 0.1 mole of solute is a 0.1M solution. ***You must convert to liters! 1 L = 1000 mL***.

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| Practice – calculate the following; you might have to convert mass to moles or vice versa | |
| Calculate molarity | Given molarity, find the following |
| 1) 2 mol NH3 in 5 L solution  2) 3 mol KNO3 in 8 L solution  3) 20 g NaOH in 2 L solution  4) 87 g NaCl in 0.5 L solution | 5) Moles in 4 L of 5 M solution  6) Volume of 2 M solution with 7 mol  7) Mass of 4 L of 0.5 M KOH solution  8) Mass of 3 L of 0.1 M CoCl2 solution |

# Preparing molar solutions

Diluting solutions – to make solutions less concentrated.

Moles of solute = molarity × liters of solution.

* TABLE T: **M1V1 = M2V2** where M1V1 = stock solution and M2V2 = diluted solution.

To prepare a molar solution, first measure out the mass needed to get the correct molarity then add water to the amount of liters needed.

Ex: To prepare 1L of a 1.5M aqueous solution of sucrose (C12H22O11) first you must realize that 1.5M means you have 1.5 moles of sucrose. Molar mass of sucrose is 342 g/mol so multiply by 1.5 to get 513 g. Measure out 513 grams then add water up to 1 liter.

# Parts per million

Parts per million describes very dilute concentrations of substances based on mass of the solute divided by the mass of the whole solution, multiplied by a million. It is often used when measuring levels of pollutants or contaminants.

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| Practice – calculate the following | |
| Find parts per million | Find mass of solute or solution |
| 1) 0.025 g Pb in 125 g sample  2) 3.5 mg As in 100 g sample  3) 0.06 g Cd in 180 g sample  4) 0.24 g O2 in 1680 g sample | 5) 250 g sample contains 8 ppm O2  6) 330 g sample contains 25 ppm Pb  7) Sample is 2.1 ppm with 0.0075 g Cd    8) Sample is 3.4 ppm with 0.0256 g As |