Solution Concentrations

Qualitative expressions: "Dilute and Concentrated"

Quantitative expressions: amount of solute in a given amount of solvent

Mass Percent ... mass of solute in a given mass of solution

$$\text{Mass \%} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$$

OR

$$\text{Mass \%} = \frac{\text{grams of solute}}{\text{grams of solute} + \text{grams of solvent}} \times 100$$

Examples:

(1) Calculate the mass percent of 5.00 g of calcium chloride in 95.0 g of water.

$$\text{Mass \%} = \frac{5.00g}{5.00g + 95.0g} \times 100 = 5.00\%$$

(2) A 135 g sample of seawater is evaporated to dryness, leaving 4.73 g of solid residue (the salts formerly dissolved in the seawater). Calculate the mass percent of solute present in the original seawater.

$$\text{Mass \%} = \frac{\text{grams of solute}}{\text{Total grams}} = \frac{4.73\,g}{135\,g} \times 100 = 3.50\,\%$$

(3) What mass of water must be added to 425 g of formaldehyde to prepare a 40.0% solution of formaldehyde? This solution, called "formalin" is used to preserve biological specimens.

x = water solvent 425 g = solute formaldehyde

$$\frac{425}{425 + x} \times 100 = 40.0\% \quad \rightarrow \quad 425 = .400(425 + x)$$

$$425 = 170. + .400x$$

$$255 = .400x$$

$$638\,g = x\ H_2O$$

$$\frac{425}{425 + x} = .400$$

Molarity … number of moles of solute per liter of solution

(Note: molar mass will be required if grams are needed!)

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{liters of solution}} = \frac{\text{moles}}{\text{liter}} = \mathbf{M}$$

Examples:

(1) Calculate the molarity of a solution prepared by dissolving 11.5 g of solid NaOH in enough water to make 1.50 L of solution.

$$\text{Molarity} = \frac{\text{moles}}{\text{liter}} \quad \text{so …}$$

23.0
16.0
1.0
40.0 g/mol

$$(11.5\text{ g})\left(\frac{1\text{ mole}}{40.0\text{g}}\right) = 0.288\text{ mole NaOH}$$

$$\text{Molarity} = 0.288\text{ moles} / 1.50\text{ L} = 0.192\text{ M solution}$$

$$\frac{11.5\text{g} \mid \text{mol} \mid}{\mid 40\text{g} \mid 1.50\text{L}}$$

(2) 24.3 g of NaCl dissolves in 2.45 L of water. What is the molarity of the resulting solution?

23.0
35.5
58.5 g/mol

$$\frac{24.3\text{g NaCl} \mid \text{mol} \mid}{\mid 58.5\text{g} \mid 2.45\text{L}} = .1695\ldots = .170\text{M}$$

(3) How many moles of NaCl are in 0.125 L of a 4.00 M salt solution?

Molarity X volume in liters = moles

$$\frac{4.00\ \frac{\text{mol NaCl}}{\text{L}} \mid .125\text{L}}{} = .500\text{ mol NaCl}$$

(4) How many grams of NaCl are in 0.125 L of a 4.00 M salt solution?

Molarity X volume in liters = moles

$$\frac{4.00\ \frac{\text{mol NaCl}}{\text{L}} \mid .125\text{L} \mid 58.5\text{g}}{\text{mol}} = 29.3\text{g NaCl}$$

(5) How many grams of NaCl are needed to make 250 mL of a 0.500 M salt solution?

$$\frac{.500\ \frac{\text{mol NaCl}}{\text{L}} \mid 250\text{mL} \mid 1\text{L} \mid 58.5\text{g}}{\text{L} \mid 1000\text{mL} \mid \text{mol}} = 7.3\text{g NaCl}$$